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REVIEW OF PARTICLE PROPERTIES

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Particle Data Group

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This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Rev. Mod. Phys. 52 (1980) No. 2, Part II]. Data are evaluated, listed, averaged, and summarized in tables. Numerous tables, figures, and formulae of interest to particle physicists are also included. A data booklet is available.

Table of Contents

I. Introduction, credits, consultants

This review is an updating through December 1981 of our previous review of particle properties [Particle Data Group (1980)]. As in previous editions we have attempted to make the text as complete and self-contained as possible.

As usual, the results of our compilation are presented in two sections, the Tables of Particle Properties and the Data Card Listings. The Tables summarize the properties of only those particles whose existence is in our judgment experimentally well founded and which have a high probability of standing the test of time. This is a conservative judgment, and surely some genuine resonances are omitted, awaiting confirmation (see section V below).

The Data Card Listings give up-to-date information, with references, on all reported particles, whether considered well established or not. The Listings also contain mini-reviews on questions of interest.

A history of the Particle Data Group, with a discussion of procedures and problems, has been given by Rosenfeld (1975), and a short survey of the history of some of the constants we compile may be found in Appendix III.

As in previous editions, we include a section of miscellaneous tables, figures, and formulae. These are aimed at the practicing high energy physics experimentalist. We welcome all suggestions and comments regarding topics for deletion or inclusion, etc. This year we have revised many of these items, but no new ones have been added.

A pocket-sized Particle Properties Data Booklet, containing the Tables and a reprint of the figures and formulae from the first part of the review, is available on request. For North and South America, Australia, and the Far East, write to Technical Information Department, Lawrence Berkeley Laboratory, Berkeley, CA 94720, USA. For all other areas, write to CERN Scientific Information Service, CH-1211 Geneva 23, Switzerland.

As usual, we wish to emphasize that we compile the experimental results of others. It is inappropriate to give us the credit for their countless hours of effort. We urge that references be given directly to the original data, and we provide complete references in the Data Card Listings for that purpose.

The responsibilities for the various sections can be broken down as follows:

(1) *Stable particles*: R. Frosch, T. Shimada, R.E. Shrock, T.G. Trippe, C.G. Wohl, and G.P. Yost.

(2) *Meson resonances*: M. Aguilar-Benitez, M.J. Losty, L. Montanet, F.C. Porter, M. Roos, and Ch. Walck.

(3) *Baryon resonances*: R.L. Crawford, G.P. Gopal, R.E. Hendrick, R.L. Kelly, M.J. Losty, L.D. Roper, and C.G. Wohl.

(4) *General, including text*: All authors.

Consultants: To overcome gaps in our coverage, both intellectual and geographical, we have solicited the help of consultants:

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The usefulness of this compilation depends in large part on the interaction between the users and the authors and consultants. We appreciate comments, criticisms, and suggestions for improvements of all stages of data retrieval, processing, evaluation, and presentation.

II. Selection of data

All particles are considered to fall into one of the three groups:

(1) Stable particles, defined to be those immune to decay via the strong interaction, including the photon, the leptons, the η, the D and F charmed mesons, the Λ_c charmed baryon, etc.

(2) Meson resonances, including the ψ, the χ, and the Υ particles.

(3) Baryon resonances.

These groups are maintained within the two main parts of the compilation:

(1) Tables of Particle Properties.

(2) Data Card Listings.

The Data Card Listings contain the original information (data, references, etc.), weighted averages, comments, and "mini-reviews". Immediately preceding the Data Card Listings is an illustrative key thereto. We attempt to give complete Data Card Listings up to our closing date (January 1, 1982) for all journals listed in the Illustrative Key. As a general rule, we do not include results from preprints or unpublished conference reports. Exceptions to this rule are made on a case-by-case basis.

Many of our encoded results, those set off in parentheses, are not used for averaging. The reasoning is then often given in a footnote below the data. If the reason is not given, it is one of the following:

The result was presented with no error stated.

The result comes from a preprint or conference report. It is our experience that such results (and particularly the errors) often change before final publication. Accordingly we keep these new results in parentheses until they are published (or explicitly verified to us by the authors).

It involves some assumptions that we do not wish to incorporate.

It is of poor quality, e.g. bad signal-to-noise ratio.

It is inconsistent with other results, e.g. because of different methods employed, rendering averaging meaningless.

It is not independent of other results, e.g. it is a result from one of several partial-wave analyses all using the same data, again rendering averaging meaningless.

Upper limits are not averaged (except in rare cases which are re-expressible as numbers with gaussian errors).

When the data for a particle have received special treatment or present special problems, this is noted in a mini-review in the Data Card Listings.

As time goes by, some early results lose all their weight in the averages. We may then remove them from the Listings without further comment. We usually do not remove the corresponding reference cards, however, so that our reference sections preserve the historical record. In this edition the meson section has undergone an extensive "house-cleaning". As a result it appears more readable (or so we hope). The earlier data may be found in the 1980 edition).

The Tables of Particle Properties contain "best" values obtained from the data in the Data Card Listings by various methods. The statistical procedures of section VII are used to combine independent data which have gaussian errors. Upper limits in the Tables usually represent the strongest limit available from a single experiment. The extent to which these methods are tempered by critical judgment is explained in the footnotes to the Tables. In general, however, the footnotes are less complete than is the collection of notes and minireviews in the Data Card Listings. The reader is thus encouraged to become familiar with the Data Card Listings and, ultimately, with the original references.

III. Nomenclature

A. Quantum numbers

The symbols $I^G(J^P)C_n$ represent:

I = isospin,
G = G parity,
J = spin (also s),
P = space parity,
C_n = charge-conjugation parity for the neutral member of the isospin multiplet.

We also use:

B = baryon number,

S = strangeness,
C = charm,
l = orbital angular momentum.

1. Mesons. The charge-conjugation operator **C** turns particle into antiparticle and has eigenvalues ±1 only for neutral states; so it is useful to define an operator **G** which has eigenvalues for charged states too. This is usually [‡1] defined by

$$\mathbf{G} = \mathbf{C}\exp(\mathrm{i}\pi I_y)\,. \qquad (1)$$

A neutral nonstrange, noncharmed state is an eigenstate of $\exp(\mathrm{i}\pi I_y)$ with eigenvalue $(-1)^I$. Then we can write the eigenvalue equation for the whole multiplet as

$$G = C_\mathrm{n}(-1)^I\,, \qquad (2)$$

where C_n (n for neutral) is the eigenvalue C would have if applied to the neutral member of the multiplet. Thus, for a π^0, **C** has the eigenvalue +1, and since $I = 1$, $G = -1$. For a charged pion, there are no eigenvalues corresponding to **C** and to the isospin rotation, but eqs. (1) and (2) still give $G = -1$.

Consider a meson as a bound state of fermion–antifermion, e.g. quark–antiquark $\bar{q}q$, with orbital angular momentum l, and with the two fermion spins coupling to give a spin s. Then one can show that the charge-conjugation eigenvalue [defined as in eq. (2)] is

$$C_\mathrm{n} = (-1)^{l+s}\,. \qquad (3)$$

Eqs. (2) and (3) combine to give

$$G = (-1)^{l+s+I}\,. \qquad (4)$$

The parity is

$$P = -(-1)^l\,. \qquad (5)$$

Eqs. (3) and (5) combine to give

$$C_\mathrm{n}P = -(-1)^s\,, \qquad (6)$$

so all singlets ($^1S_0$, $^1P_1$, ...) have $C_\mathrm{n}P = -1$, and all triplets ($^3S_1$, ...) have $C_\mathrm{n}P = +1$. For proofs of the above, see our 1969 text [Particle Data Group (1969)] and Appendix by C. Zemach.

If, instead of $\bar{q}q$, we consider the meson as a state of *boson–antiboson* (e.g. $A_2 \to \bar{K}K$), it turns out that some signs cancel, and eqs. (3) and (4) [not eq. (5)!] apply *unchanged*. Of course, the mesons are often spinless, so s is zero, but the equations are more general. Eqs. (3) and (4) can be considered as selection rules forbidding many decays.

We now use eqs. (3) and (4) to introduce the concept of "Abnormal-C_n" mesons, i.e. mesons that cannot be composed of $\bar{q}q$. For this, it is sufficient to consider the SU(3) subgroup of the full unitary group of flavors, containing the u, d, and s quarks in a {3} representation.

This triplet of quarks is of course defined to have isospin and hypercharge properties such that $\bar{q}q$ can combine (according to the SU(3) relations $\{3\} \otimes \{3\} = \{8\} \oplus \{1\}$) so as to form only octets and singlets. The non-observation of "exotic" mesons (i.e., mesons in larger SU(3) representations, or mesons requiring at least a $q\bar{q}q\bar{q}$ structure) is of course a direct consequence of the naive quark model. It is less obvious that even some *octets* are forbidden by the model, namely those with $(J^P)C_\mathrm{n} = (0^+)-, (1^-)+, (2^+)-, \ldots$. Such states are not observed, and this is an additional success of the naive quark model classification scheme.

When the naive quark model is extended to QCD, one expects gg gluonium mesons also. Since the gluon g is a flavor singlet, all gluonium states must be flavor singlets which can be expected to mix with nearby $\bar{q}q$ singlets. No gluonium states have been definitely established yet.

In what follows, do not confuse "Abnormal-C_n" with "Normal" or "Abnormal" J^P, both of which are allowed by the quark model. The series $J^P = 0^+, 1^-, 2^+, \ldots$ is called Normal because $P = (-1)^J$ as for normal spherical harmonics, and $J^P = 0^-, 1^+, \ldots$ is called Abnormal.

The top part of table 1 shows all the low angular momentum states that can be formed from $\bar{q}q$. Note that half of the J^P states can be formed by both a triplet and a singlet $\bar{q}q$ state, e.g. $^3P_1$, $^1P_1$, *or* $^3D_2$, $^1D_2$, in spectroscopic notation $[^{(2s+1)}l_J]$. Eq. (3) shows that $^3P_1$ and $^1P_1$ have opposite C_n, so the $\bar{q}q$ model allows both. But the states $^3P_0$ and $^3P_2$ have no ^1P counterparts. According to eq. (6) they have $C_\mathrm{n}P = +1$, and with the $\bar{q}q$ model there is no way to form a state with a J^P of $^3P_{0,2}$ (i.e. J^P = Normal) and

[‡1] Most texts define it as in eq. (1); see e.g. Gasiorowicz (1966); however, sometimes the rotation is taken about I_x. The difference between the two conventions is mentioned in a footnote in Källen (1964).

Table I
Orbital excitations of the $\bar{q}q$ system, and corresponding mesons. For the distinction between Abnormal J^P and Abnormal C_n, see text following eq. (6) in section III. Strange and charmed mesons share the same values of J^P as the $I = 0$ and 1 states shown, but are not eigenstates of G. The second column, which gathers together $(J^P)_N$ or $_A C_n P$, is a redundant intermediate step intended to make the table easier to read. The table repeats itself for each radial excitation.

	$\bar{q}q$ State $^{(2s+1)}\ell_J$: C_nP −	$\bar{q}q$ State $^{(2s+1)}\ell_J$: C_nP +	(J^P) C_nP Normal or abnormal	$I^G(J^P)C_n$	Examples of ground-state mesons: Non-strange, Non-charmed S = C = 0	Strange |S| = 1 (I = ½)	Charmed |C| = 1 (I = ½)	Strange, Charmed |S| = |C| = 1 (I = 0)
	NORMAL-C_n STATES THAT CAN COME FROM $\bar{q}q$ MODEL							
Parity −	$^1S_0$		$(0^-)_A-$	$0^+(0^-)+$ $1^-(0^-)+$	$\eta, \eta', \eta_c(2980)$? π	[illegible]	D(1870)	F(2030) ?
Parity −		$^3S_1$	$(1^-)_N+$	$0^-(1^-)-$ $1^+(1^-)-$	$\omega, \phi, J/\psi(3100)$ ρ	$K^*(892)$	$D^*(2010)$	$F^*(2140)$?
Parity +	$^1P_1$		$(1^+)_A-$	$0^-(1^+)-$ $1^+(1^+)-$	H B	Q_B (mix to give Q_1, Q_2)		
Parity +		$^3P_0$	$(0^+)_N+$	$0^+(0^+)+$ $1^-(0^+)+$	$\epsilon, S^*, \chi(3415)$ δ	κ		
Parity +		$^3P_1$	$(1^+)_A+$	$0^+(1^+)+$ $1^-(1^+)+$	$D, E, \chi(3510)$ A_1	Q_A (mix to give Q_1, Q_2)		
Parity +		$^3P_2$	$(2^+)_N+$	$0^+(2^+)+$ $1^-(2^+)+$	$f, f', \chi(3555)$ A_2	$K^*(1430)$		
Parity −	$^1D_2$		$(2^-)_A-$	$0^+(2^-)+$ $1^-(2^-)+$	 A_3			
Parity −		$^3D_1$	$(1^-)_N+$	same as $^3S_1$	$\psi(3770)$			
Parity −		$^3D_2$	$(2^-)_A+$	$0^-(2^-)-$ $1^+(2^-)-$	Regge recurrence of the Abnormal-C_n state $(J^P)C_n = (0^-)-$			
Parity −		$^3D_3$	$(3^-)_N+$	$0^-(3^-)-$ $1^+(3^-)-$	$\omega(1670)$ g	$K^*(1780)$		
Parity +	$^1F_3$		$(3^+)_A-$	$0^-(3^+)-$ $1^+(3^+)-$				
Parity +		$^3F_2$	$(2^+)_N+$	same as $^3P_2$				
Parity +		$^3F_3$	$(3^+)_A+$	$0^+(3^+)+$ $1^-(3^+)+$				
Parity +		$^3F_4$	$(4^+)_N+$	$0^+(4^+)+$ $1^-(4^+)+$	h			
	ABNORMAL-C_n STATES THAT CANNOT COME FROM $\bar{q}q$ MODEL							
	Abnormal C_n states Have no $\bar{q}q$ model		$(0^-)_A+$	$0^-(0^-)-$ $1^+(0^-)-$	All except $J^P = 0^-$ are J^P = normal, $C_nP = -1$			
			$(1^-)_N-$	$0^+(1^-)+$ $1^-(1^-)+$				
			$(0^+)_N-$	$0^-(0^+)-$ $1^+(0^+)-$				
			$(2^+)_N-$	$0^-(2^+)-$ $1^+(2^+)-$				
			$(3^-)_N-$	$0^+(3^-)+$ $1^-(3^-)+$				

with $C_n P = -1$. As mentioned, such octets have not been found. With the help of table 1 one can also see that the special state $^1S_0, C_n P = +1$, cannot be formed, so has Abnormal C_n.

When, in addition to the *l*-excitation, there are radial excitations of the $\bar{q}q$ system, table 1 repeats itself, and we need a radial quantum number *n* for each repetition (*n* = 1 for the ground state). Examples of first radial excitations, *n* = 2, are ρ′(1600), ψ(3685), and Υ(10020). Examples of further possible radial excitations can be found in the ψ and Υ families.

2. *General remarks.* Well-established quantum numbers are underlined in the Tables of Particle Properties (except for stable particles, where most of the quantum numbers are established). We have used what evidence is available (sometimes flimsy) to guess many of the remaining ones, and we have indicated with "?" ones (in the Baryon Table) for which there is almost no evidence.

As is customary, we define antiparticles as the result of operating with *CPT* on particles, so both share the same spins, masses, and mean lives. Whenever there is a particularly interesting test of *CPT* invariance we include it in the Stable Particles Table.

B. Particle names

If a *meson* has a well-accepted colloquial name, we use it. If not, we name it by a single symbol which specifies its J^P-"Normality", its isospin *I*, its strangeness *S* and charm *C*, and, for a non-strange, non-charmed meson, its *G* parity.

The name conventions for mesons are given in the first part of table 2.

For *some* pairs of *mesons* with supposedly identical quantum numbers, we also use primes; e.g. η, η′; f, f′; ρ, ρ′. Note that primes and subscripts do not carry any further specific meaning.

For *baryons* no attempt has been made to attach a subscript about *J* and *P*. The name conventions are given in the second part of table 2. For stable baryons of each *I* and *S* we use the symbol standing alone; for resonances, the mass is in parentheses [i.e. N(1680), Λ(1405), Σ(1775), etc.]. The J^P assignments are reported in the Baryon Table as $\frac{1}{2}+, \frac{3}{2}-, \frac{5}{2}+$, etc., and also by the symbols P_{11}, D_{13}, F_{15}, which refer to the πp or Kp partial-wave amplitude in which the resonant state occurs (the first subscript refers to the isospin state: 2 × *I* for N, Δ, and Ξ, and just *I* for Z, Λ, and Σ). When two or more baryons have identical quantum numbers we warn the reader by adding primes to the spectroscopic symbol as explained in footnote (a) of the Baryon Table.

Table 2
Particle name conventions.

Name	*I*	*S*	*C*	*G*
Mesons, J^P "Normal"				
ω, φ, ψ, Υ [a)]	0	0	0	−
ε	0	0	0	+
δ	1	0	0	−
ρ	1	0	0	+
K*, κ	1/2	±1	0	
D*	1/2	0	±1	
F*	0	±1	±1	
Mesons, J^P "Abnormal"				
η	0	0	0	+
π	1	0	0	−
K, Q	1/2	±1	0	
D	1/2	0	±1	
F	0	±1	±1	
Baryons				
N	1/2	0	0	
Δ	3/2	0	0	
Z_I	0, 1	+1	0	
Λ	0	−1	0	
Σ	1	−1	0	
Ξ	1/2	−2	0	
Ω	0	−3	0	
Λ_c	0	0	1	
Σ_c	1	0	1	

a) We use the symbol ω for those $I^G = 0^-$ mesons which are mainly $u\bar{u}$ and $d\bar{d}$ quark states; φ for those which are mainly $s\bar{s}$ quark states, ψ for mainly $c\bar{c}$ states, and Υ for mainly $b\bar{b}$ states.

IV. Conventions and parameters for strong interactions

A. Partial-wave amplitudes and resonance parameters

The vast majority of information concerning baryon resonances comes in the form of partial-wave analyses. In addition data concerning meson resonances (ππ, Kπ, πππ) are, with increasing frequency, being subjected to partial-wave analyses. We thus find it natural to introduce the resonance parameters which we compile in terms of a Breit–Wigner approximation for the partial-wave amplitude.

In general the elastic amplitude for a given angular momentum l may be written as

$$T_{11} = [\eta \exp(2i\delta) - 1]/2i\,, \tag{1}$$

where η is the absorption parameter ($0 \leqslant \eta \leqslant 1$) and δ is the phase shift. The subscripts 11 on T denote scattering from channel 1 to channel 1 (e.g. $\pi\pi \to \pi\pi$ or $\bar{K}K \to \bar{K}K$).

In fig. 1 we show an Argand plot of the elastic partial wave amplitude T_{11}. It illustrates geometrically how the real parameters η and δ are related to the real and imaginary parts of T_{11}. Many examples of such Argand plots may be found in the Baryon Data Card Listings.

Consider the so-called non-relativistic Breit–Wigner approximation for T_{11}:

$$T_{11} = \tfrac{1}{2}\Gamma_1/(M - E - \tfrac{1}{2}i\Gamma)\,, \tag{2}$$

where E is the c.m. energy or invariant mass, Γ_1 and Γ are the *elastic* and *total* widths, and M is the *resonance mass*. Eq. (2) is, of course, not the only possible description of a resonant amplitude; but it suffices to illustrate the properties of partial-wave amplitudes which we associate with resonance behavior in the absence of any background in the same partial wave (see, e.g., the πN D_{15} and F_{15} waves in the Baryon Data Card Listings). Usually the widths contain barrier-penetration factors which can vary rapidly with energy. Near threshold, $\Gamma_1(E)$ should start up as q^{2l+1}

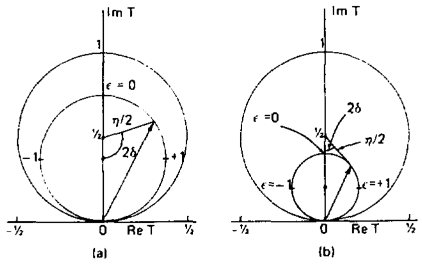

Fig. 1. Argand plots for the elastic partial wave amplitude T_{11}. The outer circles are the unitarity bound ($\eta = 1$). The inner circles correspond to the Breit–Wigner approximation of eq. (2) for (a) $x_1 = \Gamma_1/\Gamma = 0.75$ and (b) $x_1 = 0.4$. Note: $\epsilon = 2(M - E)/\Gamma$.

(also true for the inelastic width Γ_β). Various E dependences are then used for Γ_1, mostly of the form

$$\Gamma_1(E) \propto (qR)^{2l+1}/[\text{const} + \ldots + (qR)^{2l}]\,; \tag{3}$$

see Jackson (1964), Pišút and Roos (1968), and Barbaro-Galtieri (1968).

The BW approximation to the amplitude for an inelastic process leading from channel 1 to channel β ($\pi\pi \to \bar{K}K$ or $\bar{K}N \to \Sigma\pi$, for example) is

$$T_{1\beta} = \tfrac{1}{2}(\Gamma_1\Gamma_\beta)^{1/2}/(M - E - \tfrac{1}{2}i\Gamma)$$
$$= (x_1 x_\beta)^{1/2}[\tfrac{1}{2}\Gamma/(M - E - \tfrac{1}{2}i\Gamma)]\,, \tag{4}$$

where

$$\Gamma = \sum_1^N \Gamma_\beta\,, \quad x_\beta = \Gamma_\beta/\Gamma\,. \tag{5}$$

and x_1 (called the elasticity) is often written x_e. (Note that in the Data Card Listings we use the symbol P_β to denote x_β.) The channel cross section $\sigma_{1\beta}$ for the reaction $1 \to \beta$, for spin 0–spin 1/2 scattering, is

$$\sigma_{1\beta} = 4\pi\lambda\!\!\!^{-2}(J + \tfrac{1}{2})|T_{1\beta}|^2\,, \tag{6}$$

where $J = l \pm \frac{1}{2}$.

The important features of eq. (4) which characterize resonant behavior in the Argand diagram (Im $T_{1\beta}$ versus Re $T_{1\beta}$) are:

energy variation given by circles with diameter $(x_1 x_\beta)^{1/2}$ and maximum amplitude at $E = M$ of

$$T_{1\beta}^{\max} = i(x_1 x_\beta)^{1/2}\,; \tag{7}$$

a maximum in the speed near resonance, given approximately by

$$\text{“Speed” (res)} = |dT_{1\beta}/dE|_{E=M} = 2(x_1 x_\beta)^{1/2}/\Gamma(E), \tag{8}$$

for slowly varying $\Gamma(E)$. These features may be related to the η, δ representation of T_{11}. Thus when $E = M$, δ is either 90° ($x_1 > \frac{1}{2}$) or 0° ($x_1 < \frac{1}{2}$) and η dips to its minimum value.

These simple properties can be used to judge the presence or absence of resonance behavior in an Argand plot, but do not necessarily constitute the criteria we use (see section V). It must also be kept in mind that eqs. (2) and (4) are only approximations to the “true” amplitude. The simple picture given above can be distorted by various effects:

the presence of "background" in the same partial wave as the resonance,

two resonances in the same partial wave overlapping in energy,

the resonant energy M being close to an inelastic channel threshold, in which case a K-matrix-like parametrization is more appropriate,

the speed of the resonance being very slow so that the resonance is very broad, and the Breit–Wigner formula a bad approximation.

B. Sign conventions for resonance couplings

Consider the partial width Γ_β of a resonance decaying into the channel β. We can always define a coupling constant such that

$$\Gamma_\beta \propto G_\beta^2 \, .$$

In this case the inelastic amplitude in the Breit–Wigner approximation, eq. (4), will go as

$$T_{1\beta} \propto G_1 G_\beta/(M - E - \tfrac{1}{2}\mathrm{i}\Gamma) \, ,$$

where G_1 is the coupling constant for the elastic channel. In the context of exact SU(3) symmetry the relative signs of the product $G_1 G_\beta$ for different resonances are often useful as a consistency check on SU(3) assignment of baryon resonances. See Appendix I for further details.

In the Data Card Listings for baryon resonances, we tabulate measured values for $(x_1 x_\beta)^{1/2} \propto G_1 G_\beta$. When the sign of the amplitude is determined, it is given; absence of an explicit sign indicates that it is undetermined (*not* that it is positive). For Λ and Σ resonances, the signs are chosen according to the convention advocated by Levi-Setti (1969) and used in the table of SU(3) Isoscalar Factors presented in this review. Thus the signs multiplying the Breit–Wigner amplitudes for $\bar{K}N \to \Sigma(1385) \to \Sigma\pi$, $\Lambda\pi$ and $\bar{K}N \to \Lambda(1405) \to \Sigma\pi$ are simply the product of the phases of the appropriate isoscalar factors. This convention is shown in fig. 2, adapted from Levi-Setti (1969).

C. Types of partial-wave analyses

Partial-wave analyses (PWA) are classified into three categories in the Data Card Listings: energy-independent partial-wave analyses (IPWA), energy-dependent partial-wave analyses (DPWA), and model-dependent partial-wave analyses (MPWA), in increasing order of the number of explicit supplementary hypotheses that are used to extract the amplitudes from experimental data.

SU(3) RELATIVE SIGN OF RESONANT AMPLITUDES

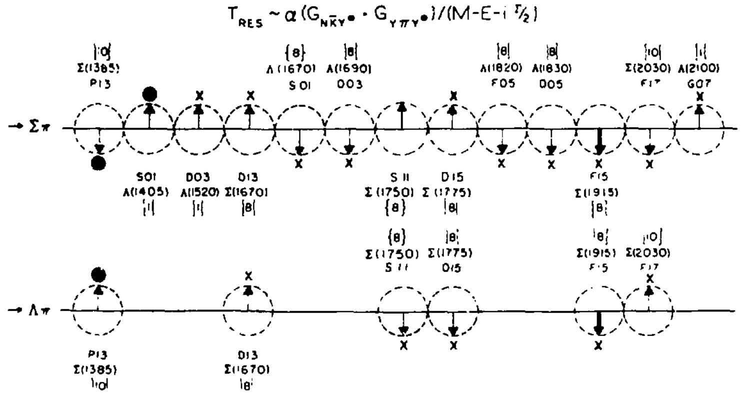

Fig. 2. Plot adapted from Levi-Setti (1969) showing the sign convention adopted here for the $\Sigma\pi$ and $\Lambda\pi$ amplitudes. Once the signs of one $I = 0$ and one $I = 1$ amplitude are fixed, the others can be measured relative to these two. Arrows here indicate signs predicted by SU(3); x marks indicate the observed phases; • indicates phase chosen according to sign convention described in text. The $\Sigma(1915)$ predictions have been changed from Levi-Setti's original figure.

In an IPWA, data at different energies are analyzed separately. Usually each partial wave included in the fit is allowed to vary freely (subject to unitarity constraints) over some large region, and waves whose angular momenta are above some cutoff value are assumed to be negligible. The sharp cutoff in angular momentum resolves continuum ambiguities in the solution (such as the overall phase ambiguity), but there remains a finite number of indistinguishable "best" solutions (i.e., solutions corresponding to identical physical observables) which have been codified by Barrelet (1972). In addition, there are generally some nearby solutions (and their associated Barrelet ambiguities) which have chi-squared values close to the minimum one.

At the end of the analysis a choice is made among these many solutions, usually on the basis of energy continuity. A popular criterion for making this choice is the shortest path technique in which the total "length" of the preferred solution is chosen to be a minimum. The definition of "length" used here is not universal but is usually closely related to the total geometrical length of the lines representing the various partial-wave amplitudes in Argand plots (see the baryon section of the Data Card Listings for examples of Argand plots). Various other criteria which are also used in some analyses are, e.g., matching with known solutions at low energies, the presence of known resonances in the final results, and limited inelasticity in high partial waves.

In a DPWA, data at different energies are fit simultaneously by using an energy-dependent parametrization of the partial-wave amplitudes. The parametrization is usually chosen to include both resonances and nonresonant background of some sort and an attempt is made to keep it as "model independent" as possible. Often the data are grouped into several energy bins which are fit separately rather than trying to fit the whole energy range under consideration simultaneously. One of the main advantages of DPWA over IPWA is that sparse data spread over many different energies can be analyzed, e.g., nearly all $S = -1$ analyses are DPWA. In addition, the built-in energy continuity helps to resolve the ambiguities that plague IPWA and eases the problems associated with resonance parameter extraction. The price one pays for these advantages lies in the danger of systematic error in the amplitudes and poor fits to the data if the parametrization is poorly chosen or insufficiently flexible.

An MPWA also uses an energy-dependent parametrization, but one based on explicit model-dependent theoretical assumptions such as Regge exchanges. This technique is usually applied to reactions where the data are incomplete. There is, of course, no sharp distinction between DPWA and MPWA, and a well chosen MPWA parametrization may actually be less biased than a model-independent but poorly chosen DPWA parametrization.

D. Production of resonances

Hereby, we mean the observation of statistically significant peaks in invariant mass plots or, loosely, in integrated cross sections. Many meson resonances are of this type. We expect most of these peaks to be associated with Breit–Wigner behavior in appropriate Argand plots; thus the ρ meson peak in $\pi\pi$ mass plots is firmly related to the $I = 1$, $l = 1$ $\pi\pi$ phase shift passing through 90°. The shape of the ρ meson is reasonably well described by the relativistic Breit–Wigner formula with the three parameters M, $\Gamma(M)$, and R of eq. (3).

From mass plots we can determine M, Γ, and the approximate branching ratios

$$x_\alpha / x_\beta = \Gamma_\alpha / \Gamma_\beta \, . \qquad (9)$$

In the case of total cross sections, the peak above background gives us, using the optical theorem, the product $(J+\frac{1}{2})x_e$:

$$\sigma^{\rm tot}(E = M) = 4\pi\lambda\!\!\!^{-2}(J+\tfrac{1}{2})x_e \, . \qquad (10)$$

V. Criteria for resonances

An experimentalist who sees indications of a resonance in some energy (or mass) region will of course want to know what has been seen in that region in the past; hence, we strive to have the Data Card Listings serve as an archive for all substantial claims for resonances. (However, we do not intend to preserve a perennial record of claims proved to be wrong. Some such claims have been removed from the Meson Listings in 198?. We refer the interested reader to our 1980 edition for our complete archives.)

For the Tables of Particle Properties, on the other hand, we wish to be more conservative than for the

Listings and to include only those peaks or resonances which we feel have a large chance of survival. An arrow (→) at the left of the Tables of Particle Properties indicates that a questionable candidate has been omitted from the Table, but that it can be found in the corresponding part of the Data Card Listings. One's betting odds for survival are of course subjective; therefore no precise criteria can be defined. Very slow speeds (ϵ and κ) make it quite difficult to decide what is a resonance and what is not. For more detailed discussions, see the mini-reviews in the Listings. In what follows we shall attempt to specify some guidelines.

(a) When energy-independent partial-wave analyses are available (mostly for N^*'s), approximate Breit–Wigner behavior of the amplitude appears to us to be the most satisfactory test for a resonance. We can check that the Argand plot follows roughly a left-hand circle, and that the "speed" of the amplitude also shows a maximum near the resonance energy; further, there should be data well above the resonance, showing that the speed again decreases. Indeed proper behavior of the partial-wave amplitude could accredit a resonance even if its elasticity is too small to make a noticeable peak in the cross section.

Of course even if Argand plots are available, it may still be a matter of opinion as to what behavior constitutes a resonance. Such an example is the $Z_0(1780)$ state seen in KN total cross-section experiments and in partial-wave analysis. The partial-wave analyses of Giacomelli (1974) and Martin (1975) find preferred solutions which exhibit a resonance-like loop in the P_{01} wave near 1740 MeV. However, Giacomelli et al. and Martin point out that, despite the resonantlike *appearance* of the loop, the evidence for resonant *energy dependence* is inconclusive. Thus we omit the $Z_0(1780)$ from the Baryon Table. A similar quandary has existed for some time concerning the $Z_1(1900)$, and it too has been omitted from the Tables.

(b) When there are insufficient data to perform energy-independent analyses, one often resorts to energy-dependent partial-wave analyses (mostly for Y^*'s). In this case Breit–Wigner behavior is an input. We therefore require that resonance solutions be found by several different analyses, preferably in different channels ($\bar{K}N \to \bar{K}N, \pi\Sigma$, etc.), before putting the claim in the table.

(c) Partial-wave analyses of three-body final states ($\pi N \to \pi\pi N$) are now available. While these analyses are based on the isobar model ($\pi N \to \rho N, \pi\Delta$, etc.) and are subject to theoretical objections of varying importance, they provide increasingly reliable information on inelastic decay modes of otherwise established resonances.

(d) Most mesons, Ξ^* peaks, and high-mass N^* and Y^* peaks fall into a category for which no partial-wave analyses exist. In general we accept such peaks if they are experimentally reliable, of high statistical significance or observed in several different production processes.

Thus, we enter into the Tables of Particle Properties only states for which there is experimentally convincing evidence, and we expect that most of these will be confirmed as resonances.

VI. Conventions and parameters for weak and electromagnetic decays

A. Muon-decay parameters

The μ-decay parameters describe the momentum spectrum (ρ and η), the asymmetry (ξ and δ), and the helicity (h) of the electron in the process $\mu^- \to e^- + \nu_\mu + \bar{\nu}_e$. Assuming a local and lepton-conserving interaction, the matrix element in the charge-retention form may be written as

$$\sum_i \langle \bar{e}|\Gamma_i|\mu\rangle\langle\bar{\nu}_\mu|\Gamma_i(C_i + C_i'\gamma_5)|\nu_e\rangle ,$$

where the summation is taken over i = S, V, T, A, P. Using the definitions and sign conventions of Sachs and Sirlin (1975) and Scheck (1978) for the Lorentz-covariant operators, we have for the momentum parameters:

$$\rho = (3g_A^2 + 3g_V^2 + 6g_T^2)/D ,$$

$$\eta = (g_S^2 - g_P^2 + 2g_A^2 - 2g_V^2)/D ;$$

for the asymmetry parameters:

$$\xi = \frac{-6g_S g_P \cos\phi_{SP} - 8g_A g_V \cos\phi_{AV} + 14g_T^2 \cos\phi_{TT}}{D} ,$$

$$\delta = (-6g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT})/D\xi ;$$

and for the parameter describing the helicity of the electron:

$$h = \frac{2g_S g_P \cos\phi_{SP} + 8g_A g_V \cos\phi_{AV} + 6g_T^2 \cos\phi_{TT}}{D}$$

Here

$$D = g_S^2 + g_P^2 + 4g_V^2 + 6g_T^2 + 4g_A^2 ,$$

$$g_i^2 = |C_i|^2 + |C_i'|^2 ,$$

and

$$\cos\phi_{ij} = \mathrm{Re}(C_i^* C_j' + C_i' C_j^*)/g_i g_j .$$

The quantities g_i are defined to be real non-negative numbers, and the ϕ_{ij} are phase angles between the i-type and j-type interactions. Under the assumption of two-component neutrinos $C_V' = -C_V$ and $C_A' = -C_A$, the S, P, and T terms vanish, and ϕ_{AV} is the phase angle between C_A and C_V in the complex plane.

By using the above equations and the experimental determinations of ρ, η, ξ, δ, and h, limits can be placed on g_S/g_V, g_A/g_V, g_T/g_V, g_P/g_V, and ϕ_{AV}. The results, given in the Data Card Listings, assume neither two-component neutrinos nor time-reversal invariance. If, however, two-component neutrinos are assumed, then $\sin\phi_{AV}$ is the amplitude of time-reversal violation. Note that most experiments study only the upper end of the spectrum where ρ and η are highly correlated, so they can only report ρ for $\eta \equiv 0$ and η for $\rho = \frac{3}{4}$. The values for ρ and η we use here were obtained by combining measurements of both upper and lower ends of the spectrum and turn out to be *nearly uncorrelated*.

Note also that the radiative corrections are unambiguous only when $g_S = g_T = g_P = 0$. The same limits on g_A/g_V and ϕ_{AV} are obtained, however, as when g_S, g_T, and g_P are left free.

Current values for the asymmetry parameters as well as $|g_A/g_V|$ and ϕ_{AV} are given in the Addendum to the Stable Particle Table. In addition, upper limits on $|g_S/g_V|$, $|g_T/g_V|$ and $|g_P/g_V|$ are given in the μ section of the Stable Particle Data Card Listings.

B. K-decay parameters

1. Dalitz plot for $K \to 3\pi$ decays. The Dalitz plot distribution for the τ mode ($K^\pm \to \pi^\pm\pi^\pm\pi^\mp$), the τ' mode ($K^\pm \to \pi^0\pi^0\pi^\pm$), and the τ^0 mode ($K_L^0 \to \pi^+\pi^-\pi^0$) of K decay can be parametrized by a series expansion such as that introduced by Weinberg (1960). We use the form

$$|M|^2 \propto 1 + g\frac{s_3 - s_0}{m_{\pi^+}^2} + h\left(\frac{s_3 - s_0}{m_{\pi^+}^2}\right)^2 + j\frac{s_2 - s_1}{m_{\pi^+}^2} + k\left(\frac{s_2 - s_1}{m_{\pi^+}^2}\right)^2 + \dots , \quad (1)$$

where $m_{\pi^+}^2$ has been introduced so as to make the coefficients g, h, j, and k dimensionless, and

$$s_i = (P_K - P_i)^2 = (m_K - m_i)^2 - 2m_K T_i , \quad i = 1, 2, 3,$$

$$s_0 = \tfrac{1}{3}\sum_i s_i = \tfrac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2) .$$

Here the P_i are four-vectors, m_i and T_i are the mass and kinetic energy of the ith pion, and the index 3 is used for the odd pion.

The coefficient g is a measure of the slope in the variable s_3 (or T_3) of the Dalitz plot, while h and k measure the quadratic dependence on s_3 and $(s_2 - s_1)$, respectively. The coefficient j is related to the asymmetry of the plot and must be zero if CP invariance holds (C stands for charge conjugation throughout the discussion in this section). Note also that if CP is good, g must be the same for τ^+ and τ^-, and similarly for h and k.

Since different experiments use different forms for $|M|^2$, in order to compare the experiments we have converted to g, h, j, and k whatever coefficients have been measured. See the mini-review in the $K^\pm$ section of the Stable Particle Data Card Listings for details on this point. The results are given in the Addendum to the Stable Particle Table and in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

Relations among $\tau^\pm$, $\tau'^\pm$, and τ^0 are predicted by the $\Delta I = \frac{1}{2}$ rule.

2. Form factors in $K_{\ell 3}$ leptonic decays. Assuming that only the vector current contributes to these decays, we write the matrix element as

$$M \propto f_+(t)[(P_K + P_\pi)_\mu \bar{u}_\ell \gamma_\mu (1 + \gamma_5) u_\nu] + f_-(t)[m_\ell \bar{u}_\ell (1 + \gamma_5) u_\nu] , \quad (2)$$

where P_K and P_π are the four-momenta of K and π mesons; m_ℓ is the lepton mass; f_+ and f_- are dimensionless form factors which can depend only on $t = (P_K - P_\pi)^2$, the square of the four-momentum transfer to the leptons, f_+ and f_- are relatively real if time-reversal invariance holds for these decays. $K_{\mu 3}$ experiments measure f_+ and f_-, while K_{e3} experiments are sensitive only to f_+ because the presence of the lepton mass makes the f_- term negligible.

(a) $K_{\mu 3}$ experiments. Analyses of $K_{\mu 3}$ data frequently assume a linear dependence of f_+ and f_- on t, i.e.

$$f_\pm(t) = f_\pm(0)[1 + \lambda_\pm(t/m_\pi^2)] \ . \quad (3)$$

Most $K_{\mu 3}$ data are adequately described by eq. (3) for f_+ and a constant f_- (i.e. $\lambda_- = 0$). There are two equivalent parametrizations commonly used in these analyses:

(1) $\lambda_+, \xi(0)$ *parametrization*. Analyses of $K_{\mu 3}$ data often introduce the ratio of the two form factors

$$\xi(t) = f_-(t)/f_+(t) \ .$$

The $K_{\mu 3}$ decay distribution is then described by the two parameters λ_+ and $\xi(0)$ (assuming time reversal invariance and $\lambda_- = 0$). These parameters can be determined by three different methods:

Method A. By studying the Dalitz plot or the pion spectrum of $K_{\mu 3}$ decay. The Dalitz plot density is [see, e.g. Chounet et al. (1972)]:

$$\rho[E_\pi, E_\mu) \propto f_+^2(t)[A + B\xi(t) + C\xi(t)^2] \ ,$$

where

$$A = m_K(2E_\mu E_\nu - m_K E'_\pi) + m_\mu^2(\tfrac{1}{4}E'_\pi - E_\nu) \ ,$$

$$B = m_\mu^2(E_\nu - \tfrac{1}{2}E'_\pi) \ ,$$

$$C = \tfrac{1}{4}m_\mu^2 E'_\pi \ ,$$

$$E'_\pi = E_\pi^{\max} - E_\pi = (m_K^2 + m_\pi^2 - m_\mu^2)/2m_K - E_\pi \ .$$

Here E_π, E_μ, and E_ν are, respectively, the pion, muon, and neutrino energies in the kaon center of mass. The density ρ is fit to the data to determine the values of $\lambda_+, \xi(0)$, and their correlation.

Method B. By measuring the $K_{\mu 3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio [see, e.g., Fearing et al. (1970)] as given in terms of λ_+ and $\xi(0)$, assuming μ–e universality:

$$\Gamma(K_{\mu 3}^\pm)/\Gamma(K_{e3}^\pm) = 0.6457 + 1.4115\lambda_+ + 0.1264\xi(0) + 0.0192\xi(0)^2 + 0.0080\lambda_+\xi(0) \ ,$$

$$\Gamma(K_{\mu 3}^0)/\Gamma(K_{e3}^0) = 0.6452 + 1.3162\lambda_+ + 0.1246\xi(0) + 0.0186\xi(0)^2 + 0.0064\lambda_+\xi(0) \ .$$

This cannot determine λ_+ and $\xi(0)$ simultaneously but simply fixes a relationship between them.

Method C. By measuring the muon polarization in $K_{\mu 3}$ decay. In the rest frame of the K, the μ is expected to be polarized in the direction $\boldsymbol{A}$ with $\boldsymbol{P} = \boldsymbol{A}/|\boldsymbol{A}|$, where $\boldsymbol{A}$ is given [Cabibbo and Maksymowicz (1964)] by

$$\boldsymbol{A} = a_1(\xi)\boldsymbol{p}_\mu - a_2(\xi)\left[\frac{\boldsymbol{p}_\mu}{m_\mu}\left(m_K - E_\pi + \frac{\boldsymbol{p}_\pi \cdot \boldsymbol{p}_\mu}{|\boldsymbol{p}_\mu|^2}(E_\mu - m_\mu)\right) + \boldsymbol{p}_\pi\right] + m_K \operatorname{Im}\xi(t)(\boldsymbol{p}_\pi \times \boldsymbol{p}_\mu) \ .$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane. Polarization experiments measure the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$.

(2) λ_+, λ_0 *parametrization*. Some of the more recent $K_{\mu 3}$ analyses have parametrized in terms of the form factors f_+ and f_0 which are associated with vector and scalar exchange, respectively, to the lepton pair. f_0 is related to f_+ and f_- by

$$f_0(t) = f_+(t) + [t/(m_K^2 - m_\pi^2)]f_-(t) \ .$$

Here $f_0(0)$ must equal $f_+(0)$ unless $f_-(t)$ diverges at $t = 0$. The earlier assumption that f_+ is linear in t and f_- is constant leads to f_0 linear in t:

$$f_0(t) = f_0(0)[1 + \lambda_0(t/m_\pi^2)] \ .$$

With the assumption that $f_0(0) = f_+(0)$, the two parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0) are equivalent as long as correlation information is retained. (λ_+, λ_0) correlations tend to be less strong than $(\lambda_+, \xi(0))$ correlations.

The experimental results for $\xi(0)$ and its correlation with λ_+ are listed in the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings in section XIA, XIB, or XIC depending on whether method A, B, or C discussed above was used. The corresponding values of λ_+ are listed in subsection L + M.

Because current experiments tend to use the (λ_+, λ_0) parametrization, we have added a subsection L0 for λ_0 results. Wherever possible we have converted $\xi(0)$ results into λ_0 results and vice versa.

(b) K_{e3} experiments. Analysis of K_{e3} data is simpler than that of $K_{\mu 3}$ because the second term of the

matrix element assuming a pure vector current [eq. (2) above] can be neglected. Here f_+ is usually assumed to be linear in t, and the linear coefficient λ_+ of eq. (3) is determined.

If we remove the assumption of a pure vector current, then the matrix element for the decay, in addition to the terms in eq. (2), would contain

$$+ 2m_K f_S \bar{u}_\ell (1+\gamma_5) u_\nu$$
$$+ (2f_T/m_K)(P_K)_\lambda (P_\pi)_\mu \bar{u}_\ell \sigma_{\lambda\mu} (1+\gamma_5) u_\nu ,$$

where f_S is the scalar form factor, and f_T is the tensor form factor. In the case of the K_{e3} decays where the f_- term can be neglected, experiments have yielded limits on $|f_S/f_+|$ and $|f_T/f_+|$.

The K_{e3} results for λ_+, $|f_S/f_+|$, and $|f_T/f_+|$ are listed in the subsections L + M, FS, and FT, respectively, of the $K^\pm$ and K_L^0 sections of the Stable Particle Data Card Listings.

See also the Note on $K_{\ell 3}^\pm$ and $K_{\ell 3}^0$ Form Factors in the $K^\pm$ section of the Stable Particle Data Card Listings for additional discussion of the $K_{\mu 3}^0$ parameters, correlations, and conversion between parametrization and also for a comparison of the experimental results.

3. CP violation in K^0 decays. We list parameters for four different reactions in which *CP* can be tested [for details, see Okun and Rubbia (1967), Steinberger (1969), and Wolfenstein (1969)].

(a) $K_S \to \pi^+\pi^-\pi^0$. The quantity measured here is the ratio of amplitudes

$$A_S(K_S \to \pi^+\pi^-\pi^0)/A_L(K_L \to \pi^+\pi^-\pi^0) \equiv x + iy . \quad (4)$$

If *CPT* invariance holds and there is no $I = 3$ state present, then x can be neglected and *CP* violation would be observed as a nonzero y. We give the result for eq. (4) in the K_L^0 section of the Stable Particle Table and under Branching Ratio R4 in the K_S^0 section of the Stable Particle Data Card Listings. Our procedure is to assume that $x = 0$, and to list $(A_S/A_L)^2$ in the form of a branching ratio.

(b) Charge asymmetry in $K_L \to 3\pi$ decays. As mentioned above, the presence of a term in $(s_2 - s_1)$ in expression (1) describing the Dalitz plot distribution for $\tau^\pm, \tau^0$ decays of K mesons would be an indication of *CP* violation. Experimenters have used several forms for this *CP*-violation term. As described in the mini-review in the $K^\pm$ section of the Stable Particle Data Card Listings, we have converted all results to coefficient j in eq. (1) above. The latter is listed among the *CP*-violating parameters at the back of the K_L^0 section of the Stable Particle Data Card Listings. Note that only upper limits have been reported for this quantity.

(c) Asymmetry in the $K_L \to \pi^\mp \ell^\pm \nu$ decays. The quantity measured and compiled here is

$$\delta = \frac{\Gamma(K_L \to \pi^- \ell^+ \nu) - \Gamma(K_L \to \pi^+ \ell^- \nu)}{\Gamma(K_L \to \pi^- \ell^+ \nu) + \Gamma(K_L \to \pi^+ \ell^- \nu)} .$$

This asymmetry violates *CP* invariance. If *CPT* is good, for a pure K_L^0 beam, δ can be written as

$$\delta = 2[(1 - |x|^2)/(|1 - x|^2)] \; \mathrm{Re}\, \epsilon ,$$

where x is the $\Delta S = \Delta Q$-violating parameter defined in section B4, and ϵ is the parameter of the expansion

$$|K_L\rangle = [(1+\epsilon)|K\rangle - (1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2} , \quad (5a)$$

$$|K_S\rangle = [(1+\epsilon)|K\rangle + (1-\epsilon)|\bar{K}\rangle]/[2(1+|\epsilon|^2)]^{1/2} . \quad (5b)$$

We give δ in the Addendum to the Stable Particle Table. In addition, in the K_L^0 *CP*-violation section of the Stable Particle Data Card Listings, we list δ separately for $K_L^0 \to \pi\mu\nu$ and $K_L^0 \to \pi e\nu$.

(d) $K_L \to 2\pi$ decay. The relevant parameters are

$$\eta_{+-} = A(K_L \to \pi^+\pi^-)/A(K_S \to \pi^+\pi^-)$$
$$= |\eta_{+-}| \exp(i\phi_{+-}) ,$$
$$\eta_{00} = A(K_L \to \pi^0\pi^0)/A(K_S \to \pi^0\pi^0)$$
$$= |\eta_{00}| \exp(i\phi_{00}) .$$

ϵ, defined in eqs. (5) above, and

$$\epsilon' = \tfrac{1}{2} i\sqrt{2} \exp[i(\delta_2 - \delta_0)] \; \mathrm{Im}(A_2/A_0) .$$

Here, A_i and δ_i are the amplitude and phase of $\pi\pi$ scattering at the K mass, defined by

$$\langle I = 0|T|K\rangle = \exp(i\delta_0) A_0 ,$$
$$\langle I = 2|T|K\rangle = \exp(i\delta_2) A_2 .$$

Wu and Yang (1964) have derived the relationships

$$\eta_{+-} = \epsilon + \epsilon' , \quad \eta_{00} = \epsilon - 2\epsilon' .$$

We give η_{+-}, η_{00}, ϕ_{+-}, and ϕ_{00} in the Addendum to the Stable Particle Table. The phases are measured directly, whereas the magnitudes η_{+-} and η_{00} are derived parameters. We use, as far as we can, the directly measured quantities as input and calculate η_{+-} and η_{00} from the values given by our constrained fits. Therefore, if one looks at the Data Card Listings, most of the $|\eta|$ measurements appear in the form of branching ratios, with appropriate comments. We then give the values of η_{+-} and $|\eta_{00}|^2$ in a separate list at the end of the *CP*-violating parameters section of the K_L^0 section of the Stable Particle Data Card Listings.

4. $\Delta S = \Delta Q$ rule in K^0 decays. The relative amount of $\Delta S \neq \Delta Q$ component present is measured by the parameter x, defined as

$$x = A(\bar{K}^0 \to \pi^- \ell^+ \nu)/A(K^0 \to \pi^- \ell^+ \nu) .$$

We list Re $\{x\}$ and Im $\{x\}$ for both K_{e3} and $K_{\mu 3}$ at the end of the Stable Particle Data Card Listings and give values in the Addendum to the Stable Particle Table.

C. η-decay parameters

1. C-violation in η decays. As a test of possible *C*-violation in electromagnetic interactions, a number of experiments have looked for possible charge asymmetries in the decays $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$. We list the following parameters:

(a) The left–right asymmetry

$$A = (N^+ - N^-)/(N^+ + N^-) ,$$

where $N^{(\pm)}$ means the number of events with the $\pi^{(\pm)}$ energy greater than the $\pi^{(\mp)}$ energy in the η rest frame.

(b) The sextant asymmetry

$$A_s = \frac{N_1 + N_3 + N_5 - N_2 - N_4 - N_6}{N_1 + N_2 + N_3 + N_4 + N_5 + N_6}$$

for the decay $\eta \to \pi^+\pi^-\pi^0$. The numbers refer to the sextants of the Dalitz plot [see, for example, Layter (1972)]. A_s is sensitive to an $I = 0$ *C*-violating asymmetry.

(c) The quadrant asymmetry A_q, defined in a similar way as A_s, but with each sector of the Dalitz plot now containing $\pi/2$ rather than $\pi/3$ radians. A_q is sensitive to an $I = 2$ *C*-violating final state.

(d) The d-wave contribution to the *C*-violating amplitude in the decay $\eta \to \pi^+\pi^-\gamma$. The upper limit for this contribution is measured by the parameter β, defined by

$$\mathrm{d}N/\mathrm{d}|\cos\theta| \propto \sin^2\theta(1 + \beta\cos^2\theta) ,$$

where θ is the angle between the π^+ and the γ in the di-pion center of mass. A term proportional to $\cos^2\theta$ could also be due to p- and f-wave interference.

We list A for the decay modes $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$, A_s and A_q for the decay $\eta \to \pi^+\pi^-\pi^0$, and β for the decay $\eta \to \pi^+\pi^-\gamma$ in the η section of the Stable Particle Data Card Listings.

2. Dalitz plot for $\eta \to \pi^+\pi^-\pi^0$. The Dalitz plot for the decay $\eta \to \pi^+\pi^-\pi^0$ may be fit by the distribution

$$|M(x,y)|^2 \propto 1 + ay + by^2 + cx + dx^2 + exy .$$

Here,

$$x = \sqrt{3}(T_+ - T_-)/Q , \quad y = (3T_0/Q) - 1 ,$$

T_+, T_-, T_0 are the kinetic energies of the π^+, π^-, and π^0 in the η rest system, and $Q = m_\eta - m_{\pi^+} - m_{\pi^-} - m_{\pi^0}$. The coefficient of the term linear in x is sensitive to *C*-violation due to an $I = 0$ or $I = 2$ final state. We list papers presenting determinations of the parameters a, b, c, and d in the η section of the Stable Particle Data Card Listings. However, we do not tabulate values of these parameters because the assumptions made by different authors are not compatible and do not allow comparison of the numerical values.

3. Dalitz plot for $\eta \to \pi^+\pi^-\gamma$. The Dalitz plot for the decay $\eta \to \pi^+\pi^-\gamma$ may be fit to the expression

$$|M|^2 \propto 1 + 2\alpha z ,$$

where

$$z = \tfrac{2}{3}\sum_{i=1}^{3} [3(m_\eta - 3m_\pi)^{-1}(E_i - \tfrac{1}{3}m_\eta)]^2 = \rho^2/\rho^2_{\max} .$$

Here E_i is the energy of the ith pion in the η rest frame, and ρ is the distance to the center of the Dalitz plot. We list the parameter α in the η section of the Stable Particle Data Card Listings.

D. Baryon-decay parameters

1. A/V ratio for baryon leptonic decays. Consider the decay

$$B_i \to B_f + \ell + \nu .$$

Assuming V, A theory, neglecting "induced" scalar, "induced" pseudoscalar, and axial weak-magnetism terms, and neglecting the q^2 dependence of the form factors, the baryon part of the matrix element for these decays may be written [Goldberger and Treiman (1958)] as

$$\langle B_f | \gamma_\lambda (g_V - g_A \gamma_5) + (g_W/m_{B_i}) \sigma^{\lambda\nu} q_\nu | B_i \rangle ,$$

where B_i and B_f represent initial and final baryons, g_A and g_V the axial and vector coupling constants, g_W the weak magnetism coupling constant, and q_ν the sum of the lepton momenta. Here the Pauli representation is used for the γ matrices. The ratio g_A/g_V may be written as

$$g_A/g_V = |g_A/g_V| \exp(i\phi) ,$$

where ϕ is $0 + n\pi$ if time reversal holds [see Jackson et al. (1957)].

Experiments on the leptonic decays of baryons other than the neutron have generally assumed ϕ to be either 0 or π, and have thus measured the magnitude and sign of g_A/g_V. In studying neutron beta decay, however, experiments have been sensitive enough to measure ϕ more precisely, and we include the phase angle in our Listings for this case. It is consistent with time-reversal invariance, and by using the above definition of the matrix element with the Pauli representations, the value of g_A/g_V in neutron beta decay is negative.

Due to statistical limitations the weak magnetism form factor g_W is usually assumed from CVC and SU(3), so that usually only g_A and g_V are determined experimentally. This determination is accomplished in a variety of ways.

(a) The lepton–neutrino angular correlation provides a measure of the absolute value of g_A/g_V [for relevant formulas, see, e.g., Albright (1959)].

(b) The up–down asymmetry of the lepton from polarized baryon decays provides a measure of g_A/g_V with its sign [for relevant formulas, see, e.g., Albright (1959)].

(c) The lepton spectrum, given enough statistics, provides a measure of g_A/g_V with its sign [for relevant formulas, see, e.g., Bender (1968)]. The lepton spectrum also provides a measure of g_W/g_A if the CVC-SU(3) assumption is relaxed.

(d) The polarization of the decay baryon, from polarized or unpolarized initial baryon, also provides g_A/g_V with its sign [for formulas, see, e.g., Willis and Thompson (1968)].

(e) The presence of a term proportional to

$$\boldsymbol{\sigma}_{B_i} \cdot (\boldsymbol{p}_e \times \boldsymbol{p}_\nu) ,$$

where the initial baryon is polarized or

$$\boldsymbol{\sigma}_{B_f} \cdot (\boldsymbol{p}_e \times \boldsymbol{p}_\nu) ,$$

where the polarization of the decay baryon is observed provides a measure of the deviation of ϕ from 0 or π, and is thus a test of time-reversal invariance [see, e.g., Willis and Thompson (1968)].

We compile the ratio g_A/g_V with its sign, for those decays for which it has been measured.

All the coupling constants and decay rates for baryon leptonic decays are related by Cabibbo's theory [Cabibbo (1963)], extended to six quarks (and three mixing angles) by Kobayashi and Maskawa (1973). A recent fit to this theory has been done by Shrock and Wang (1978).

2. Asymmetry parameters in nonleptonic hyperon decays. The transition matrix for the hyperon decay may be written as

$$M = s + p(\boldsymbol{\sigma} \cdot \boldsymbol{q}) , \tag{6}$$

where s and p are the parity-changing and the parity-conserving amplitudes, respectively; $\boldsymbol{\sigma}$ is the Pauli spin operator, and $\boldsymbol{q}$ is a unit vector along the direction of the decay baryon in the hyperon rest frame.

The asymmetry parameters are defined by the relations

$$\alpha = 2\,\mathrm{Re}(s^* p)/(|s|^2 + |p|^2) ,$$

$$\beta = 2\,\mathrm{Im}(s^* p)/(|s|^2 + |p|^2) ,$$

$$\gamma = (|s|^2 - |p|^2)/(|s|^2 + |p|^2) .$$

With the transition matrix (6), the angular distribution of the decay baryon, in the hyperon rest system, is of the form

$$I = 1 + \alpha \boldsymbol{P}_Y \cdot \boldsymbol{q} ,$$

where $\boldsymbol{P}_Y = \langle Y | \boldsymbol{\sigma} | Y \rangle$ is the hyperon polarization.

In the notation of Lee and Yang (1957) the polarization $\boldsymbol{P}_B$ of the decay baryons is [‡2]

$$\boldsymbol{P}_B = \frac{(\alpha + \boldsymbol{P}_Y \cdot \boldsymbol{q})\boldsymbol{q} + \beta(\boldsymbol{P}_Y \times \boldsymbol{q}) + \gamma \boldsymbol{q} \times (\boldsymbol{P}_Y \times \boldsymbol{q})}{1 + \alpha \boldsymbol{P}_Y \cdot \boldsymbol{q}} ,$$

[‡2] Note that Lee and Yang (1957) contains a misprint. The minus sign in the definition of β should be replaced by a 2. In addition, our unit vector $\boldsymbol{q}$ is the direction of the baryon, whereas their unit vector $\boldsymbol{p}$ is the direction of the pion.

where P_B is defined in that rest system of the baryon obtained by a Lorentz transformation along q from the hyperon rest system in which q and P_Y are defined. Note that α is the helicity of the decay baryon for unpolarized hyperons.

The three parameters α, β, and γ satisfy the relation

$$\alpha^2 + \beta^2 + \gamma^2 = 1 .$$

It is then convenient to describe hyperon nonleptonic decays in terms of the two independent parameters α and the angle ϕ defined by

$$\beta = (1 - \alpha^2)^{1/2} \sin \phi ,$$

$$\gamma = (1 - \alpha^2)^{1/2} \cos \phi ,$$

which has a more nearly gaussian distribution than β or γ. Evidently

$$-\tfrac{1}{2}\pi \leqslant \phi \leqslant \tfrac{1}{2}\pi \quad \text{for } \gamma > 0 ,$$

$$+\tfrac{1}{2}\pi \leqslant \phi \leqslant \tfrac{3}{2}\pi \quad \text{for } \gamma < 0 .$$

In discussing time-reversal invariance, the quantity of interest is Δ, defined by

$$\alpha = 2|s||p| \cos \Delta/(|s|^2 + |p|^2) ,$$

$$\beta = -2|s||p| \sin \Delta/(|s|^2 + |p|^2) ;$$

that is, Δ is the phase angle of s relative to p. Evidently

$$-\tfrac{1}{2}\pi \leqslant \Delta \leqslant \tfrac{1}{2}\pi \quad \text{for } \alpha > 0 ,$$

$$+\tfrac{1}{2}\pi \leqslant \Delta \leqslant \tfrac{3}{2}\pi \quad \text{for } \alpha < 0 .$$

Under the assumption of time-reversal invariance, the angle Δ must satisfy the relation

$$\Delta = \delta_s - \delta_p ,$$

modulo π, where δ_s and δ_p are the pion–baryon scattering phase shifts at the appropriate energy and for the appropriate isospin state. For Λ decay, assuming the validity of the $|\Delta I| = \frac{1}{2}$ rule,

$$\Delta = \delta_s - \delta_p = (7.0 \pm 1.0) \text{ deg } ^{\ddagger 3} .$$

In the Stable Particle Data Card Listings we give α and ϕ for each decay since they are the most closely related to the experiments and are essentially uncorrelated. Whenever necessary we have changed the signs of the reported values, so as to agree with our conventions. In the Stable Particle Table we give α, ϕ, and Δ with errors; and for convenience we also give the central value of γ, without an error.

‡3 This value for $\delta_s - \delta_p$ is derived from the phase-shift analyses by Ayed (1976). The error is our estimation of the uncertainty allowing for possible correlations.

VII. Statistical procedures

We divide this discussion on obtaining averages and errors into two sections:

A. The unconstrained case, or "simple averaging", and

B. The constrained case.

In what follows, the term "error" means one standard deviation (1σ); that is, for central value $\bar{x}$ and error $\delta\bar{x}$, the range $\bar{x} \pm \delta\bar{x}$ constitutes a 68.3% confidence interval.

A. Unconstrained averaging

We are returning this year to the use of a standard gaussian procedure (with "scale factor") as our only method of averaging the data. The Student's distribution procedure, introduced in 1976 as a second method of averaging, has been discontinued. This results primarily from our observation that, although the data are better represented by a Student's distribution, the standard deviation (= the 68.3% confidence limit) of this Student's distribution turns out to be equal to the gaussian standard deviation. If one would choose to quote, e.g., 90% confidence limits, however, the gaussian procedure would give too small errors.

We begin by assuming that measurements of a given quantity obey a gaussian distribution, and thus we calculate a weighted average and error

$$\bar{x} \pm \delta\bar{x} = \left(\sum_i w_i x_i \Big/ \sum_i w_i \right) \pm \left(\sum_i w_i \right)^{-1/2} ,$$

$$w_i = [1/(\delta x_i)^2] , \qquad (1)$$

where x_i and δx_i are the value and error, respectively, reported by the ith experiment, and the sums run over N experiments. We also calculate χ^2 and compare it with its expectation value of $N - 1$.

If $\chi^2/(N - 1)$ is less than or equal to 1, and there are no known problems with the data, we accept the above results.

If $\chi^2/(N-1)$ is very large, or if there is prior knowledge of extremely large inconsistencies between experiments, we may choose not to average the data at all. Alternatively, we may quote the calculated average, but then give an educated guess as to the error; such a guess is generally a quite conservative estimate designed to take into account known problems with the data.

Finally, if $\chi^2/(N-1)$ is greater than 1, but not to such a large extent, we still average the data, but then try to make up for this fact in two ways:

(i) We plot an ideogram to guide the reader in deciding which data might be rejected before selected averages are made. An example of such an ideogram is given in fig. 3 below. Each experiment appearing in the plot is represented by a gaussian with central value x_i, error δx_i, and area proportional to $1/\delta x_i$. The choice of area is a somewhat arbitrary one; it is based on the assumption that an experimenter will work to reduce his (or her) systematic errors until they are slightly smaller (but seldom much smaller) than the statistical errors. Thus, as a bubble chamber physicist gets more events, he (or she) will use them both to reduce the statistical errors and to study the biases. Our

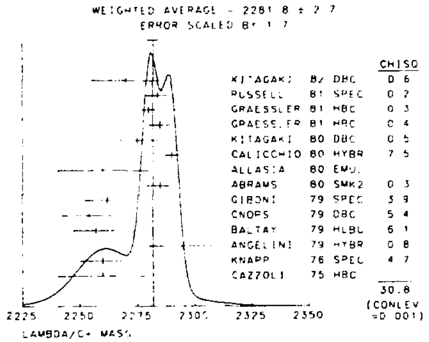

Fig. 3. Ideogram of measurements of the Λ_c^+ mass. The vertical line indicates the position of the weighted average, while the horizontal bar atop the line gives the error in the average after scaling by the SCALE factor. Only those experiments indicated by + error flags were precise enough to be accepted in the calculation of the SCALE factor; the column on the far right gives the χ^2 contribution of each of these experiments. The less precise experiments were included in the calculation of the weighted average, but not SCALE; they have ⊥ error flags.

confidence that a significant systematic error has not been made in a given experiment, as compared with other contradictory experiments, then tends to go up as $1/\delta x_i$.

But why not assign a weight $1/\delta_i^2$, as is done when computing a weighted average? We feel that this is equivalent to assuming that large systematic errors are as infrequent as large statistical fluctuations, and that this is unrealistic.

We emphasize the difference between least-squares averaging (where the weighting factor is the inverse square of the error) and the ideograms prepared for visual display. The former arithmetic is of course best if one has statistically distributed input, and yields a narrow gaussian distribution centered at the weighted mean. The ideogram (often multipeaked and certainly not gaussian) is based on the opposite hypothesis that some of the input is systematically in error. The idea behind least-squares averaging is that experiments 1, 2, 3, etc., are *all* valid (so we should multiply their probabilities). Our *ideograms* are based on the assumption that 1 *or* 2 *or* 3, etc., is valid, "hedged" with $1/\delta x_i$ betting odds; we then add their probabilities. Both approaches cannot simultaneously be right; we leave it to the reader to choose. A glance at the ideogram will show, however, that the discrepancy is often not severe for reasonably distributed input.

(ii) The second way in which we try to take account of $\chi^2/(N-1)$ being greater than 1 is to scale up our quoted error $\delta\bar{x}$ in eq. (1) by a factor

$$\mathrm{SCALE} = [\chi^2/(N-1)]^{1/2} . \quad (2)$$

Our reasoning is as follows. Since we do not know which one or more of the experiments are wrong, we assume that all experimentalists underestimated their errors by the same scale factor (2). If we scale up all input errors by this factor, χ^2 returns to $N-1$, and of course the output error scales up by the same factor.

If all the experiments have errors of about the same size, the above (straightforward) procedure for calculating SCALE is carried out. If, however, we are to combine experiments with widely varying errors, we must modify the procedure slightly. This is because it is the more precise experiments that most influence not only the average value $\bar{x}$, but also the error $\delta\bar{x}$. Now, on the average, the low-precision experiments each contribute about unity to *both* the numerator and the denominator of SCALE, hence the χ^2 contribution of the sensitive experiments is diluted, i.e., reduced. Therefore, we evaluate SCALE by using *only* experiments for which the errors are not much greater than those of the more precise experiments. Explicitly, to calculate SCALE we use only the most sensitive experiments, i.e., those with errors less than δ_0, where the ceiling δ_0 is (arbitrarily) chosen to be

$$\delta_0 = 3N^{1/2}\delta\bar{x} .$$

Here $\delta\bar{x}$ is the unscaled error of the mean of all the experiments. Note that if each experiment had the same error δx_i, then $\delta\bar{x}$ would be $\delta x_i/N^{1/2}$, so each individual experiment would be well under the ceiling on SCALE.

This scaling approach has the property that if there are two values with comparable errors separated by much more than their stated errors (with or without a number of other experiments of lower accuracy), the error on the mean value $\delta\bar{x}$ is increased so that it is approximately half the interval between the two discrepant values.

We wish to emphasize the fact that our scaling procedures for *errors* in no way affect central values. In addition, if one wishes to recover the unscaled error $\delta\bar{x}$, one need only divide the given error by the SCALE factor for that error.

B. Constrained fits

Except for trivial cases, all branching ratios and rate measurements are analyzed by the computer program AHR. This program makes a simultaneous least-squares fit to all the data, and outputs the partial-decay fractions $\bar{P}_i$, width Γ, partial widths Γ_i, and their error matrix.

The original version of AHR was written by J. Peter Berge. It is documented separately, and we wish here only to give the simplest nontrivial example that permits us to comment on the error matrix and the scale factor.

Assume that a state has only three partial-decay fractions, P_1, P_2, and P_3 ($\Sigma P_i = 1$), which have been measured in four different ratios, $R_1, ..., R_4$, where, e.g., $R_1 = P_1/P_2$, $R_2 = P_1/P_3$, etc. [‡4] Further assume that *each* ratio has been measured by N experiments (we designate each experiment with a subscript x, e.g., R_{1x}). Then AHR finds the best values of P_1, P_2, and P_3 by minimizing χ^2, namely

$$\chi^2 = \sum_{r=1}^{4} \left[\sum_{x=1}^{N} \left(\frac{R_{rx} - R_r(P_1, P_2, P_3)}{\delta R_{rx}} \right)^2 \right] . \qquad (3)$$

In addition to the fitted values $\bar{P}_i$, the program calculates an error matrix $\langle \delta\bar{P}_i \delta\bar{P}_j \rangle$. We tabulate the diagonal elements $\delta\bar{P}_i = \langle \delta\bar{P}_i\, \delta\bar{P}_i \rangle^{1/2}$ [except that some errors are scaled according to eq. (2) as discussed below]. In the listings we give the complete error matrix; we also calculate the fitted value of each ratio, for comparison with the input data, and list it below the relevant input, along with a simple unconstrained average of the same input.

Two further comments on the example above.

(1) There was no connection between measurements of the width and the branching ratios. But often we also have information on partial widths Γ_i as well as total width Γ. In this case AHR must introduce Γ as a parameter into the fit, along with the relations $\Gamma_i = \Gamma P_i$, $\Sigma\Gamma_i = \Gamma$. When appropriate, we tabulate the Γ_i along with the P_i, and give error matrices in the listings.

(2) Note that we do *not* allow for correlations between input data. We *do* try to pick those ratios and widths which are as independent and as close to the original data as possible.

In *asymmetric* errors, we use a continuous function of $\delta(P)^+$ and $\delta(P)^-$ in the fitting. When no errors are reported, we merely list the data for inspection.

Hyperon-decay parameters. The program AHR handles any type of input, α, ϕ, Δ, β, or γ, according to the definitions of section VI. If for a particular hyperon decay there are data for more than two of the decay parameters, they are analyzed by using the constraint

$$\alpha^2 + \beta^2 + \gamma^2 = 1 .$$

Inconsistent constrained data. According to our simple example, which led to eq. (3), the double sum for χ^2 is summed over experiments $x = 1$ to N, leaving a single sum over ratios

$$\chi^2 = \sum_r \chi_r^2 ;$$

[‡4] We can handle any R of the form $R = \Sigma\,\alpha_i P_i / \Sigma\,\beta_i P_i$, where α_i and β_i are constants, usually 1 or 0. The forms $R = P_i \cdot P_j$ and $R = (P_i \cdot P_j)^{1/2}$ are also allowed.

Even before fitting, some of the χ_r^2 may be too large. But if we scaled them before fitting, then the scaling would move the central value, contrary to our policy. So we do not scale until after the first fit; then, knowing the fitted χ_r^2 and its expectation value $\langle\chi_r^2\rangle$ we form SCALE factors (just as before), i.e.,

$$(\mathrm{SCALE})_r^2 = \chi_r^2/\langle\chi_r^2\rangle ,$$

and if any $(\mathrm{SCALE})_r$ is greater than 1, all N of the measurements of that particular ratio are equally penalized by having their errors increased by $(\mathrm{SCALE})_r$. Program AHR then recycles on all the data, those with errors unchanged as well as those with errors increased. We then get new values, $\delta\bar{P}_i'$ for the errors in the partial-decay modes.

Because of the constraint ($\Sigma P_i = 1$) some SCALE factors may still be greater than 1 even after this second pass. If this is so, the whole procedure (i.e., increasing errors by the new SCALE factors and recycling through AHR) is repeated until AHR has converged.

At the end of AHR's final pass we have two measures of the errors for the $\bar{P}_i$. One is, of course, the $\delta\bar{P}_i'$, i.e., the errors in the final fitted values $\bar{P}_i'$ which include the effects of scaling the input errors. The other measure of the errors is $(\bar{P}_i - \bar{P}_i')$, i.e., the *shift* in the central values of the ith mode between the first (unscaled) fit and the final (scaled) fit. In practice we find that on the average these two measures of the uncertainty are about equal. Rather than selecting just one or the other, our tabulated errors are given by the combination

$$(\delta\bar{P}_i)_{\mathrm{tab}} = [\delta\bar{P}_i'^2 + (\bar{P}_i - \bar{P}_i')^2]^{1/2} ,$$

where $\bar{P}_i$ is the fitted value of the ith partial-decay mode before scaling, $\bar{P}_i'$ is its value after scaling, and $\delta\bar{P}_i'$ is the error in $\bar{P}_i'$. The SCALE factors we finally list in such cases are defined by

$$(\mathrm{SCALE})_i = (\delta\bar{P}_i)_{\mathrm{tab}}/\delta\bar{P}_i .$$

However, in line with our policy of not letting SCALE affect the central values, we give the values of $\bar{P}_i$ obtained from the original (unscaled) fits. [The differences between the $\bar{P}_i$ calculated with either the scaled or the unscaled errors are, of course, always within the tabulated errors, $(\delta\bar{P}_i)_{\mathrm{tab}}$.]

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TABLES OF PARTICLE PROPERTIES

April 1982

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F.C. Porter, A. Rittenberg, M. Roos, L.D. Roper, T. Shimada, R.E. Shrock, T.G. Trippe, Ch. Walck, C.G. Wohl, G.P. Yost

(Closing date for data: Jan. 1, 1982)

Stable Particle Table

For additional parameters, see Addendum to this table.

Quantities in italics have changed by more than one (old) standard deviation since April 1980.

Particle	$I^G(J^P)C_n$ [a]	Mass [a] (MeV) Mass^2 (GeV^2)	Mean life [b] (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction [b]	p or p_{max} [c] (MeV/c)
			PHOTON			
γ	$0,1(1^-)-$	$(<6\times10^{-22})$	-------	stable		
			LEPTONS			
ν_e	$J=\frac{1}{2}$	(<0.000046)[d]	stable $(>3\times10^8 m_{\nu_e}$ (MeV))	stable		
e	$J=\frac{1}{2}$	0.5110034 ±0.0000014	stable $(>?\times10^{22}$y)	stable		
ν_μ	$J=\frac{1}{2}$	$0(<0.52)$	stable $(>1.1\times10^5 m_{\nu_\mu}$ (MeV))	stable		
				$\mu^-\to$ (or $\mu^+\to$CC)		
μ	$J=\frac{1}{2}$	105.65943	2.19714×10^{-6}	$e^-\bar{\nu}\nu$	(98.6 ± 0.4)%	53
		±0.00018	±0.00007	$e^-\bar{\nu}\nu\gamma$	[e](1.4)%	53
		m^2=0.01116392	$c\tau=6.5868\times10^4$	†[$e^-\nu_e\bar{\nu}_\mu$	(<9)%]	53
				$e^-\gamma$	(<1.9)$\times10^{-10}$	53
				$e^-e^+e^-$	(<1.9)$\times10^{-9}$	53
				$e^-\gamma\gamma$	(<5)$\times10^{-8}$	53
ν_τ	$J=\frac{1}{2}$	<250				
				$\tau^-\to$ (or $\tau^+\to$CC)		
τ	$J=\frac{1}{2}$	1784.2	$(4.6\pm1.9)\times10^{-13}$	$\mu^-\bar{\nu}\nu$	(18.5 ± 1.2)%	889
		±3.2	$c\tau$=0.014	$e^-\bar{\nu}\nu$	(16.2 ± 1.0)%	892
		m^2=3.18		hadron$^-$ neutrals	(37.0 ± 3.2)%	
				3(hadron$^\pm$) neutrals	(28.4 ± 3.0)%	
				5(hadron$^\pm$) neutrals	(<6)%	
				†[3(hadron$^\pm$)ν	(13 ± 8)%	
				3(hadron$^\pm$)$\nu(\geq1\gamma)$	(15 ± 7)%]	
				†[$\pi^-\nu$	(10.7 ± 1.6)%	887
				$\rho^-\nu$	(21.6 ± 3.6)%	726
				K^- neutrals	(small)	
				$\pi^-\pi^-\pi^+\nu$	(7 ± 5)%	864
				$\pi^-\pi^-\pi^+(\geq0\pi^0)\nu$	(18 ± 7)%]	864
				†[$K^{*-}(892)\nu$	(1.7 ± 0.7)%	669
				$K^{*-}(1430)\nu$	(<0.9)%	316
				$\pi^-\rho^0\nu$	(5.4 ± 1.7)%]	718

(continued next page)

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$ [a]	Mass [b] (MeV) Mass^2 (GeV^2)	Mean life [b] (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction [b]	p or p_{max} [c] (MeV/c)
				τ^- → (or τ^+ → CC)		
τ (continued)				e^- chgd.parts. + μ^- chgd.parts.	(<4)%	
				$\mu^-\gamma$	(<5.5)$\times10^{-4}$	889
				$e^-\gamma$	(<6.4)$\times10^{-4}$	892
				$\mu^-\mu^+\mu^-$	(<4.9)$\times10^{-4}$	876
				$e^-\mu^+\mu^-$	(<3.3)$\times10^{-4}$	886
				$\mu^-e^+e^-$	(<4.4)$\times10^{-4}$	889
				$e^-e^+e^-$	(<4.0)$\times10^{-4}$	892
				$\mu^-\pi^0$	(<8.2)$\times10^{-4}$	884
				$e^-\pi^0$	(<2.1)$\times10^{-3}$	887
				μ^-K^0	(<1.0)$\times10^{-3}$	819
				e^-K^0	(<1.3)$\times10^{-3}$	823
				$\mu^-\rho^0$	(<4.4)$\times10^{-4}$	722
				$e^-\rho^0$	(<3.7)$\times10^{-4}$	726

NONSTRANGE MESONS [a]

Particle	$I^G(J^P)C_n$	Mass	Mean life	Mode	Fraction	p or p_{max}
				π^+ → (or π^- → CC)		
$\pi^\pm$	$1^-(0^-)$	139.5673	2.6030×10^{-8}	$\mu^+\nu$	100%	30
		±0.0007	±0.0023	$e^+\nu$	($1.267\pm0.023)\times10^{-4}$	70
		m^2=0.0194790	$c\tau$=780.4	$\mu^+\nu\gamma$	[e]($1.24\pm0.25)\times10^{-4}$	30
		$m_{\pi^\pm}-m_{\mu^\pm}$ =33.9079	$(\tau^+-\tau^-)/\bar{\tau}$=	$e^+\nu\gamma$	[e]($5.6\pm0.7)\times10^{-8}$	70
		±0.0007	(0.05 ± 0.07)%	$e^+\nu\pi^0$	($1.02\pm0.07)\times10^{-8}$	5
			(test of CPT)	$e^+\nu e^+e^-$	(<5)$\times10^{-9}$	70
π^0	$1^-(0^-)+$	134.9630	0.83×10^{-16}	$\gamma\gamma$	(98.787 ± 0.030)%	67
		±0.0038	±0.06 S=1.8*	γe^+e^-	(1.213)%	67
		m^2=0.018215	$c\tau$=2.5×10^{-6}	$\gamma\gamma\gamma$	(<3.8)$\times10^{-7}$	67
		$m_{\pi^\pm}-m_{\pi^0}$ = 4.6043		$e^+e^-e^+e^-$	[f](3.32)$\times10^{-5}$	67
		±0.0037		$\gamma\gamma\gamma\gamma$	(<4)$\times10^{-6}$	67
				e^+e^-	($2.2^{+2.4}_{-1.1}$)$\times10^{-7}$	67
				$\nu\nu$	(<2.4)$\times10^{-5}$	67
η	$0^+(0^-)+$	548.8	Γ=(0.83$\pm$0.12)keV	$\gamma\gamma$	(39.1 ± 0.8)%	274
		±0.6	Neutral decays	$3\pi^0$	(31.8 ± 0.8)% S=1.1*	180
		S=1.4*	(70.9$\pm$0.7)%	$\pi^0\gamma\gamma$	[g](<0.3)%	258
		m^2=0.3012		$\pi^+\pi^-\pi^0$	(23.7 ± 0.5)%	175
				$\pi^+\pi^-\gamma$	(4.91 ± 0.13)%	236
				$e^+e^-\gamma$	(0.50 ± 0.12)%	274
				$\mu^+\mu^-\gamma$	(3.1 ± 0.4)$\times10^{-4}$	253
				e^+e^-	(<3)$\times10^{-4}$	274
				$\mu^+\mu^-$	(6.5 ± 2.1)$\times10^{-6}$	253
			Charged decays	$\pi^+\pi^-e^+e^-$	(0.13 ± 0.13)%	236
			(29.1$\pm$0.7)%	$\pi^+\pi^-\gamma\gamma$	(<0.21)%	236
				$\pi^+\pi^-\pi^0\gamma$	(<6)$\times10^{-4}$	175
				$\pi^+\pi^-$	(<0.15)%	236
				$\pi^0e^+e^-$	(<5)$\times10^{-5}$	258
				$\pi^0\mu^+\mu^-$	(<5)$\times10^{-6}$	211
				$\pi^0\mu^+\mu^-\gamma$	(<3)$\times10^{-6}$	211

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$ [a]	Mass [b] (MeV) Mass^2 (GeV^2)	Mean life [b] (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction [b]	p or p_{max} [c] (MeV/c)
STRANGE MESONS [a]						
				K^+ (or $K^- \to$ CC)		
$K^\pm$	$\frac{1}{2}(0^-)$	493.667	1.2371×10^{-8}	$\mu^+\nu$	(63.50 ± 0.16)%	236
		±0.015	±0.0026 S=1.9*	$\pi^+\pi^0$	(21.16 ± 0.15)%	205
		m^2=0.2437	$c\tau$=370.9	$\pi^+\pi^+\pi^-$	(5.59 ± 0.03)% S=1.1*	125
			$(\tau^+ - \tau^-)/\bar{\tau}$=	$\pi^+\pi^0\pi^0$	(1.73 ± 0.05)% S=1.4*	133
			(0.11±0.09)%	$\pi^0\mu^+\nu$	(3.20 ± 0.09)% S=1.7*	215
			(test of CPT)	$\pi^0e^+\nu$	(4.82 ± 0.05)% S=1.1*	228
			S=1.2*	$\mu^+\nu\gamma$	[e](5.8 ± 3.5)$\times10^{-3}$	236
				$\pi^0\pi^0e^+\nu$	(1.8 $^{+2.4}_{-0.6}$)$\times10^{-5}$	207
		$m_{K^\pm}-m_{K^0}$=−4.01		$\pi^+\pi^-e^+\nu$	(3.90 ± 0.15)$\times10^{-5}$	203
		±0.13		$\pi^+\pi^+e^-\bar{\nu}$	(<1.2)$\times10^{-8}$	203
		S=1.1*		$\pi^+\pi^-\mu^+\nu$	(1.4 ± 0.9)$\times10^{-5}$	151
				$\pi^+\pi^+\mu^-\bar{\nu}$	(<3.0)$\times10^{-6}$	151
				$e^+\nu$	(1.54 ± 0.07)$\times10^{-5}$	247
				$e^+\nu\gamma$ (SD+)[h]	(1.52 ± 0.23)$\times10^{-5}$	247
				$e^+\nu\gamma$ (SD−)[h]	(<1.6)$\times10^{-4}$	247
				$\pi^+\pi^0\gamma$	[i,e](2.75 ± 0.16)$\times10^{-4}$	205
				$\pi^+\pi^+\pi^-\gamma$	[e](1.0 ± 0.4)$\times10^{-4}$	125
				$\pi^0\mu^+\nu\gamma$	[e](<6)$\times10^{-5}$	215
				$\pi^0e^+\nu\gamma$	[e](3.7 ± 1.4)$\times10^{-4}$	228
				$\pi^+e^+e^-$	(2.7 ± 0.5)$\times10^{-7}$	227
				$\pi^-e^+e^+$	(<1)$\times10^{-8}$	227
				$\pi^+\mu^+\mu^-$	(<2.4)$\times10^{-6}$	172
				$\pi^+\gamma\gamma$	[e](<3.5)$\times10^{-5}$	227
				$\pi^+\gamma\gamma\gamma$	[e](<3.0)$\times10^{-4}$	227
				$\pi^+\nu\bar{\nu}$	(<1.4)$\times10^{-7}$	227
				$\pi^+\gamma$	(<4)$\times10^{-6}$	227
				$\pi^\mp e^+\mu^\pm$	(<7)$\times10^{-9}$	214
				$\pi^+e^-\mu^+$	(<5)$\times10^{-9}$	214
				$e^+\nu\nu\bar{\nu}$	(<6)$\times10^{-5}$	247
				$\mu^+\nu\nu\bar{\nu}$	(<6)$\times10^{-6}$	236
				$\mu^+\nu e^+e^-$	(11 ± 3)$\times10^{-7}$	236
				$\mu^-\nu e^+e^+$	(<2.0)$\times10^{-8}$	236
				$e^+\nu e^+e^-$	(2 $^{+2}_{-1}$)$\times10^{-7}$	247
				$\mu^+\nu_e$	(<4)$\times10^{-3}$	236
K^0 $\bar{K}^0$	$\frac{1}{2}(0^-)$	497.67 ±0.13 S=1.1* m^2=0.24768		50 % K_{Short}, 50% K_{Long}		
K^0_S	$\frac{1}{2}(0^-)$		0.8923×10^{-10}	$\pi^+\pi^-$	(68.61 ± 0.24)% S=1.1*	206
			±0.0022	$\pi^0\pi^0$	(31.39)%	209
			$c\tau$=2.675	$\pi^+\pi^-\gamma$	[e](1.85 ± 0.10)$\times10^{-3}$	206
				$\mu^+\mu^-$	(<3.2)$\times10^{-7}$	225
				e^+e^-	(<3.4)$\times10^{-4}$	249
				$\gamma\gamma$	(<0.4)$\times10^{-3}$	249

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$ [a]	Mass [b] (MeV) Mass² (GeV²)	Mean life [b] (sec) cτ (cm)	Partial decay mode: Mode	Fraction [b]		p or p_{max} [c] (MeV/c)
K_L^0	$\frac{1}{2}(0^-)$		5.183×10^{-8} ±0.040 cτ=1554	$\pi^0\pi^0\pi^0$	(21.5 ± 1.0)%	S=1.7*	139
				$\pi^+\pi^-\pi^0$	(12.39 ± 0.20)%	S=1.3*	133
				$\pi^\pm\mu^\mp\nu$	(27.1 ± 0.4)%	S=1.4*	216
				$\pi^\pm e^\mp\nu$	(38.7 ± 0.5)%	S=1.5*	229
				†[$\pi e\nu\gamma$	[e](1.3 ± 0.8)%]		229
	$m_{K_L}-m_{K_S}$	$= 0.5349\times10^{10}\ \hbar\ \mathrm{sec}^{-1}$ ±0.0022		$\pi^+\pi^-$	[j](0.203 ± 0.005)%	S=1.1*	206
				$\pi^0\pi^0$	[j](0.094 ± 0.018)%	S=1.5*	209
				$\pi^+\pi^-\gamma$	[e](4.41 ± 0.32)$\times10^{-5}$		206
				$\pi^0\gamma\gamma$	(<2.4)$\times10^{-4}$		231
				$\gamma\gamma$	(4.9 ± 0.4)$\times10^{-4}$		249
				$e\mu$	[k](<6)$\times10^{-6}$		238
				$\mu^+\mu^-$	(9.1 ± 1.9)$\times10^{-9}$		225
				$\mu^+\mu^-\gamma$	(2.8 ± 2.8)$\times10^{-7}$		225
				$\pi^0\mu^+\mu^-$	(<1.2)$\times10^{-[illegible]}$		177
				e^+e^-	[k](<2.0)$\times10^{-7}$		249
				$e^+e^-\gamma$	(1.7 ± 0.9)$\times10^{-5}$		249
				$\pi^0e^+e^-$	(<2.3)$\times10^{-6}$		231
				$\pi^+\pi^-e^+e^-$	(<8.8)$\times10^{-6}$		206
				$\pi^0\pi^\pm e^\mp\nu$	(6.2 ± 2.0)$\times10^{-5}$		207

CHARMED NONSTRANGE MESONS [a]

Particle	$I^G(J^P)C_n$	Mass	Mean life	Mode	Fraction		p or p_{max}
				D^+ ⅂ (or D^- →CC)			
$D^\pm$	$\frac{1}{2}(0^-)$	1869.4 ±0.6 m^2=3.495	$(9.1^{+2.2}_{-1.5})\times10^{-13}$ cτ=0.027	$e^\pm$ anything	(19 $^{+4}_{-3}$)%		
				K^- anything	(16 ± 4)%		
				$\bar{K}^0$ any + K^0 any	(48 ± 15)%		
				K^+ anything	(6.0 ± 3.3)%		
	$m_{D^\pm}-m_{D^0}$	= 4.7 ±0.3		η anything	[ℓ](< 13)%		
				†[$K^-\pi^+\pi^+$	(4.6 ± 1.1)%		845
				$K^-\pi^+\pi^+\pi^+\pi^-$	(<4)%		772
				$\bar{K}^0\pi^+$	(1.8 ± 0.5)%		862
				$\bar{K}^0\pi^+\pi^0$	(13 ± 8)%		845
				$\bar{K}^0\pi^+\pi^+\pi^-$	(8.4 ± 3.5)%		814
				$\bar{K}^0K^+$	(0.45 ± 0.30)%		792
				$K^+K^-\pi^+$	(<0.6)%		744
				$K^+\pi^+\pi^-$	(<0.23)%		845
				$\pi^+\pi^0$	(<0.5)%		925
				$\pi^+\pi^+\pi^-$	(<0.37)%]		908
				†[$\bar{K}^{*0}\pi^+$	(<3.7)%]		714
				D^0 ⅂ (or $\bar{D}^0$ →CC)			
D^0 $\bar{D}^0$	$\frac{1}{2}(0^-)$	1864.7 ±0.6 m^2=3.477	$(4.8\ ^{+2.4}_{-1.5})\times10^{-13}$ cτ=0.014	$e^\pm$ anything	(<6)%		
				K^- anything	(44 ± 10)%	S=1.3*	
				$\bar{K}^0$ any + K^0 any	(33 ± 10)%		
				K^+ anything	(8 ± 3)%		
				η anything	[ℓ](< 13)%		
				†[$K^-\pi^+$	(*2.4* ± *0.4*)%		861
				$K^-\pi^+\pi^0$	(9.3 ± 2.8)%		844
				$K^-\pi^+\pi^+\pi^-$	(*4.5* ± *1.3*)%	S=1.4*	812
				$K^-\pi^+\pi^0\pi^0$	(seen)		815
				$\bar{K}^0\pi^0$	(2.2 ± 1.1)%		860
	$\frac{\Gamma(D^0\to\bar{D}^0\to K^+\pi^-)}{\Gamma(D^0\to K\pi)}$	< 0.16		$\bar{K}^0\pi^+\pi^-$	(4.2 ± 0.8)%		842
				$\pi^+\pi^-$	(7.9 ± 3.8)$\times10^{-4}$		922
				$\pi^+\pi^+\pi^-\pi^-$	(<9)$\times10^{-4}$		768
				K^+K^-	(2.7 ± 0.8)$\times10^{-3}$]		791
				†[$K^{*-}\pi^+$	(3.4 ± 1.4)%		711
				$\bar{K}^{*0}\pi^0$	(1.4 $^{+2.3}_{-1.4}$)%		711
				$K^-\rho^+$	(7.2 $^{+3.0}_{-3.1}$)%		679
				$\bar{K}^0\rho^0$	(0.1 $^{+0.6}_{-0.1}$)%]		677

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$ [a]	Mass [b] (MeV) Mass² (GeV²)	Mean life [b] (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction [b]	p or p_{max} [c] (MeV/c)
			CHARMED STRANGE MESON [a]			
				$F^+ \rightarrow$ (or $F^- \rightarrow$ CC)		
$F^\pm$	$0(0^-)$ [m]	2021	$(2.2^{+2.8}_{-1.1})\times10^{-13}$	$\eta\pi^+$	(seen)	930
		±15		$\eta\pi^+\pi^+\pi^-$	(seen)	885
				$\eta'\pi^+\pi^+\pi^-$	(seen)	713
				$\rho^+\phi$	(seen)	467
→ B						
			NONSTRANGE BARYONS [a]			
p	$\frac{1}{2}(\frac{1}{2}^+)$	938.2796	stable ($\gtrsim 8\times10^{30}$y)	stable		
		±0.0027				
		m^2=0.880369		$\lvert q_p\rvert - \lvert q_e\rvert < 10^{-21}\lvert q_e\rvert$ [n]		
n	$\frac{1}{2}(\frac{1}{2}^+)$	939.5731	925±11	$pe^-\bar{\nu}$	100%	1
		±0.0027	$c\tau=2.77\times10^{13}$	$p\nu\bar{\nu}$ (chg.noncons.)	$(<9\ )\times10^{-24}$	1
		m^2=0.882798				
		$m_p - m_n = -1.29343$				
		±0.00004		$\lvert q_n\rvert < 10^{-21}\lvert q_e\rvert$ [n]		
			STRANGENESS −1 BARYONS [a]			
Λ	$0(\frac{1}{2}^+)$	1115.60	2.632×10^{-10}	$p\pi^-$	(64.2 ± 0.5)%	100
		±0.05	±0.020 S=1.6*	$n\pi^0$	(35.8 ± 0.5)%	104
		S=1.2*	$c\tau$ =7.89	$pe^-\nu$	$(8.35\pm0.15)\times10^{-4}$	163
		m^2=1.2446		$p\mu^-\nu$	$(1.57\pm0.35)\times10^{-4}$	131
		$m_\Lambda - m_{\Sigma^0} = -76.86$		$p\pi^-\gamma$	[e] $(8.5\pm1.4)\times10^{-4}$	100
		±0.08				
Σ^+	$1(\frac{1}{2}^+)$	1189.36	0.800×10^{-10}	$p\pi^0$	(51.64 ± 0.30)%	189
		±0.06	±0.004	$n\pi^+$	(48.36 ± 0.30)%	185
		S=1.8*	$c\tau$=2.40	$p\gamma$	$(1.20\pm0.13)\times10^{-3}$ S=1.4*	225
		m^2=1.4146		$n\pi^+\gamma$	[e] $(4.5\pm0.5)\times10^{-4}$	185
				$\Lambda e^+\nu$	$(2.0\pm0.5)\times10^{-5}$	71
		$m_{\Sigma^+} - m_{\Sigma^-} = -7.97$		$n\mu^+\nu$	$(<3.0\ )\times10^{-5}$	202
		±0.07	$\frac{\Gamma(\Sigma^+\rightarrow \ell^+ n\nu)}{\Gamma(\Sigma^-\rightarrow \ell^- n\nu)} < .04$	$ne^+\nu$	$(<5\ )\times10^{-6}$	224
		S=1.3*		pe^+e^-	$(<7\ )\times10^{-6}$	225
Σ^0	$1(\frac{1}{2}^+)$ [p]	1192.46	5.8×10^{-20}	$\Lambda\gamma$	100%	74
		±0.08	±1.3	Λe^+e^-	[g] $(5.45\ )\times10^{-3}$	74
		m^2=1.4220	$c\tau=1.7\times10^{-9}$	$\Lambda\gamma\gamma$	(<3)%	74
Σ^-	$1(\frac{1}{2}^+)$	1197.34	1.482×10^{-10}	$n\pi^-$	100%	193
		±0.05	±0.011 S=1.3*	$ne^-\nu$	$(1.08\pm0.04)\times10^{-3}$	230
		m^2=1.4336	$c\tau$=4.44	$n\mu^-\nu$	$(0.45\pm0.04)\times10^{-3}$	210
				$\Lambda e^-\nu$	$(0.61\pm0.05)\times10^{-4}$	79
		$m_{\Sigma^0} - m_{\Sigma^-} = -4.88$		$n\pi^-\gamma$	[e] $(4.6\pm0.6)\times10^{-4}$	193
		±0.06				

Stable Particle Table *(cont'd)*

Particle	$I^G(J^P)C_n$ [a]	Mass [b] (MeV) Mass^2 (GeV^2)	Mean life [b] (sec) $c\tau$ (cm)	Partial decay mode: Mode	Fraction [b]	p or p_{max} [c] (MeV/c)
			STRANGENESS −2 BARYONS [a]			
Ξ^0	$\frac{1}{2}(\frac{1}{2}^+)$ [q]	1314.9	2.90×10^{-10}	$\Lambda\pi^0$	100%	135
		±0.6	±0.10	$\Lambda\gamma$	(0.5 ± 0.5)%	184
		m^2=1.729	$c\tau$=8.69	$\Sigma^0\gamma$	(<7)%	117
				$p\pi^-$	(<3.6)$\times10^{-5}$	299
				$pe^-\nu$	(<1.3)$\times10^{-3}$	323
		$m_{\Xi^0}-m_{\Xi^-}=-6.4$		$\Sigma^+e^-\nu$	(<1.1)$\times10^{-3}$	120
		±0.6		$\Sigma^-e^+\nu$	(<0.9)$\times10^{-3}$	112
				$\Sigma^+\mu^-\nu$	(<1.1)$\times10^{-3}$	65
				$\Sigma^-\mu^+\nu$	(<0.9)$\times10^{-3}$	49
				$p\mu^-\nu$	(<1.3)$\times10^{-3}$	309
Ξ^-	$\frac{1}{2}(\frac{1}{2}^+)$ [q]	1321.32	1.641×10^{-10}	$\Lambda\pi^-$	100%	139
		±0.13	±0.016	$\Lambda e^-\nu$	(2.9 ± 1.1)$\times10^{-4}$	190
		m^2=1.7459	$c\tau$=4.92	$\Sigma^0e^-\nu$	(<1.4)$\times10^{-4}$	123
				$\Lambda\mu^-\nu$	(3.5 ± 3.5)$\times10^{-4}$	163
				$\Sigma^0\mu^-\nu$	(<8)$\times10^{-4}$	70
				$n\pi^-$	(<1.1)$\times10^{-3}$	303
				$ne^-\nu$	(<3.2)$\times10^{-3}$	327
				$n\mu^-\nu$	(<1.5)%	313
				$\Sigma^-\gamma$	(<1.2)$\times10^{-3}$	118
				$p\pi^-\pi^-$	(<4)$\times10^{-4}$	223
				$p\pi^-e^-\nu$	(<4)$\times10^{-4}$	304
				$p\pi^-\mu^-\nu$	(<4)$\times10^{-4}$	250
				$\Xi^0e^-\nu$	(<2.3)$\times10^{-3}$	6
			STRANGENESS −3 BARYON [a]			
Ω^-	$0(\frac{3}{2}^+)$ [q]	1672.45	0.819×10^{-10}	ΛK^-	(68.6 ± 1.3)%	211
		±0.32	±0.027	$\Xi^0\pi^-$	(23.4 ± 1.3)%	294
		m^2=2.7971	$c\tau$=2.46	$\Xi^-\pi^0$	(8.0 ± 0.8)%	290
				$\Xi^0e^-\nu$	(~1)%	319
				$\Xi^0(1530)\pi^-$	(~2)$\times10^{-3}$	
				$\Lambda\pi^-$	(<1.3)$\times10^{-3}$	449
				$\Xi^-\gamma$	(<3.1)$\times10^{-3}$	314
			NONSTRANGE CHARMED BARYON [a]			
Λ_c^+	$0(\frac{1}{2}^+)$ [r]	2282.2	$(1.1^{+0.9}_{-0.4})\times10^{-13}$	$pK^-\pi^+$	(2.2 ± 1.0)%	820
		±3.1	$c\tau$=0.003	$p\overline{K}^0$	(1.1 ± 0.7)%	870
		S=1.8*		$p\overline{K}^0\pi^+\pi^-$	(<4)%	751
		m^2=5.21		$\Lambda\pi^+$	(0.6 ± 0.5)%	861
				$\Lambda\pi^+\pi^+\pi^-$	(<3.1, seen)%	804
				$\Sigma^0\pi^+$	(seen)	822
				†[pK^{*0}	(0.48 ± 0.30)%	682
				$\Delta^{++}K^-$	(0.45 ± 0.27)%	707
				$pK^{*-}\pi^+$	(seen)]	576
				e^+ anything	(4.5 ± 1.7)%	
				†[pe^+ anything	(1.8 ± 0.9)%	
				Λe^+ anything	(1.1 ± 0.8)%]	

→ Λ_b^0
→ searches for massive neutrinos and lepton mixing
→ ν bounds from astrophysics and cosmology
→ heavy lepton searches
→ weak gauge boson searches
→ free quark searches
→ magnetic monopole searches
→ charm searches and evidence
→ bottom hadron searches
→ top hadron searches
→ other stable particle searches

ADDENDUM TO

Stable Particle Table

	Magnetic Moment	
e^{w}	1.001 159 652 209 ±.000 000 000 031	$\frac{e\hbar}{2m_e c}$
μ^{w}	1.001 165 924 ±.000 000 009	$\frac{e\hbar}{2m_\mu c}$

μ Decay parameters[f]

$\rho = 0.752 \pm 0.003$ $\eta = -0.12 \pm 0.21$
$\xi \cdot P_\mu = 0.972 \pm 0.014$ $\delta = 0.755 \pm 0.009$ $h = 1.01 \pm 0.06$
$|g_A/g_V| = 0.86^{+0.33}_{-0.11}$ $\phi = 180° \pm 15°$

η

Mode	Left-right asymmetry	Sextant asymmetry	Quadrant asymmetry
$\pi^+\pi^-\pi^0$	$(0.12 \pm .17)\%$	$(0.19 \pm 0.16)\%$	$(-0.17 \pm 0.17)\%$
$\pi^+\pi^-\gamma$	$(0.88 \pm .40)\%$		$\beta = 0.047 \pm 0.062$

	Mode	Partial rate (sec^{-1})	
$K^\pm$	$\mu\nu$	$(51.33 \pm 0.17) \times 10^6$	S=1.2*
	$\pi\pi^0$	$(17.10 \pm 0.13) \times 10^6$	S=1.1*
	$\pi\pi^+\pi^-$	$(4.52 \pm 0.02) \times 10^6$	S=1.1*
	$\pi\pi^0\pi^0$	$(1.40 \pm 0.04) \times 10^6$	S=1.4*
	$\mu\pi^0\nu$	$(2.58 \pm 0.07) \times 10^6$	S=1.7*
	$e\pi^0\nu$	$(3.90 \pm 0.04) \times 10^6$	S=1.1*
K^0_S	$\pi^+\pi^-$	$^j(0.7689 \pm .0033) \times 10^{10}$	
	$\pi^0\pi^0$	$^j(0.3517 \pm .0029) \times 10^{10}$	S=1.1*
K^0_L	$\pi^0\pi^0\pi^0$	$(4.14 \pm 0.20) \times 10^6$	S=1.7*
	$\pi^+\pi^-\pi^0$	$(2.39 \pm 0.04) \times 10^6$	S=1.2*
	$\pi\mu\nu$	$(5.23 \pm 0.09) \times 10^6$	S=1.3*
	$\pi e\nu$	$(7.47 \pm 0.11) \times 10^6$	S=1.3*
	$\pi^+\pi^-$	$^j(3.91 \pm 0.10) \times 10^4$	S=1.1*
	$\pi^0\pi^0$	$^j(1.81 \pm 0.36) \times 10^4$	S=1.5*

Slope parameters for $K \to 3\pi$[f]

$K^+ \to \pi^+\pi^+\pi^-$ $g = -0.215 \pm .004$ S=1.4*
$K^- \to \pi^-\pi^-\pi^+$ $g = -0.217 \pm .007$ S=2.5*
$K^\pm \to \pi^0\pi^0\pi^\pm$ $g = 0.607 \pm .030$ S=1.3*
$K^0_L \to \pi^+\pi^-\pi^0$ $g = 0.670 \pm .014$ S=1.6*

See Data Card Listings for quadratic coefficients.

Form factors for $K_{\ell 3}$ decays

$K^\pm_{\ell 3}$: $\lambda^e_+ = 0.029 \pm .004$; $\lambda^\mu_+ = 0.026 \pm .008$ S=1.5*; $\lambda^\mu_0 = -0.003 \pm .007$ S=1.5*

$K^0_{\ell 3}$: $\lambda^e_+ = 0.0300 \pm .0016$ S=1.2*; $\lambda^\mu_+ = 0.034 \pm .006$ S=2.5*; $\lambda^\mu_0 = 0.020 \pm .007$ S=2.5*

See Data Card Listings for ξ, f_s, and f_t.

CP violation parameters[u,j]

$|\eta_{+-}| = (2.274 \pm .022) \times 10^{-3}$ $|\eta_{00}| = (2.33 \pm .08) \times 10^{-3}$ S=1.1*
$\phi_{+-} = (44.6 \pm 1.2)°$ $\phi_{00} = (54 \pm 5)°$
$|\eta_{+-0}|^2 < 0.$[illegible] $|\eta_{000}|^2 < 0.28$ $\delta = (0.330 \pm .012)\%$

$\Delta S = -\Delta Q$

Re x = 0.009 ± .020 S=1.4* Im x = −0.004 ± .026 S=1.1*

	Magnetic moment ($e\hbar/2m_pc$)	Mode	Decay parameters[v] Measured α	ϕ(degree)	Derived γ	Δ(degree)	Coupling Constant Ratios
p	2.7928456 ±.0000011						
n^{w}	−1.91304184 ±.00000088	$pe^-\nu$					$g_A/g_V = -1.255 \pm 0.006$ $\phi_{AV} = (180.11 \pm 0.17)°$
Λ^{w}	−0.613 ±.004	$p\pi^-$	0.642 ± 0.013	$(-6.5 \pm 3.5)°$	0.76	$(7.7 \pm 4.1)°$	
		$n\pi^0$	0.646 ± 0.044				
		$pe\nu$					$g_A/g_V = -0.690 \pm 0.034$ S=1.4*
Σ^+	2.33 ±.13	$p\pi^0$	-0.979 ± 0.016	$(36 \pm 34)°$	0.17	$(187 \pm 6)°$	
		$n\pi^+$	$+0.068 \pm 0.013$	$(167 \pm 20)°$	−0.97	$(-73^{+134}_{-10})°$	
		$p\gamma$	-0.72 ± 0.29	S=1.1*			
Σ^-	−1.41 ±.25	$n\pi^-$	-0.068 ± 0.008	$(10 \pm 15)°$	0.98	$(249^{+12}_{-116})°$	
		$ne^-\nu$					$g_A/g_V = \pm(0.385 \pm 0.070)$ S=2.3*
		$\Lambda e^-\nu$					$g_V/g_A = 0.14 \pm 0.24$ S=1.6* $g_{WM}/g_A = 2.4 \pm 1.7$
Ξ^0	−1.250 ±.014	$\Lambda\pi^0$	-0.413 ± 0.022 S=2.0*	$(21 \pm 12)°$	0.85	$(218^{+12}_{-18})°$	
Ξ^-	−1.85 ±.75	$\Lambda\pi^-$	-0.434 ± 0.015 S=1.4*	$(2 \pm 6)°$ S=1.1*	0.90	$(184 \pm 12)°$	
Ω^-		ΛK^-	-0.10 ± 0.38 S=1.2*				

Stable Particle Table *(cont'd)*

→ Indicates an entry in the Stable Particle Data Card Listings *not entered in the Stable Particle Table*.

• S = Scale factor = $\sqrt{\chi^2/(N-1)}$, where N ≈ number of experiments. S should be ≈1. If S > 1, we have enlarged the error of the mean, $\delta\bar{x}$; i.e., $\delta\bar{x} \to S\delta\bar{x}$. *This convention is still inadequate, since if S >> 1 the experiments are probably inconsistent, and therefore the real uncertainty is probably even greater than* $S\delta\bar{x}$. See text, and ideograms in Stable Particle Data Card Listings.

† Square brackets indicate subreactions of some previous unbracketed decay mode(s). Reactions in one set of brackets may overlap with reactions in another set of brackets.

a. The baryon number B, strangeness S, and charm C of the hadrons which appear in the tables are as follows:

Mesons (B=0)	S	C	Baryons (B=1)	S	C
π,η	0	0	p,n	0	0
K^+,K^0	+1	0	Λ,Σ	−1	0
$K^-,\bar{K}^0$	−1	0	Ξ	−2	0
D^+,D^0	0	+1	Ω^-	−3	0
$D^-,\bar{D}^0$	0	−1	Λ_c^+	0	+1
F^+	+1	+1			
F^-	−1	−1			

b. Quoted upper limits correspond to a 90% confidence level.

c. In decays with more than two bodies, p_{max} is the maximum momentum that any particle can have.

d. 99% confidence level. Lower limit from same experiment, > 14 eV, not yet confirmed. See Stable Particle Data Card Listings.

e. See Stable Particle Data Card Listings for energy limits used in this measurement.

f. Theoretical value; see also Stable Particle Data Card Listings.

g. See note in Stable Particle Data Card Listings.

h. Structure-dependent part with positive (SD+) and negative (SD−) photon helicity.

i. The direct emission branching fraction is $(1.56\pm.35)\times10^{-5}$.

j. The $K_S^0\to\pi\pi$ and $K_L^0\to\pi\pi$ rates (and branching fractions) are from our branching fraction and rate fits and do not include results of K_L^0-K_S^0 interference experiments. The $|\eta_{+-}|$ and $|\eta_{00}|$ values given in the addendum are these rates combined with the $|\eta_{+-}|$ and $|\eta_{00}|$ results from interference experiments.

k. The stronger limit $<2\times10^{-9}$ of Clark et al., Phys. Rev. Lett. **26**, 1667 (1971) is not listed because of possible (but unknown) systematic errors. See Stable Particle Data Card Listings.

ℓ. This is a weighted average of $D^\pm$ (44%) and D^0 (56%) branching fractions.

m. Quantum numbers shown are favored but not yet established. See Stable Particle Data Card Listings.

n. Limit from neutrality-of-matter experiments. Assumes $|q_n|=|q_p| - |q_e|$.

p. J^P not measured for Σ^0. Assumed same as $\Sigma^\pm$ to allow isotriplet association.

q. P for Ξ and J^P for Ω^- not yet measured. Values shown are SU(3) predictions.

r. J^P for Λ_c^+ not yet measured. Values shown are SU(4) predictions.

s. $|g_A/g_V|$ defined by $g_A^2 = |C_A|^2+|C'_A|^2$, $g_V^2 = |C_V|^2+|C'_V|^2$, and $\Sigma\langle\bar{e}|\Gamma_i|\mu\rangle\langle\bar{\nu}|\Gamma_i(C_i+C'_i\gamma_5)|\nu\rangle$; ϕ defined by $\cos\phi = -\mathrm{Re}(C_A^*C'_V+C'_AC_V^*)/g_Ag_V$. P_μ is muon longitudinal polarization [for more details, see text Section VI A].

t. The definition of the slope parameter of the Dalitz plot is as follows [see also text Section VI B.1]: $|M|^2 = 1 + g\left(\frac{s_3-s_0}{m_{\pi^+}^2}\right)$

u. The definition for the CP violation parameters is as follows [see also text Section VI B.3]:

$$\eta_{+-} = |\eta_{+-}|e^{i\phi_{+-}} = \frac{A(K_L^0\to\pi^+\pi^-)}{A(K_S^0\to\pi^+\pi^-)} \qquad \eta_{00} = |\eta_{00}|e^{i\phi_{00}} = \frac{A(K_L^0\to\pi^0\pi^0)}{A(K_S^0\to\pi^0\pi^0)}$$

$$\delta = \frac{\Gamma(K_L^0\to\ell^+)-\Gamma(K_L^0\to\ell^-)}{\Gamma(K_L^0\to\ell^+)+\Gamma(K_L^0\to\ell^-)}, \quad |\eta_{+-0}|^2 = \frac{\Gamma(K_S^0\to\pi^+\pi^-\pi^0)^{\text{CP viol.}}}{\Gamma(K_L^0\to\pi^+\pi^-\pi^0)}, \quad |\eta_{000}|^2 = \frac{\Gamma(K_S^0\to\pi^0\pi^0\pi^0)^{\text{CP viol.}}}{\Gamma(K_L^0\to\pi^0\pi^0\pi^0)}.$$

v. The definition of these quantities is as follows [for more details on sign convention, see text Section VI B]:

$\alpha = \dfrac{2\lvert s\rvert\lvert p\rvert\cos\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\beta = \sqrt{1-\alpha^2}\sin\phi$	g_A, g_V, g_{WM} defined by $\langle B_f\lvert\gamma_\lambda(g_V-g_A\gamma_5)+(g_{WM}/m_{B_i})\sigma^{\lambda\nu}q_\nu\rvert B_i\rangle$
$\beta = \dfrac{-2\lvert s\rvert\lvert p\rvert\sin\Delta}{\lvert s\rvert^2+\lvert p\rvert^2}$	$\gamma = \sqrt{1-\alpha^2}\cos\phi$	ϕ_{AV} defined by $g_A/g_V = \lvert g_A/g_V\rvert e^{i\phi_{AV}}$

w. For limits on electric dipole moment, see Data Card Listings. Forbidden by P and T invariance.

Meson Table

April 1982

In addition to the entries in the Meson Table, the Meson Data Card Listings contain all substantial claims for meson resonances. See contents of Meson Data Card Listings below.

Quantities in italics are new or have changed by more than one (old) standard deviation since April 1980.

J^P	G \ I	0	1	½
N	+	ε	ρ	K*
	−	ω/φ	δ	
A	+−	η	π	K

	$I^G(J^P)C_n$ ⟼ *estab.*	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$[a] (GeV^2)	Partial decay mode: Mode	Fraction(%) [Upper limits (%) are 90% CL]		p or p_{max}[b] (MeV/c)
NONSTRANGE MESONS								
$\pi^{\pm}$	$1^-(0^-)+$	139.57	0.0	0.019479	See Stable Particle Table			
π^0		134.96	7.95 eV	0.018215				
			±0.55 eV					
η	$0^+(0^-)+$	548.8	0.83 keV	0.301	Neutral	70.9	See Stable	
		±0.6	±0.12 keV	±0.000	Charged	29.1	Particle Table	
$\rho(770)$	$1^+(1^-)-$	*769*‡	154‡	0.591	$\pi\pi$	≈ 100		358
		±*3*§	±5§	±0.118	$\pi\gamma$	*0.044±0.005*		372
					$\mu^+\mu^-$	0.0067±0.0012[d]		370
					e^+e^-	0.0043±0.0005[d]		384
					$\eta\gamma$	seen‡		189
M and Γ from neutral mode.					For upper limits, see footnote *e*			
$\omega(783)$	$0^-(1^-)-$	782.6	9.9	0.612	$\pi^+\pi^-\pi^0$	89.9±0.5		327
		±0.2	±0.3	±0.008	$\pi^0\gamma$	8.7±0.5		380
		S=1.1*			$\pi^+\pi^-$	1.4±0.2		366
					$\pi^0\mu^+\mu^-$	*0.010±0.002*		349
					e^+e^-	0.0072±0.0007	S=1.3*	391
					$\eta\gamma$	seen‡		199
					For upper limits, see footnote *f*			
$\eta'(958)$	$0^+(0^-)+$‡	957.57	0.28	0.917	$\eta\pi\pi$	65.3±1.6		231
		±0.25	±0.10	±0.0003	$\rho^0\gamma$	30.0±1.6		170
					$\omega\gamma$	2.8±0.5		159
					$\gamma\gamma$	1.9±0.2		479
					$\mu^+\mu^-\gamma$	*0.009±0.002*		467
					For upper limits, see footnote *g*			
$S^*(975)$	$0^+(0^+)+$	975[c]	33[c]	0.951	$\pi\pi$	*78±3*		467
		±4	±6	±0.032	$K\bar{K}$	*22±3*		
		S=1.4*						
See note on $\pi\pi$ and $K\bar{K}$ S wave.‡								
$\delta(980)$‡	$1^-(0^+)+$	983[h]	54[h]	0.966	$\eta\pi$	seen		320
		±2	±7	±0.053	$K\bar{K}$	seen		
$\phi(1020)$	$0^-(1^-)-$	1019.61	4.21	1.040	K^+K^-	49.1±1.0	S=1.3*	127
		±0.07	±0.13	±0.004	K_LK_S	34.6±1.0	S=1.3*	111
					$\pi^+\pi^-\pi^0$ (incl. $\rho\pi$)	14.8±0.7	S=1.2*	462
					$\eta\gamma$	1.5±0.2		362
					$\pi^0\gamma$	0.14±0.05		501
					e^+e^-	0.031±0.001		510
					$\mu^+\mu^-$	0.025±0.003		499
					$\pi^+\pi^-$	*0.02±0.01*		490
					For upper limits, see footnote *i*			
H(1190)	$0^-(1^+)-$	*1190*	*320*	1.416	$\rho\pi$	*seen*		327
		±60	*±50*	±0.381				
Seen in one experiment only.								
B(1235)	$1^+(1^+)-$	1233	137	1.52	$\omega\pi$	only mode seen		349
		±10§	±10§	±0.17	[D/S amplitude ratio = 0.29±0.05]			
					For upper limits, see footnote *j*			

Meson Table *(cont'd)*

J^P / G	0	1	½
N: +	ε	ρ	K^*
−	ω/φ	δ	
A: + −	η	π	K

Name	$I^G(J^P)C_n$ ⟼ *estab.*	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Partial decay mode: Mode	Fraction(%) [Upper limits (%) are 90% CL]	p or p_{max}[b] (MeV/c)
f(1270)	$0^+(2^+)+$	1273 ±5[§]	179 ±20[§]	1.62 ±0.23	ππ	83.1±1.9 S=1.4*	621
					$2\pi^+2\pi^-$	2.8±0.4 S=1.2*	558
					$K\bar{K}$	2.9±0.2 S=1.2*	397
					γγ	*0.0016±0.0003*	637
					$\pi^+\pi^-2\pi^0$	seen	561
					For upper limits, see footnote *k*		
$A_1(1270)$	$1^-(1^+)+$	*1275*[‡] *±30*	*315*[‡] *±45*	1.63 ±0.40	ρπ	*dominant*	389
					$\pi(\pi\pi)_{S\text{-wave}}$	*seen*	599
→ D(1285)	$0^+(1^+)+$	1283 ±5[§]	26 ±5[§]	1.65 ±0.03	$K\bar{K}\pi$	11±3	302
					ηππ	49±6	482
					†[δπ	36±7]	236
					4π (prob. ρππ)[‡]	40±7	564
ε(1300)	$0^+(0^+)+$	~1300	200–600		ππ	~90	635
					$K\bar{K}$	~10	418
					ηη		348
See note on ππ and $K\bar{K}$ S wave.[‡]							
π(1300)	$1^-(0^-)+$	*1300*[§] *±100*[§]	*200−600*		ρπ	*seen*	407
					$\pi(\pi\pi)_{S\text{-wave}}$	*seen*	612
Not a well-established resonance.							
$A_2(1320)$	$1^-(2^+)+$	1318 ±5[§]	*110* *±5*[§]	1.74 ±0.14	ρπ	70.1±2.2	419
					ηπ	14.5±1.2	534
					ωππ	10.6±2.5	361
					$K\bar{K}$	4.8±0.5	434
					η′π	< 2 (CL=97%)	286
					πγ	0.45±0.11	652
					γγ	*0.0007±0.0004*	659
E(1420)[‡]	$0^+(1^+)+$	1418 ±10[§]	52 ±10[§]	2.01 ±0.07	$K\bar{K}\pi$ (prob. $K^*\bar{K}+K\bar{K}^*$)	seen	423
					ηππ	possibly seen	565
					†[δπ	possibly seen]	348
f′(1515)	$0^+(2^+)+$	1520 ±10[§]	75 ±10[§]	2.31 ±0.11	$K\bar{K}$	dominant	574
					ππ	possibly seen	747
ρ′(1600)	$1^+(1^-)-$	1600[‡] ±20[§]	300[‡] ±100[§]	2.56 ±0.48	4π (incl. $\rho\pi^+\pi^-$, $A_1\pi$)	large	738
					ππ	< 30[‡]	788
					$K^*\bar{K} + \bar{K}^*K$	~15	388
					ηππ	~13	675
					$\bar{K}K$	~1	630
					e^+e^-	seen	800
→ ω(1670)	$0^-(3^-)-$	1688 ±5	166 ±15[§] S=1.1*	2.78 ±0.28	3π	seen	806
					†[ρπ	seen]	648
					5π	seen	740
					†[ωππ (prob. Bπ)	seen]	616
$A_3(1680)$[‡]	$1^-(2^-)+$	*1680*[§] *±30*[§]	250[§] ±50[§]	2.82 ±0.42	fπ	55±5	337
					ρπ	36±6	656
					$\pi(\pi\pi)_{S\text{-wave}}$	9±5	813
					For upper limits, see footnote *ℓ*		
φ′(1680)	$0^-(1^-)-$	*1684* *±15*[§]	*126* *±22*	2.84 ±0.21	$K^*\bar{K} + \bar{K}^*K$	*dominant*	541
					ωππ	*seen*	624
					$K\bar{K}$	*seen*	682
g(1690)[‡]	$1^+(3^-)-$	1691 ±5[§]	200[§] ±20[§]	2.86 ±0.34	2π	23.8±1.3	834
					4π (incl. ππρ, ρρ, $A_2\pi$, ωπ)	70.9±1.9	787
					$K\bar{K}\pi$ (incl. $K^*\bar{K}$)	*3.8±1.2*	625
					$K\bar{K}$	1.5±0.3 S=1.3*	684

→ J^P, M, and Γ from the 2π and $K\bar{K}$ modes.

Meson Table *(cont'd)*

J^P \ G I	0	1	½	$I^G(J^P)C_n$ ⟶ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Partial decay mode: Mode	Fraction(%) [Upper limits (%) are 90% CL]	p or p_{max} [b] (MeV/c)
N +	ε	ρ	K*							
N −	ω/φ	δ								
A +−	η	π	K							

Particle	$I^G(J^P)C_n$	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Mode	Fraction(%)	p or p_{max} (MeV/c)
h(2040)	$0^+(4^+)+$	$2040^{\S}$ $\pm 20^{\S}$	$150^{\S}$ $\pm 50^{\S}$	4.16 $\pm$0.31	$\pi\pi$	seen	1010
					$K\bar{K}$	seen	890
$\eta_c(2980)$	$0^+(\ )+$	*2981* *±6*	*< 20*	8.89	$\eta\pi^+\pi^-$	*seen*	1426
					$2(\pi^+\pi^-)$	*seen*	1458
					$K^+K^-\pi^+\pi^-$	*seen*	1343
					$p\bar{p}$	*seen*	1158
J/ψ(3100)	$0^-(1^-)-$	3096.9 ±0.1	0.063 ±0.009	9.591 ±0.000	e^+e^-	7.4±1.2	1548
					$\mu^+\mu^-$	7.4±1.2	1545
					hadrons + radiative	85±2	

Decay modes into stable hadrons

Mode	Fraction(%)	p (MeV/c)
†[$2(\pi^+\pi^-)\pi^0$	3.7±0.5	1496
$3(\pi^+\pi^-)\pi^0$	2.9±0.7	1433
$\pi^+\pi^-\pi^0K^+K^-$	1.2±0.3	1368
$4(\pi^+\pi^-)\pi^0$	0.9±0.3	1345
$\pi^+\pi^-K^+K^-$	0.72±0.23	1407
$p\bar{p}\pi^+\pi^-$	0.53±0.06	1107
$2(\pi^+\pi^-)$	0.4±0.1	1517
$3(\pi^+\pi^-)$	0.4±0.2	1466
$n\bar{n}\pi^+\pi^-$	*0.38±0.36*	1106
$\Xi\bar{\Xi}$	0.32±0.08	818
$2(\pi^+\pi^-)K^+K^-$	0.31±0.13	1320
$K_S^0K^\pm\pi^\mp$	0.26±0.07	1440
$\Sigma^+\bar{\Sigma}^-$	*0.24±0.26*	988
$p\bar{p}\eta$	0.23±0.04	948
$p\bar{p}$	0.22±0.02	1232
$p\bar{n}\pi^-$ or $\bar{p}n\pi^+$	0.21±0.02	1174
$n\bar{n}$	0.18±0.09	1231
$p\bar{p}\pi^+\pi^-\pi^0$	0.16 ± 0.06^m	1033
$\Sigma^0\bar{\Sigma}^0$	0.13±0.04	988
$\Lambda\bar{\Lambda}$	0.11±0.02	1074
$p\bar{p}\pi^0$	0.11±0.01	1176
$2(K^+K^-)$	*0.07±0.03*	1131
K^+K^-	*0.022±0.008*	1468
$\pi^+\pi^-$	*0.011±0.005*	1542
$\Lambda\bar{\Sigma}$	< 0.015	1032
$K_S^0K_L^0$	< *0.009*]	1466

Decay modes into hadronic resonances

Mode	Fraction(%)		p (MeV/c)
†[$\rho\pi$	1.22±0.12		1449
$\omega 2\pi^+2\pi^-$	0.85±0.34		1392
ρA_2	0.84±0.45		1126
$\omega\pi\pi$	0.68±0.19		1435
$K^{*0}(892)\bar{K}^{*0}(1430)$+c.c.	0.67±0.26		1007
$K^\pm K^{*\mp}(892)$	0.34±0.05		1373
$B^\pm(1235)\pi^\mp$	0.29±0.07		1299
$K^0\bar{K}^{*0}(892)$+c.c.	0.27±0.06		1373
ωf	0.23±0.08	S=1.2*	1144
$\phi\pi^+\pi^-$	0.21±0.09		1365
$\eta' p\bar{p}$	0.18±0.06		596
$\phi K\bar{K}$	0.18±0.08		1176
$\omega p\bar{p}$	0.16±0.03		768
$\omega K\bar{K}$	0.16±0.10		1265
$\phi\eta$	0.10±0.06		1320
$\phi f'(1515)$	*0.08±0.05*		874
$\pi^\pm A_2^\mp$	< *0.43*		1263
$K^{*0}(1430)\bar{K}^{*0}(1430)$	< *0.29*		584
$K^0\bar{K}^{*0}(1430)$+c.c.	< *0.2*		1154
$K^\pm K^{*\mp}(1430)$	< *0.2*		1154
$\phi 2\pi^+2\pi^-$	< *0.15*		1318
$\phi\eta'$	< *0.13*		1192
$K^{*0}(892)\bar{K}^{*0}(892)$	< *0.05*		1266
ϕf	< *0.037*		1037
$\omega f'$	< *0.016*]		1006

Radiative decay modes

Mode	Fraction(%)	p (MeV/c)
†[$\gamma\iota(1440)$	0.55 ± 0.22^n	1224
$\gamma\eta'$	*0.36±0.05*	1400
γf	0.15±0.04	1287
$\gamma\eta$	*0.086±0.009*	1500
$\gamma\pi^0$	*0.007±0.005*	1546
$\gamma D(1285)$	< *0.6*	1283
2γ	< *0.05*	1548
$\gamma f'(1515)$	< *0.03*	1175
$\gamma p\bar{p}$	< *0.01*	1232
3γ	< *0.006*]	1548

Particle	$I^G(J^P)C_n$	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Mode	Fraction(%)	p or p_{max} (MeV/c)
χ(3415)	$0^+(0^+)+$	3415.0 ±1.0		11.662	$2(\pi^+\pi^-)$ (incl. $\pi\pi\rho$)	4.3±0.9	1679
					$\pi^+\pi^-K^+K^-$ (incl. $\pi K\bar{K}^*$)	3.4±0.9	1580
					$3(\pi^+\pi^-)$	1.7±0.6	1633
					$\pi^+\pi^-$	0.9±0.2	1702
					$\gamma J/\psi(3100)$	*0.8±0.2*	303
					K^+K^-	0.8±0.2	1635
					$p\bar{p}\pi^+\pi^-$	0.6±0.2	1320
					For upper limits, see footnote *o*		

Meson Table *(cont'd)*

J^P \ G, I	0	1	½
N +	ε	ρ	K*
N −	ω/φ	δ	
A +−	η	π	K

Name	$I^G(J^P)C_n$ ⟼ estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Mode	Fraction(%) [Upper limits (%) are 90% CL]	p or p_{max} ^{b} (MeV/c)
P_c or χ(3510)	$0^+(1^+)+$	3510.0 ±0.6		12.320	$\gamma J/\psi(3100)$	28±3	389
					$3(\pi^+\pi^-)$	2.4±0.9	1683
					$2(\pi^+\pi^-)$ (incl. $\pi\pi\rho$)	1.8±0.5	1727
					$\pi^+\pi^-K^+K^-$ (incl. $\pi K\bar{K}^*$)	1.0±0.4	1632
					$\pi^+\pi^-p\bar{p}$	0.15±0.10	1381
					For upper limits, see footnote *p*		
χ(3555)	$0^+(2^+)+$	3555.8 ±0.6		12.644	$\gamma J/\psi(3100)$	15.7±1.7	429
					$2(\pi^+\pi^-)$ (incl. $\pi\pi\rho$)	2.3±0.5	1750
					$\pi^+\pi^-K^+K^-$ (incl $\pi K\bar{K}^*$)	2.0±0.5	1656
					$3(\pi^+\pi^-)$	1.2±0.8	1706
					$\pi^+\pi^-p\bar{p}$	0.35±0.14	1410
					$\pi^+\pi^-$	*0.20±0.11*	1772
					K^+K^-	*0.16±0.12*	1708
					For upper limits, see footnote *q*		
→ *ψ(3685)*	$0^-(1^-)-$	*3686.0* ±0.1	*0.215* ±0.040	*13.587* ±0.001	e^+e^-	*0.9±0.1*	*1843*
					$\mu^+\mu^-$	0.8±0.2	1840
					hadrons + radiative	98.1±0.3	
	$m_{\psi(3685)} - m_{\psi(3100)}$ = *589.06±0.13*						

Radiative decay modes			Decay modes into hadrons		
†[$\gamma\chi(3415)$	8.2±1.4	261	†[$J/\psi\pi^+\pi^-$	33±2	477
$\gamma\chi(3510)$	8.0±1.3	*172*	$J/\psi\pi^0\pi^0$	*17±2*	*481*
$\gamma\chi(3555)$	7.4±1.3	128	$J/\psi\eta$	*2.8±0.6*§	196
$\gamma\eta_c(2980)$	*0.43±0.26*	638	$2(\pi^+\pi^-)\pi^0$	0.35±0.15	1799
$\gamma\eta_c'(3590)$	*0.2* to *1.3*	91	$\pi^+\pi^-K^+K^-$	0.16±0.04	1726
$\gamma\pi^0$	*<0.5* (CL=95%)	1841	$J/\psi\pi^0$	*0.10±0.03*	528
$\gamma\eta$	*<0.02*	1802	$p\bar{p}\pi^+\pi^-$	0.08±0.02	1491
$\gamma\eta'$	*<0.02*	1719	$K^{*0}(892)K^\pm\pi^\mp$	*0.067±0.025*	1674
$\gamma\iota(1440)$	*<0.018*^{n}]	1570	$2(\pi^+\pi^-)$	0.05±0.01	1817
			$\rho^0\pi^+\pi^-$	*0.042±0.015*	1751
			$p\bar{p}$	*0.019±0.005*	1586
			$3(\pi^+\pi^-)$	*0.015±0.010*	1774
			K^+K^-	*0.010±0.007*	1776
			$\pi^+\pi^-$	*0.008±0.005*	1838
			$\rho\pi$	*<0.1*	1760
			$\Lambda\bar{\Lambda}$	*<0.04*]	1467

Name	$I^G(J^P)C_n$	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M$ (GeV^2)	Mode	Fraction(%)	p or p_{max} (MeV/c)
ψ(3770)	$(1^-)-$	3770 ±3	25 ±3	14.213 ±0.094	e^+e^-	0.0011±0.0002	1885
					$D\bar{D}$	dominant	242
	$m_{\psi(3770)} - m_{\psi(3685)}$ = 83.9±2.4 S=1.8*						
ψ(4030)	$(1^-)-$	4030§ ±5§	52 ±10	16.241 ±0.210	e^+e^-	0.0014±0.0004	2015
					hadrons	dominant	
ψ(4160)	$(1^-)-$	4159 ±20	78 ±20	17.297 ±0.324	e^+e^-	0.0010±0.0004	2079
					hadrons	dominant	
ψ(4415)	$(1^-)-$	4415 ±6	43 ±20§	19.492 ±0.190	e^+e^-	0.0010±0.0003 S=1.4*	2208
					hadrons	dominant	
Υ(9460)	$(1^-)-$	9456 ±10	0.042 ±0.015	89.416 ±0.0004	$\mu^+\mu^-$	3.2±0.7	4727
					e^+e^-	2.8±1.1	4728
Υ(10020)	$(1^-)-$	10016 ±10	0.030 ±*0.010*	100.320 ±0.0003	$\mu^+\mu^-$	*seen*	5007
					e^+e^-	*1.7±0.6*	5008
					$\Upsilon(9460)\pi\pi$	*30±6*	472
	$m_{\Upsilon(10020)} - m_{\Upsilon(9460)}$ = 559±3						
Υ(10350)	$(1^-)-$	*10347* ±*10*		107.060	e^+e^-	*seen*	5174
	$m_{\Upsilon(10350)} - m_{\Upsilon(9460)}$ = *891±4*						

Meson Table *(cont'd)*

J^P / G	I: 0	1	½
N: +	ε	ρ	K*
−	ω/φ	δ	
A: +−	η	π	K

Name	$I^G(J^P)C_n$ —— estab.	Mass M (MeV)	Full Width Γ (MeV)	M^2 $\pm\Gamma M^a$ (GeV^2)	Partial decay mode: Mode	Fraction(%) [Upper limits (%) are 90% CL]	p or p_{max} ^{b} (MeV/c)
Υ(10570)	$(1^-)-$	*10569* *±10*	*14* *±5*	111.704 ±0.15	e^+e^-	*0.0019±0.0008*	5285
	$m_{\Upsilon(10570)} - m_{\Upsilon(9460)} = 1113\pm4$						
STRANGE MESONS							
K^+	$1/2(0^-)$	493.67		0.244	See Stable Particle Table		
K^0		497.67		0.248			
K*(892)	$1/2(1^-)$	891.8 ±0.4 S=1.2*	50.8 ±0.9	0.795 ±0.045	Kπ	≈ 100	288
					Kγ	0.15±0.07	309
					Kππ	< 0.07 (CL=95%)	216
M and Γ from charged mode; $m^0 - m^\pm = 6.7\pm1.2$ MeV.							
$Q_1(1280)$	$1/2(1^+)$	1270§ ±10§	90§ ±20§	1.61 ±0.11	Kρ	*42±6*	45
					κπ	*28±4*	
					K*π	*16±5*	299
					Kω	*11±2*	
					Kε	*3±2*	
κ(1350)	$1/2(0^+)$	~1350	~250	1.82 ±0.34	Kπ	seen	574
See note on Kπ S wave.‡							
$Q_2(1400)$	$1/2(1^+)$	1414 ±13	180 ±10	2.00 ±0.25	K*π	*94±6*	410
					Kρ	*3±3*	308
					Kε	*2±2*	
					Kω	*1±1*	294
K*(1430)	$1/2(2^+)$	1434§ ±5§	100§ ±10§	2.06 ±0.14	Kπ	*44.8±2.3* S=2.7*	623
					K*π	*24.6±2.0* S=1.1*	424
					K*ππ	13.0±2.6 S=1.1*	374
					Kρ	*8.8±1.1* S=1.3*	334
					Kω	4.2±1.5	320
					Kη	5±5§	492
L(1770)‡	$1/2(2^-)$	*~1770*§	*~200*§	3.13 ±0.35	K*(1430)π	dominant	278
					K*(892)π	*seen*	652
					Kf	*seen*	
See note on L(1770).‡							
K*(1780)‡	$1/2(3^-)$	*1775*§ *±10*§	140§ ±20§	3.15 ±0.25	Kππ	large	793
					†[Kρ	large]	616
					†[K*π	large]	654
					Kπ	17±5§	812
See note on K*(1780).‡							
CHARMED, NONSTRANGE MESONS							
D^+	$1/2(0^-)$	1869.4		3.495	See Stable Particle Table		
D^0		1864.7		3.477			
$D^{*+}(2010)$	$1/2(1^-)$	2010.1 ±0.7	< 2.0	4.041	$D^0\pi^+$	64±11	39
					$D^+\pi^0$	28±9	38
					$D^+\gamma$	8±7	136
	$m_{D^{*+}} - m_{D^0} = 145.4\pm0.2$ MeV						
$D^{*0}(2010)$	$1/2(1^-)$	2007.2 ±2.1	< 5	4.029	$D^0\pi^0$	55±15	44
					$D^0\gamma$	45±15	137
CHARMED, STRANGE MESON							
F^+	$0(0^-)$	2021		4.084	See Stable Particle Table		

Meson Table *(cont'd)*

Contents of Meson Data Card Listings

Non-strange ($S = 0$; $C,B = 0$)						Strange ($\|S\| = 1$; $C,B = 0$)	
entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I^G(J^P)C_n$	entry	$I\ (J^P)$
π	$1^-(0^-)+$	f' (1515)	$0^+(2^+)+$	→ δ (2450)	$1^-(6^+)+$	K	$1/2(0^-)$
η	$0^+(0^-)+$	ρ' (1600)	$1^+(1^-)-$	→ e^+e^- (1100−2200)		K^* (892)	$1/2(1^-)$
ρ (770)	$1^+(1^-)-$	→ θ (1640)	$0^+(2^+)+$	→ $\bar{N}N$ (1400−3600)		Q_1 (1280)	$1/2(1^+)$
ω (783)	$0^-(1^-)-$	ω (1670)	$0^-(3^-)-$	→ X (1900−3600)		κ (1350)	$1/2(0^+)$
η' (958)	$0^+(0^-)+$	A_3 (1680)	$1^-(2^-)+$	η_c (2980)	$+$	Q_2 (1400)	$1/2(1^+)$
S^* (975)	$0^+(0^+)+$	ϕ' (1680)	$0^-(1^-)-$	J/ψ (3100)	$0^-(1^-)-$	→ K' (1400)	$1/2(0^-)$
δ (980)	$1^-(0^+)+$	g (1690)	$1^+(3^-)-$	χ (3415)	$0^+(0^+)+$	K^* (1430)	$1/2(2^+)$
ϕ (1020)	$0^-(1^-)-$	→ ϕ (1850)	0	P_c or χ(3510)	$0^+(1^+)+$	→ L (1580)	$1/2(2^-)$
H (1190)	$0^-(1^+)-$	→ X (1850)	(2^+)	χ (3555)	$0^+(2^+)+$	→ K^* (1650)	$1/2(1^-)$
B (1235)	$1^+(1^+)-$	→ S (1935)		→ η_c' (3590)	$+$	L (1770)	$1/2(2^-)$
→ ρ' (1250)	$1^+(1^-)-$	→ δ (2030)	$1^-(4^+)+$	ψ (3685)	$0^-(1^-)-$	K^* (1780)	$1/2(3^-)$
f (1270)	$0^+(2^+)+$	h (2040)	$0^+(4^+)+$	ψ (3770)	$(1^-)-$	→ K^* (2060)	$1/2(4^+)$
A_1 (1270)	$1^-(1^+)+$	→ π (2050)	$1^-(3^+)+$	ψ (4030)	$(1^-)-$	→ K^* (2200)	
→ η (1275)	$0^+(0^-)+$	→ π (2100)	$1^-(2^-)+$	ψ (4160)	$(1^-)-$	Charmed ($\|C\| = 1$)	
D (1285)	$0^+(1^+)+$	→ ρ (2150)	$1^+(1^-)-$	ψ (4415)	$(1^-)-$	D (1870)	$1/2(0^-)$
ϵ (1300)	$0^+(0^+)+$	→ ϵ (2150)	$0^+(2^+)+$	Υ (9460)	$(1^-)-$	D^* (2010)	$1/2(1^-)$
π (1300)	$1^-(0^-)+$	→ ρ (2250)	$1^+(3^-)-$	Υ (10020)	$(1^-)-$	F (2020)	$0\ (0^-)$
A_2 (1320)	$1^-(2^+)+$	→ ϵ (2300)	$0^+(4^+)+$	Υ (10350)	$(1^-)-$	→ F^* (2140)	
E (1420)	$0^+(1^+)+$	→ ρ (2350)	$1^+(5^-)-$	Υ (10570)	$(1^-)-$	Bottom (Beauty) ($\|B\| = 1$)	
						→ B (5200)	
						→ Exotics	

→ Indicates an entry in the Meson Data Card Listings not entered in the Meson Table. We do not regard these as established resonances. All the entries in the Listings can be found in the Table of Contents of the Meson Data Card Listings immediately preceding these footnotes.

‡ See Meson Data Card Listings.

• Quoted error includes scale factor $S = \sqrt{\chi^2/(N-1)}$. See footnote to Stable Particle Table.

† Square brackets indicate a subreaction of the previous (unbracketed) decay mode(s).

§ This is only an educated guess; the error given is larger than the error on the average of the published values. (See the Meson Data Card Listings for the latter.)

a. ΓM is approximately the half-width of the resonance when plotted against M^2.

b. For decay modes into ≥ 3 particles, p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated by using the averaged central mass values, without taking into account the widths of the resonances.

c. From pole position $(M - i\Gamma/2)$.

d. The e^+e^- branching fraction is from $e^+e^- \to \pi^+\pi^-$ experiments only. The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. See note in the Meson Data Card Listings. The $\mu^+\mu^-$ branching fraction is compiled from 3 experiments, each possibly with substantial $\omega\rho$ interference. The error reflects this uncertainty; see notes in the Meson Data Card Listings. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times 0.99785$.

Meson Table *(cont'd)*

e. Empirical limits on fractions for other decay modes of $\rho(770)$ are $\pi^{\pm}\eta < 0.8\%$ (CL=84%), $\pi^+\pi^+\pi^-\pi^- < 0.15\%$, $\pi^{\pm}\pi^+\pi^-\pi^0 <$ 0.2% (CL=84%).

f. Empirical limits on fractions for other decay modes of $\omega(783)$ are $\pi^+\pi^-\gamma < 5\%$, $\pi^0\pi^0\gamma < 1\%$, η + neutral(s) < 1.5%, $\mu^+\mu^- <$ 0.02%.

g. Empirical limits on fractions for other decay modes of $\eta'(958)$ are $\pi^+\pi^- < 2\%$ (CL=84%), $\pi^+\pi^-\pi^0 < 5\%$ (CL=84%), $\pi^+\pi^+\pi^-\pi^-$ < 1% (CL=95%) $\pi^+\pi^+\pi^-\pi^-\pi^0 < 1\%$ (CL=84%), $6\pi < 1\%$, $\pi^+\pi^-e^+e^- < 0.6\%$, $\pi^0e^+e^- < 1.3\%$ (CL=84%), $\eta e^+e^- < 1.1\%$, $\pi^0\rho^0$ < 4%, $\eta\mu^+\mu^- < 1.5 \times 10^{-5}$, $\pi^0\mu^+\mu^- < 6 \times 10^{-5}$.

h. The mass and width are from the $\eta\pi$ mode only. If the $K\bar{K}$ channel is strongly coupled, the width may be larger.

i. Empirical limits on fractions for other decay modes of $\phi(1020)$ are $\pi^+\pi^-\gamma < 0.7\%$, $\omega\gamma < 5\%$ (CL=84%), $\rho\gamma < 2\%$ (CL=84%), $2\pi^+2\pi^-\pi^0 < 1\%$ (CL=95%), $2\pi^+2\pi^- < 0.1\%$.

j. Empirical limits on fractions for other decay modes of B(1235) are $\pi\pi < 15\%$, $K\bar{K} < 2\%$ (CL=84%), $4\pi < 50\%$ (CL=84%), $\phi\pi <$ 1.5% (CL=84%), $\eta\pi < 25\%$, $(\bar{K}K)^{\pm}\pi^0 < 8\%$, $K_SK_S\pi^{\pm} < 2\%$, $K_SK_L\pi^{\pm} < 6\%$.

k. Empirical limits (CL=95%) on fractions for other decay modes of f(1270) are $\eta\pi\pi < 1\%$, $K^0K^-\pi^+$ + c.c. < 0.5%, $\eta\eta < 2\%$.

ℓ. Empirical limits on fractions for other decay modes of $A_3(1680)$ are $\eta\pi < 10\%$, $5\pi < 10\%$.

m. Includes $p\bar{p}\pi^+\pi^-\gamma$ and excludes $p\bar{p}\eta$, $p\bar{p}\omega$, $p\bar{p}\eta'$.

n. The $\iota(1440)$ evidence is listed under E(1420); see E(1420) mini-review.

o. Empirical limits on fractions for other decay modes of $\chi(3415)$ are $2\gamma < 0.17\%$, $p\bar{p} < 0.011\%$.

p. Empirical limits on fractions for other decay modes of $\chi(3510)$ are ($\pi^+\pi^-$ and K^+K^-) < 0.2%, $\gamma\gamma < 0.16\%$, $p\bar{p} < 0.13\%$.

q. Empirical limits on fractions for other decay modes of $\chi(3555)$ are $2\gamma < 0.06\%$, $p\bar{p} < 0.10\%$, $J/\psi\pi^+\pi^-\pi^0 < 1.5\%$.

Established Nonets, and octet-singlet mixing angles θ obtained from the Gell-Mann-Okubo mass formula [Appendix II, Eq. (3)]. Of the two isosinglets, the "mainly octet" one is written first, followed by a semicolon. The angle $\delta = \theta - 35.3°$ measures the deviation from ideal mixing.

$(J^P)C_n$	Nonet members	$\theta_{lin.}$	$\theta_{quadr.}$	$\delta_{lin.}$	$\delta_{quadr.}$
$(0^-)+$	π, K, η; η'	-24.4 ± 0.1°	-11.1 ± 0.2°	-59.7 ± 0.1°	-46.4 ± 0.2°
$(1^-)-$	ρ, K^*, ϕ; ω	35.9 ± 0.5°	38.6 ± 0.4°	0.6 ± 0.5°	3.3 ± 0.4°
$(2^+)+$	A_2, $K^*(1430)$, f′; f	26 ± 3°	28 ± 3°	-9 ± 3°	-7 ± 3°
$(1^+)+^{\dagger}$	A_1, Q_A, E; D	52 ± 13°	51 ± 12°	16 ± 13°	15 ± 12°

† $m(Q_A)$ is assumed to be the average of $m(Q_1)$ and $m(Q_2)$.

More generally, because of unitarity, the mixing angles are energy dependent and complex above the first threshold (see Appendix II C), which is important especially for the scalar and the axial mesons. Note also that the two axial strange mesons (Q_1 and Q_2) are mixtures of the exact SU(3) states: $Q_1 = \cos\phi\, Q_A + \sin\phi\, Q_B$, $Q_2 = -\sin\phi\, Q_A + \cos\phi\, Q_B$. Below we give the mixing angles δ and ϕ obtained in a unitary mixing scheme using both masses and widths as input data:

$(J^P)C_n$	Nonet members	Mixing angles
$(1^+)+$	A_1, Q_A, E; D	$\delta_{DE}(1283) = 14° + i1°$
		$\delta_{DE}(1418) = 25° + i8°$
$(1^+)-$	B, Q_B, $H'^{\dagger}$; H	$\delta_{HH'}(1190) = -6° + i4°$
		$\delta_{HH'}(1400) = -15° + i10°$
		$\phi_{Q_1Q_2}(1270) = 50° + i3°$
		$\phi_{Q_1Q_2}(1414) = 61° - i3°$
$(0^+)+$	δ, κ, S^*; ϵ	$\delta_{S^*\epsilon}(975) = +4° + i29°$
		$\delta_{S^*\epsilon}(1300) = -33° + i7°$

† as yet, not seen experimentally

Baryon Table

April 1982

The following short list gives the name, the nominal mass, the quantum numbers (where known), and the status of each of the Baryon States in the Data Card Listings. States with 3- or 4-star status are included in the Baryon Table below; the others are omitted because the evidence for the existence of the effect and/or for its interpretation as a resonance is open to question.

N(939) P11 ****	Δ(1232) P33 ****	Λ(1115) P01 ****	Σ(1193) P11 ****	Ξ(1317) P11 ****
N(1440) P11 ****	Δ(1550) P31 **	Λ(1405) S01 ****	Σ(1385) P13 ****	Ξ(1530) P13 ****
N(1520) D13 ****	Δ(1600) P33 ***	Λ(1520) D03 ****	Σ(1480) *	Ξ(1630) **
N(1535) S11 ****	Δ(1620) S31 ****	Λ(1600) P01 ***	Σ(1560) **	Ξ(1680) S11 **
N(1540) P13 *	Δ(1700) D33 ****	Λ(1670) S01 ****	Σ(1580) D13 **	Ξ(1820) 13 ***
N(1650) S11 ****	Δ(1900) S31 ***	Λ(1690) D03 ****	Σ(1620) S11 **	Ξ(1940) **
N(1675) D15 ****	Δ(1905) F35 ****	Λ(1800) S01 ***	Σ(1660) P11 ***	Ξ(2030) 1 ***
N(1680) F15 ****	Δ(1910) P31 ****	Λ(1800) P01 ***	Σ(1670) D13 ****	Ξ(2120) *
N(1700) D13 ****	Δ(1920) P33 ***	Λ(1800) G09 Dead	Σ(1670) **	Ξ(2250) *
N(1710) P11 ****	Δ(1930) D35 ****	Λ(1800) *	Σ(1690) **	Ξ(2370) 1 **
N(1720) P13 ****	Δ(1940) D33 *	Λ(1820) F05 ****	Σ(1750) S11 ***	Ξ(2500) **
N(1990) F17 ***	Δ(1950) F37 ****	Λ(1830) D05 ****	Σ(1770) P11 Dead	
N(2000) F15 **	Δ(2150) S31 *	Λ(1890) P03 ****	Σ(1775) D15 ****	Ω(1672) P03 ****
N(2080) D13 ***	Δ(2160) *	Λ(2000) *	Σ(1840) P13 *	
N(2100) S11 *	Δ(2200) G37 **	Λ(2020) F07 *	Σ(1880) P11 **	Λ_c(2282) ****
N(2100) P11 *	Δ(2300) H39 **	Λ(2100) G07 ****	Σ(1915) F15 ****	
N(2190) G17 ****	Δ(2350) D35 *	Λ(2110) F05 ***	Σ(1940) D13 ***	Σ_c(2450) **
N(2200) D15 ***	Δ(2400) F37 *	Λ(2325) D03 *	Σ(2000) S11 *	
N(2220) H19 ****	Δ(2400) G39 *	Λ(2350) ****	Σ(2030) F17 ****	Λ_b(5500) *
N(2250) G19 ****	Δ(2420) H311 ***	Λ(2585) ***	Σ(2070) F15 *	
N(2600) I111 ***	Δ(2500) *		Σ(2080) P13 **	Dibaryons
N(2700) K113 *	Δ(2750) I313 *		Σ(2100) G17 *	NN(2170) 1D2 ***
N(2800) G19 *	Δ(2850) ***		Σ(2250) ****	NN(2250) 3F3 ***
N(3000) *	Δ(2950) K315 *		Σ(2455) ***	NN(?) *
N(3030) ***	Δ(3230) ***		Σ(2620) ***	ΛN(2130) 3S1 ***
N(3245) *			Σ(3000) **	ΞN(?) *
N(3690) *	Z0(1780) P01 *		Σ(3170) *	
N(3755) *	Z0(1865) D03 *			
	Z1(1900) P13 *			
	Z1(2150) *			
	Z1(2500) *			

- **** Good, clear, and unmistakable.
- *** Good, but in need of clarification or not absolutely certain.
- ** Needs confirmation.
- * Weak.

Particle[a]	$I(J^P)L_{2I \cdot 2J}$[b]	P_{beam}[c] (GeV/c) $\sigma = 4\pi\lambda^2$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2[f] $\pm\Gamma M$ (GeV^2)	Partial decay mode: Mode[g]	Fraction[h] (%)	p[i] (MeV/c)
			S=0 I=1/2 NUCLEON RESONANCES (N)					
p	1/2(1/2$^+$)		938.3		0.880	See Stable Particle Table		
n			939.6		0.883			
N(1440)	1/2(1/2$^+$)P'_{11}	p = 0.61	1400 to	120 to	2.07	Nπ	50–70	397
		σ = 31.0	1480	350	±0.29	Nη	8–18	†
				(200)		Nππ	~30	342
						[Δπ	12–28 •	143
						Nρ	~ 7	†
						Nε]	~ 5	†
N(1520)	1/2(3/2$^-$)D'_{13}	p = 0.74	1510 to	100 to	2.31	Nπ	50–60	456
		σ = 23.5	1530	140	±0.19	Nη	< 1	149
				(125)		Nππ	35–50	410
						[Δπ	15–25 •	228
						Nρ	15–25	†
						Nε]	< 5	†
N(1535)	1/2(1/2$^-$)S'_{11}	p = 0.76	1520 to	100 to	2.36	Nπ	35–50	467
		σ = 22.4	1560	250	±0.23	Nη	40–65	182
				(150)		Nππ	~ 5	422
						[Δπ	~ 1 •	242
						Nρ	~ 3	†
						Nε]	~ 2	†

Baryon Table *(cont'd)*

Particle[a]	$I(J^P)L_{2I\cdot 2J}$[b]	P_{beam}[c] (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2[f] ±ΓM (GeV^2)	Partial decay mode: Mode[g]	Fraction[h] (%)	p[i] (MeV/c)
N(1650)	$1/2(1/2^-)S''_{11}$	p = 0.96	1620 to	100 to	2.72	Nπ	55–65	547
		σ = 16.4	1680	200	±0.25	Nη	~ 1	346
				(150)		ΛK	5–10	161
						ΣK	3–10	†
						Nππ	~30	511
						Δπ	4–15	344
						Nρ	~20	†
						Nε	< 5	†
N(1675)	$1/2(5/2^-)D'_{15}$	p = 1.01	1660 to	120 to	2.81	Nπ	30–40	563
		σ = 15.4	1690	180	±0.26	Nη	< 2	374
				(155)		ΛK	< 1	209
						Nππ	55–70	529
						Δπ	50–65	364
						Nρ	~ 5	†
N(1680)	$1/2(5/2^+)F'_{15}$	p = 1.01	1670 to	110 to	2.82	Nπ	55–65	567
		σ = 15.2	1690	140	±0.21	Nη	< 1	379
				(125)		Nππ	~40	532
						Δπ	~12	369
						Nρ	~10	†
						Nε	~20	†
N(1700)	$1/2(3/2^-)D''_{13}$	p = 1.05	1670 to	70 to	2.89	Nπ	8–12	580
		σ = 14.5	1730	120	±0.17	Nη	~ 4	400
				(100)		ΛK	~ 1	250
						Nππ	~85	547
						Δπ	15–40	385
						Nρ	~ 5	†
						Nε	<40	†
N(1710)	$1/2(1/2^+)P''_{11}$	p = 1.07	1680 to	90 to	2.92	Nπ	10–20	587
		σ = 14.2	1740	130	±0.19	Nη	5–35	410
				(110)		ΛK	5–15	264
						ΣK	2–10	138
						Nππ	>50	554
						Δπ	10–25	393
						Nρ	25–65	48
						Nε	15–40	†
N(1720)	$1/2(3/2^+)P''_{13}$	p = 1.09	1690 to	125 to	2.96	Nπ	10–20	594
		σ = 13.9	1800	250	±0.34	Nη	3–6	420
				(200)		ΛK	2–12	278
						ΣK	2–5	162
						Nππ	~70	561
						Δπ	~20	401
						Nρ	45–70	104
						Nε	~20	†
N(1990)	$1/2(7/2^+)F_{17}$	p = 1.62	1950 to	120 to	3.96	Nπ	~ 5	766
		σ = 8.34	2050	400	±0.70	Nη	~ 3	648
				(350)		ΛK	seen	554
						ΣK	seen	497
→ N(2080)	$1/2(3/2^-)D'''_{13}$	p = 1.82	2030 to	115 to	4.33	Nπ	~10	821
		σ = 7.26	2100	300	±0.57	ΛK	seen	627
				(275)		ΣK	seen	576
→ N(2190)	$1/2(7/2^-)G_{17}$	p = 2.07	2120 to	200 to	4.80	Nπ	~14	888
		σ = 6.21	2230	500	±0.77	Nη	~ 2	790
				(350)		ΛK	< 1	712
N(2200)	$1/2(5/2^-)D''_{15}$	p = 2.10	1900 to	150 to	4.84	Nπ	~ 8	894
		σ = 6.12	2230	400	±0.66	Nη	seen	797
				(300)		ΛK	seen	718
N(2220)	$1/2(9/2^+)H_{19}$	p = 2.14	2150 to	300 to	4.93	Nπ	~18	905
		σ = 5.97	2300	500	±0.89	Nη	~ 1	811
				(400)				

Baryon Table *(cont'd)*

Particle[a]	$I(J^P)L_{2I \cdot 2J}$[b]	P_{beam}[c] (GeV/c) $\sigma = 4\pi\lambda^2$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2[f] $\pm\Gamma M$ (GeV^2)	Partial decay mode: Mode[g]	Fraction[h] (%)	p[i] (MeV/c)
N(2250)	$1/2(9/2^-)G'_{19}$	p = 2.21 σ = 5.74	2130 to 2270	200 to 500 (300)	5.06 ±0.68	Nπ Nη	~10 ~ 2	923 831
N(2600)	$1/2(11/2^-)I_{111}$	p = 3.12 σ = 3.86	2580 to 2700	>300 (400)	6.76 ±1.04	Nπ	~ [illegible]	1126
N(3030)	1/2(?)	p = 4.41 σ = 2.62	~3030	~400 (400)	9.18 ±1.21	Nπ	(J+1/2)x <0.1 [j]	1366
		S=0 I=3/2 DELTA RESONANCES (Δ)						
Δ(1232)	$3/2(3/2^+)P'_{33}$	p = 0.30 σ = 95.0	1230 to 1234	110 to 120 (115)	1.52 ±0.14	Nπ Nγ	99.4 0.6	227 259
	Δ(++) pole position:[k] $M-i\Gamma/2 = (1210.6\pm0.5) - i(49.7\pm0.3)$ [ℓ]							
	Δ(0) pole position:[k] $M-i\Gamma/2 = (1210.3\pm1.0) - i(53.0\pm1.0)$ [ℓ]							
Δ(1600)	$3/2(3/2^+)P''_{33}$	p = 0.87 σ = 18.7	1500 to 1900	150 to 350 (250)	2.56 ±0.40	Nπ Nππ [Δπ Nρ]	15–25 ~80 20–65]• <10	512 473 301 †
Δ(1620)	$3/2(1/2^-)S'_{31}$	p = 0.91 σ = 17.7	1600 to 1650	120 to 160 (140)	2.62 ±0.23	Nπ Nππ [Δπ Nρ]	25–35 ~70 35–50]• <40	526 488 318 †
Δ(1700)	$3/2(3/2^-)D'_{33}$	p = 1.05 σ = 14.5	1630 to 1740	190 to 300 (250)	2.89 ±0.43	Nπ Nππ [Δπ Nρ]	10–20 ~85 <50]• ~40	580 547 385 †
Δ(1900)	$3/2(1/2^-)S''_{31}$	p = 1.44 σ = 9.71	1850 to 2000	130 to 300 (150)	3.61 ±0.29	Nπ ΣK	6–12 ~10	710 410
Δ(1905)	$3/2(5/2^+)F_{35}$	p = 1.45 σ = 9.63	1890 to 1920	250 to 400 (300)	3.63 ±0.57	Nπ ΣK Nππ [Δπ Nρ]	8–15 < 3 ~80 10–30]• ~60	713 415 687 542 421
Δ(1910)	$3/2(1/2^+)P''_{31}$	p = 1.46 σ = 9.54	1850 to 1950	200 to 330 (220)	3.65 ±0.42	Nπ ΣK Nππ [Δπ Nρ]	20–25 2–20 >40 small]• <40	716 421 691 545 426
Δ(1920)	$3/2(3/2^+)P'''_{33}$	p = 1.48 σ = 9.39	1860 to 2160	190 to 300 (250)	3.69 ±0.48	Nπ ΣK	14–20 ~ [illegible]	722 431
Δ(1930)	$3/2(5/2^-)D'_{35}$	p = 1.50 σ = 9.21	1890 to 1960	150 to 350 (250)	3.72 ±0.48	Nπ ΣK	4–14 <10	729 441
Δ(1950)	$3/2(7/2^+)F'_{37}$	p = 1.54 σ = 8.91	1910 to 1960	200 to 340 (240)	3.80 ±0.47	Nπ ΣK Nππ [Δπ Nρ]	35–45 < 1 ~60 ~40]• ~20	741 460 716 574 469
Δ(2420)	$3/2(11/2^+)H_{311}$	p = 2.64 σ = 4.68	2380 to 2450	300 to 500 (300)	5.86 ±0.73	Nπ	5–15	1023
Δ(2850)	$3/2(\ ?^+)$	p = 3.[illegible] σ = 3.05	2800 to 2900	~400 (400)	8.12 ±1.14	Nπ	(J+1/2)x ~0.25 [j]	1266
Δ(3230)	3/2(?)	p = 5.08 σ = 2.25	3200 to 3350	~440 (440)	10.43 ±1.42	Nπ	(J+1/2)x ~0.05 [j]	1475

Baryon Table *(cont'd)*

Particle[a]	$I(J^P)L_{I\cdot 2J}$[b]	P_{beam}^c (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2[f] ±ΓM (GeV²)	Partial decay mode: Mode	Fraction[h] (%)	p[i] (MeV/c)
			S=−1 I=0 LAMBDA RESONANCES (Λ)					
Λ	0(1/2⁺)		1115.6		1.245	See Stable Particle Table		
Λ(1405)	$0(1/2^-)S'_{01}$	Below K^-p threshold	1405 ±5[ℓ]	40±10[ℓ]	1.97 ±0.06	Σπ	100	152
Λ(1520)	$0(3/2^-)D'_{03}$	p = 0.395 σ = 82.2	1519.4 ±1.0[ℓ]	15.6±1.0[ℓ]	2.31 ±0.02	N$\bar{K}$	45±1	244
						Σπ	42±1	267
						Λππ	10±1	252
						Σππ	0.9±0.1	152
Λ(1600)	$0(1/2^+)P'_{01}$	p = 0.58 σ = 41.6	1560 to 1700	50 to 250 (150)	2.56 ±0.24	N$\bar{K}$	15–30	343
						Σπ	10–60	336
Λ(1670)	$0(1/2^-)S''_{01}$	p = 0.74 σ = 28.5	1660 to 1680	25 to 50 (35)	2.79 ±0.06	N$\bar{K}$	15–25	414
						Σπ	20–60	393
						Λη	15–35	64
Λ(1690)	$0(3/2^-)D''_{03}$	p = 0.78 σ = 26.1	1685 to 1695	50 to 70 (60)	2.86 ±0.10	N$\bar{K}$	20–30	433
						Σπ	20–40	409
						Λππ	~25	415
						Σππ	~20	350
Λ(1800)	$0(1/2^-)S'''_{01}$	p = 1.01 σ = 17.6	1720 to 1850	200 to 400 (300)	3.24 ±0.54	N$\bar{K}$	25–40	528
						Σπ	seen	493
						Σ(1385)π	seen	345
						N$\bar{K}$*(892)	seen	†
Λ(1800)	$0(1/2^+)P''_{01}$	p = 1.01 σ = 17.6	1750 to 1850	50 to 250 (150)	3.24 ±0.27	N$\bar{K}$	20–50	528
						Σπ	10–40	493
						Σ(1385)π	seen	345
						N$\bar{K}$*(892)	30–60	†
→ Λ(1820)	$0(5/2^+)F'_{05}$	p = 1.06 σ = 16.5	1815 to 1825	70 to 90 (80)	3.29 ±0.15	N$\bar{K}$	55–65	545
						Σπ	8–14	508
						Σ(1385)π	5–10	362
Λ(1830)	$0(5/2^-)D_{05}$	p = 1.08 σ = 16.0	1810 to 1830	60 to 110 (95)	3.35 ±0.17	N$\bar{K}$	3–10	553
						Σπ	35–75	515
						Σ(1385)π	>15	371
Λ(1890)	$0(3/2^+)P'_{03}$	p = 1.21 σ = 13.6	1850 to 1910	60 to 200 (100)	3.57 ±0.19	N$\bar{K}$	20–35	599
						Σπ	3–10	559
						Σ(1385)π	seen	420
						N$\bar{K}$*(892)	seen	233
→ Λ(2100)	$0(7/2^-)G_{07}$	p = 1.68 σ = 8.68	2090 to 2110	100 to 250 (200)	4.41 ±0.42	N$\bar{K}$	25–35	751
						Σπ	~ 5	704
						Λη	< 3	617
						ΞK	< 3	483
						Λω	< 8	443
						N$\bar{K}$*(892)	10–20	514
Λ(2110)	$0(5/2^+)F''_{05}$	p = 1.70 σ = 8.54	2090 to 2140	150 to 250 (200)	4.45 ±0.42	N$\bar{K}$	5–25	757
						Σπ	10–40	711
						Λω	seen	455
						Σ(1385)π	seen	589
						N$\bar{K}$*(892)	10–60	524
→ Λ(2350)	0(9/2⁺)	p = 2.29 σ = 5.84	2340 to 2370	100 to 250 (150)	5.52 ±0.35	N$\bar{K}$	~12	915
						Σπ	~10	867
Λ(2585)	0(?)	p = 2.92 σ = 4.35	~2585	~300 (300)	6.68 ±0.78	N$\bar{K}$	(J+1/2)x ~1.0[j]	1060

Baryon Table *(cont'd)*

Particle[a]	$I(J^P)L_{I\cdot 2J}$[b]	P_{beam}[c] (GeV/c) $\sigma = 4\pi\lambda^2$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2[f] $\pm\Gamma M$ (GeV^2)	Partial decay mode: Mode	Fraction[h] (%)	p[i] (MeV/c)
			S=−1 I=1 SIGMA RESONANCES (Σ)					
Σ	$1(1/2^+)$		(+)1189.4		1.415	See Stable Particle Table		
			(0)1192.5		1.422			
			(−)1197.3		1.434			
Σ(1385)	$1(3/2^+)P'_{13}$	Below	(+)1382.3±0.4	35±1	1.92	Λπ	88±2	208
		K^-p	S=1.6[m]	S=1.0[m]	±0.05	Σπ	12±2	127
		threshold	(0)1382.0±2.5	~35				
			S=1.6[m]					
			(−)1387.4±0.6	40±2				
			S=2.2[m]	S=1.9[m]				
Σ(1660)	$1(1/2^+)P'_{11}$	p = 0.72	1630 to	40 to	2.76	$N\bar{K}$	10–30	405
		σ = 29.8	1690	200	±0.17	Λπ	seen	439
				(100)		Σπ	seen	385
Σ(1670)	$1(3/2^-)D''_{13}$	p = 0.74	1665 to	40 to	2.79	$N\bar{K}$	7–13	414
		σ = 28.5	1685	80	±0.10	Λπ	5–15	447
				(60)		Σπ	30–60	393
Σ(1750)	$1(1/2^-)S''_{11}$	p = 0.91	1730 to	60 to	3.06	$N\bar{K}$	10–40	486
		σ = 20.7	1800	160	±0.16	Λπ	seen	507
				(90)		Σπ	< 8	455
						Ση	15–55	81
Σ(1775)	$1(5/2^-)D_{15}$	p = 0.96	1770 to	105 to	3.15	$N\bar{K}$	37–43	508
		σ = 19.0	1780	135	±0.21	Λπ	14–20	525
				(120)		Σπ	2–5	474
						Σ(1385)π	8–12	324
						Λ(1520)π	17–23	198
Σ(1915)	$1(5/2^+)F'_{15}$	p = 1.26	1900 to	80 to	3.67	$N\bar{K}$	5–15	618
		σ = 12.8	1935	160	±0.23	Λπ	seen	622
				(120)		Σπ	seen	577
						Σ(1385)π	< 5	440
Σ(1940)	$1(3/2^-)D'''_{13}$	p = 1.32	1900 to	150 to	3.76	$N\bar{K}$	<20	637
		σ = 12.1	1950	300	±0.43	Λπ	seen	639
				(220)		Σπ	seen	594
						Σ(1385)π	seen	460
						Λ(1520)π	seen	354
						Δ(1232)$\bar{K}$	seen	410
						$N\bar{K}^*$(892)	seen	320
Σ(2030)	$1(7/2^+)F_{17}$	p = 1.52	2025 to	150 to	4.12	$N\bar{K}$	17–23	702
		σ = 9.93	2040	200	±0.37	Λπ	17–23	700
				(180)		Σπ	5–10	657
						ΞK	< 2	412
						Σ(1385)π	5–15	529
						Λ(1520)π	10–20	430
						Δ(1232)$\bar{K}$	10–20	498
						$N\bar{K}^*$(892)	< 5	438
Σ(2250)	1(?)	p = 2.04	2210 to	60 to	5.06	$N\bar{K}$	<10	851
		σ = 6.76	2280	150	±0.23	Λπ	seen	842
				(100)		Σπ	seen	803
Σ(2455)	1(?)	p = 2.57	~2455	~120	6.03	$N\bar{K}$	(J+1/2)x	981
		σ = 5.08		(120)	±0.29		~0.2[j]	
Σ(2620)	1(?)	p = 3.02	~2600	~200	6.86	$N\bar{K}$	(J+1/2)x	1081
		σ = 4.19		(200)	±0.52		~0.3[j]	

Baryon Table *(cont'd)*

Particle[a]	$I(J^P)L_{2I\cdot 2J}$ [b]	P^c_{beam} (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2 [f] ±ΓM (GeV^2)	Partial decay mode: Mode	Fraction (%)	p^i (MeV/c)
			S=−2 I=1/2 CASCADE RESONANCES (Ξ)					
Ξ	1/2(1/2$^+$)		(0)1314.9 (−)1321.3		1.729 1.746	See Stable Particle Table		
Ξ(1530)	1/2(3/2$^+$)P_{13}		(0)1531.8±0.3 S = 1.3[m] (−)1535.0±0.6	9.1±0.5 10.1±1.9	2.34 ±0.02	Ξπ	100	148
Ξ(1820)	1/2(3/2)		1823 ±6[ℓ]	20^{+15}_{-10} [ℓ]	3.31 ±0.04	ΛK̄ ΣK̄ Ξπ Ξ(1530)π	~45 ~10 small ~45	396 306 413 231
Ξ(2030)	1/2(?)		2024 ±6[ℓ]	16^{+15}_{-5} [ℓ]	4.12 ±0.03	ΛK̄ ΣK̄ Ξπ Ξ(1530)π	~20 ~80 small small	587 524 573 418
Ω^-	0(3/2$^+$)		1672.4±0.3		2.797	See Stable Particle Table		
Λ_c^+	0(1/2$^+$)		2282±3		5.21	See Stable Particle Table		

Particle[a]	$I(J^P)^{2S+1}L_J$ [b]	P^c_{beam} (GeV/c) $\sigma = 4\pi\lambda\!\!\!^{-2}$ (mb)	Mass[d] M (MeV)	Full[e] width Γ (MeV)	M^2 [f] ±ΓM (GeV^2)	Partial decay mode: Mode	Fraction[h] (%)	p^i (MeV/c)
			S=0 DIBARYONS					
d	0(1$^+$)		1875.6		3.518			
NN(2170)	1(2$^+$)$^1D_2$	p = 1.26 σ = 16.5	2140 to 2190	50 to 125 (90)	4.71 ±0.20	NN πd	10–20 seen	545 241
NN(2250)	1(3$^-$)$^3F_3$	p = 1.49 σ = 12.7	2200 to 2400	75 to 225 (150)	5.06 ±0.34	NN πd	20–30 seen	621 318
			S=−1 DIBARYONS					
ΛN(2130)	1/2(1$^+$)$^3S_1$	p = 0.64 σ = 61.5	2100 to 2200	5 to 25 (15)	4.54 ±0.03	ΛN	seen	282

Baryon Table *(cont'd)*

→ Each arrow in the left-hand margin indicates there is an entry in the Data Card Listings for a baryon that is not well enough established (status *less than 3 stars) to be included here. There is* a short list of *all* the baryons in the Listings, whatever their status, at the front of this Table.

†. *This mode is energetically* forbidden when the nominal mass of the decaying resonance (and of any resonance in the final state) is used, but is in fact allowed due to the finite width of the resonance(s).

*. The modes in brackets are sub-reactions of the first preceding unbracketed mode.

a. The nominal mass here (in MeV) is used for identification. See column 4 for the actual mass.

b. When there is more than one baryon with the same quantum numbers, one prime is attached to the spectroscopic symbol for the first of them (e.g., S'_{11}), two primes to the second, etc.

c. The quantities here are calculated using the nominal mass of column 1.

d. Usually a conservatively large range of masses rather than a statistical average of various determinations of the mass is given. In these cases, the mass determinations are nearly entirely from various phase-shift analyses of more or less the same data. It is thus not appropriate to treat the determinations as independent measurements or to average them together. The masses, widths, and branching fractions in this Table are Breit-Wigner parameters. The Data Card List*ings also include pole parameters* where they are available.

e. Usually a conservatively large range of widths rather than a statistical average of various determinations of the width is given (see note *d* for the reason). The nominal value in parentheses is then simply a best guess.

f. The quantities here are calculated using the nominal mass of column 1 and the nominal width of column 5.

g. For information on the $N\gamma$ decay modes of the N and Δ baryons, see the mini-review on these states in the Listings.

h. Most of the inelastic branching fractions come from partial-wave analyses, and these determine $\sqrt{xx'}$, where x and x' are the elastic and inelastic branching fractions, not x' directly. Thus any uncertainty (and it is often considerable) in x carries over into x'. When x' so determined is really poorly known, we here simply note that the mode is seen. The values of $\sqrt{xx'}$ are given in the Data Card Listings.

i. For a 2-body decay mode, this is the momentum of the *decay products in the rest frame of the decaying particle*. For a mode with more than two decay products, this is the maximum momentum any of the products can have in this frame. The nominal mass of column 1 is used, as is the nominal mass of any resonance in the final state.

j. The size of the bump in the total cross section gives $(J+1/2)x$, where x is the elastic branching fraction, but the value of J is not known.

k. These pole positions are from fits to phase shifts (without Coulomb corrections). The Data Card Listings now include pole positions and residues for most of the N and Δ resonances. See Sect. I of the N and Δ mini-review in the Listings for a *brief discussion of the advantages of pole parameters over* the usual Breit-Wigner parameters.

ℓ. The error given here is only an educated guess. It is larger than the error on the weighted average of the published values *(the error on* this average is given in the Listings).

m. The error given here has been scaled up by the "S factor" (see the * footnote to the Stable Particle Table for how S is defined) because the various measurements disagree more seriously than one would expect from statistics.

PHYSICAL AND NUMERICAL CONSTANTS*

PHYSICAL CONSTANTS

		Uncert. (ppm)
N_A	$= 6.022\ 045(31)\times10^{23}$ mole^{-1}	5.1
V_m	$= 22413.83(70)$ cm^3 mole^{-1} = molar volume of ideal gas at STP	31
c	$= 2.997\ 924\ 58(1.2)\times10^{10}$ cm sec^{-1}	0.004
e	$= 4.803\ 242(14)\times10^{-10}$ esu $= 1.602\ 189\ 2(46)\times10^{-19}$ coulomb	2.9; 2.9
1 MeV	$= 1.602\ 189\ 2(46)\times10^{-6}$ erg	2.9
$\hbar=h/2\pi$	$= 6.582\ 173(17)\times10^{-22}$ MeV sec $= 1.054\ 588\ 7(57)\times10^{-27}$ erg sec	2.6; 5.4
$\hbar c$	$= 1.973\ 285\ 8(51)\times10^{-11}$ MeV cm $= 197.32858(51)$ MeV fermi	2.6; 2.6
$(\hbar c)^2$	$= 0.389\ 385\ 7(20)$ GeV^2 mb	5.2
α	$= e^2/\hbar c = 1/137.03604(11)$	0.82
$k_{Boltzmann}$	$= 1.380\ 662(44)\times10^{-16}$ erg °K^{-1}	32
	$= 8.61735(28)\times10^{-11}$ MeV °K^{-1} = 1 eV/11604.50(36) °K	32; 31
$\sigma_{Stef.\ Boltz.}$	$= 5.67032(71)\times10^{-5}$ erg sec^{-1} cm^{-2} °K^{-4}	125
	$= 3.53911(44)\times10^{7}$ eV sec^{-1} cm^{-2} °K^{-4}	125
m_e	$= 0.511\ 003\ 4(14)$ MeV $= 9.109\ 534(47)\times10^{-28}$ g	2.8; 5.1
m_p	$= 938.2796(27)$ MeV $= 1836.15152(70)\ m_e = 6.722\ 775(39)\ m_{\pi^\pm}$	2.8; 0.38; 5.8
	$= 1.007\ 276\ 470(11)$ amu	0.011
1 amu	$= 1/12\ m_{C^{12}} = 931.5016(26)$ MeV	2.8
m_d	$= 1875.6280(53)$ MeV	2.8
r_e	$= e^2/m_ec^2 = 2.817\ 938\ 0(70)$ fermi (1 fermi $= 10^{-13}$ cm)	2.5
$\lambda\!\!\!^{-}_e$	$= \hbar/m_ec = r_e\alpha^{-1} = 3.861\ 590\ 5(64)\times10^{-11}$ cm	1.6
$a_{\infty Bohr}$	$= \hbar^2/m_ee^2 = r_e\alpha^{-2} = 0.529\ 177\ 06(44)$ Å (1 Å $= 10^{-8}$ cm)	0.82
$\sigma_{Thomson}$	$= (8/3)\pi r_e^2 = 0.665\ 244\ 8(33)$ barn (1 barn $= 10^{-24}$ cm^2)	4.9
μ_{Bohr}	$= e\hbar/2m_ec = 0.578\ 837\ 85(95)\times10^{-14}$ MeV gauss^{-1}	1.6
μ_N	$= e\hbar/2m_pc = 3.152\ 451\ 5(53)\times10^{-18}$ MeV gauss^{-1}	1.7
μ_p/μ_{Bohr}	$= 0.001\ 521\ 032\ 209(16)$	0.011
$1/2\omega^e_{cyclotron}$	$= e/2m_ec = 8.794\ 024(25)\times10^{6}$ rad sec^{-1} gauss^{-1}	2.8
$1/2\omega^p_{cyclotron}$	$= e/2m_pc = 4.789\ 378(14)\times10^{3}$ rad sec^{-1} gauss^{-1}	2.8

Hydrogen-like atom (nonrelativistic, μ = reduced mass):

$$\frac{v}{c)_{rms}} = \frac{z\alpha}{n};\quad E_n = \frac{\mu}{2}\,v^2 = \frac{\mu}{2}\left(\frac{cz\alpha}{n}\right)^2;\quad a_n = \frac{n^2\hbar}{\mu z c\alpha}$$

$R_\infty = m_ee^4/2\hbar^2 = m_ec^2\alpha^2/2$	$= 13.605\ 804(36)$ eV (Rydberg)	2.6
	$= m_ec\alpha^2/2h = 109\ 737.3177(83)$ cm^{-1}	0.075

pc = 0.3 Hρ (MeV, kilogauss, cm)

1 year (sidereal)	$= 365.256$ days $= 3.1558\times10^{7}$ sec ($\approx\pi\times10^7$ sec)	
density of dry air	$= 1.204$ mg cm^{-3} (at 20°C, 760 mm)	
acceleration by gravity	$= 980.62$ cm sec^{-2} (sea level, 45°)	
gravitational constant	$= 6.6720(41)\times10^{-8}$ cm^3 g^{-1} sec^{-2}	615
1 calorie (thermochemical)	$= 4.184$ joules	
1 atmosphere	$= 1.01325$ bar (1 bar $= 10^6$ dynes cm^{-2})	
1 eV per particle	$= 11604.50(36)$ °K (from E = kT)	31

NUMERICAL CONSTANTS

π	$= 3.141\ 592\ 7$	1 rad	$= 57.295\ 779\ 5$ deg	$\sqrt{\pi}$	$= 1.772\ 453\ 85$
e	$= 2.718\ 281\ 8$	1/e	$= 0.367\ 879\ 4$	$\sqrt{2}$	$= 1.414\ 213\ 6$
ln2	$= 0.693\ 147\ 2$	ln10	$= 2.302\ 585\ 1$	$\sqrt{3}$	$= 1.732\ 050\ 8$
$\log_{10}2$	$= 0.301\ 030\ 0$	$\log_{10}e$	$= 0.434\ 294\ 5$	$\sqrt{10}$	$= 3.162\ 277\ 7$

* Revised 1982 by Barry N. Taylor. Originally prepared by Stanley J. Brodsky, based mainly on the "1973 Least-Squares Adjustment of the Fundamental Constants," by E. R. Cohen and B. N. Taylor, J. Phys. Chem. Ref. Data **2**, 663 (1973). The figures in parentheses correspond to the one-standard-deviation uncertainty in the last digits of the main number. The equivalent uncertainty in parts per million (ppm) is given in the last column. Note that the uncertainties of the output values of a least-squares adjustment are in general correlated, and the general law of error propagation must be used in calculating additional quantities.

The set of constants resulting from the 1973 adjustment of Cohen and Taylor has been recommended for international use by CODATA (Committee on Data for Science and Technology), and is the most up-to-date, generally accepted set currently available. However, since the publication of the 1973 adjustment, a number of new experiments have been completed, yielding improved values for some of the constants: N_A = 6.022 097 8(63)$\times10^{23}$ mole^{-1} (1.04 ppm); α^{-1} = 137.035 963(15) (0.11 ppm); m_p/m_e=1863.15300(25) (0.14 ppm); and R_∞ = 109 737.31521(11) cm^{-1} (0.001 ppm). But it must be realized that, since the output values of a least-squares adjustment are related in a complex way and a change in the measured value of one constant usually leads to corresponding changes in the adjusted values of others, one must be cautious in carrying out calculations using both the output values from the 1973 adjustment and the results of more recent experiments. A new adjustment is planned for completion by mid 1982.

CLEBSCH-GORDAN COEFFICIENTS, SPHERICAL HARMONICS, AND d FUNCTIONS

Note: A $\sqrt{\ }$ is to be understood over every coefficient; e.g., for -8/15 read $-\sqrt{8/15}$.

Notation:

		J	J	...
		M	M	...
m_1	m_2			
m_1	m_2	Coefficients		
.	.			
.	.			

1/2 × 1/2

m_1	m_2	J=1, M=+1
+1/2	+1/2	1

m_1	m_2	J=1, M=0	J=0, M=0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2

m_1	m_2	J=1, M=-1
-1/2	-1/2	1

1 × 1/2

m_1	m_2	J=3/2, M=+3/2
+1	+1/2	1

m_1	m_2	J=3/2, M=+1/2	J=1/2, M=+1/2
+1	-1/2	1/3	2/3
0	+1/2	2/3	-1/3

m_1	m_2	J=3/2, M=-1/2	J=1/2, M=-1/2
0	-1/2	2/3	1/3
-1	+1/2	1/3	-2/3

m_1	m_2	J=3/2, M=-3/2
-1	-1/2	1

2 × 1/2

m_1	m_2	J=5/2, M=+5/2
+2	1/2	1

m_1	m_2	J=5/2, M=+3/2	J=3/2, M=+3/2
+2	-1/2	1/5	4/5
+1	+1/2	4/5	-1/5

m_1	m_2	J=5/2, M=+1/2	J=3/2, M=+1/2
+1	-1/2	2/5	3/5
0	+1/2	3/5	-2/5

m_1	m_2	J=5/2, M=-1/2	J=3/2, M=-1/2
0	-1/2	3/5	2/5
-1	+1/2	2/5	-3/5

m_1	m_2	J=5/2, M=-3/2	J=3/2, M=-3/2
-1	-1/2	4/5	1/5
-2	+1/2	1/5	-4/5

m_1	m_2	J=5/2, M=-5/2
-2	-1/2	1

3/2 × 1/2

m_1	m_2	J=2, M=+2
+3/2	+1/2	1

m_1	m_2	J=2, M=+1	J=1, M=+1
+3/2	-1/2	1/4	3/4
+1/2	+1/2	3/4	-1/4

m_1	m_2	J=2, M=0	J=1, M=0
+1/2	-1/2	1/2	1/2
-1/2	+1/2	1/2	-1/2

m_1	m_2	J=2, M=-1	J=1, M=-1
-1/2	-1/2	3/4	1/4
-3/2	+1/2	1/4	-3/4

m_1	m_2	J=2, M=-2
-3/2	-1/2	1

2 × 1

m_1	m_2	J=3, M=+3
+2	+1	1

m_1	m_2	J=3, M=+2	J=2, M=+2
+2	0	1/3	2/3
+1	+1	2/3	-1/3

m_1	m_2	J=3, M=+1	J=2, M=+1	J=1, M=+1
+2	-1	1/15	1/3	3/5
+1	0	8/15	1/6	-3/10
0	+1	6/15	-1/2	1/10

m_1	m_2	J=3, M=0	J=2, M=0	J=1, M=0
+1	-1	1/5	1/2	3/10
0	0	3/5	0	-2/5
-1	+1	1/5	-1/2	3/10

m_1	m_2	J=3, M=-1	J=2, M=-1	J=1, M=-1
0	-1	6/15	1/2	1/10
-1	0	8/15	-1/6	-3/10
-2	+1	1/15	-1/3	3/5

m_1	m_2	J=3, M=-2	J=2, M=-2
-1	-1	2/3	1/3
-2	0	1/3	-2/3

m_1	m_2	J=3, M=-3
-2	-1	1

1 × 1

m_1	m_2	J=2, M=+2
+1	+1	1

m_1	m_2	J=2, M=+1	J=1, M=+1
+1	0	1/2	1/2
0	+1	1/2	-1/2

m_1	m_2	J=2, M=0	J=1, M=0	J=0, M=0
+1	-1	1/6	1/2	1/3
0	0	2/3	0	-1/3
-1	+1	1/6	-1/2	1/3

m_1	m_2	J=2, M=-1	J=1, M=-1
0	-1	1/2	1/2
-1	0	1/2	-1/2

m_1	m_2	J=2, M=-2
-1	-1	1

3/2 × 1

m_1	m_2	J=5/2, M=+5/2
+3/2	+1	1

m_1	m_2	J=5/2, M=+3/2	J=3/2, M=+3/2
+3/2	0	2/5	3/5
+1/2	+1	3/5	-2/5

m_1	m_2	J=5/2, M=+1/2	J=3/2, M=+1/2	J=1/2, M=+1/2
+3/2	-1	1/10	2/5	1/2
+1/2	0	3/5	1/15	-1/3
-1/2	+1	3/10	-8/15	1/6

m_1	m_2	J=5/2, M=-1/2	J=3/2, M=-1/2	J=1/2, M=-1/2
+1/2	-1	3/10	8/15	1/6
-1/2	0	3/5	-1/15	-1/3
-3/2	+1	1/10	-2/5	1/2

m_1	m_2	J=5/2, M=-3/2	J=3/2, M=-3/2
-1/2	-1	3/5	2/5
-3/2	0	2/5	-3/5

m_1	m_2	J=5/2, M=-5/2
-3/2	-1	1

$$Y_1^0 = \sqrt{\frac{3}{4\pi}}\cos\theta$$

$$Y_1^1 = -\sqrt{\frac{3}{8\pi}}\sin\theta\, e^{i\phi}$$

$$Y_2^0 = \sqrt{\frac{5}{4\pi}}\left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

$$Y_2^1 = -\sqrt{\frac{15}{8\pi}}\sin\theta\cos\theta\, e^{i\phi}$$

$$Y_2^2 = \frac{1}{4}\sqrt{\frac{15}{2\pi}}\sin^2\theta\, e^{2i\phi}$$

$$Y_\ell^{-m} = (-1)^m Y_\ell^{m*}$$

$$d^\ell_{m,0} = \sqrt{\frac{4\pi}{2\ell+1}}\, Y_\ell^m e^{-im\phi}$$

$$\langle j_1 j_2 m_1 m_2 | j_1 j_2 J M\rangle = (-1)^{J-j_1-j_2}\langle j_2 j_1 m_2 m_1 | j_2 j_1 J M\rangle$$

$$d^j_{m',m} = (-1)^{m-m'} d^j_{m,m'} = d^j_{-m,-m'}$$

2 × 3/2

m_1	m_2	J=7/2, M=+7/2
+2	+3/2	1

m_1	m_2	J=7/2, M=+5/2	J=5/2, M=+5/2
+2	+1/2	3/7	4/7
+1	+3/2	4/7	-3/7

m_1	m_2	J=7/2, M=+3/2	J=5/2, M=+3/2	J=3/2, M=+3/2
+2	-1/2	1/7	16/35	2/5
+1	1/2	4/7	1/35	-2/5
0	3/2	2/7	-18/35	1/5

m_1	m_2	J=7/2, M=+1/2	J=5/2, M=+1/2	J=3/2, M=+1/2	J=1/2, M=+1/2
+2	-3/2	1/35	6/35	2/5	2/5
+1	-1/2	12/35	5/14	0	-3/10
0	1/2	18/35	-3/35	-1/5	1/5
-1	3/2	4/35	-27/70	2/5	-1/10

m_1	m_2	J=7/2, M=-1/2	J=5/2, M=-1/2	J=3/2, M=-1/2	J=1/2, M=-1/2
+1	-3/2	4/35	27/70	2/5	1/10
0	-1/2	18/35	3/35	-1/5	-1/5
-1	1/2	12/35	-5/14	0	3/10
-2	3/2	1/35	-6/35	2/5	-2/5

m_1	m_2	J=7/2, M=-3/2	J=5/2, M=-3/2	J=3/2, M=-3/2
0	-3/2	2/7	18/35	1/5
-1	-1/2	4/7	-1/35	-2/5
-2	1/2	1/7	-16/35	2/5

m_1	m_2	J=7/2, M=-5/2	J=5/2, M=-5/2
-1	-3/2	4/7	3/7
-2	-1/2	3/7	-4/7

m_1	m_2	J=7/2, M=-7/2
-2	-3/2	1

3/2 × 3/2

m_1	m_2	J=3, M=+3
+3/2	+3/2	1

m_1	m_2	J=3, M=+2	J=2, M=+2
+3/2	+1/2	1/2	1/2
+1/2	+3/2	1/2	-1/2

m_1	m_2	J=3, M=+1	J=2, M=+1	J=1, M=+1
+3/2	-1/2	1/5	1/2	3/10
+1/2	+1/2	3/5	0	-2/5
-1/2	+3/2	1/5	-1/2	3/10

m_1	m_2	J=3, M=0	J=2, M=0	J=1, M=0	J=0, M=0
+3/2	-3/2	1/20	1/4	9/20	1/4
+1/2	-1/2	9/20	1/4	-1/20	-1/4
-1/2	+1/2	9/20	-1/4	-1/20	1/4
-3/2	+3/2	1/20	-1/4	9/20	-1/4

m_1	m_2	J=3, M=-1	J=2, M=-1	J=1, M=-1
+1/2	-3/2	1/5	1/2	3/10
-1/2	-1/2	3/5	0	-2/5
-3/2	+1/2	1/5	-1/2	3/10

m_1	m_2	J=3, M=-2	J=2, M=-2
-1/2	-3/2	1/2	1/2
-3/2	-1/2	1/2	-1/2

m_1	m_2	J=3, M=-3
-3/2	-3/2	1

2 × 2

m_1	m_2	J=4, M=+4
+2	+2	1

m_1	m_2	J=4, M=+3	J=3, M=+3
+2	+1	1/2	1/2
+1	+2	1/2	-1/2

m_1	m_2	J=4, M=+2	J=3, M=+2	J=2, M=+2
+2	0	3/14	1/2	2/7
+1	+1	4/7	0	-3/7
0	+2	3/14	-1/2	2/7

m_1	m_2	J=4, M=+1	J=3, M=+1	J=2, M=+1	J=1, M=+1
+2	-1	1/14	3/10	3/7	1/5
+1	0	3/7	1/5	-1/14	-3/10
0	+1	3/7	-1/5	-1/14	3/10
-1	+2	1/14	-3/10	3/7	-1/5

m_1	m_2	J=4, M=0	J=3, M=0	J=2, M=0	J=1, M=0	J=0, M=0
+2	-2	1/70	1/10	2/7	2/5	1/5
+1	-1	8/35	2/5	1/14	-1/10	-1/5
0	0	18/35	0	-2/7	0	1/5
-1	1	8/35	-2/5	1/14	1/10	-1/5
-2	2	1/70	-1/10	2/7	-2/5	1/5

m_1	m_2	J=4, M=-1	J=3, M=-1	J=2, M=-1	J=1, M=-1
+1	-2	1/14	3/10	3/7	1/5
0	-1	3/7	1/5	-1/14	-3/10
-1	0	3/7	-1/5	-1/14	3/10
-2	1	1/14	-3/10	3/7	-1/5

m_1	m_2	J=4, M=-2	J=3, M=-2	J=2, M=-2
0	-2	3/14	1/2	2/7
-1	-1	4/7	0	-3/7
-2	0	3/14	-1/2	2/7

m_1	m_2	J=4, M=-3	J=3, M=-3
-1	-2	1/2	1/2
-2	-1	1/2	-1/2

m_1	m_2	J=4, M=-4
-2	-2	1

$$d^{1/2}_{1/2,1/2} = \cos\frac{\theta}{2} \qquad d^{1/2}_{1/2,-1/2} = -\sin\frac{\theta}{2}$$

$$d^1_{1,1} = \frac{1+\cos\theta}{2} \qquad d^1_{1,0} = -\frac{\sin\theta}{\sqrt{2}} \qquad d^1_{1,-1} = \frac{1-\cos\theta}{2} \qquad d^1_{0,0} = \cos\theta$$

$$d^{3/2}_{3/2,3/2} = \frac{1+\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,1/2} = -\sqrt{3}\,\frac{1+\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-1/2} = \sqrt{3}\,\frac{1-\cos\theta}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{3/2,-3/2} = -\frac{1-\cos\theta}{2}\sin\frac{\theta}{2}$$

$$d^{3/2}_{1/2,1/2} = \frac{3\cos\theta-1}{2}\cos\frac{\theta}{2}$$

$$d^{3/2}_{1/2,-1/2} = -\frac{3\cos\theta+1}{2}\sin\frac{\theta}{2}$$

$$d^2_{2,2} = \left(\frac{1+\cos\theta}{2}\right)^2$$

$$d^2_{2,1} = -\frac{1+\cos\theta}{2}\sin\theta$$

$$d^2_{2,0} = \frac{\sqrt{6}}{4}\sin^2\theta$$

$$d^2_{2,-1} = -\frac{1-\cos\theta}{2}\sin\theta$$

$$d^2_{2,-2} = \left(\frac{1-\cos\theta}{2}\right)^2$$

$$d^2_{1,1} = \frac{1+\cos\theta}{2}(2\cos\theta-1)$$

$$d^2_{1,0} = -\sqrt{\frac{3}{2}}\sin\theta\cos\theta$$

$$d^2_{1,-1} = \frac{1-\cos\theta}{2}(2\cos\theta-1)$$

$$d^2_{0,0} = \left(\frac{3}{2}\cos^2\theta - \frac{1}{2}\right)$$

Sign convention is that of Wigner (Group Theory, Academic Press, New York, 1959), also used by Condon and Shortley (The Theory of Atomic Spectra, Cambridge Univ. Press, New York, 1953), Rose (Elementary Theory of Angular Momentum, Wiley, New York, 1957), and Cohen (Tables of the Clebsch-Gordan Coefficients, North American Rockwell Science Center, Thousand Oaks, Calif., 1974). The signs and numbers in the current tables have been calculated by computer programs written independently by Cohen and at LBL. (Table extended April 1974.)

SU(3) ISOSCALAR FACTORS, SU(N) MULTIPLICITIES, AND PROPERTIES OF QUARKS

The most commonly used isoscalar factors, corresponding to the singlet, octet, and decuplet content of $8 \otimes 8$ and $10 \otimes 8$, are displayed at the right. The notation uses particles names to identify the coefficients, so that the pattern of relative couplings can be seen at a glance. We illustrate the use of the coefficients by example; see J. J. de Swart, Rev. Mod. Phys. 35, 916 (1963) for detailed explanation and phase conventions.

A $\sqrt{}$ is understood over every integer in the matrices; the exponent $\frac{1}{2}$ is a reminder of this. For example, in de Swart's notation the $\Xi \to \Omega K$ element of our $10 \to 10 \otimes 8$ matrix reads

$$\begin{pmatrix} 10 & & 8 & & \\ 0 & -2 & \frac{1}{2} & 1 \end{pmatrix}\left|\begin{matrix} 10 & \\ \frac{1}{2} & -1 \end{matrix}\right) = \frac{-\sqrt{6}}{\sqrt{24}} \ .$$

Intra-multiplet relative decay strengths can be read directly from our matrices. Thus, the partial widths for $\Delta^* \to (N\pi)_{I=3/2}$ and $\Omega^* \to (\Xi\bar{K})_{I=0}$ are in the ratio

$$\frac{\Gamma(\Omega^* \to (\Xi\bar{K})_{I=0})}{\Gamma(\Delta^* \to (N\pi)_{I=3/2})} = \frac{12}{6} \times \text{(threshold factors)} \ .$$

Supplying isospin Clebsch-Gordan coefficients one obtains, e.g.,

$$\frac{\Gamma(\Omega^{*-} \to \Xi^0 K^-)}{\Gamma(\Delta^{*+} \to p\pi^0)} = \frac{1/2}{2/3} \times \frac{12}{6} \times \text{tf} = \frac{3}{2} \times \text{tf} \ .$$

Partial widths for $8 \to 8 \otimes 8$ involve a linear superposition of 8_1 (symmetric) and 8_2 (anti-symmetric) couplings. For example,

$$\Gamma(\Xi^* \to \Xi\pi) \sim \left(-\sqrt{\frac{9}{20}}\, g_1 + \sqrt{\frac{3}{12}}\, g_2\right)^2 \ .$$

The relation between g_1, g_2 (with de Swart's normalization) and the standard D,F couplings appearing in the interaction Lagrangian,

$$\mathcal{L} = -\sqrt{2}\, D\, \mathrm{Tr}\left([\bar{B},B]_+ M\right) + \sqrt{2}\, F\, \mathrm{Tr}\left([\bar{B},B]_- M\right) \ ,$$

is

$$D = \frac{\sqrt{30}}{40}\, g_1 \ , \qquad F = \frac{\sqrt{6}}{24}\, g_2 \ .$$

Thus, $\Gamma(\Xi^* \to \Xi\pi) \sim (1 - 2\alpha)^2$

where $\alpha \equiv D/(D+F)$.

$1 \to 8 \otimes 8$

$$(\Lambda)_1 \to (N\bar{K} \quad \Sigma\pi \quad \Lambda\eta \quad \Xi K)_{8\otimes 8} = \frac{1}{\sqrt{8}} \begin{pmatrix} 2 & 3 & -1 & -2 \end{pmatrix}^{\frac{1}{2}}$$

$8_1 \to 8 \otimes 8$

$$\begin{pmatrix} N \\ \Sigma \\ \Lambda \\ \Xi \end{pmatrix}_{8_1} \to \begin{pmatrix} N\pi & N\eta & \Sigma K & \Lambda K & \\ N\bar{K} & \Sigma\pi & \Lambda\pi & \Sigma\eta & \Xi K \\ N\bar{K} & \Sigma\pi & \Lambda\eta & \Xi K & \\ \Sigma\bar{K} & \Lambda\bar{K} & \Xi\pi & \Xi\eta & \end{pmatrix}_{8\otimes 8} = \frac{1}{\sqrt{20}} \begin{pmatrix} 9 & -1 & -9 & -1 & \\ -6 & 0 & 4 & 4 & -6 \\ 2 & -12 & -4 & -2 & \\ 9 & -1 & -9 & -1 & \end{pmatrix}^{\frac{1}{2}}$$

$8_2 \to 8 \otimes 8$

$$\begin{pmatrix} N \\ \Sigma \\ \Lambda \\ \Xi \end{pmatrix}_{8_2} \to \begin{pmatrix} N\pi & N\eta & \Sigma K & \Lambda K & \\ N\bar{K} & \Sigma\pi & \Lambda\pi & \Sigma\eta & \Xi K \\ N\bar{K} & \Sigma\pi & \Lambda\eta & \Xi K & \\ \Sigma\bar{K} & \Lambda\bar{K} & \Xi\pi & \Xi\eta & \end{pmatrix}_{8\otimes 8} = \frac{1}{\sqrt{12}} \begin{pmatrix} 3 & 3 & 3 & -3 & \\ 2 & 8 & 0 & 0 & -2 \\ 6 & 0 & 0 & 6 & \\ 3 & 3 & 3 & -3 & \end{pmatrix}^{\frac{1}{2}}$$

$10 \to 8 \otimes 8$

$$\begin{pmatrix} \Delta \\ \Sigma \\ \Xi \\ \Omega \end{pmatrix}_{10} \to \begin{pmatrix} N\pi & \Sigma K & & & \\ N\bar{K} & \Sigma\pi & \Lambda\pi & \Sigma\eta & \Xi K \\ \Sigma\bar{K} & \Lambda\bar{K} & \Xi\pi & \Xi\eta & \\ \Xi\bar{K} & & & & \end{pmatrix}_{8\otimes 8} = \frac{1}{\sqrt{12}} \begin{pmatrix} -6 & 6 & & & \\ -2 & 2 & -3 & 3 & 2 \\ 3 & -3 & 3 & 3 & \\ 12 & & & & \end{pmatrix}^{\frac{1}{2}}$$

$8 \to 10 \otimes 8$

$$\begin{pmatrix} N \\ \Sigma \\ \Lambda \\ \Xi \end{pmatrix}_{8} \to \begin{pmatrix} \Delta\pi & \Sigma K & & \\ \Delta\bar{K} & \Sigma\pi & \Sigma\eta & \Xi K \\ \Sigma\pi & \Xi K & & \\ \Sigma\bar{K} & \Xi\pi & \Xi\eta & \Omega K \end{pmatrix}_{10\otimes 8} = \frac{1}{\sqrt{15}} \begin{pmatrix} -12 & 3 & & \\ 8 & -2 & -3 & 2 \\ -9 & 6 & & \\ 3 & -3 & -3 & 6 \end{pmatrix}^{\frac{1}{2}}$$

$10 \to 10 \otimes 8$

$$\begin{pmatrix} \Delta \\ \Sigma \\ \Xi \\ \Omega \end{pmatrix}_{10} \to \begin{pmatrix} \Delta\pi & \Delta\eta & \Sigma K & \\ \Delta\bar{K} & \Sigma\pi & \Sigma\eta & \Xi K \\ \Sigma\bar{K} & \Xi\pi & \Xi\eta & \Omega K \\ \Xi\bar{K} & \Omega\eta & & \end{pmatrix}_{10\otimes 8} = \frac{1}{\sqrt{24}} \begin{pmatrix} 15 & 3 & -6 & \\ 8 & 8 & 0 & -8 \\ 12 & 3 & -3 & -6 \\ 12 & -12 & & \end{pmatrix}^{\frac{1}{2}}$$

SU(n) Multiplicities

The table below gives the multiplicities of the multiplets that occur in qq, $q\bar{q}$, and qqq systems in various SU(n). Normal mesons are $q\bar{q}$ systems, and normal baryons are qqq systems. Also given are the multiplets that occur in meson-baryon scattering when the meson multiplet is the one to which the pion belongs and the baryon multiplet is the one to which the proton belongs. Complex-conjugate representations are indicated by a bar. The two 20-dimensional representations of SU(4) are indicated as 20 (which contains the SU(3) decuplet) and 20' (which contains the SU(3) octet). The C(N,M)'s are the binomial coefficients $N!/[M!(N-M)!]$.

qq	
SU(2):	$2 \otimes 2 \to 3 \oplus 1$
SU(3):	$3 \otimes 3 \to 6 \oplus \bar{3}$
SU(4):	$4 \otimes 4 \to 10 \oplus 6$
SU(n):	$n \otimes n \to n(n+1)/2 \oplus n(n-1)/2$

$q\bar{q}$ (Mesons)	
SU(2):	$2 \otimes \bar{2} \to 3 \oplus 1$
SU(3):	$3 \otimes \bar{3} \to 8 \oplus 1$
SU(4):	$4 \otimes \bar{4} \to 15 \oplus 1$
SU(n):	$n \otimes \bar{n} \to (n^2-1) \oplus 1$

qqq (Baryons)	
SU(2):	$2 \otimes 2 \otimes 2 \to 4 \oplus 2 \oplus 2$
SU(3):	$3 \otimes 3 \otimes 3 \to 10 \oplus 8 \oplus 8 \oplus 1$
SU(4):	$4 \otimes 4 \otimes 4 \to 20 \oplus 20' \oplus 20' \oplus \bar{4}$
SU(n):	$n \otimes n \otimes n \to C(n+2,3) \oplus 2C(n+1,3) \oplus 2C(n+1,3) \oplus C(n,3)$

Meson-Baryon Scattering	
SU(2):	$3 \otimes 2 \to 4 \oplus 2$
SU(3):	$8 \otimes 8 \to 27 \oplus 10 \oplus \overline{10} \oplus 8 \oplus 8 \oplus 1$
SU(4):	$15 \otimes 20' \to 140 \oplus 60 \oplus 36 \oplus 20 \oplus 20' \oplus 20' \oplus \bar{4}$

SU(3) ISOSCALAR FACTORS, SU(N) MULTIPLICITIES, AND PROPERTIES OF QUARKS (Cont'd)

Properties of Quarks

Quantum number	d	u	s	c	b	t
baryon number B	1/3	1/3	1/3	1/3	1/3	1/3
charge Q	−1/3	+2/3	−1/3	+2/3	−1/3	+2/3
isospin z component I_z	−1/2	+1/2	0	0	0	0
strangeness S	0	0	−1	0	0	0
charm C	0	0	0	+1	0	0
bottom (beauty) B	0	0	0	0	+1	0
top (truth) T	0	0	0	0	0	+1

WEAK INTERACTIONS OF QUARKS AND LEPTONS

The "standard" $SU(2)_L \otimes U(1)$ model[1,2] is described here for six quarks and six leptons in left-handed doublets of $SU(2)_{weak}$ and right-handed singlets of $SU(2)_{weak}$ (T_3 = third component of weak isospin):

$$\begin{matrix} T_3=+1/2 \\ T_3=-1/2 \end{matrix} \quad \begin{pmatrix}\nu_e\\ e^-\end{pmatrix}_L \begin{pmatrix}\nu_\mu\\ \mu^-\end{pmatrix}_L \begin{pmatrix}\nu_\tau\\ \tau^-\end{pmatrix}_L \begin{pmatrix}u\\ d'\end{pmatrix}_L \begin{pmatrix}c\\ s'\end{pmatrix}_L \begin{pmatrix}t\\ b'\end{pmatrix}_L ,$$

$$T = T_3 = 0 \qquad e_R^- \quad \mu_R^- \quad \tau_R^- \quad u_R \quad d_R \quad c_R \quad s_R \quad t_R \quad b_R .$$

Mixing occurs between quarks d, s, b of charge −1/3 (by convention the charge 2/3 quarks, u, c, t, are unmixed) and can be written

$$\begin{pmatrix}d'\\ s'\\ u'\end{pmatrix} = \begin{pmatrix}V_{ud} & V_{us} & V_{ub}\\ V_{cd} & V_{cs} & V_{cb}\\ V_{td} & V_{ts} & V_{tb}\end{pmatrix}\begin{pmatrix}d\\ s\\ b\end{pmatrix}$$

where, for example, the mixing matrix element V_{ud} modulates the strength of the udW vertex. In the Kobayashi-Maskawa parametrization[2] this matrix is expressed

$$\begin{pmatrix}d'\\ s'\\ b'\end{pmatrix} = \begin{pmatrix}c_1 & s_1c_3 & s_1s_3\\ -s_1c_2 & c_1c_2c_3+s_2s_3e^{i\delta} & c_1c_2s_3-s_2c_3e^{i\delta}\\ -s_1s_2 & c_1s_2c_3-c_2s_3e^{i\delta} & c_1s_2s_3+c_2c_3e^{i\delta}\end{pmatrix}\begin{pmatrix}d\\ s\\ b\end{pmatrix} ,$$

where $c_i = \cos\theta_i$, $s_i = \sin\theta_i$, $i = 1,2,3$. In the limit $\theta_2=\theta_3=\delta=0$, this reduces to the usual Cabibbo mixing with θ_1 the Cabibbo angle.

The interaction Lagrangian is

$$\mathcal{L}_{int} = e\left[A^\alpha J_\alpha^{em} + \frac{1}{\sin\theta_W\cos\theta_W} Z^\alpha J_\alpha^N + \frac{1}{\sqrt{2}\,\sin\theta_W}\left(W^{+\alpha} J_\alpha^C + W^{-\alpha} J_\alpha^{C\dagger}\right)\right] .$$

Here θ_W is the weak mixing angle in the relations

$$W^0 = Z\cos\theta_W + A\sin\theta_W$$

$$B = -Z\sin\theta_W + A\cos\theta_W$$

which relate the physical fields A (photon) and Z (neutral weak gauge boson) to W^0 ($SU(2)_{weak}$ partner of W^+ and W^-) and B (U(1) gauge field). The charged current is written

$$J_\alpha^C = (\bar\nu_e\ \bar\nu_\mu\ \bar\nu_\tau)\left[\gamma_\alpha \frac{(1-\gamma_5)}{2}\right]\begin{pmatrix}e^-\\ \mu^-\\ \tau^-\end{pmatrix} + (\bar u\ \bar c\ \bar t)\left[\gamma_\alpha \frac{(1-\gamma_5)}{2}\right]\left(V_{ij}\right)\begin{pmatrix}d\\ s\\ b\end{pmatrix} ;$$

i.e., V−A structure. The neutral current is written

$$J_\alpha^N = (\bar\nu_e\ \bar\nu_\mu\ \bar\nu_\tau)\left[\frac{1}{2}\gamma_\alpha \frac{(1-\gamma_5)}{2}\right]\begin{pmatrix}\nu_e\\ \nu_\mu\\ \nu_\tau\end{pmatrix}$$

$$+ (\bar e\ \bar\mu\ \bar\tau)\left[-\frac{1}{2}\gamma_\alpha \frac{(1-\gamma_5)}{2} + \sin^2\theta_W\gamma_\alpha\right]\begin{pmatrix}e\\ \mu\\ \tau\end{pmatrix}$$

$$+ (\bar u\ \bar c\ \bar t)\left[\frac{1}{2}\gamma_\alpha \frac{(1-\gamma_5)}{2} - \frac{2}{3}\sin^2\theta_W\gamma_\alpha\right]\begin{pmatrix}u\\ c\\ t\end{pmatrix}$$

$$+ (\bar d\ \bar s\ \bar b)\left[-\frac{1}{2}\gamma_\alpha \frac{(1-\gamma_5)}{2} + \frac{1}{3}\sin^2\theta_W\gamma_\alpha\right]\begin{pmatrix}d\\ s\\ b\end{pmatrix} ,$$

where for fermion f the coupling $[\Gamma_\alpha^f]$ has a V−A term depending on T_3^f and a vector term depending on charge Q_f:

$$\left[\Gamma_\alpha^f\right] = \left[T_3^f\gamma_\alpha \frac{(1-\gamma_5)}{2} - Q_f\sin^2\theta_W\gamma_\alpha\right].$$

The effective Lagrangian for exchange of $W^\pm$ and Z between two currents reduces at low q^2 to

$$\mathcal{L}_{weak} = \frac{G}{\sqrt{2}}\,4\left(J^{C\alpha}J_\alpha^{C\dagger} + 2\rho J^{N\alpha}J_\alpha^N\right)$$

with $G/\sqrt{2} = \pi\alpha/(2M_W^2\sin^2\theta_W)$, $\alpha = e^2/(4\pi)$, and $\rho = M_W^2/(M_Z^2\cos^2\theta_W)$. Assuming the simplest Higgs structure, $\rho=1$, and the W and Z masses are related by $M_Z = M_W/\cos\theta_W$. Currently reported values of the weak interaction parameters are

$|V_{ud}| = |\cos\theta_1| = 0.9737 \pm 0.0025$; $|V_{us}| = |\sin\theta_1\,\cos\theta_3| = 0.219 \pm 0.011$ } Ref. 3 ;

$|V_{ub}| = |\sin\theta_1\,\sin\theta_3| = 0.06 \pm 0.06$ } Refs. 3,4 ;

$|V_{cb}|^2 \gg |V_{ub}|^2$ } Ref 5 ;

$G = G_\mu = (1.16632 \pm 0.00002)\times 10^{-5}\ \mathrm{GeV}^{-2}$ } Refs. 3,8 ;

$\sin^2\theta_W = 0.224 \pm 0.019$, $\rho = 0.992 \pm 0.020$; $\sin^2\theta_W = 0.229 \pm 0.010$, $\rho \equiv 1$ (fixed) } Ref. 9 .

The resulting mass estimates for $W^\pm$ and Z are $M_W = 37.3\ \mathrm{GeV}/\sin\theta_W = 77.9 \pm 1.7$ GeV, and $M_Z = 88.8 \pm 1.4$ GeV, where the numerical values are obtained using the simplest Higgs structure ($\rho \equiv 1$). Electroweak radiative corrections to these estimates may be as large as 5%.[10]

Lepton-Nucleon Inclusive Scattering

For reactions $\ell+N \to \ell'+X$, differential cross sections can be written using several choices of independent variables. These are related by

$$\frac{d^2\sigma}{dxdy} = 2ME_\ell^2 y\,\frac{d^2\sigma}{d\nu dQ^2} = 2ME_\ell x\,\frac{d^2\sigma}{dxdQ^2} = \frac{2\pi ME_\ell^2 y}{|\vec p_\ell|\,|\vec p_{\ell'}|}\,\frac{d^2\sigma}{d\Omega dE_{\ell'}}$$

$$\simeq \frac{2\pi\, ME_\ell y}{E_{\ell'}}\,\frac{d^2\sigma}{d\Omega dE_{\ell'}} ,$$

where ν, Q^2, x, and y are defined in the Relativistic Kinematics section IV(c), E_ℓ, $\vec p_\ell$ and $E_{\ell'}$, $\vec p_{\ell'}$ are the incident and outgoing lepton lab energies and momenta, and M is the target nucleon mass.

WEAK INTERACTIONS OF QUARKS AND LEPTONS (Cont'd)

Structure Functions[11,12]

For charged-current (C.C.) and neutral-current (N.C.) reactions, we have

$$\frac{d^2\sigma^{\nu(\bar\nu)}}{dxdy} = \frac{G^2ME_\ell}{\pi}\left[\left(1-y-\frac{M}{2E_\ell}xy\right)F_2^{\nu(\bar\nu)}(x,Q^2) + \frac{y^2}{2}\,2xF_1^{\nu(\bar\nu)}(x,Q^2) \pm \left(y-\frac{y^2}{2}\right)xF_3^{\nu(\bar\nu)}(x,Q^2)\right],$$

where the upper and lower signs refer to ν and $\bar\nu$ scattering, respectively, and F_3 is defined as a positive quantity.[13] The other common structure functions W_i are related by $MW_1 = F_1$, $\nu W_2 = F_2$, and $\nu W_3 = F_3$. For electron and muon scattering, $F_3=0$, and G^2 is replaced by $8\pi^2\alpha^2/(Q^2)^2$. The ratio of the longitudinally to transversely polarized photon absorption cross section is

$$R = \frac{\sigma_L}{\sigma_T} = \frac{1}{2xF_1(x,Q^2)}\left[F_2(x,Q^2) - 2xF_1(x,Q^2) + \frac{4M^2x^2}{Q^2}F_2(x,Q^2)\right].$$

To compare with the parton-model predictions below, we write for $E_\ell \gg M$:

$$\frac{d^2\sigma^{\nu(\bar\nu)}}{dxdy} = \frac{G^2ME_\ell}{\pi}\left[\frac{1}{2}\left(2xF_1^{\nu(\bar\nu)} \pm xF_3^{\nu(\bar\nu)}\right) + \frac{1}{2}(1-y)^2\left(2xF_1^{\nu(\bar\nu)} \mp xF_3^{\nu(\bar\nu)}\right) + (1-y)\left(F_2^{\nu(\bar\nu)} - 2xF_1^{\nu(\bar\nu)}\right)\right],$$

$$\frac{d^2\sigma^{e,\mu}}{dxdy} = \frac{8\pi\alpha^2ME_\ell}{(Q^2)^2}\left[\frac{1+(1-y)^2}{2}\,2xF_1^{e,\mu} + (1-y)\left(F_2^{e,\mu} - 2xF_1^{e,\mu}\right)\right].$$

The Free-Quark-Parton-Model Predictions[14]

For this model in the Bjorken limit ($Q^2,\nu\to\infty$ with x fixed), $F_i(x,Q^2) \to F_i(x)$.[11,12] For spin-½ quark partons, we have $2xF_1(x) = F_2(x)$, the Callan-Gross relation. Thus, in this approximation, $R=0$ and there is no $(1-y)$ term in the cross section.

- (C.C.) $$\frac{d^2\sigma^{\nu N\to\mu^- X}}{dxdy} = \frac{G^2ME_\ell}{\pi}\,2x\sum_q\left[f_q(x) + f_{\bar q}(x)(1-y)^2\right].$$

For $\bar\nu N \to \mu^+X$, interchange $f_q(x)$ and $f_{\bar q}(x)$ in the formula. Here $f_q(x)dx$ is the number of quarks q in the target nucleon with momentum fraction x to $x+dx$. We include $f_q(x)$ and $f_{\bar q}(x)$ in the sum only for negative (positive) charged quarks and antiquarks in $\nu(\bar\nu)$ reactions.

- (N.C.) $$\frac{d^2\sigma^{\nu N\to\nu X}}{dxdy} = \frac{G^2ME_\ell}{\pi}\,2\rho^2x\sum_q\left\{(\epsilon_L^q)^2\left[f_q(x) + f_{\bar q}(x)(1-y)^2\right] + (\epsilon_R^q)^2\left[f_q(x)(1-y)^2 + f_{\bar q}(x)\right]\right\},$$

and the sum runs over all quarks. Here the neutral-current coupling is decomposed according to

$$\Gamma_\alpha^q = \epsilon_L^q\gamma_\alpha\frac{(1-\gamma_5)}{2} + \epsilon_R^q\gamma_\alpha\frac{(1+\gamma_5)}{2}$$

with left- and right-handed coupling constants ϵ_L^q and ϵ_R^q.[15] In the "standard" SU(2) ⊗ U(1) model

$$\epsilon_L^q = T_3^q - Q_q\sin^2\theta_W, \qquad \epsilon_R^q = -Q_q\sin^2\theta_W.$$

For $\bar\nu N \to \bar\nu X$, interchange ϵ_L^q and ϵ_R^q in the cross-section formula.

- (E.M.) $$\frac{d^2\sigma^{e,\mu}}{dxdy} = \frac{8\pi\alpha^2ME_\ell}{(Q^2)^2}\,x\sum_q Q_q^2\left[f_q(x) + f_{\bar q}(x)\right]\frac{1+(1-y)^2}{2}.$$

Comparison with earlier structure function formulas gives:

(C.C.) $$F_2(x) = 2x\sum_q\left[f_q(x) + f_{\bar q}(x)\right],$$
$$xF_3(x) = 2x\sum_q\left[f_q(x) - f_{\bar q}(x)\right];$$

(N.C.) $$F_2(x) = 2\rho^2x\sum_q\left[(\epsilon_L^q)^2 + (\epsilon_R^q)^2\right]\left[f_q(x)+f_{\bar q}(x)\right],$$
$$xF_3(x) = 2\rho^2x\sum_q\left[(\epsilon_L^q)^2 - (\epsilon_R^q)^2\right]\left[f_q(x)-f_{\bar q}(x)\right],$$
$$F_i^\nu(x) = F_i^{\bar\nu}(x);$$

(E.M.) $$F_2(x) = x\sum_q Q_q^2\left[f_q(x) + f_{\bar q}(x)\right].$$

In the examples below, $u(x)$, $\bar u(x)$, $d(x)$, $\bar d(x)$, etc., mean f_q ($f_{\bar q}$) for the individual quark (antiquark) in the proton (for neutron, interchange $u(x)$ and $d(x)$). Charm production is taken into account.

- $$F_2^{\nu p\to\mu^-X} = 2x\left[d(x) + s(x) + \bar u(x) + \bar c(x)\right],$$
$$F_2^{\bar\nu p\to\mu^+X} = 2x\left[u(x) + c(x) + \bar d(x) + \bar s(x)\right],$$
$$xF_3^{\nu p\to\mu^-X} = 2x\left[d(x) + s(x) - \bar u(x) - \bar c(x)\right],$$
$$xF_3^{\bar\nu p\to\mu^+X} = 2x\left[u(x) + c(x) - \bar d(x) - \bar s(x)\right].$$

Hereafter we neglect small contributions of the s, $\bar s$, c, $\bar c$ quarks in the sea.

- For charge-symmetric nuclei with $q(x) = u(x) + d(x)$, $\bar q(x) = \bar u(x) + \bar d(x)$,

$$F_2^{\nu N\to\mu^-X} = F_2^{\bar\nu N\to\mu^+X} = x\left[q(x) + \bar q(x)\right],$$
$$xF_3^{\nu N\to\mu^-X} = xF_3^{\bar\nu N\to\mu^+X} = x\left[q(x) - \bar q(x)\right].$$

- $$F_2^{ep,\mu p}(x) = x\left[\frac{4}{9}\left(u(x) + \bar u(x)\right) + \frac{1}{9}\left(d(x) + \bar d(x)\right)\right],$$

$$F_2^{ed}(x) \cong \frac{5}{18}\,F_{2\ \mathrm{C.C.}}^{\nu(\bar\nu)d}$$

($\frac{5}{18}$: average squared charge of u,d quarks).

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RELATIVISTIC KINEMATICS

I. BASICS

(a) Lorentz transformations -- Let E and $\vec{p}$ be the energy and 3-momentum of a particle or system as seen from a certain inertial frame, and let E^* and $\vec{p}^*$ be the same quantities as seen from a second inertial frame that moves with velocity $\vec{\beta}$ relative to the first. Then starred and unstarred quantities are related by

$$\begin{pmatrix} E^* \\ p_\parallel^* \end{pmatrix} = \begin{pmatrix} \gamma & -\gamma\beta \\ -\gamma\beta & \gamma \end{pmatrix} \begin{pmatrix} E \\ p_\parallel \end{pmatrix}, \quad p_\perp^* = p_\perp .$$

Here $\gamma = (1-\beta^2)^{-1/2}$, and subscripts $\parallel$ and $\perp$ indicate components of $\vec{p}$ or $\vec{p}^*$ that are parallel or perpendicular to $\vec{\beta}$ (often η is used for $\gamma\beta$). The inverse transformation is given by changing β to $-\beta$. A particle of mass m at rest in the second frame, so that it is moving at velocity $\vec{\beta}$ relative to the first, has $E^* = m$ and $\vec{p}^* = 0$, so here

$$E = \gamma m , \quad \vec{p} = \gamma\vec{\beta}m .$$

In any frame, the energy, momentum, and mass are related by

$$E^2 = p^2 + m^2 .$$

(b) Four momenta; scalar products -- The 4-momentum vector of a particle or system having energy E and 3-momentum $\vec{p}$ is

$$q = (E, \vec{p}) = (E, p_x, p_y, p_z) .$$

Conservation of energy and the components of 3-momentum for any process $a + b \to \ldots \to 1 + 2 + \ldots$ may then be written as

$$q_a + q_b + \ldots = q_1 + q_2 + \ldots .$$

Although the components of a 4-momentum are different in different frames, the scalar product of any two 4-momenta q and q', defined as

$$q \cdot q' = EE' - \vec{p}\cdot\vec{p}' ,$$

is an invariant; i.e., in numerical calculations the same result is obtained in any frame, and in algebraic calculations results obtained in different frames may be equated. For a particle of mass m, the scalar product q·q is

$$q \cdot q = q^2 = E^2 - \vec{p}^2 = m^2 .$$

The invariant mass M (or total c.m. energy) of an n-particle system is given by

$$M^2 = \Big(\sum_{i=1}^{n} q_i\Big)^2 = \Big(\sum_i E_i\Big)^2 - \Big(\sum_i \vec{p}_i\Big)^2 ,$$

where $q_i = (E_i, \vec{p}_i)$ is the 4-momentum of the i^{th} particle.

(c) Electric and magnetic forces -- In Gaussian cgs units, the force on a particle with charge q moving with velocity $\vec{v}$ in electric and magnetic fields $\vec{E}$ and $\vec{B}$ is

$$\vec{F} = q\vec{E} + q\vec{\beta}\times\vec{B} ,$$

where $\vec{\beta} = \vec{v}/c$. The units are $\vec{F}$ in dynes, q in esu, $\vec{E}$ in statvolts/cm, and $\vec{B}$ in gauss. In mksa units, the force is

$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B} ,$$

where the units are $\vec{F}$ in newtons (1 N = 10^5 dynes), q in coulombs (1 C $\approx 3\times10^9$ esu; each 3 in this section is really 2.9979...), $\vec{E}$ in volts/m (1 V $\approx$ 1/300 statvolt), and $\vec{B}$ in tesla (1 T = 10^4 G). The force is zero if $\vec{E}$ and $\vec{B}$ are at right angles, $\vec{\beta}$ (or $\vec{v}$) is in the direction $\vec{E}\times\vec{B}$, and $\beta = E/B$ (cgs) or $v = E/B$ (mksa).

In a uniform, static magnetic field, the path of a charged particle is a helix of constant radius R and constant pitch angle λ, with the axis of the helix being along $\vec{B}$. The momentum is related to the other quantities by

$$p \cos\lambda \approx 3\times10^{-4}\, qBR ,$$

where the units (very mixed!) are p in GeV/c, q in multiples of the electronic charge e, B in kG, and R in cm. The angular velocity about the axis of the helix is

$$\omega \approx 3\times10^{-4}\, qB/\gamma m ,$$

where the units are ω in rad/sec, q in multiples of the electronic charge e, B in kG, and the energy γm in GeV.

II. DECAYS

(a) Survival probabilities -- Let a particle have mass m and proper mean life τ_0. In a frame in which its 4-momentum is (E, $\vec{p}$), the probability that it survives a time greater than t before decaying is

$$\text{Prob.}(>t) = \exp(-t/\gamma\tau_0) = \exp(-mt/E\tau_0) .$$

The probability that it goes a distance greater than x before decaying is

$$\text{Prob.}(>x) = \exp(-x/\gamma\beta c\tau_0) = \exp(-mx/pc\tau_0) ;$$

values of $c\tau_0$ (in cm) are given in the Stable Particle Table. If the particle has charge $\pm e$ and is in a uniform magnetic field $\vec{B}$ [see I(c)], then the probability that the projection of its helical path on the plane perpendicular to $\vec{B}$ turns through an angle greater than θ before decaying is

$$\text{Prob.}(>\theta) = \exp(-Cm\theta/B\tau_0) ,$$

where, if m is in GeV, θ in deg, B in kG, and τ_0 in sec, then C is numerically 1.942×10^{-9}. This last distribution is independent of p or the helical pitch angle λ; its only dependence is geometrical.

(b) Two-body decays -- A particle of mass m decays into two particles, masses m_1 and m_2. In the rest frame of m, the energies of m_1 and m_2 are

$$\epsilon_1 = (m^2 + m_1^2 - m_2^2)/2m$$
$$\epsilon_2 = (m^2 + m_2^2 - m_1^2)/2m .$$

In this frame, the 3-momenta of m_1 and m_2 are equal and opposite and of magnitude

$$k = (\epsilon_1^2 - m_1^2)^{1/2} = (\epsilon_2^2 - m_2^2)^{1/2}$$
$$= \{[m^2 - (m_1 + m_2)^2][m^2 - (m_1 - m_2)^2]\}^{1/2}/2m .$$

See also the third paragraph of III(b).

(c) Three-body decays -- A particle of mass m decays into three particles, masses m_1, m_2, and m_3. The invariant masses m_{ij} of the 2-particle systems, where $m_{ij}^2 = (q_i + q_j)^2$, satisfy the relation

$$m_{12}^2 + m_{13}^2 + m_{23}^2 = m^2 + m_1^2 + m_2^2 + m_3^2 ,$$

so that only two of the three m_{ij}'s are independent. In a rectangular Dalitz plot, m_{13}^2 (say) is plotted against m_{12}^2. The kinematic boundaries may be calculated as follows: (i) The lower and upper limits on m_{12}^2 are $(m_1 + m_2)^2$ and $(m - m_3)^2$. (ii) For any m_{12}^2 between these limits, the lower and upper limits on m_{13}^2 are given by taking the + and − signs in

$$m_{13}^2 = (E_1 + E_3)^2 - (p_1 \pm p_3)^2 ,$$

where

$$E_1 = (m_{12}^2 + m_1^2 - m_2^2)/2m_{12}$$
$$E_3 = (m^2 - m_{12}^2 - m_3^2)/2m_{12}$$
$$p_1 = (E_1^2 - m_1^2)^{1/2}$$
$$p_3 = (E_3^2 - m_3^2)^{1/2} .$$

(These are the energies and momenta of particles 1 and 3 in the rest frame of m_{12}.) The phase-space density is uniform over the areas of both the above and the following form of the Dalitz plot.

In a triangular Dalitz plot, the kinetic energies T_1, T_2, and T_3 of the final-state particles in the rest frame of m are plotted as the distances inward from the sides of an equilateral triangle whose altitude is the energy Q released by the decay:

$$Q = T_1 + T_2 + T_3 = m - m_1 - m_2 - m_3 .$$

The kinetic energies are related to the 2-particle invariant masses by

$$2mT_1 = (m - m_1)^2 - m_{23}^2 = (m_{23}^{max})^2 - m_{23}^2 ,$$

etc.

RELATIVISTIC KINEMATICS (Cont'd)

(d) Four-body decays -- A particle of mass m decays into four particles, masses m_1, m_2, m_3, and m_4. In a triangle (or Goldhaber) plot, the invariant mass of two of the particles is plotted against that of the other two, say m_{34} versus m_{12}, where $m_{ij}^2 = (q_i + q_j)^2$. The kinematic boundaries of this plot are the sides of the triangle whose vertices are at the points $(m_{12}, m_{34}) = (m_1 + m_2, m_3 + m_4)$, $(m_1 + m_2, m - m_1 - m_2)$, and $(m - m_3 - m_4, m_3 + m_4)$. The phase-space density is not uniform over the enclosed area.

III. REACTIONS (MAINLY 2-BODY)

(a) Initial state -- Two particles, masses m_1 and m_2, interact. In the lab frame, where particle 2 is at rest, the 4-momenta are $(E_1, \vec{p}_1)$ and $(m_2, 0)$. In the c.m. frame, where the 3-momenta are equal and opposite, the 4-momenta are $(\epsilon_1, \vec{k})$ and $(\epsilon_2, -\vec{k})$. Then the total c.m. energy $\mathcal{E}$ is given by

$$\mathcal{E}^2 = (\epsilon_1 + \epsilon_2)^2 = m_1^2 + m_2^2 + 2E_1m_2 .$$

The c.m. energies of particles 1 and 2 are

$$\epsilon_1 = (m_1^2 + E_1m_2)/\mathcal{E} = (\mathcal{E}^2 + m_1^2 - m_2^2)/2\mathcal{E}$$

$$\epsilon_2 = (m_2^2 + E_1m_2)/\mathcal{E} = (\mathcal{E}^2 + m_2^2 - m_1^2)/2\mathcal{E} .$$

The c.m. momentum k is

$$k = p_1m_2/\mathcal{E} .$$

See also the expression in II(b) for k, in which replace m with $\mathcal{E}$.

The velocity of the c.m. relative to the lab is

$$\beta = p_1/(E_1 + m_2) .$$

The parameters for the Lorentz transformation between these frames [see I(a)] are

$$\gamma = (E_1 + m_2)/\mathcal{E}$$

and

$$\gamma\beta = p_1/\mathcal{E} .$$

(b) Two-body final states -- In the reaction 1 + 2 → 3 + 4, let the masses be m_i and the final-state c.m. 4-momenta be $(\epsilon_3, \vec{k}')$ and $(\epsilon_4, -\vec{k}')$. Then

$$\epsilon_3 = (\mathcal{E}^2 + m_3^2 - m_4^2)/2\mathcal{E}$$

$$\epsilon_4 = (\mathcal{E}^2 + m_4^2 - m_3^2)/2\mathcal{E} ;$$

and

$$k' = (\epsilon_3^2 - m_3^2)^{1/2} = (\epsilon_4^2 - m_4^2)^{1/2}$$

$$= \{[\mathcal{E}^2 - (m_3 + m_4)^2][\mathcal{E}^2 - (m_3 - m_4)^2]\}^{1/2}/2\mathcal{E} .$$

Let Θ_3 be the lab production angle of particle 3 (the angle between $\vec{p}_3$ and $\vec{p}_1$), and let θ_3 be the c.m. production angle (the angle between $\vec{k}'$ and $\vec{k}$). These angles are related by

$$\tan\Theta_3 = \frac{p_{3\perp}}{p_{3\parallel}} = \frac{\sin\theta_3}{\gamma(\cos\theta_3 + \beta/\beta_3)} ,$$

where $p_{3\perp}$ and $p_{3\parallel}$ are the components of $\vec{p}_3$ perpendicular and parallel to $\vec{p}_1$, and $\beta_3 = k'/\epsilon_3$ is the c.m. velocity of particle 3. [See III(a) for γ and β.] If $\beta > \beta_3$, then particle 3 can only go forward in the lab, the maximum Θ_3 being given by

$$\tan\Theta_3^{max} = \beta_3\left(\frac{1 - \beta^2}{\beta^2 - \beta_3^2}\right)^{1/2} .$$

The components of $\vec{p}_3$ satisfy

$$\left(\frac{p_{3\parallel} - \gamma\beta\epsilon_3}{\gamma k'}\right)^2 + \left(\frac{p_{3\perp}}{k'}\right)^2 = 1 ,$$

which is the equation of an ellipse with semi-major axis $\gamma k'$ and semi-minor axis k'. Thus the possible lab momenta of particle 3 are the vectors to the ellipse from the point a distance $\gamma\beta\epsilon_3$ back along the major axis from the center of the ellipse.

The results of the preceding paragraph also apply to 2-body decay. Just set $m_2 = 0$, in which case $\mathcal{E} = m_1$. [The decay-product masses are here m_3 and m_4, not m_1 and m_2 as in II(b).]

The Mandelstam variables s, t, and u are the Lorentz scalars defined in terms of the particle 4-momenta q_i as

$$s = (q_1 + q_2)^2 = (q_3 + q_4)^2$$

$$t = (q_1 - q_3)^2 = (q_2 - q_4)^2$$

$$u = (q_1 - q_4)^2 = (q_2 - q_3)^2 .$$

They satisfy the relation

$$s + t + u = m_1^2 + m_2^2 + m_3^2 + m_4^2 ,$$

so that only two of the three are independent. Evaluating s in the c.m. frame gives

$$s = (\epsilon_1 + \epsilon_2)^2 = \mathcal{E}^2 ,$$

and evaluating t and u, the 4-momentum-transfer-squared variables, in this frame gives

$$t = m_1^2 + m_3^2 - 2\epsilon_1\epsilon_3 + 2kk'\cos\theta_3$$

$$= t_0 - 4kk'\sin^2(\theta_3/2)$$

$$u = m_1^2 + m_4^2 - 2\epsilon_1\epsilon_4 + 2kk'\cos\theta_4$$

$$= u_0 - 4kk'\sin^2(\theta_4/2) ,$$

where θ_4 is the c.m. production angle of particle 4 ($\theta_3 + \theta_4 = \pi$), and

$$t_0 = t(\theta_3 = 0) = (\epsilon_1 - \epsilon_3)^2 - (k - k')^2$$

$$u_0 = u(\theta_4 = 0) = (\epsilon_1 - \epsilon_4)^2 - (k - k')^2 .$$

The differences $\Delta t = t_0 - t_\pi$ and $\Delta u = u_0 - u_\pi$, where $t_\pi = t(\theta_3 = \pi)$ and $u_\pi = u(\theta_4 = \pi)$, are

$$\Delta t = \Delta u = 4kk' .$$

For elastic scattering, where $m_1 = m_3 = m$ and $m_2 = m_4 = M$, t_0 is zero and

$$t = -2k^2(1 - \cos\theta_3) = -4k^2\sin^2(\theta_3/2) .$$

And now

$$u_0 = (m^2 - M^2)^2/s .$$

Evaluating t in the lab frame gives

$$t = -2MT_4 ,$$

where $T_4 = E_4 - M$ is the lab kinetic energy of particle 4. For small-angle elastic scattering,

$$(-t)^{1/2} \approx k\theta_3 \approx p_1\Theta_3 \approx p_4 ,$$

where p_1, Θ_3, and p_4 are lab quantities.

IV. OTHER VARIABLES

(a) Rapidity -- For a system of energy E and momentum $\vec{p}$, the rapidity y is given by

$$y = \frac{1}{2}\ln\left(\frac{E+p_\parallel}{E-p_\parallel}\right) = \tanh^{-1}\left(\frac{p_\parallel}{E}\right) = \ln\left(\frac{E+p_\parallel}{m_\perp}\right) ,$$

where $p_\parallel$ is the component of $\vec{p}$ along a particular axis (the "rapidity axis", chosen, for example, parallel to the direction of an incoming beam), and $m_\perp = (m^2 + p_\perp^2)^{1/2}$. Inverting these equations, we find

$$E = m_\perp\cosh y$$

$$p_\parallel = m_\perp\sinh y .$$

The shape of a rapidity distribution is invariant under a Lorentz transformation between inertial frames with relative motion parallel to the rapidity axis. Such a transformation is given by

$$y^* = y - \ln[\gamma(1+\beta)] = y - \frac{1}{2}\ln\left(\frac{1+\beta}{1-\beta}\right) ,$$

where the sign of β is positive in the direction of increasing rapidity and $p_\parallel$.

RELATIVISTIC KINEMATICS (Cont'd)

(b) Scaling variable, hadron reactions -- In the inclusive reaction $h + 2 \to 3 + X$, with h any hadron, Feynman's x for particle 3 is defined as

$$x = k'_{\parallel}/k'_{max} .$$

where k' is the c.m. momentum of particle 3. k'_{max} is obtained [see Sec. III(b)] using the smallest mass m_X [called m_4 in III(b)] consistent with quantum conservation laws. At high energies, $k'_{max} \simeq \sqrt{s}/2$. Rapidity and x are related at large $\sqrt{s}$ by

$$x \simeq \frac{2m_{\perp}}{\sqrt{s}} \sinh y^* ,$$

where y^* is evaluated in the c.m.

(c) Scaling variables, lepton reactions -- For the inclusive reaction $\ell + 2 \to \ell' + X$, with particles ℓ and ℓ' leptons, we define the 4-vector

$$q = (p_\ell - p_{\ell'})$$

so that

$$Q^2 \equiv -q^2 = 2E_\ell E_{\ell'} - 2|\vec{p}_\ell||\vec{p}_{\ell'}| \cos\theta - m_{\ell'}^2 - m_\ell^2 \geq^{\dagger} 0$$

where θ is the $\ell \to \ell'$ scattering angle, and the preceding relation is valid in any frame. Also useful are

$$\nu = p_2 \cdot q/m_2 = [\, E_\ell - E_{\ell'} \,]_{LAB} = [\, E_X - m_2 \,]_{LAB}$$

and

$$W = \sqrt{p_X^2} = (-Q^2 + 2m_2\nu + m_2^2)^{1/2} = m_X .$$

Q^2, ν, and W are Lorentz invariants, and the notation "LAB" refers to the reference frame with particle 2 at rest. (Note: ν is sometimes written $\nu = p_2 \cdot q$, leading to the replacement of $m_2\nu$ with ν throughout.)

Scaling variables in common use include

$$x \equiv \omega^{-1} = Q^2/2m_2\nu , \; 0 \leq^{\dagger} x \leq^{\dagger} 1$$

and

$$y = m_2\nu/p_\ell \cdot p_2 = [\, (E_\ell - E_{\ell'})/E_\ell \,]_{LAB} , \; 0 \leq^{\dagger} y \leq 1 .$$

Both x and y are dimensionless.

Cross sections for inclusive reactions in the energy region where masses are negligible can be written in terms of E_ℓ and certain pairs of these variables, usually Q^2 and ν, x and y, or Q^2 and x. If, in any frame, $|\vec{p}_\ell||\vec{p}_{\ell'}| \simeq E_\ell E_{\ell'}$ and $E_\ell E_{\ell'} \sin^2(\theta/2) >> m_{\ell'}^2$ and m_ℓ^2 (i.e., m_ℓ, $m_{\ell'}$ small), then

$$Q^2 \simeq 4E_\ell E_{\ell'} \sin^2(\theta/2)$$

and

$$x \simeq \frac{2E_\ell E_{\ell'} \sin^2(\theta/2)}{m_2\nu} .$$

†Inequality sometimes violated unless $m_X \geq m_2$ and $m_{\ell'} \geq m_\ell$.

LORENTZ INVARIANT PHASE SPACE FORMULAE

For a system of n particles with overall four-momentum p and final four momenta $p_1, \cdots, p_n$ [$p_i = (E_i, \vec{P}_i)$], Lorentz Invariant Phase Space is given by

$$d\,\mathrm{LIPS}(s;p_1,\cdots,p_n) = (2\pi)^4 \delta^4(p - \sum_i p_i) \frac{1}{(2\pi)^{3n}} \prod_{i=1}^{n} \frac{d^3\vec{P}_i}{2E_i} . \quad (1)$$

For 2-body:
$$d\,\mathrm{LIPS}(s,p_1,p_2) = \frac{1}{(2\pi)^2} \delta^4(p-p_1-p_2)\, d^4p \frac{|\vec{p}_1^{\,cm}|}{4\sqrt{s}} d\Omega_1^{cm} . \quad (2)$$

For 3-body:
$$d\,\mathrm{LIPS}(s,p_1,p_2,p_3) = \frac{1}{(2\pi)^5} \delta^4(p-p_1-p_2-p_3)\, d^4p \frac{1}{32s} ds_{12}\, ds_{23}\, d\alpha\, d\cos\beta\, d\gamma , \quad (3)$$

where α, β, and γ are Euler angles.

For $a + b \to$ n particles or $X \to$ n particles, in general $|i\rangle \to |f\rangle$,

$$\sigma_{if} = \frac{1}{4F} \int |\mathcal{M}_{if}|^2 \, d\,\mathrm{LIPS}(s;p_1,\cdots,p_n), \quad (4)$$

or

$$\Gamma_{if} = \frac{1}{2m_X} \int |\mathcal{M}_{if}|^2 \, d\,\mathrm{LIPS}(m_X^2;p_1,\cdots,p_n), \quad (5)$$

where $\mathcal{M}_{if}$ is an invariant matrix element. F is Møller's invariant flux factor, $F^2 = (p_a \cdot p_b)^2 - m_a^2 m_b^2$. If a is beam, b, target ($\vec{P}_b^{lab} = 0$), then $F = |\vec{P}_a^{lab}|\, m_b = |\vec{P}_a^{cm}| \sqrt{s}$.

For elastic scattering in c.m., $|\vec{P}_a^{cm}| = |\vec{P}_1^{cm}|$, and (2) and (4) yield

$$\frac{d\sigma}{d\Omega} = \frac{|\mathcal{M}|^2}{(8\pi)^2 s} \quad \text{or} \quad \frac{d\sigma}{dt} = \frac{|\mathcal{M}|^2}{64\pi |\vec{P}_a^{cm}|^2 s} . \quad (6)$$

The normalization is such that the optical theorem reads

$$\mathrm{Im}\, \mathcal{M}|_{t=0} = 2|\vec{P}_a^{cm}| \sqrt{s}\, \sigma_{tot} . \quad (7)$$

The choice of Eq. (1) implies a particular normalization of any spinors that may occur in $\mathcal{M}$. The advantage of this normalization is that it greatly simplifies the structure of $\mathcal{M}$ by putting factors such as $\frac{1}{(2\pi)^3}$ $\frac{1}{2E}$ into the phase space where they really belong. In addition, the labels, i, f, refer to specific spin (helicity) states, so that the usual "average and sum" rule is implicit.

C.M. ENERGY AND MOMENTUM VS. BEAM MOMENTUM

$$E_{cm}dE_{cm} = m_p dT_{beam} = m_p v_{beam} dP_{beam} \approx m_p dP_{beam}$$

PBEAM (GEV/C)	C. M. ENERGY (GEV) γp,νp ~ep	πp	Kp	pp	MOMENTUM IN C. M. (GEV/C) γp,νp ~ep	πp	Kp	pp
0.00	.938	1.076	1.432	1.877	.000	.000	[illegible]	.000
0.02	.958	1.079	1.432	1.877	.020	.017	[illegible]	.010
0.04	.977	1.083	1.433	1.877	.038	.035	[illegible]	.020
0.06	.996	1.089	1.434	1.878	.055	.052	[illegible]	.030
0.08	1.015	1.096	1.436	1.878	.074	.068	[illegible]	.040
0.10	1.033	1.105	1.439	1.879	.091	.085	[illegible]	.050
0.12	1.051	1.116	1.441	1.880	.107	.101	[illegible]	.060
0.14	1.069	1.127	1.445	1.882	.123	.117	[illegible]	.070
0.16	1.087	1.139	1.448	1.883	.138	.132	[illegible]	.080
0.18	1.104	1.152	1.453	1.885	.153	.147	[illegible]	.090
0.20	1.121	1.165	1.457	1.887	.167	.161	[illegible]	.099
0.22	1.137	1.178	1.462	1.889	.182	.175	[illegible]	.109
0.24	1.154	1.192	1.468	1.892	.195	.189	[illegible]	.119
0.26	1.170	1.206	1.473	1.894	.209	.202	[illegible]	.129
0.28	1.186	1.219	1.480	1.897	.222	.215	[illegible]	.138
0.30	1.201	1.233	1.486	1.900	.234	.228	[illegible]	.148
0.32	1.217	1.247	1.493	1.903	.247	.241	[illegible]	.158
0.34	1.232	1.261	1.500	1.906	.259	.253	[illegible]	.167
0.36	1.247	1.275	1.507	1.910	.271	.265	[illegible]	.177
0.38	1.262	1.288	1.514	1.913	.282	.277	[illegible]	.186
0.40	1.277	1.302	1.522	1.917	.294	.288	[illegible]	.196
0.42	1.292	1.316	1.530	1.921	.305	.300	[illegible]	.205
0.44	1.306	1.329	1.538	1.925	.316	.311	[illegible]	.214
0.46	1.320	1.342	1.546	1.929	.327	.322	[illegible]	.224
0.48	1.335	1.356	1.554	1.934	.337	.332	[illegible]	.233
0.50	1.349	1.369	1.563	1.938	.348	.343	[illegible]	.242
0.52	1.362	1.382	1.571	1.943	.358	.353	[illegible]	.251
0.54	1.376	1.395	1.580	1.947	.368	.363	[illegible]	.260
0.56	1.390	1.408	1.589	1.952	.378	.373	[illegible]	.269
0.58	1.403	1.421	1.598	1.957	.388	.383	[illegible]	.278
0.60	1.416	1.434	1.607	1.962	.397	.393	[illegible]	.287
0.62	1.430	1.447	1.616	1.968	.407	.402	[illegible]	.296
0.64	1.443	1.459	1.625	1.973	.416	.412	[illegible]	.304
0.66	1.456	1.472	1.634	1.978	.425	.421	[illegible]	.313
0.68	1.468	1.484	1.643	1.984	.434	.430	[illegible]	.322
0.70	1.481	1.496	1.653	1.989	.443	.439	[illegible]	.330
0.72	1.494	1.509	1.662	1.995	.452	.448	[illegible]	.339
0.74	1.506	1.521	1.671	2.001	.461	.457	[illegible]	.347
0.76	1.519	1.533	1.681	2.007	.470	.465	[illegible]	.355
0.78	1.531	1.545	1.690	2.013	.478	.474	[illegible]	.364
0.80	1.543	1.557	1.699	2.019	.486	.482	[illegible]	.372
0.82	1.555	1.569	1.709	2.025	.495	.490	[illegible]	.380
0.84	1.567	1.580	1.718	2.031	.503	.499	[illegible]	.388
0.86	1.579	1.592	1.728	2.037	.511	.507	[illegible]	.396
0.88	1.591	1.604	1.737	2.043	.519	.515	[illegible]	.404
0.90	1.603	1.615	1.747	2.050	.527	.523	[illegible]	.412
0.92	1.615	1.627	1.756	2.056	.535	.531	[illegible]	.420
0.94	1.626	1.638	1.765	2.062	.542	.538	[illegible]	.428
0.96	1.638	1.649	1.775	2.069	.550	.546	[illegible]	.435
0.98	1.649	1.661	1.784	2.075	.558	.554	[illegible]	.443
1.00	1.660	1.672	1.794	2.082	.565	.561	[illegible]	.451
1.02	1.672	1.683	1.803	2.088	.573	.569	[illegible]	.458
1.04	1.683	1.694	1.812	2.095	.580	.576	[illegible]	.466
1.06	1.694	1.705	1.822	2.102	.587	.583	[illegible]	.473
1.08	1.705	1.716	1.831	2.109	.594	.591	[illegible]	.481
1.10	1.716	1.726	1.840	2.115	.601	.598	[illegible]	.488
1.12	1.727	1.737	1.850	2.122	.609	.605	[illegible]	.495
1.14	1.738	1.748	1.859	2.129	.616	.612	[illegible]	.502
1.16	1.748	1.759	1.868	2.136	.622	.619	[illegible]	.510
1.18	1.759	1.769	1.877	2.142	.629	.626	[illegible]	.517
1.20	1.770	1.780	1.887	2.149	.636	.633	[illegible]	.524
1.22	1.780	1.790	1.895	2.156	.643	.639	[illegible]	.531
1.24	1.791	1.800	1.905	2.163	.650	.646	[illegible]	.538
1.26	1.801	1.811	1.914	2.170	.656	.653	[illegible]	.545
1.28	1.812	1.821	1.923	2.177	.663	.660	[illegible]	.552
1.30	1.822	1.831	1.932	2.184	.669	.666	[illegible]	.559
1.32	1.832	1.841	1.941	2.191	.676	.673	[illegible]	.565
1.34	1.843	1.851	1.950	2.198	.682	.679	[illegible]	.572
1.36	1.853	1.862	1.959	2.205	.689	.685	[illegible]	.579
1.38	1.863	1.872	1.968	2.212	.695	.692	[illegible]	.585
1.40	1.873	1.882	1.977	2.219	.701	.698	[illegible]	.592
1.42	1.883	1.891	1.986	2.226	.708	.704	[illegible]	.599
1.44	1.893	1.901	1.995	2.233	.714	.711	[illegible]	.605
1.46	1.903	1.911	2.004	2.240	.720	.717	[illegible]	.612
1.48	1.913	1.921	2.013	2.247	.726	.723	[illegible]	.618
1.50	1.922	1.931	2.022	2.254	.732	.729	[illegible]	.624
1.52	1.932	1.940	2.031	2.261	.738	.735	[illegible]	.631
1.54	1.942	1.950	2.039	2.268	.744	.741	[illegible]	.637
1.56	1.951	1.959	2.048	2.275	.750	.747	[illegible]	.643
1.58	1.961	1.969	2.057	2.282	.756	.753	[illegible]	.650
1.60	1.970	1.978	2.065	2.289	.762	.759	[illegible]	.656
1.62	1.980	1.988	2.074	2.296	.768	.765	[illegible]	.662
1.64	1.989	1.997	2.083	2.304	.773	.770	[illegible]	.668
1.66	[illegible]	2.006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PBEAM (GEV/C)	C. M. ENERGY (GEV) γp,νp ~ep	πp	Kp	pp	MOMENTUM IN C. M. (GEV/C) γp,νp ~ep	πp	Kp	pp
1.70	2.018	2.025	2.109	2.325	.791	.788	.756	.686
1.72	2.027	2.034	2.117	2.332	.796	.793	.762	.692
1.74	2.036	2.043	2.126	2.339	.802	.799	.768	.698
1.76	2.045	2.053	2.134	2.346	.807	.805	.774	.704
1.78	2.054	2.062	2.143	2.353	.813	.810	.780	.710
1.80	2.064	2.071	2.151	2.360	.818	.816	.785	.716
1.82	2.073	2.080	2.159	2.367	.824	.821	.791	.721
1.84	2.082	2.089	2.168	2.374	.829	.827	.796	.727
1.86	2.091	2.098	2.176	2.381	.835	.832	.802	.733
1.88	2.100	2.107	2.184	2.388	.840	.837	.808	.739
1.90	2.109	2.115	2.193	2.395	.845	.843	.813	.744
1.92	2.117	2.124	2.201	2.402	.851	.848	.819	.750
1.94	2.126	2.133	2.209	2.409	.856	.853	.824	.756
1.96	2.135	2.142	2.217	2.416	.861	.859	.829	.761
1.98	2.144	2.151	2.226	2.423	.867	.864	.835	.767
2.0	2.153	2.159	2.234	2.430	.872	.869	.840	.772
2.1	2.196	2.202	2.274	2.465	.897	.895	.865	.799
2.2	2.238	2.244	2.314	2.500	.922	.920	.892	.826
2.3	2.280	2.286	2.353	2.534	.947	.944	.917	.852
2.4	2.320	2.326	2.392	2.568	.970	.968	.941	.877
2.5	2.360	2.366	2.430	2.602	.994	.991	.965	.901
2.6	2.400	2.405	2.468	2.636	1.02	1.01	.989	.926
2.7	2.439	2.444	2.505	2.669	1.04	1.04	1.01	.949
2.8	2.477	2.482	2.542	2.702	1.06	1.06	1.03	.972
2.9	2.514	2.520	2.578	2.735	1.08	1.08	1.06	.995
3.0	2.551	2.556	2.613	2.768	1.10	1.10	1.08	1.02
3.1	2.588	2.593	2.649	2.800	1.12	1.12	1.10	1.04
3.2	2.624	2.629	2.683	2.832	1.14	1.14	1.12	1.06
3.3	2.660	2.664	2.718	2.863	1.16	1.16	1.14	1.08
3.4	2.695	2.699	2.752	2.895	1.18	1.18	1.16	1.10
3.5	2.729	2.734	2.785	2.926	1.20	1.20	1.18	1.12
3.6	2.763	2.768	2.818	2.957	1.22	1.22	1.20	1.14
3.7	2.797	2.801	2.851	2.987	1.24	1.24	1.22	1.16
3.8	2.830	2.835	2.884	3.018	1.26	1.26	1.24	1.19
3.9	2.863	2.868	2.916	3.048	1.28	1.28	1.26	1.20
4.0	2.896	2.900	2.947	3.077	1.30	1.29	1.27	1.22
4.1	2.928	2.932	2.979	3.107	1.31	1.31	1.29	1.24
4.2	2.960	2.964	3.010	3.136	1.33	1.33	1.31	1.26
4.3	2.992	2.996	3.041	3.165	1.35	1.35	1.33	1.27
4.4	3.023	3.027	3.071	3.194	1.37	1.36	1.34	1.29
4.5	3.054	3.058	3.101	3.223	1.38	1.38	1.36	1.31
4.6	3.084	3.088	3.131	3.251	1.40	1.40	1.38	1.33
4.7	3.115	3.118	3.161	3.279	1.42	1.41	1.40	1.34
4.8	3.144	3.148	3.190	3.307	1.43	1.43	1.41	1.36
4.9	3.174	3.178	3.220	3.335	1.45	1.45	1.43	1.38
5.0	3.204	3.207	3.248	3.363	1.46	1.46	1.44	1.40
5.2	3.262	3.265	3.305	3.417	1.50	1.49	1.48	1.43
5.4	3.319	3.322	3.362	3.471	1.53	1.53	1.51	1.46
5.6	3.375	3.378	3.417	3.524	1.56	1.56	1.54	1.49
5.8	3.430	3.433	3.471	3.576	1.59	1.59	1.57	1.52
6.0	3.484	3.487	3.524	3.627	1.62	1.61	1.60	1.55
6.2	3.538	3.541	3.577	3.678	1.64	1.64	1.63	1.58
6.4	3.590	3.593	3.629	3.728	1.67	1.67	1.65	1.61
6.6	3.642	3.645	3.680	3.778	1.70	1.70	1.68	1.64
6.8	3.693	3.696	3.731	3.827	1.73	1.73	1.71	1.67
7.0	3.744	3.747	3.781	3.875	1.75	1.75	1.74	1.70
7.2	3.794	3.797	3.830	3.923	1.78	1.78	1.76	1.72
7.4	3.843	3.846	3.878	3.970	1.81	1.81	1.79	1.75
7.6	3.891	3.894	3.926	4.016	1.83	1.83	1.82	1.78
7.8	3.939	3.942	3.974	4.062	1.86	1.86	1.84	1.80
8.0	3.987	3.989	4.021	4.106	1.88	1.88	1.87	1.83
8.2	4.033	4.036	4.067	4.153	1.91	1.91	1.89	1.85
8.4	4.080	4.082	4.113	4.198	1.93	1.93	1.92	1.88
8.6	4.125	4.128	4.158	4.242	1.96	1.95	1.94	1.90
8.8	4.171	4.173	4.203	4.286	1.98	1.98	1.96	1.93
9.0	4.215	4.218	4.247	4.329	2.00	2.00	1.99	1.95
9.2	4.260	4.262	4.291	4.372	2.03	2.03	2.01	1.97
9.4	4.303	4.306	4.335	4.415	2.05	2.05	2.03	2.00
9.6	4.347	4.349	4.378	4.457	2.07	2.07	2.06	2.02
9.8	4.390	4.392	4.420	4.498	2.09	2.09	2.08	2.04
10.0	4.432	4.435	4.462	4.540	2.12	2.12	2.10	2.07
10.5	4.537	4.539	4.566	4.641	2.17	2.17	2.16	2.12
11.0	4.539	4.642	4.668	4.741	2.22	2.22	2.21	2.18
11.5	4.739	4.742	4.767	4.839	2.28	2.28	2.26	2.23
12.0	4.837	4.839	4.864	4.934	2.33	2.33	2.31	2.28
12.5	4.933	4.935	4.960	5.028	2.38	2.38	2.36	2.33
13.0	5.027	5.030	5.053	5.120	2.43	2.43	2.41	2.36
13.5	5.120	5.122	5.145	5.211	2.47	2.47	2.46	2.43
14.0	5.211	5.213	5.236	5.300	2.52	2.52	2.51	2.48
14.5	5.300	5.302	5.324	5.388	2.57	2.57	2.56	2.53
15.0	5.388	5.390	5.412	5.474	2.61	2.61	2.60	2.57
15.5	5.474	5.476	5.498	5.559	2.66	2.66	2.65	2.62
16.0	5.559	5.561	5.582	5.642	2.70	2.70	2.69	2.66
[illegible]	5.643	5.645	[illegible]	5.725	2.74	2.74	[illegible]	[illegible]
[illegible]	5.726	[illegible]	[illegible]	[illegible]	2.79	[illegible]	[illegible]	2.75

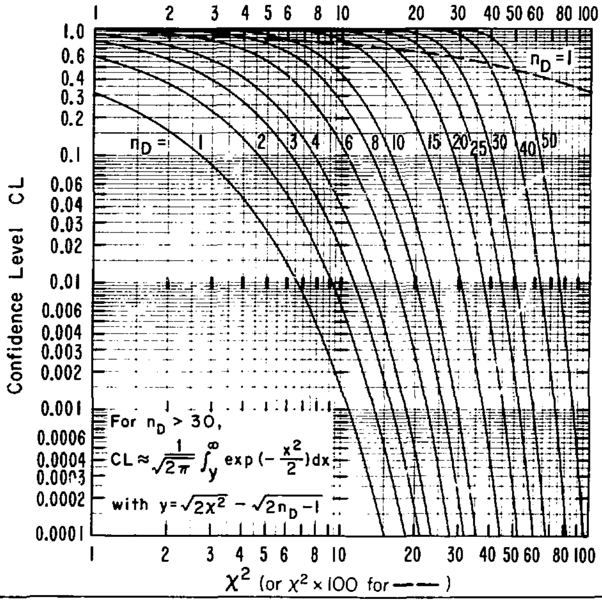
PBEAM (GEV/C)	C. M. ENERGY (GEV) γp,νp ~ep	πp	Kp	pp	MOMENTUM IN C. M. (GEV/C) γp,νp ~ep	πp	Kp	pp
17.5	5.807	5.809	5.829	5.886	2.83	2.83	2.82	2.79
18.0	5.887	5.889	5.909	5.965	2.87	2.87	2.86	2.83
18.5	5.966	5.968	5.988	6.043	2.91	2.91	2.90	2.87
19.0	6.044	6.046	6.066	6.120	2.95	2.95	2.94	2.91
19.5	6.122	6.123	6.142	6.196	2.99	2.99	2.98	2.95
20	6.198	6.199	6.216	6.272	3.03	3.03	3.02	2.99
21	6.347	6.349	6.367	6.419	3.10	3.10	3.09	3.07
22	6.493	6.495	6.513	6.564	3.18	3.18	3.17	3.14
23	6.636	6.638	6.655	6.705	3.25	3.25	3.24	3.22
24	6.776	6.778	6.795	6.843	3.32	3.32	3.31	3.29
25	6.913	6.915	6.932	6.979	3.39	3.39	3.38	3.36
26	7.048	7.049	7.066	7.112	3.46	3.46	3.45	3.43
27	7.180	7.181	7.197	7.243	3.53	3.53	3.52	3.50
28	7.309	7.311	7.326	7.371	3.59	3.59	3.59	3.56
29	7.436	7.438	7.453	7.497	3.65	3.66	3.65	3.63
30	7.562	7.563	7.578	7.621	3.72	3.72	3.71	3.69
31	7.685	7.686	7.701	7.743	3.79	3.78	3.78	3.76
32	7.806	7.807	7.822	7.864	3.85	3.85	3.84	3.82
33	7.925	7.926	7.941	7.982	3.91	3.91	3.90	3.88
34	8.043	8.044	8.058	8.099	3.97	3.97	3.96	3.94
35	8.158	8.160	8.174	8.214	4.03	4.02	4.02	4.00
36	8.273	8.274	8.288	8.327	4.08	4.08	4.08	4.06
37	8.385	8.386	8.400	8.439	4.14	4.14	4.13	4.11
38	8.496	8.498	8.511	8.549	4.20	4.20	4.19	4.17
39	8.606	8.607	8.621	8.658	4.25	4.25	4.24	4.23
40	8.715	8.716	8.729	8.766	4.31	4.31	4.30	4.28
41	8.822	8.823	8.836	8.872	4.36	4.36	4.35	4.34
42	8.927	8.928	8.941	8.978	4.41	4.41	4.41	4.39
43	9.032	9.033	9.046	9.081	4.47	4.47	4.46	4.44
44	9.135	9.136	9.149	9.184	4.52	4.52	4.51	4.50
45	9.237	9.238	9.251	9.286	4.57	4.57	4.56	4.55
46	9.338	9.339	9.352	9.386	4.62	4.62	4.62	4.60
47	9.438	9.439	9.451	9.486	4.67	4.67	4.67	4.65
48	9.537	9.538	9.550	9.584	4.72	4.72	4.72	4.70
49	9.635	9.636	9.648	9.681	4.77	4.77	4.77	4.75
50	9.732	9.733	9.745	9.778	4.82	4.82	4.81	4.80
52	9.923	9.924	9.935	9.968	4.92	4.92	4.91	4.89
54	10.11	10.11	10.12	10.15	5.01	5.01	5.01	4.99
56	10.29	10.30	10.31	10.34	5.10	5.10	5.10	5.08
58	10.47	10.48	10.49	10.52	5.20	5.19	5.19	5.17
60	10.65	10.65	10.66	10.69	5.28	5.28	5.28	5.26
62	10.83	10.83	10.84	10.87	5.37	5.37	5.37	5.35
64	11.00	11.00	11.01	11.04	5.46	5.46	5.45	5.44
66	11.17	11.17	11.18	11.21	5.54	5.54	5.54	5.53
[illegible]	11.34	11.34	11.35	11.37	5.63	5.63	5.62	5.61
70	11.50	11.50	11.51	11.54	5.71	5.71	5.71	5.69
72	11.66	11.66	11.67	11.70	5.79	5.79	5.79	5.77
74	11.82	11.82	11.83	11.86	5.87	5.87	5.87	5.85
76	11.98	11.98	11.99	12.02	5.95	5.95	5.95	5.93
78	12.13	12.14	12.14	12.17	6.03	6.03	6.03	5.01
80	12.29	12.29	12.30	12.32	6.11	6.11	6.10	8.09
82	12.44	12.44	12.45	12.48	6.18	6.18	6.18	6.17
84	12.59	12.59	12.60	12.63	6.26	6.26	6.26	6.24
86	12.74	12.74	12.75	12.77	6.33	6.33	6.33	6.32
88	12.88	12.89	12.89	12.92	6.41	6.41	6.40	6.39
90	13.03	13.03	13.04	13.06	6.48	6.48	6.48	6.46
92	13.17	13.17	13.18	13.21	6.55	6.55	6.55	6.54
94	13.31	13.32	13.32	13.35	6.62	6.62	6.62	6.61
96	13.45	13.46	13.46	13.49	6.69	6.69	6.69	6.68
98	13.59	13.59	13.60	13.63	6.76	6.76	6.76	6.75
100	13.73	13.73	13.74	13.76	6.83	6.83	6.83	6.82
150	16.80	16.80	16.81	16.83	8.38	8.38	8.37	8.36
200	19.40	19.40	19.40	19.42	9.68	[illegible]	9.67	9.66
250	21.68	21.68	21.69	21.70	10.8	[illegible]	10.8	10.8
300	23.75	23.75	23.75	23.76	11.9	11.9	11.9	11.8
350	25.65	25.65	25.65	25.66	12.8	12.8	12.8	12.8
400	27.41	27.41	27.42	27.43	13.7	13.7	13.7	13.7
450	29.07	29.07	29.08	29.09	14.5	14.5	14.5	14.5
500	30.65	30.65	30.65	30.66	15.3	15.3	15.3	15.3
550	32.14	32.14	32.14	32.15	16.1	16.1	16.1	16.0
600	33.57	33.57	33.57	33.58	16.8	16.8	16.8	16.8
650	34.94	34.94	34.94	34.95	17.5	17.5	17.5	17.4
700	36.26	36.26	36.26	36.27	18.1	18.1	18.1	18.1
750	37.53	37.53	37.53	37.54	18.8	18.8	18.8	18.7
800	38.76	38.76	38.76	38.77	19.4	19.4	19.4	19.4
850	39.95	39.95	39.95	39.96	20.0	20.0	20.0	20.0
900	41.11	41.11	41.11	41.12	20.5	20.5	20.5	20.5
950	42.23	42.23	42.24	42.24	21.1	21.1	21.1	21.1
1000	43.33	43.33	43.33	43.34	21.7	21.7	21.7	21.6
2000	61.27	61.27	61.27	61.28	30.6	30.6	30.6	30.6
5000	96.87	96.87	96.87	96.87	48.4	48.4	48.4	48.4
10000	137.0	137.0	137.0	137.0	68.5	68.5	68.5	68.5
20000	193.7	193.7	193.7	193.7	96.9	96.9	96.9	96.9
50000	306.3	306.3	306.3	306.3	153	153	153	153
100000	433.2	433.2	433.2	433.2	217	217	217	217
200000	612.6	612.6	612.6	612.6	306	306	306	306
500000	968.6	968.6	968.6	968.6	484	484	484	484
1000000	1370	1370	1370	1370	685	685	685	685

PROBABILITY AND STATISTICS

A. PROBABILITY DISTRIBUTIONS AND CONFIDENCE LEVELS

We give here properties of the three probability distributions most commonly used in high energy physics: Normal (or Gaussian), Chi-squared, and Poisson. We warn the reader that there is no universal convention for the term "confidence level" as used by physicists; thus, explicit definitions are given for each distribution, and we have attempted to choose definitions that correspond to common usage. It is explained below how confidence levels for all three distributions can be extracted from the following figure.

χ^2 Confidence Level vs. χ^2 for ν Degrees of Freedom



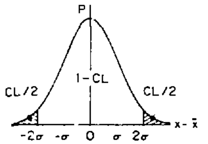
A.1. Normal Distribution

The normal distribution with mean $\bar{x}$ and standard deviation σ (variance σ^2) is:

$$P(x)dx = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\bar{x})^2/2\sigma^2} dx. \qquad (1)$$

The confidence level associated with an observed deviation from the mean, δ, is the probability that $|x-\bar{x}| > \delta$, i.e.,

$$CL = 2\int_{\bar{x}+\delta}^{\infty} dx\, P(x) \qquad (2)$$



[The small figure in Eq. (2) is drawn with $\delta = 2\sigma$.] CL is given by the ordinate of the $n_D = 1$ curve in the figure at $\chi^2 = (\delta/\sigma)^2$. The confidence level for $\delta = 1\sigma$ is 31.7%; 2σ, 4.6%; 3σ, 0.3%. The central confidence interval, 1-CL, (which is also sometimes called confidence level) for $\delta = 1\sigma$ is 68.3%; 2σ, 95.4%; 3σ, 99.7%. The odds against exceeding δ, (1-CL)/CL, for $\delta = 1\sigma$ are 2.15:1; 2σ, 21:1; 3σ, 370:1; 4σ, 16,000:1; 5σ, 1,700,000:1. Relations between σ and other measures of the width: probable error (CL = 0.5 deviation) = 0.67σ; mean absolute deviation = 0.80σ; RMS deviation = σ; half width at half maximum = 1.18σ.

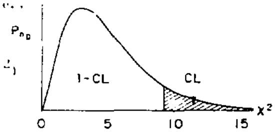
A.2. Chi-squared Distribution

The chi-squared distribution for n_D degrees of freedom is:

$$P_{n_D}(\chi^2)d\chi^2 = \frac{1}{2^h\Gamma(h)}(\chi^2)^{h-1}e^{-\chi^2/2}d\chi^2 \quad (\chi^2 \geq 0), \qquad (3)$$

where h (for "half") = $n_D/2$. The mean and variance are n_D and $2n_D$, respectively. In evaluating Eq. (3) one may use Stirling's approximation: $\Gamma(h) = (h-1)! \approx 2.507\, e^{-h} h^{(h-1/2)} \times (1 + 0.0833/h)$ which is accurate to ± 0.1% for all h ≥ 1/2. The confidence level associated with a given value of n_D and an observed value of χ^2 is the probability of chi-squared exceeding the observed value, i.e.,

$$CL = \int_{\chi^2}^{\infty} d\chi^2\, P_{n_D}(\chi^2) \qquad (4)$$



[The small figure in Eq. (4) is drawn with $n_D = 5$ and CL = 10%.] CL is plotted as a function of χ^2 for several values of n_D in the above figure. For large n_D, χ^2 becomes normally distributed about n_D. Thus,

$$y_1 = (\chi^2 - n_D)/\sqrt{2n_D} \qquad (5)$$

becomes normally distributed with unit standard deviation. A better approximation, due to Fisher,[1] is that χ, not χ^2, becomes normally distributed, specifically

$$y_2 = \sqrt{2\chi^2} - \sqrt{2n_D - 1} \qquad (6)$$

approaches normality with unit standard deviation. For small CL's in particular, y_2 is much more accurate than y_1. Thus, for $n_D = 50$ and $\chi^2 = 80$, the true CL = 0.45%, but y_1 is 3.0 corresponding to a CL of 0.13%, while y_2 is 2.7 corresponding to a CL of 0.35%.

PROBABILITY AND STATISTICS (Cont'd)

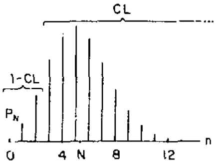
A.3. Poisson Distribution

The Poisson distribution with mean $\bar n$ is:

$$P_{\bar n}(n) = \frac{e^{-(\bar n)}(\bar n)^n}{n!} \quad (n = 0, 1, 2, \cdots) . \tag{7}$$

The variance is equal to the mean. Confidence levels for Poisson distributions are usually defined in terms of quantities called "upper limits" as follows: The confidence level associated with a given upper limit N and an observed value n_0 of n is the probability that $n > n_0$ if $\bar n = N$, i.e.,

$$CL = \sum_{n=n_0+1}^{\infty} P_N(n) = 1 - \sum_{n=0}^{n_0} P_N(n) \tag{8}$$



[The small figure in Eq. (8) is drawn with $n_0 = 2$ and CL = 90%.] A useful relation between Poisson and chi-squared confidence levels allows one to look up this quantity on the above figure. Specifically, the quantity 1-CL is given by the ordinate of the $n_D = 2(n_0+1)$ curve at $\chi^2 = 2N$. Thus, 90% confidence level upper limits for $n_0 = 0$, 1, and 2 are given by half the χ^2 value corresponding to an ordinate of 0.1 on the $n_D = 2, 4$, and 6 curves, respectively; the values are N = 2.3, 3.9, and 5.3.

- -

Tables of confidence levels for all three of these distributions, the relation between Poisson and chi-squared confidence levels, and numerous other useful tables and relations may be found in Ref. 2.

B. STATISTICS

We consider here the situation in which one is presented with N independent data, $y_n \pm \sigma_n$, and it is desired to make some inference about the "true" value of the quantity represented by these data. For this purpose we interpret each datum y_n as a single sample point drawn randomly (and independently of the other data) from a distribution having mean $\bar y_n$ (which we wish to estimate) and variance σ_n^2. (Identification of the true σ_n with the σ_n datum is an approximation which may become seriously inaccurate when σ_n is an appreciable fraction of y_n.) Some methods of estimation commonly used in high energy physics are given below; see Ref. 3 for numerous applications. Section B.1. deals with the case in which all $\bar y_n$ are the same, e.g., several different measurements of the same quantity; Sec. B.2. deals with the case in which $\bar y_n = \bar y(x_n)$, where x_n represents some set of independent variables, e.g., cross-section measurements at various values of energy and angle, $x_n = \{E_n, \theta_n\}$.

B.1. Single Mean and Variance Estimates

(1) If the y_n represent a set of values all supposedly drawn from a single distribution with mean $\bar y$ and variance σ^2 (i.e., the σ_n are all the same, but the common value is unknown) then

$$\bar y_e = \frac{1}{N}\sum_n y_n \quad \text{and} \tag{9}$$

$$\sigma_e^2 = \frac{1}{N-1}\sum_n (y_n - \bar y_e)^2 = \frac{N}{N-1}\left[\overline{(y^2)} - \bar y^2\right] \tag{10}$$

are unbiased estimates of $\bar y$ and σ^2. The variance of $\bar y_e$ is σ^2/N. If the parent distribution is normal and N is large, the variance of σ_e^2 is $2\sigma^4/N$.

(2) If the $\bar y_n$ all have the common value $\bar y$ and the σ_n are known, then the weighted average

$$\bar y_e = \frac{1}{w}\sum_n w_n y_n , \tag{11}$$

where $w_n = 1/\sigma_n^2$ and $w = \Sigma w_n$, is an appropriate unbiased estimate of $\bar y$. This choice of weighting factors in Eq. (11) minimizes the variance of the estimate; the variance is $1/w$.

B.2. Linear Least Squares Fit

A least squares fit of the function $y(x) = \Sigma_i a_i f_i(x)$ to independent data $y_n \pm \sigma_n$ at points x_n (e.g., a Legendre fit in which the f_i are Legendre polynomials and the a_i are Legendre coefficients) gives the following estimates of the parameters a_i:

$$a_{e,i} = \sum_{j,n} V_{ij} f_j(x_n)\, y_n/\sigma_n^2 . \tag{12}$$

Here V is the covariance matrix of the fitted parameters

$$V_{ij} = \overline{(a_{e,i} - \bar a_{e,i})(a_{e,j} - \bar a_{e,j})} , \tag{13}$$

which is given by

$$(V^{-1})_{ij} = \sum_n f_i(x_n) f_j(x_n)/\sigma_n^2 . \tag{14}$$

The variance of an interpolated or extrapolated value of y at point x, $y_e = \Sigma\, a_{e,i} f_i(x)$, is:

$$\overline{(y_e - \bar y_e)^2} = \sum_{ij} V_{ij} f_i(x) f_j(x) . \tag{15}$$

For the case of a straight line fit, $y(x) = a + bx$, one obtains the following estimates of a and b,

$$a_e = (S_y S_{xx} - S_x S_{xy})/D, \qquad b_e = (S_1 S_{xy} - S_x S_y)/D, \tag{16}$$

where

$$S_1, S_x, S_y, S_{xx}, S_{xy} = \Sigma\,(1, x_n, y_n, x_n^2, x_n y_n)/\sigma_n^2 , \qquad D = S_1 S_{xx} - S_x^2 . \tag{17}$$

The covariance matrix of the fitted parameters is:

$$\begin{pmatrix} V_{aa} & V_{ab} \\ V_{ab} & V_{bb} \end{pmatrix} = \frac{1}{D}\begin{pmatrix} S_{xx} & -S_x \\ -S_x & S_1 \end{pmatrix} \tag{18}$$

The variance of an interpolated or extrapolated value of y at point x is:

$$\overline{(y_e - \bar y_e)^2} = \frac{1}{S_1} + \frac{S_1}{D}\left(x - \frac{S_x}{S_1}\right)^2 \tag{19}$$

C. ERROR PROPAGATION

We consider here the situation in which one wishes to calculate the value and error of a function of some other quantities with errors, e.g., in a Monte Carlo program. Let $\{y\}$ be a set of random variables with means $\{\bar y\}$ and covariance matrix V. Then the mean and variance of a function of these variables are approximately (to second order in $\{y - \bar y\}$):

$$\bar f \approx f(\{\bar y\}) + \frac{1}{2}\sum_{mn} V_{mn}\left(\frac{\partial^2 f}{\partial y_m \partial y_n}\right)_{\{y\} = \{\bar y\}} \tag{20}$$

$$\overline{(f - \bar f)^2} = \sum_{mn} V_{mn}\left(\frac{\partial f}{\partial y_m}\right)_{\{y\} = \{\bar y\}}\left(\frac{\partial f}{\partial y_n}\right)_{\{y\} = \{\bar y\}} . \tag{21}$$

E.g., the mean and variance of a function of a single variable with mean $\bar y$ and variance σ^2 are:

$$\bar f \approx f(\bar y) + \frac{1}{2}\sigma^2 f''(\bar y), \tag{22}$$

$$\overline{(f - \bar f)^2} = \sigma^2 f'(\bar y)^2 . \tag{23}$$

Note that these equations will usually be applied by substituting some measured quantities, $\{y\}$ say, for the true means, $\{\bar y\}$. If, as is often the case, $\bar y_n - \bar y_n$ is of order $\sqrt{V_{nn}}$, then there is no point in keeping the second order terms in Eq. (20) or (22) since the substitution itself introduces first order errors.

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1. R. A. Fisher, Statistical Methods for Research Workers (Oliver and Boyd, Edinburgh and London, 1958).
2. M. Abramowitz and I. Stegun, eds., Handbook of Mathematical Functions (National Bureau of Standards, Applied Mathematics Series, Vol. 55, Washington, 1964).
3. W. T. Eadie, D. Drijard, F. E. James, M. Roos, and B. Sadoulet, Statistical Methods in Experimental Physics (North-Holland, Amsterdam and London, 1971).

Revised and expanded April 1974.

PARTICLE DETECTORS, ABSORBERS, AND RANGES*

A. DETECTOR PARAMETERS

In this section we give various parameters for common detectors. The quoted numbers represent at best *an order of magnitude*, and are useful only for preliminary design. A more detailed introduction to detectors can be found in "A Consumer's Guide to Particle Detectors," by D.J. Miller, Rutherford Lab Report RL-76-072, July 1976.

A.1 Scintillators: Photon yield $\approx 1\gamma/100$ eV in plastic scintillator[1] and $\approx 1\gamma/25$ eV in NaI.[1,2]

A.2 Cerenkov:[3] Half-angle θ_c of cone aperture in terms of velocity β and index of refraction n:

$$\theta_c = \arc\cos\left(\frac{1}{\beta n}\right) \sim \left[2\left(1-\frac{1}{\beta n}\right)\right]^{1/2}.$$

Threshold velocity: $\beta_t = 1/n$; $\gamma_t = 1/\sqrt{1-\beta_t^2}$.

Therefore, $\beta_t\gamma_t = 1/\sqrt{2\delta+\delta^2}$, where $\delta = n-1$. Values of δ for various commonly used gases are given as a function of pressure and wavelength in Ref. 4; for values at atmospheric pressure, see the Table of Atomic and Nuclear Properties, following.

Number of photons, N, per cm:

$$N = \frac{\alpha}{c}\int\left(1-\frac{1}{\beta^2 n^2}\right)2\pi d\nu = \frac{\alpha}{c}\beta_t^2\int\left(\frac{1}{\beta_t^2\gamma_t^2}-\frac{1}{\beta^2\gamma^2}\right)2\pi d\nu$$

$\approx 500 \sin^2\theta_c$/cm (visible spectrum) .

A.3 Photon Collection: In addition to the photon yield, one should take into account the light collection efficiency ($\lesssim$10% for typical 1-cm-thick scintillator), attenuation length ($\approx$1 to 4 m for typical scintillators[5]), and quantum efficiency of the photomultiplier cathode ($\lesssim$25%).

A.4 Typical Detector Characteristics:

Detector Type	Accuracy (rms)	Resolution Time	Dead Time
Bubble chamber	$\approx\pm 10$ to $\approx\pm 150\mu$	$\approx$ 1 ms	$\approx$1/20 s[a]
Streamer chamber	$\pm 300\mu$	$\approx$ 2 μs	$\approx$100 ms
Optical spark chamber	$\pm 200\mu$[b]	$\approx$ 2 μs	$\approx$ 10 ms
Magnetostrictive spark chamber	$\pm 500\mu$	$\approx$ 2 μs	$\approx$ 10 ms
Proportional chamber	$\geq\pm 300\mu$[c,d]	$\approx$ 50 ns	$\approx$200 ns
Drift chamber	± 50 to 300μ	$\approx$ 2 ns[e]	$\approx$100 ns
Scintillator	--	$\approx$150 ps	$\approx$ 10 ns
Emulsion	$\pm 1\mu$	--	--

[a] Multiple pulsing time.
[b] 60μ for high pressure.
[c] 300μ is for 1 mm pitch.
[d] Delay line cathode readout can give $\pm 150\mu$ parallel to anode wire.
[e] For two chambers.

A.5 Shower Detectors: Typical energy resolutions (FWHM) for incident electron in the 1 GeV range, E in GeV. For a fixed number of radiation lengths, FWHM in the last three detectors would be expected to be proportional to $\sqrt{t}$ for t (= plate thickness) $\geq$ 0.2 radiation lengths.[6]

NaI (20 rad. lengths):[7] $\dfrac{2\%}{E^{1/4}}$

Lead Glass (14 rad. lengths):[8] $\dfrac{10-12\%}{\sqrt{E}}$

Lead-Liquid Argon (15.75 rad. lengths):[6] $\dfrac{16\%}{\sqrt{E}}$
(42 cells: 1.1 mm lead, 2 mm liquid argon, 2.3 mm lead-G10, 2 mm liquid argon)

Lead-Scintillator Sandwich (12.5 rad. lengths):[9] $\dfrac{17\%}{\sqrt{E}}$
(66 cells: 1 mm lead, 5 mm scintillator)

Proportional Wire Shower Chamber (17 rad. lengths):[10] $\dfrac{40\%}{\sqrt{E}}$
(36 cells: 0.474 rad. length type-metal + Al, 9.5 mm 80% Ar - 20% CH_4 gas)

A.6. Proportional Chamber Wire Instability: The limit on the voltage V for a wire tension T, due to mechanical effects when the electrostatic repulsion of adjacent wires exceeds the restoring force of wire tension, is given by[11]

$$V \leq \frac{sT^{1/2}}{\ell C}$$

where s, ℓ, and C are the wire spacing, length, and capacitance per unit length. An approximation to C for chamber half-gap t and wire diameter d (good for s $\lesssim$ t) gives[12]

$$V \lesssim 59T^{1/2}\left[\frac{t}{\ell}+\frac{s}{\pi\ell}\ell n\left(\frac{s}{\pi d}\right)\right],$$

where V is in kV, and T is in grams.

A.7 Proportional and Drift Chamber Potentials: Potential distributions and fields for an array of parallel line charges q (coul./m) along z and located at y = 0, x = 0, ±a, ±2a,..., can usually be calculated with good accuracy from (MKSA):

$$V(x,y) = -\frac{q}{4\pi\epsilon_0}\ell n\left\{4\left[\sin^2\left(\frac{\pi x}{a}\right)+\sinh^2\left(\frac{\pi y}{a}\right)\right]\right\}.$$

B. COSMIC RAY FLUXES

The fluxes of particles of different types depend on the latitude, their energy, and the conditions of measurement. Some typical sea-level values[13] for charged particles are given below:

- I_v flux per unit solid angle about vertical direction crossing unit horizontal area
- J_1 perpendicular component of total flux crossing unit horizontal area from above
- J_2 total flux crossing unit horizontal area

	Total Intensity	Hard Component	Soft Component	
I_v	1.1×10^{-2}	0.8×10^{-2}	0.3×10^{-2}	cm^{-2} sec^{-1} sterad^{-1}
J_1	1.8×10^{-2}	1.3×10^{-2}	0.5×10^{-2}	cm^{-2} sec^{-1}
J_2	2.4×10^{-2}	1.7×10^{-2}	0.7×10^{-2}	cm^{-2} sec^{-1}

Very approximately, about 75% of all particles at sea-level are penetrating, and are muons. The absolute flux of protons at sea-level, in a momentum range 700-1100 MeV/c, is 1.5×10^{-5} cm^{-2} sec^{-1} sterad^{-1}, or ~0.1% of all particles.

The muon flux at sea-level has a mean energy of 2 GeV and a differential spectrum falling as E^{-2}, steepening smoothly to $E^{-3.6}$ above a few TeV. The angular distribution is $\cos^2\theta$, changing to $\sec\theta$ at energies above a TeV, where θ is the zenith angle at production. The +/- charge ratio is 1.25-1.30. The mean energy of muons originating in the atmosphere is roughly 300 GeV at slant depths $\gtrsim$ a few hundred meters. Beyond slant depths of ~10 km water-equivalent, the muons are due primarily to in-the-earth neutrino interactions (roughly 1/8 interaction ton^{-1} year^{-1} for $E_\nu > 300$ MeV, ~ constant throughout the earth).[14] Muons from this source arrive with a mean energy of 20 GeV, and have a flux of 2×10^{-13} cm^{-2} sec^{-1} sterad^{-1} in the vertical direction and about twice that in the horizontal,[15] down at least as far as the deepest mines.

C. PASSAGE OF PARTICLES THROUGH MATTER

C.1 Energy Loss Rates for Heavy Charged Projectiles: A heavy projectile (much more massive than an electron) of charge $Z_{inc}e$, incident at speed βc ($\beta \gg 1/137$) through a *slowing medium*, dissipates energy principally via interactions with the electrons of the medium. The mean rate of such energy loss per unit path length x may be written as:[16]

$$\left(\frac{dE}{dx}\right)_{inc} = \frac{D\, Z_{med}\,\rho_{med}}{A_{med}}\left(\frac{Z_{inc}}{\beta}\right)^2$$

$$\times\left[\ell n\left(\frac{2m_e\gamma^2\beta^2c^2}{I}\right)-\beta^2-\frac{\delta}{2}-\frac{c}{Z_{med}}\right]\left\{1+\nu\right\},$$

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

where $D = 4\pi N_A r_e^2 m_e c^2 = 0.3070$ MeV cm^2/g (see Physical and Numerical Constants Table).

Here Z_{med} and A_{med} are the charge and mass numbers of the medium and ρ_{med} is the mass density of the medium; I, δ, C, and ν are phenomenological functions. Frequently, the values of δ, C, and ν are negligibly small; the parameter I characterizes the binding of the electrons of the medium. As a rule of thumb, we may estimate I for an idealized medium as $I \simeq 16\ (Z_{med})^{0.9}$ eV when $Z_{med} > 1$. For realistic media the value of I will vary at the 10% level from this estimate; for H_2, $I = 20.0$ eV. We may approximately treat media which are chemical mixtures or compounds by computing

$$\frac{dE}{dx} \approx \sum_{n=1}^{N} \left(\frac{dE}{dx} \right)_n ,$$

with $(dE/dx)_n$ appropriate to the n^{th} chemical constituent (using $\rho_{med}^{(n)}$ as the partial density in the formula for dE/dx).[17]

The function δ represents the density effect upon the energy loss rate; it is non-negligible only for highly relativistic projectiles in denser media.[18] For ultra-relativistic projectiles, δ approaches $2\ \ell n\gamma$ + constant, where the value of the constant depends upon the density of the medium as well as its chemical composition.

The function C represents shell corrections to the energy loss rate.[16] These effects are non-negligible only for projectiles with speeds not much faster than the speeds of the fastest electrons bound in the medium.

The function ν represents corrections due to higher-order electrodynamics.[19] These effects become important when $|Z_{inc}/\beta|$ is comparable to 137. For relativistic unit-charge projectiles, $|\nu|$ is of the order of 1%; positively charged projectiles lose energy more rapidly than do their charge conjugates.[19,20]

For non-relativistic projectiles, our formulae above are inapplicable. At the very slowest speeds, total energy loss rates are believed to be proportional to β, rising through a peak at projectile speeds comparable to atomic speeds, after having passed through a smaller peak (due to elastic Coulomb collisions with the *nuclei* of the slowing medium[21]) at intermediate speeds. In some cases, energy loss rates depend significantly upon the relation of the projectile trajectory to the crystalline structure of the slowing medium.[22]

For relativistic projectiles, $(dE/dx)_{inc}$ falls rapidly with increasing β until reaching a minimum around $\beta = 0.96$ (almost independent of medium), followed by a slow rise. Because of the density effect, the quantity in square brackets approaches $\ell n\gamma$ + constant for large γ.

The quantity $(dE/dx)_{inc}\delta x$ is the *mean* total energy loss via interactions with electrons of the medium in a layer of thickness δx. For any finite δx, Poisson fluctuations can cause the actual energy loss to deviate from the mean. For thin layers, the distribution is broad and skewed, being peaked below $(dE/dx)\delta x$, and having a long tail toward large energy losses.[23] Only for a very thick layer $[(dE/dx)\delta x \gg 2m_e\beta^2\gamma^2c^2]$ will the distribution of energy losses become nearly Gaussian. The large fluctuations of the total energy loss rate from the mean are due to a small number of collisions involving large energy transfers. The fluctuations are greatly reduced for the so-called restricted energy loss rate, described in Section C.4.

C.2 Ionization Yields: Physicists frequently relate total energy loss to the number of ion pairs produced in the stopping medium. This relation becomes complicated for relativistic projectiles due to the wandering of energetic knock-on electrons whose ranges exceed the dimensions of the fiducial volume. For a qualitative appraisal of the non-locality of energy deposition by such modestly energetic knock-on electrons in various media, see Ref. 24. The mean energy loss per ion pair produced, W, is essentially constant for relativistic projectiles, but increases at slow projectile speeds.[25] The numerical value of W for gases can be surprisingly sensitive to trace amounts of various contaminants.[25] Of course, in addition to the preceding effects, practical ionization yields may be greatly influenced by subsequent recombinations, etc.[26]

C.3 Energetic Knock-On Electrons: For a relativistic spinless point-charge projectile, the production of high energy (kinetic energy $T \gg I$) electrons is given by (neglecting the spin of the electron):

$$\frac{d^2N}{dTdx} = \frac{1}{2} D \left[\frac{Z_{med}}{A_{med}} \right] \left[\frac{Z_{inc}}{\beta} \right]^2 \rho_{med} \frac{1}{T^2} ,$$

for $I \ll T \le T_{max}$, where

$$T_{max} = \frac{2m_e\beta^2\gamma^2c^2}{1 + 2\gamma \dfrac{m_e}{M_{inc}} + \left[\dfrac{m_e}{M_{inc}} \right]^2} .$$

M_{inc} is the mass of the incident projectile, and all other quantities are as in Section C.1. This formula does not differ significantly from the precise result, incorporating spin effects, for any projectile (including $e^{\pm}$) in the restricted range $I \ll T \ll T_{max}$; more accurate formulae are available for various projectiles.[27,28] Our formula is inaccurate for T close to I; for $2I \lesssim T \lesssim 10I$, the $1/T^2$ dependence above becomes $\simeq T^{-\eta}$ with $3 \lesssim \eta \lesssim 5$.[29]

C.4 Rates of Restricted Energy Loss for Relativistic Charged Projectiles: The variability of energy loss for heavy projectiles is due primarily to the variability in the production of energetic knock-on electrons. Bremsstrahlung and pair-production processes make this variability even greater for electrons than for heavy particles as projectiles (see, e.g., the figure "Fractional Energy Loss for e^+ and e^- in Lead," following). If an instrument, such as a bubble chamber, is capable of isolating these high-energy-loss interactions, then it is appropriate to consider the rate of energy loss excluding them, i.e., a restricted energy loss rate. The mean energy loss rate via all collisions which have energy transfer T such that $T \le E_{max} \ll T_{max}$ is:[16]

$$\left(\frac{dE}{dx} \right)_{\le E_{max}} = \frac{1}{2} D \frac{Z_{med}\rho_{med}}{A_{med}} \left(\frac{Z_{inc}}{\beta} \right)^2 \times \left[\ell n \left(\frac{E_{max}T_{max}}{I^2} \right) - \beta^2 - \delta - \frac{2C}{Z_{med}} \right] .$$

Notice the overall factor of 1/2.

The density effect causes the restricted energy loss rate to approach a constant, the Fermi plateau value, for the fastest projectiles.

C.5 Multiple Scattering through Small Angles: As a charged particle traverses a medium it is deflected by many small-angle elastic scatterings. The bulk of this deflection is due to elastic Coulomb scattering from the nuclei within the medium, hence the usual identification as multiple Coulomb scattering (note, however, that strong interactions do contribute to the total multiple scattering for hadronic projectiles). For both Coulomb and strong interactions, the Central Limit Theorem provides little useful guidance in establishing the precise nature of the distribution of the total deflections resulting from multiple scattering. The true distribution is roughly Gaussian only for small deflection angles while it shows much greater probability for large-angle scatterings $\gtrsim$ a few θ_0, see below, depending on absorber) than the Gaussian would suggest. These tails on the distribution (a few % of peak height in the region where the Gaussian part becomes negligible) are more pronounced for hadrons than for muons as projectiles. The large-angle behavior of these distributions is best estimated by computing the exact distribution for the vectorial sum of the largest deflections based upon the true elastic scattering cross section of the projectile against the medium,[30] or, when applicable, by interpolation from tabular data.[31] An easier alternative which may suffice for non-critical applications would be to use a Gaussian approximation with the following width:[32]

$$\theta_0 = \frac{14.1\ \text{MeV/c}}{p\beta} Z_{inc}\sqrt{L/L_R} \left[1 + \frac{1}{9} \log_{10} \left(L/L_R \right) \right] \text{(radians)},$$

where p, β, and Z_{inc} are the momentum (in MeV/c), velocity, and charge number of the incident particle, and L/L_R is the thickness, in radiation lengths, of the scattering medium. L_R for certain materials is given in the Table of Atomic and Nuclear Properties of Materials (following). The angle, θ_0, is a fit to Moliere[30] theory, accurate to about 5% for $10^{-3} < L/L_R < 10$ except for very light elements or low velocity where the error is about 10 to 20%. In this Gaussian approximation, θ_0 has the meaning

$$\theta_0 = \theta_{\rm plane}^{\rm rms} = \frac{1}{\sqrt{2}}\,\theta_{\rm space}^{\rm rms}\,.$$

The non-projected (space) and projected (plane) angular distributions are given approximately[30] by the Gaussian forms:

$$\frac{1}{2\pi\theta_0^2}\,\exp\left[-\frac{\theta_{\rm space}^2}{2\theta_0^2}\right] d\Omega,$$

$$\frac{1}{\sqrt{2\pi}\,\theta_0}\,\exp\left[-\frac{\theta_{\rm plane}^2}{2\theta_0^2}\right] d\theta_{\rm plane},$$

where θ is the deflection angle.

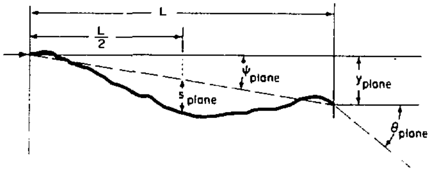
Other quantities are sometimes used to describe the amount of multiple Coulomb scattering: the auxiliary quantities $\psi_{\rm plane}$, $y_{\rm plane}$, and $s_{\rm plane}$ (see the figure) obey:

$$y_{\rm plane}^{\rm rms} = \frac{1}{\sqrt{3}}\,L\,\theta_{\rm plane}^{\rm rms} = \frac{1}{\sqrt{3}}L\theta_0\,,$$

$$\psi_{\rm plane}^{\rm rms} = \frac{1}{\sqrt{3}}\,\theta_{\rm plane}^{\rm rms} = \frac{1}{\sqrt{3}}\theta_0\,,$$

and

$$s_{\rm plane}^{\rm rms} = \frac{1}{4\sqrt{3}}\,L\,\theta_{\rm plane}^{\rm rms} = \frac{1}{4\sqrt{3}}L\theta_0\,.$$



All the quantitative estimates in this section apply only in the limit of small $\theta_{\rm plane}^{\rm rms}$ and in the absence of large-angle scatters.

C.6 Longitudinal Distribution of Electromagnetic Showers: A photon of energy E (GeV) $\geq$ 0.1 GeV converting in a semi-infinite medium produces an electromagnetic cascade whose intensity initially increases with depth and then falls off. The average number of $e^{\pm}$ with kinetic energy above 1.5 MeV, crossing a plane at a depth of t radiation lengths from the beginning of the medium, in a material of atomic number Z, calculated using the Monte Carlo program EGS,[33] can be fit by the empirical formula[34]

$$N = N_0 t^a e^{-bt}\,,$$

where $N_0 = 5.51\,E\,\sqrt{Z}\,b^{a+1}/\Gamma(a+1)$ and $b = 0.634 - 0.0021\,Z$. For $Z \geq 26$, $a = 2.0 - Z/340 + (0.664 - Z/340)\,\ln E$. For $Z = 13$, $a = 1.77 - 0.52\,\ln E$. The maximum intensity, N_{max}, occurs at the depth $t = a/b$. The maximum error of the fit occurs in the vicinity of this depth and is less than $0.15\,N_{max}$. The integral of the tail, $\int_{1.5\,a/b}^{\infty} N\,dt$ is fit to better than 2.5%. The total longitudinally-projected $e^{\pm}$ path length, $\int_0^{\infty} N\,dt = 5.51\,E\,\sqrt{Z}$, is less than the total $e^{\pm}$ path length due primarily to multiple Coulomb scattering.

*Prepared April 1974 by Sherwood Parker and Bernard Sadoulet. Revised April 1982 by Sherwood Parker, Ray Hagstrom, Didier Besset, and John Learned.

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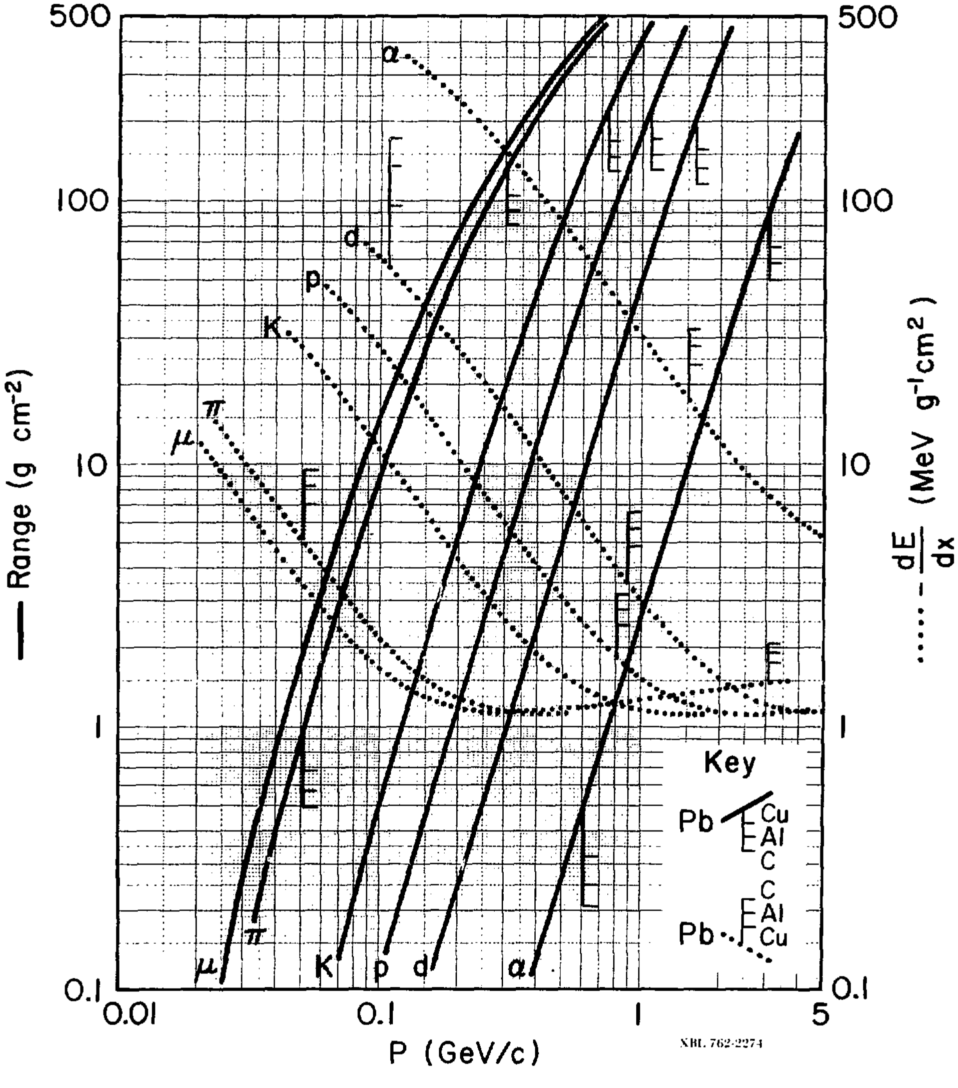
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

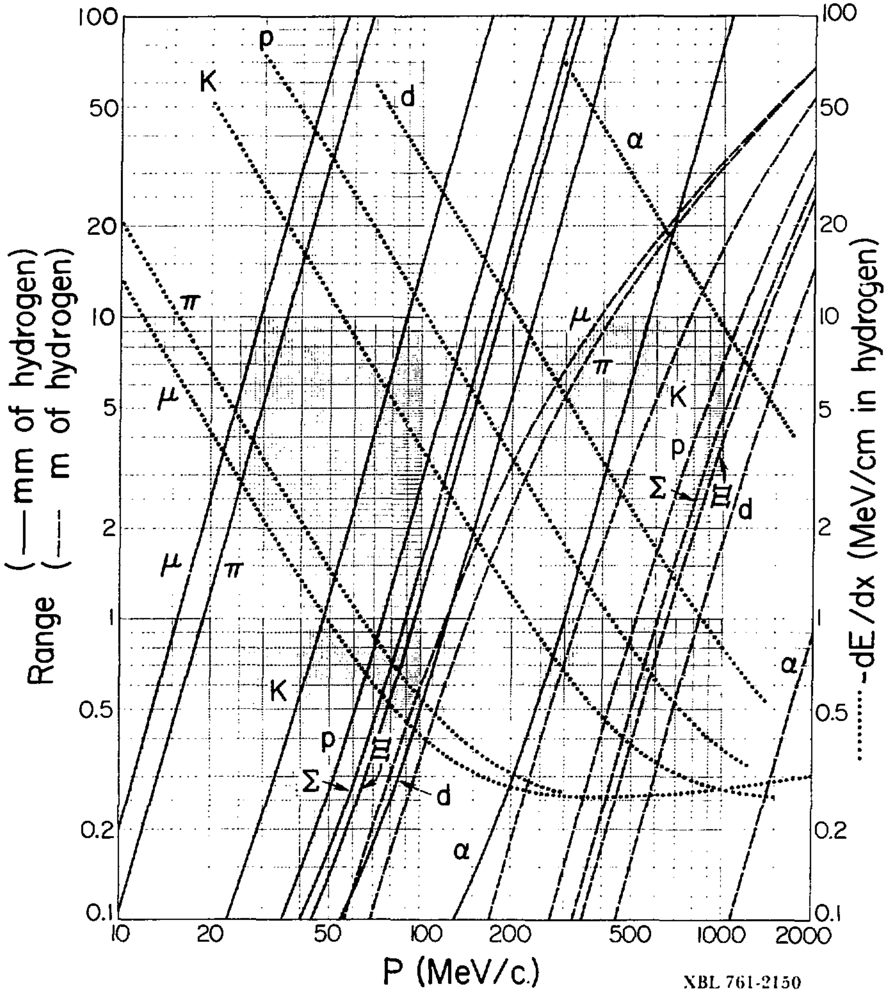
Mean Range and Energy Loss in Lead, Copper, Aluminum, and Carbon



Mean range and energy loss due to ionization for the indicated particles in Pb, with scaling to Cu, Al, and C indicated, using Bethe-Bloch equation (Section C.1 above) with corrections. Calculated using program of Hans Bichsel (UCRL-17538), with density correction added (Hans Bichsel, private communication). See also Joseph F. Janni [Air Force Weapons Laboratory Technical Report No. AFWL-TR-65-150 (1966)]. The average ionization potentials (I) assumed were: Pb (820 eV), Cu (320 eV), Al (166 eV), and C(77.5 eV). Figure indicates total path length; observed range may be smaller (by ~ 1% - 2% in heavy elements) due to multiple scattering, primarily from small energy-loss collisions with nuclei. The functional forms have not been experimentally verified to better than roughly ± 1%. For higher energies refer to discussion by Cobb ["A Study of Some Electromagnetic Interactions of High Velocity Particles with Matter," University of Oxford Report HEP/T/55 (1973)] and by Turner ["Penetration of Charged Particles in Matter: A Symposium", National Academy of Sciences, Washington D.C. (1970), p. 48]. Scaling to other beam particles is, to a good approximation, described by the expression on the next page.

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Range and Energy Loss in Liquid Hydrogen



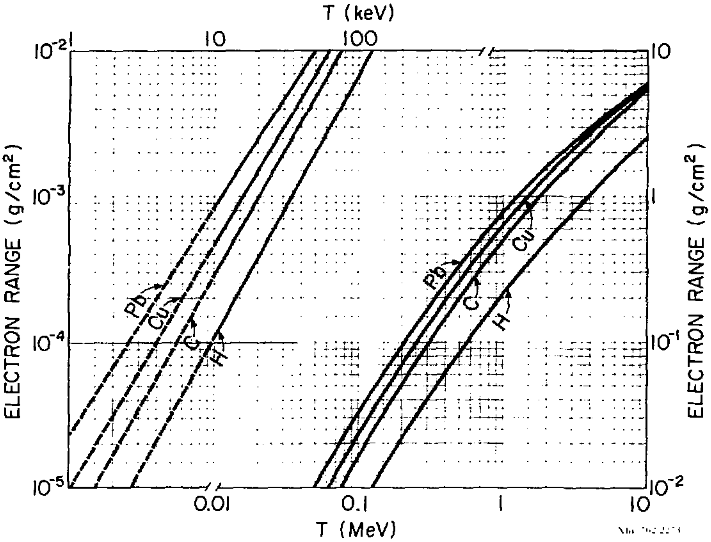
XBL 761-2150

Range and energy loss in liquid hydrogen bubble chamber, based on Bethe-Bloch equation (Section C.1 above), using an average ionization potential for H_2 of I = 20.0 eV, which is an approximate average of the experimental result of *Garbincius and Hyman [Phys. Rev.* A2, *1834 (1970)] and the theoretical result of* Ford and Browne [Phys. Rev. A7, 418 (1973)]. Bubble chamber conditions are chosen to be those of Garbincius and Hyman: parahydrogen of density = 0.0625 g/cm^3 (note: range $\propto$ 1/density), with vapor-pressure 60.8 lb/in^2 (absolute) and temperature 26.2°K. The functional dependence of the Bethe-Bloch equation is not experimentally verified to better than about ±1% over large momentum ranges. It should be noted that the number of bubbles per cm of a track in a bubble chamber is nearly proportional to $1/\beta^2$, not dE/dx. For the linear portions of the range curves, $R \propto p^{3.6}$. Scaling law for particles of other mass or charge (except electrons): for a given medium, the range R_b of any beam particle with mass M_b, charge z_b, and momentum p_b is given in terms of the range R_a of any other particle with mass M_a, charge z_a, and momentum $p_a = p_b M_a/M_b$ (i.e., having the same velocity) by the expression:

$$R_b(M_b,z_b,p_b) = \left[\frac{M_b/M_a}{z_b^2/z_a^2}\right] R_a(M_a,z_a,p_a = p_b M_a/M_b) .$$

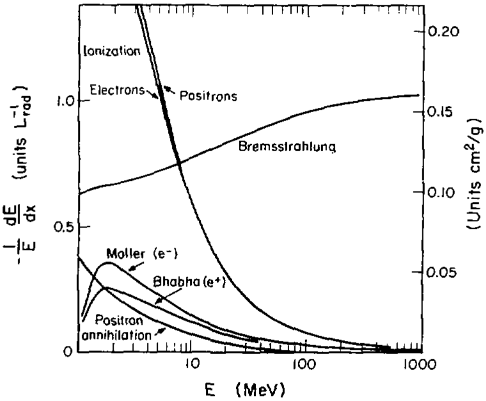
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Mean Electron Range in Lead, Copper, Carbon, and Liquid Hydrogen



Mean range of electrons in the continuous-slowing-down approximation, taking into account energy loss by collisions with atomic electrons and by bremsstrahlung; strong fluctuations are to be expected for individual tracks. This range is the total path length; the "practical range" — a common measure of straight-line penetration distance — is shorter because of multiple Coulomb scattering, which becomes increasingly important as the electron slows down. E.g., for a fast electron the rms projected angle due to multiple Coulomb scattering reaches 1 radian by the time the electron has slowed to 0.4 MeV in hydrogen, 1.5 MeV in carbon, 9 MeV in copper, and 24 MeV (off scale) in lead. Electron energy deposition and penetration probability vs. range are discussed by L. V. Spencer, "Energy Dissipation by Fast Electrons," NBS Monograph #1, 1959, and S. M. Seltzer, "Transmission of Electrons through Foils," NBSIR 74, 457 (1974). Electrons which have energy less than 0.2 MeV in Ar, 1.5 MeV in Cu, 3.5 MeV in Sn, and 5 MeV in Pb are likely to deposit 10% of their energy behind their starting plane. The practical range, R_p, is defined as that absorber thickness obtained by extrapolating to zero the linearly decreasing part of the curve of penetration probability vs. absorber thickness. Data for Al in the T range of the figure are available, and fit (to ~±10%) $R_p = AT[1-B/(1+CT)]$ mg cm^{-2} [a form suggested by K.-H. Weber, Nucl. Inst. Meth. 25, 261 (1964)], with $A=0.55$ mg cm^{-2} keV^{-1}, $B=0.9841$, and $C=0.0030$ keV^{-1}. At this penetration depth, 90 - 95% of the incident electrons have stopped. Data for other elements are sketchy, but suggest that higher-Z ($\lesssim 50$) elements have $1 \lesssim R_p/R_p(\mathrm{Al}) \lesssim 1.4$ below ~10 keV, and $0.6 \lesssim R_p/R_p(\mathrm{Al}) \lesssim 1$ above ~100 keV. The "critical energy" (above which the energy loss due to bremsstrahlung exceeds that due to ionization, and showering becomes important) is 400 MeV for hydrogen, 100 MeV for carbon, 25 MeV for copper, and 10 MeV for lead. The mean positron range may differ from the mean electron range by several percent. See Berger and Seltzer, NASA SP-3012 (1964) and SP-3036, and P. Trower, UCRL-2426, Vol. III, Rev. (1966). 1 - 10 keV range was obtained by linear extrapolation; in this region the true range may actually lie above the curves.

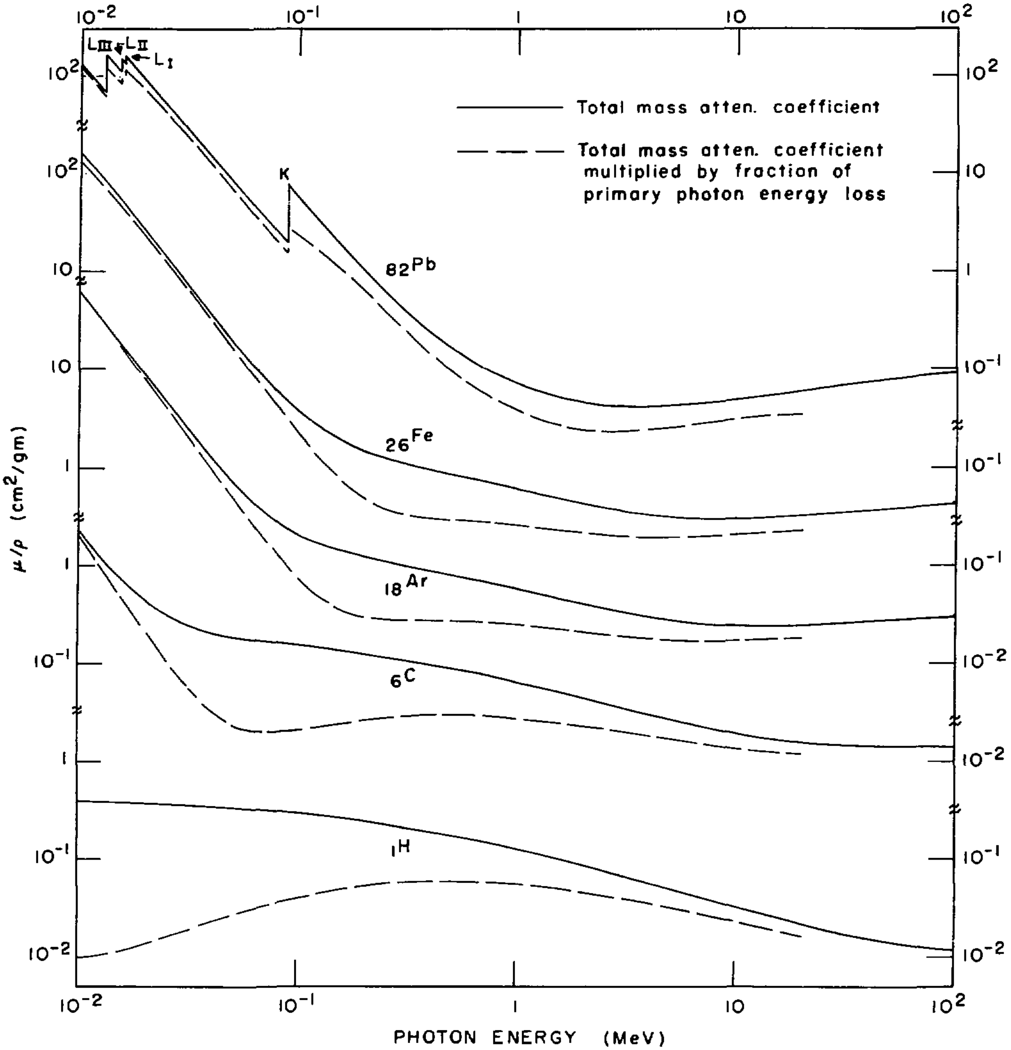
Fractional Energy Loss for e^+ and e^- in Lead



Fractional energy loss per radiation length in lead as a function of electron or positron energy. Electron (positron) scattering is considered as ionization when the energy loss per collision is below 0.255 MeV, and as Moller (Bhabha) scattering when it is above. Adapted from Fig. 3.2 from Messel and Crawford, Electron-Photon Shower Distribution Function Tables for Lead, Copper and Air Absorbers, Pergamon Press, 1970. Messel and Crawford use $L_r(\mathrm{Pb}) = 5.82$ g/cm^2, but we have modified the figures to reflect the value given in the Table of Atomic and Nuclear Properties of Materials (following), namely $L_r(\mathrm{Pb}) = 6.4$ g/cm^2. The development of electron-photon cascades is approximately independent of absorber when the results are expressed in terms of inverse radiation lengths (i.e., scale on left of plot).

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

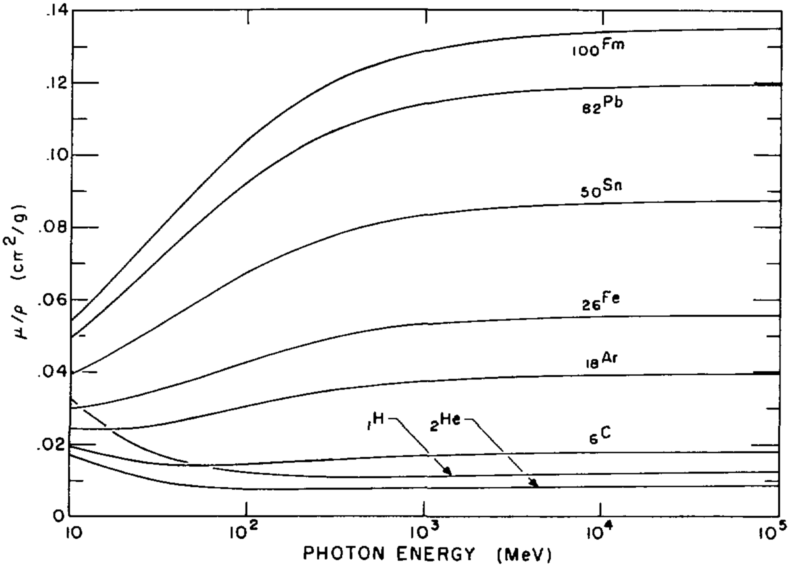
Photon Mass Attenuation Coefficients, Energy Deposition



The photon mass attenuation coefficient for various absorbers as a function of photon energy (solid curves). For a homogeneous medium of density ρ, the intensity I remaining after traversal of thickness t is given by $I = I_o \exp(-\mu t)$. The accuracy is a few percent. Interpolation to other Z should be done in the cross section $\sigma = (\mu/\rho)\, M/N_A$ cm²/atom, where M is the atomic weight of the absorber material and N_A is Avogadro's number. For a chemical compound or mixture, use $(\mu/\rho)_{eff} \cong \sum_i w_i (\mu/\rho)_i$, accurate to a few percent, where w_i is the proportion by weight of the i^{th} constituent. The dashed curve is the mass energy-absorption coefficient, giving μ/ρ multiplied by the fraction of photon energy deposited in a small volume (assumed large enough to contain the ranges of most secondary electrons) about the interaction. This fraction is smaller than 1.0 because such processes as Compton scattering and electron bremsstrahlung imply radiation of some of the energy away from the immediate area. The absorption coefficient is an approximation to the energy available for chemical, biological, and other effects associated with exposure to ionizing radiation. See next page for high energy range. From Hubbell, Gimm, and Øverbø, J. Phys. Chem. Ref. Data 9, 1023 (1980). Figures courtesy J. H. Hubbell.

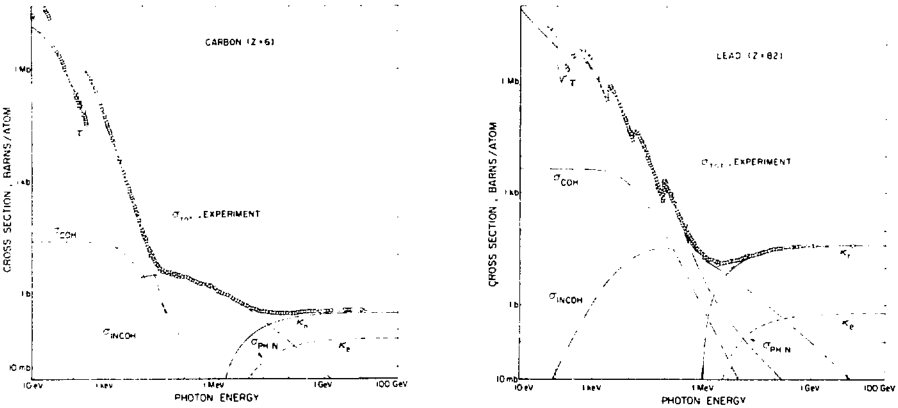
PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Photon Mass Attenuation Coefficients (High Energy)



The photon mass attenuation coefficient, high energy range (note that ordinate is linear scale). See caption on previous page for details.

Contributions to Photon Cross Section in Carbon and Lead



Photon total cross sections as a function of energy in carbon and lead, showing the contributions of different processes.

τ = Atomic photo-effect (electron ejection, photon absorption)
σ_{COH} = Coherent scattering (Rayleigh scattering — atom neither ionized nor excited)
σ_{INCOH} = Incoherent scattering (Compton scattering off an electron)
κ_n = Pair production, nuclear field
κ_e = Pair production, electron field
$\sigma_{PH.N.}$ = Photonuclear absorption (nuclear absorption, usually followed by emission of a neutron or other particle)

From Hubbell, Gimm, and Øverbø, J. Phys. Chem. Ref. Data 9, 1023 (1980). Figures courtesy J. H. Hubbell.

PARTICLE DETECTORS, ABSORBERS, AND RANGES (Cont'd)

Atomic and Nuclear Properties of Materials*

Material	Z	A	Nuclear[a] total cross section σ_T[barn]	Nuclear[b] inelastic cross section σ_I[barn]	Nuclear[c] collision length λ_T [g/cm^2]	Nuclear[c] interaction length λ_I [g/cm^2]	dE/dx min[d] $\left[\frac{MeV}{g/cm^2}\right]$	dE/dx min[d] $\left[\frac{MeV}{cm}\right]$	Radiation length[e] L_{rad} [g/cm^2]	Radiation length[e] L_{rad} [cm]	Density[f] [g/cm^3] () is for gas [g/ℓ]	Refractive index n;[f] () is (n−1)×10^6 for gas
H_2	1	1.01	0.0387	0.032	43.3	52.4	4.12	0.292	63.05	890	0.0708(0.090)	1.112(140)
D_2	1	2.01	0.073	0.062	45.7	53.8	2.07	0.342	126.1	764	0.165	1.28
He	2	4.00	0.136	0.109	49.9	60.9	1.94	0.243	94.32	755	0.125(0.178)	1.024(35)
Li	3	6.94	0.216	0.158	53.8	72.9	1.58	0.843	82.76	155	0.534	--
Be	4	9.01	0.268	0.199	55.8	75.2	1.61	2.97	65.19	35.3	1.848	--
C	6	12.01	0.331	0.231	60.2	86.3	1.78	4.03	42.70	18.8	2.265[g]	--
N_2	7	14.01	0.379	0.262	61.4	88.8	1.82	1.47	37.99	47.0	0.808(1.25)	1.205(300)
O_2	8	16.00	0.420	0.288	63.2	92.2	1.82	2.07	34.24	30.0	1.14(1.43)	1.22(266)
Ne	10	20.18	0.502	0.340	66.7	98.5	1.73	2.09	28.94	24.0	1.207(0.90)	1.092(67)
Al	13	26.98	0.634	0.421	70.6	106.4	1.62	4.37	24.01	8.9	2.70	--
Ar	18	39.95	0.850	0.554	78.0	119.7	1.51	2.11	19.55	14.0	1.40(1.78)	1.233(283)
Fe	26	55.85	1.113	0.703	83.3	131.9	1.48	11.6	13.84	1.76	7.87	--
Cu	29	63.54	1.232	0.782	85.6	134.9	1.44	12.9	12.86	1.43	8.96	--
Sn	50	118.69	1.967	1.191	100.2	165.5	1.26	9.2	8.82	1.21	7.31	--
W	74	183.85	2.767	1.649	110.3	185.1	1.16	22.4	6.76	0.35	19.3	--
Pb	82	207.19	2.960	1.776	116.2	193.7	1.13	12.8	6.37	0.56	11.35	--
U	92	238.03	3.378	1.983	117.0	199.3	1.09	≈20.7	6.00	≈0.32	≈18.95	--
Air (20°C)					62.0	90.0	1.82	0.0022	36.66	30423	0.001205(1.29)	1.000273(293)
H_2O					60.1	84.9	2.03	2.03	36.08	36.1	1.00	1.33
Shielding concrete[h]					67.4	99.9	1.70	4.25	26.7	10.7	2.5	--
SiO_2 (quartz)					67.0	99.2	1.72	3.78	27.05	12.3	2.2	1.458
H_2 (bubble chamber 26°K)					43.3	52.4	4.12	≈0.26	63.05	≈1000	≈0.063[i]	1.112
D_2 (bubble chamber 31°K)					45.7	53.8	2.07	≈0.29	126.1	≈900	≈0.140[i]	1.110
H-Ne mixture (50 mole percent)[j]					65.0	94.5	1.84	0.75	29.70	73.0	0.407	1.092
Propane (C_3H_8)[k]					56.5	77.2	2.25	0.92	45.38	111	0.41(2.0)	1.25(1005)
Freon 13B1 (CF_3Br)[k]					76.8	117	1.56	≈2.34	16.53	≈11.0	≈1.50(8.71)	1.238(750)
Ilford emulsion G5					82.0	134	1.44	5.49	11.02	2.89	3.815	--
NaI					94.8	152	1.32	4.84	9.49	2.59	3.67	1.775
LiF					62	89.2	1.63	4.30	39.25	14.9	2.64	1.394
BGO ($Bi_4Ge_3O_{12}$)					97.4	156	1.27	9.0	7.98	1.12	7.1	2.15
Polystyrene, scintillator (CH)[ℓ]					58.4	82.0	1.95	2.01	43.8	42.4	1.032	1.581
Lucite, Plexiglas ($C_5H_8O_2$)					59.2	83.6	1.95	≈2.30	40.55	≈34.4	1.16-1.20	≈1.49
Polyethylene (CH_2)					56.9	78.8	2.09	≈1.95	44.8	≈47.9	0.92-0.95	--
Mylar ($C_5H_4O_2$)					60.2	85.7	1.86	2.58	39.95	28.7	1.39	--
Borosilicate glass (Pyrex)[m]					66.2	97.6	1.72	3.84	28.3	12.7	2.23	1.474
CO_2					62.4	90.5	1.82	0.0033	36.2	20220.	(1.79)	(410)
Methane CH_4					54.7	74.0	2.41	0.0017	46.5	64850.	0.423(0.717)	(444)
Isobutane C_4H_{10}					56.3	77.4	2.22	0.0059	45.2	16930.	(2.67)	(1270)
Freon 12 (CCl_2F_2)[n]					70.6	106	1.62	0.0080	23.7	4810.	(4.93)	(1080)
Freon 13 ($CClF_3$)[n]					68.1	101	1.64	0.0070	27.15	6370.	(4.26)	(720)
Silica Aerogel[o]					65.5	95.7	1.83	≈0.36	29.85	≈150.	0.1-0.3	1.0+0.25ρ
Spark or proportional chamber[p]					0.028%	0.020%	--	0.034	0.067%		0.019	

* Table revised March 1982 by J. Engler. For details, see Report KfK 8000, Kernforschungzentrum D 75 Karlsruhe, P.O. Box 3640, Federal Republic of Germany.

a. σ_{total} at 80-240 GeV for neutrons (≈ σ for protons) from Murthy et al., Nucl. Phys. **B92**, 269 (1975).

b. $\sigma_{inelastic} = \sigma_{total} - \sigma_{elastic} - \sigma_{quasielastic}$; for neutrons at 60-375 GeV from Roberts et al., Nucl. Phys., **B159**, 56 (1979). For protons and other particles, see Carroll et al., Phys. Lett. **80B**, 319 (1979); note that $\sigma_I(p) \approx \sigma_I(n)$.

c. Mean free path between collision (λT) or inelastic interaction (λI), calculated $\lambda = A/(N\times\sigma)$.

d. For minimum-ionizing protons and pions from Barkas and Berger, *Tables of Energy Losses and Ranges of Heavy Charged Particles*, NASA-SP-3013 (1964). For electrons see: Penetration of Charged Particles in Matter, NAS-NS39 (1964).

e. From Y.S. Tsai, Rev. Mod. Phys. **46**, 815 (1974).

f. Values for solids, or the liquid phase at boiling point. Values in parentheses for gaseous phase STP (0°C, 1 atm.), except where noted. Refractive index given for sodium D line.

g. For pure graphite, industrial graphite density may vary 2.1 - 2.3 g/cm^3.

h. Standard shielding blocks, typical composition O_2 52%, Si 32.5%, Ca 6%, Na 1.5%, Fe 2%, Al 4% plus reinforcing iron bars. Attenuation length ℓ = 115 ± 5 g/cm^2, also valid for earth (typical ρ = 2.15) from CERN-LRL-RHEL Shielding exp., UCRL-17841 (1968).

i. Density may vary about ±3%, depending on operating conditions.

j. Values for typical working conditions with H_2 target: 50 mole percent, 29°K, 7 atm.

k. Values for typical chamber working conditions: Propane ~57°C, 8-10 atm. Freon 13B1 ~28°C, 8-10 atm.

ℓ. Typical scintillator; e.g., PILOT B and NE 102A have an atomic ratio H/C = 1.10.

m. Main components: 80% SiO_2 + 12% B_2O_3 + 5% Na_2O.

n. Used in Cerenkov counters. Values at 26°C and 1 atm. Indices of refraction from E.R. Hayes et al., ANL-6916 (1964).

o. $n(SiO_2) + 2n(H_2O)$ used in Cerenkov counters, ρ = density in g/cm^3. From M. Cantin et al., Nucl. Instr. Meth. **118**, 177 (1974).

p. Values for typical construction: 2 layers 50 μm Cu/Be wires, 8 mm gap, 60% argon, 40% isobutane or CO_2; 2 layers 50 μm Mylar/Aclar foils.

ELECTROMAGNETIC RELATIONS

Maxwell's Equations

Quantity	CGS (statcoul., statamp., sec cm^{-1})	MKSA (coul., amp., ohm)
Potentials:	$V = \sum_{\text{charges}} \frac{q}{r}$	$V = \frac{1}{4\pi\epsilon_0} \sum_{\text{charges}} \frac{q}{r}$
	$\vec{A} = \frac{1}{c} \sum_{\text{currents}} \frac{\vec{I}}{r}$	$\vec{A} = \frac{\mu_0}{4\pi} \sum_{\text{currents}} \frac{\vec{I}}{r}$
	c = speed of light in vacuum	$\epsilon_0 = \frac{1}{36\pi} 10^{-9}$ MKSA
		$\mu_0 = 4\pi\ 10^{-7}$ MKSA
Fields:	$\vec{E} = -\vec{\nabla}V - \frac{1}{c}\frac{\partial\vec{A}}{\partial t}$	$\vec{E} = -\vec{\nabla}V - \frac{\partial\vec{A}}{\partial t}$
	$\vec{B} = \vec{\nabla}\times\vec{A}$	$\vec{B} = \vec{\nabla}\times\vec{A}$
Materials:	$\vec{D} = \epsilon\vec{E}, \quad \vec{B} = \mu\vec{H}$	$\vec{D} = \epsilon\vec{E}, \quad \vec{B} = \mu\vec{H}$
Force:	$\vec{F} = q\left(\vec{E} + \frac{\vec{v}}{c}\times\vec{B}\right)$	$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$
Maxwell:	$\vec{\nabla}\cdot\vec{D} = 4\pi\rho$	$\vec{\nabla}\cdot\vec{D} = \rho$
	$\vec{\nabla}\times\vec{E} = -\frac{1}{c}\frac{\partial\vec{B}}{\partial t}$	$\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$
	$\vec{\nabla}\cdot\vec{B} = 0$	$\vec{\nabla}\cdot\vec{B} = 0$
	$\vec{\nabla}\times\vec{H} = \frac{4\pi\vec{j}}{c} + \frac{1}{c}\frac{\partial\vec{D}}{\partial t}$	$\vec{\nabla}\times\vec{H} = \vec{j} + \frac{\partial\vec{D}}{\partial t}$
Relativistic transformations:	$\vec{E}'_{\parallel} = \vec{E}_{\parallel}$	$\vec{E}'_{\parallel} = \vec{E}_{\parallel}$
	$\vec{E}'_{\perp} = \gamma\left(\vec{E}_{\perp} + \frac{1}{c}\vec{v}\times\vec{B}\right)$	$\vec{E}'_{\perp} = \gamma(\vec{E}_{\perp} + \vec{v}\times\vec{B})$
	$\vec{B}'_{\parallel} = \vec{B}_{\parallel}$	$\vec{B}'_{\parallel} = \vec{B}_{\parallel}$
	$\vec{B}'_{\perp} = \gamma\left(\vec{B}_{\perp} - \frac{1}{c}\vec{v}\times\vec{E}\right)$	$\vec{B}'_{\perp} = \gamma\left(\vec{B}_{\perp} - \frac{1}{c^2}\vec{v}\times\vec{E}\right)$

Impedances: Alternating Currents (MKSA)

Ohm's law: $V = ZI, \quad V = V_0 e^{i\omega t}$

1. Impedance of self-inductance L: $Z = i\omega L$.
2. Impedance of a capacitor of capacitance C: $Z = \frac{1}{i\omega C}$.
3. Impedance of a flat conductor of width w at high frequency:

$$Z = \frac{(1+i)\rho}{w\delta} ;$$

ρ = resistivity in $10^{-8}\ \Omega$ m:

~1.7 for Cu	~5.5 for W
~2.4 for Au	~73 for SS 304
~2.8 for Al (Al alloys may have up to double this value.)	~100 for Nichrome

δ = effective skin depth

$$= \sqrt{\frac{\rho}{\pi\nu\mu}} \approx \frac{6.6\ \text{cm}}{\sqrt{\nu(\sec^{-1})}} \quad \text{for Cu} .$$

4. Impedance of free space: $Z = \sqrt{\mu_0/\epsilon_0} = 376.7\ \Omega$.

Capacitance C and Inductance L per Unit Length (MKSA)

1. For flat plates of width w, separated by $d \ll w$:

$$C = \frac{\epsilon w}{d} \quad ; \quad L = \mu\frac{d}{w} .$$

2. For coax cable of interior and exterior radii r_1 and r_2:

$$C = \frac{2\pi\epsilon}{\ln(r_2/r_1)} \quad ; \quad L = \frac{\mu}{2\pi}\ln(r_2/r_1) ;$$

ϵ = dielectric constant { 2 to 6 for plastics; 4 to 8 for porcelain, glasses;

μ = magnetic susceptibility.

Transmission Lines (No Loss) (MKSA)

Velocity $= 1/\sqrt{LC} = 1/\sqrt{\mu\epsilon}$.

Impedance $= \sqrt{L/C}$.

L and C are inductance and capacitance per unit length.

Synchrotron Radiation (CGS)

Energy loss/revolution $= \frac{4\pi}{3}\frac{e^2}{R}\beta^3\gamma^4$, R = orbit radius .

For electrons ($\beta \approx 1$), $\frac{\Delta E(\text{MeV})}{\text{rev.}} = 0.0885\,[E(\text{GeV})]^4/R(\text{meter})$.

Critical frequency: $\omega_c = 3\gamma^3\frac{c}{R}$.

Frequency spectrum (for $\gamma \gg 1$):

$$I(\omega) \cong 3.3\,\frac{e^2}{c}\left(\frac{\omega R}{c}\right)^{1/3} , \quad \omega \ll \omega_c ;$$

$$I(\omega) \cong (1.3,\ 1.8,\ 1.8,\ 0.5,\ 0.08)\ \frac{e^2\gamma}{c}$$

at $\frac{\omega}{\omega_c}$ = 0.01, 0.1, 0.2, 1.0, 2.0, respectively;

$$I(\omega) \cong \sqrt{3\pi}\ \frac{e^2\gamma}{c}\left(\frac{\omega}{\omega_c}\right)^{1/2} e^{-2\omega/\omega_c} , \quad \omega \gtrsim 2\omega_c .$$

The radiation is confined to angles $\lesssim 1/\gamma$ relative to the instantaneous direction of motion.

See J. D. Jackson, Classical Electrodynamics, 2nd edition (John Wiley & Sons, New York, 1975) for more formulae and details. (Prepared April 1974; revised April 1980.)

RADIOACTIVITY AND RADIATION PROTECTION

Unit of activity = Curie:
1 Ci = 3.7×10^{10} disintegrations/sec
Unit of exposure dose for x and γ radiation = Roentgen:
1 R = 1 esu/cm^3 = 87.8 erg/g (5.49×10^7 MeV/g) of air
Unit of absorbed dose = rad:
1 rad = 100 erg/g (6.25×10^7 MeV/g) in any material
Unit of dose equivalent (for protection) = rem:
rems (Roentgen equivalents for man) = rads $\times$ QF,
where QF (quality factor) depends upon the type of radiation and other factors. For γ rays and HE protons, QF $\approx$ 1; for thermal neutrons, QF $\approx$ 3; for fast neutrons, QF ranges up to 10; and for α particles and heavy ions, QF ranges up to 20.

Maximum permissible occupational dose for the whole body:
5 rem/year (maximum 3 rem/calendar quarter)
Fluxes (per cm^2) to liberate 1 rad in carbon:
3.5×10^7 minimum ionizing singly charged particles
1.0×10^9 photons of 1 MeV energy
(These fluxes are correct to within a factor of 2 for all materials.)
Natural background: 120 to 130 millirem/year
cosmic radiation (charged particles + neutrons) ~25 mrem/yr
cosmic radiation (γ rays) ~25 mrem/yr
radiation from rocks and air (γ rays) ~73 mrem/yr
Cosmic ray background in counters: ~ 1/min/cm^2/ster

PERIODIC TABLE OF THE ELEMENTS

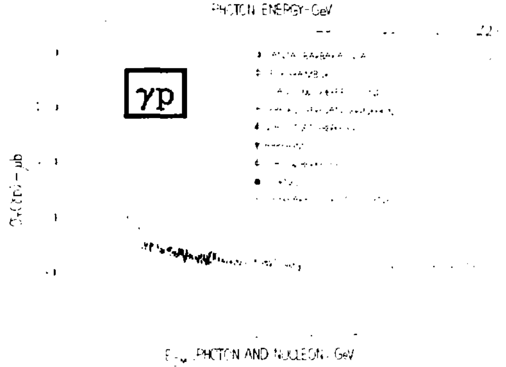
IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	
								1 H 1.0079									2 He 4.00260
3 Li 6.94	4 Be 9.01218											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.17
11 Na 22.98977	12 Mg 24.305											13 Al 26.98154	14 Si 28.0855	15 P 30.97376	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.08	21 Sc 44.9559	22 Ti 47.90	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.546	30 Zn 65.38	31 Ga 69.735	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.467	38 Sr 87.62	39 Y 88.9059	40 Zr 91.22	41 Nb 92.9064	42 Mo 95.94	43 Tc 98.9062	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.4	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.9054	56 Ba 137.33	57–71 Rare Earths	72 Hf 178.49	73 Ta 180.947	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.9665	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0254	89– Acti- nides	104 (260)	105 (260)	106 (263)												

57 La 138.9055	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967	Rare earths (Lanthanide series)
89 Ac (227)	90 Th 232.0381	91 Pa 231.0359	92 U 238.029	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)	Actinide series

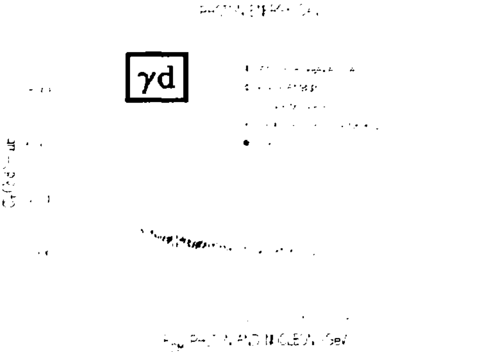
Upper number is atomic number, expressing the positive charge of the nucleus in multiples of the electronic charge e. Lower number is atomic mass weighted by isotopic abundance in earth's surface, relative to the mass of the carbon 12 isotope, which has been arbitrarily assigned a mass of 12.00000 atomic mass units (amu). Numbers in parentheses are mass numbers (the whole number nearest the value of the atomic mass, in amu) of most stable isotope of that element. Adapted from the Handbook of Chemistry and Physics, 62nd Ed., 1981-1982. (Particle Data Group update, April 1982.)

PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES

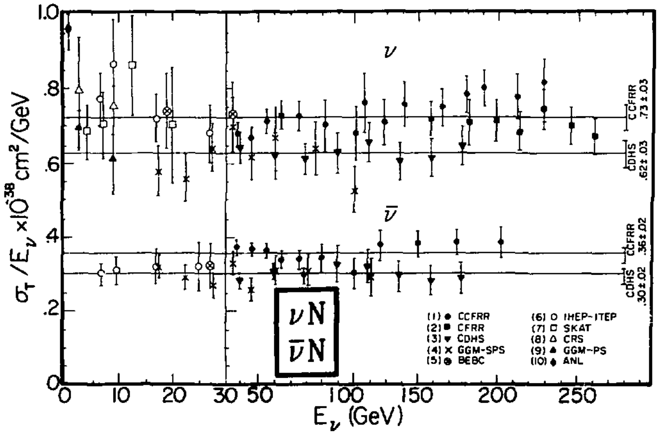
NOTE: THE FIGURES IN THIS SECTION ARE INTENDED TO SHOW THE "BEST" OR "MOST REPRESENTATIVE" DATA IN THE OPINION OF THE COMPILER. THEY ARE NOT NECESSARILY COMPLETE COMPILATIONS OF ALL THE WORLD'S RELIABLE DATA.



γp total cross section versus photon energy (top scale) and photon-plus-nucleon total center-of-mass energy (lower scale). References: SANTA BARBARA-SLAC: D.O.Caldwell et al., Phys. Rev. D7, 1362 (1973); DESY-HAMBURG: H.Meyer et al., Phys. Lett. 33B, 189 (1970); GLASGOW-SHEFFIELD-DNPL: T.A.Armstrong et al., Phys. Rev. D5, 1640 (1972); LEBEDEV-YEREVAN-SERPUKHOV: A.S.Belousov et al., Preprint 19, Moscow (1973), A.S.Belousov et al., Sov. Phys. Doklady 19, 123 (1974), and A.S.Belousov et al., Sov. J. Nucl. Phys. 21(3), 289 (1975); SLAC-BERKELEY-TUFTS: J.Ballam et al., Phys. Rev. D5, 545 (1972); ABBHHM: H.G.Hilpert et al., Phys. Lett. 27B, 474 (1968); SLAC and BERKELEY: J.Ballam et al., Phys. Rev. Lett. 21, 1544 (1968), and H.H.Bingham et al., Phys. Rev. D8, 1277 (1973); CORNELL: S.Michalowski et al., Phys. Rev. Lett. 39, 737 (1977); SANTA BARBARA-TORONTO-FNAL: D.O.Caldwell et al., Phys. Rev. Lett. 40, 1222 (1978). See, also, the ep data of E.D.Bloom et al., SLAC-PUB-653 (1969). Courtesy Gething M. Lewis, Glasgow.



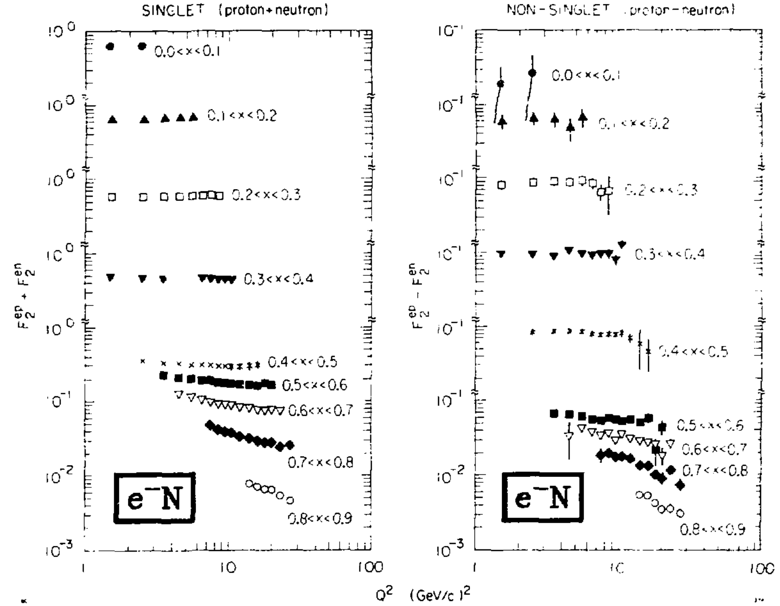
γd total cross section versus photon energy (top scale) and photon-plus-single-nucleon total center-of-mass energy (lower scale). References: SANTA BARBARA-SLAC: D.O.Caldwell et al., Phys. Rev. D7, 1362 (1973); DESY-HAMBURG: H.Meyer et al., Phys. Lett. 33B, 189 (1970); GLASGOW-SHEFFIELD-DNPL: T.A.Armstrong et al., Nucl. Phys. B41, 445 (1972); LEBEDEV-YEREVAN-SERPUKHOV: A.S.Belousov et al., Sov. J. Nucl. Phys. 21(3), 289 (1975); CORNELL: S.Michalowski et al., Phys. Rev. Lett. 39, 737 (1977). Courtesy Gething M. Lewis, Glasgow.



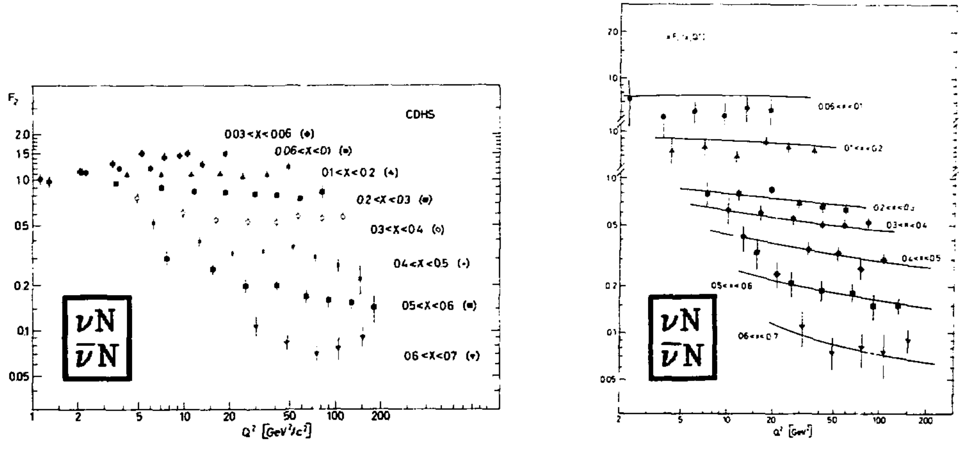
σ_T/E_ν for the muon neutrino and antineutrino *charged-current total cross section as a function of neutrino energy.* The error bars include both statistical and systematic errors. The straight lines are averages for the CCFRR and CDHS measurements. References: (1) R. Blair et al., in Proc. of Neutrino '81, Univ. of Hawaii (1981); (2) James Roy Lee, Ph.D. Thesis, Caltech (1981), "Measurements of νN Charged Current Cross Sections from E_ν=25 GeV to E_ν=260 GeV;" (3) J. G. H. de Groot et al., Zeit. fur Physik C - Particles and Fields 1, 143 (1979); (4) J. Morfin et al., Phys. Lett. 104B, 235 (1981); (5) D. C. Colley et al., Zeit. fur Physik C - Particles and Fields 2, 187 (1979); (6) A. S. Vovenko et al., Sov. J. Nucl. Phys. 30, 527 (1979); (7) D. S. Baranov et al., Phys. Lett. 81B, 255 (1979); (8) C. Baltay et al., Phys. Rev. Lett. 44, 916 (1980); (9) S. Ciampolillo et al., Phys. Lett. 84B, 281 (1979); (10) S. J. Barish et al., Phys. Rev. D19, 2521 (1979). Courtesy M. Shaevitz, Nevis Laboratory.

PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES (Cont'd)

Structure Functions

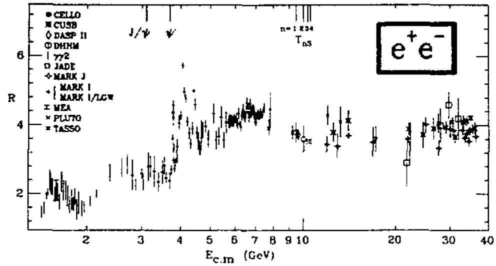


F_2 structure functions derived from inelastic electron-nucleon data taken at SLAC[1-4] with recoil mass >2 GeV and four-momentum transfer squared $Q^2 > 1(GeV/c)^2$ are shown. For definitions of F_2, x, and Q^2, see the "Relativistic Kinematics" section and the "Weak Interactions of Quarks and Leptons" section. $R \equiv \sigma_L/\sigma_T = 0.21$[3] *was assumed. Systematic errors are comparable in size to* the data point symbols. Corrections for nucleon motion in deuterium have been made. These corrections are small except for $x > 0.7$. No error was included to account for uncertainties in this correction. References: 1) A.Bodek et al., Phys. Rev. D20, 1471 (1979); 2) W.B.Atwood, SLAC Report No. 185 (1975); *3) M.D.Mestayer, SLAC Report No. 214 (1978);* 4) S.Stein et al., Phys. Rev. D12, 1884 (1975). Courtesy W. B. Atwood, SLAC.



Nucleon structure functions as measured by the CDHS collaboration in high energy (30–200 GeV) charged-current neutrino- and anti-neutrino-nucleon scattering [J.G.H.de Groot et al., Z. Physik C - Particles and Fields 1, 143 (1979); reproduced by permission]. Definitions, and a discussion of the significance of these structure functions, may be found in the above reference, and also in the "Weak Interactions of Quarks and Leptons" section of the present work. See de Groot et al., for a discussion of experimental details, including corrections, etc. *Curves are based on a QCD parametrization* of Buras and Gaemers [Nucl. Phys. B132, 249 (1978)].

PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES (Cont'd)

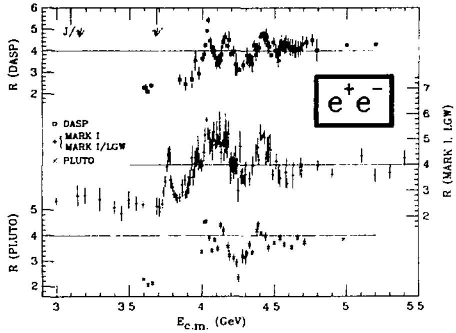


Measurements of $R = \sigma(e^+e^- \to \text{hadrons})/\sigma(e^+e^- \to \mu^+\mu^-)$, where the annihilation proceeds via one photon. The denominator is a calculated quantity:

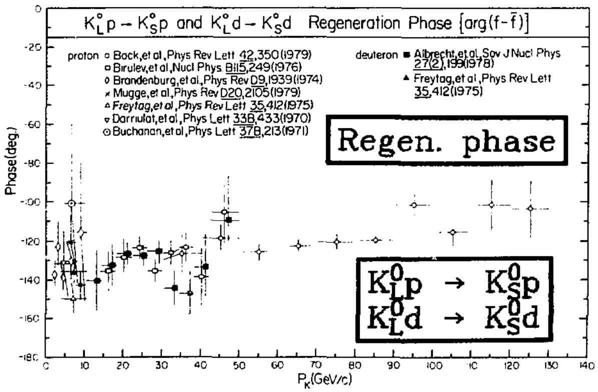
$$\sigma(e^+e^- \to \ell^+\ell^-) = (\hbar c)^2 \frac{\alpha^2}{4E_{cm}^2}\,\beta_\ell \int_{(4\pi)} d\Omega_{cm}\,(2 - \beta_\ell^2 \sin^2\theta_{cm})$$

$$\xrightarrow{\beta_\ell \to 1} \frac{4\pi}{3}(\hbar c)^2 \frac{\alpha^2}{E_{cm}^2} = \frac{86.8}{[E_{cm}(\text{GeV})]^2}\ \text{nb} \ ; \quad \beta_\ell = \frac{p_\ell^{cm}}{E_\ell^{cm}} \ ;$$

for $e^+e^- \to \mu^+\mu^-$, $\beta_\mu \to 1$ for energies shown. Radiative corrections and, where important, corrections for two-photon processes and τ production have been made. Note that the ADONE data (γγ2 and MEA) is for ≥3 hadrons. The points in the ψ″(3770) region are from the MARK I − Lead Glass Wall experiment. The DASP and PLUTO measurements have been omitted in the charm threshold region for clarity − they are shown in the expanded (lower) figure. Also for clarity, some points have been combined or shifted slightly (<4%) in $E_{c.m.}$. Systematic normalization errors are not included; they range from ~5 − 20%, depending on experiment. Note the suppressed zero. The horizontal extent of the plot symbols has no significance. The positions of the J/ψ, ψ′, and the four known ϒ vector-meson resonances are indicated at the top of the figure. References: CELLO − H.-J. Behrend et al., Phys. Lett. B, to be published (preprint DESY 81-029); CUSB − J. Rice et al., submitted to Phys. Rev. Lett.; DASP − R. Brandelik et al., Phys. Lett. 76B, 361 (1978); DASP II − S. Weseler, thesis, IHEP-HD/ARGUS/81-3, to be published in Phys. Lett. B; DHHM − J. Bock et al. (DESY-Hamburg-Heidelberg-MPI München Collab.), Zeit. für Physik C6, 125 (1980); γγ2 − C. Bacci et al., Phys. Lett. 86B, 234 (1979); JADE − W. Bartel et al., Phys. Lett. 88B, 171 (1979); MARK J − H. Newman, private communication; MARK I − J. L. Siegrist et al., SLAC-PUB-2831, LBL-13464, submitted to Phys. Rev. D (1982); MARK I + Lead Glass Wall − P. A. Rapidis et al., Phys. Rev. Lett. [illegible], 526 (1977); P. A. Rapidis, thesis, SLAC-Report-220 (1979); MEA − B. Esposito et al., Lett. Nuovo Cimento 19, 21 (1977); PLUTO − A. Bäcker, thesis, Gesamthochschule Siegen, DESY F33-77/03 (1977); C. Gerke, thesis, Hamburg Univ. (1979); Ch. Berger et al., Phys. Lett. 81B, 410 (1979); W. Lackas, thesis, RWTH Aachen, DESY PLUTO-81/11 (1981); TASSO − R. Brandelik et al., submitted to Phys. Lett. B (1982).

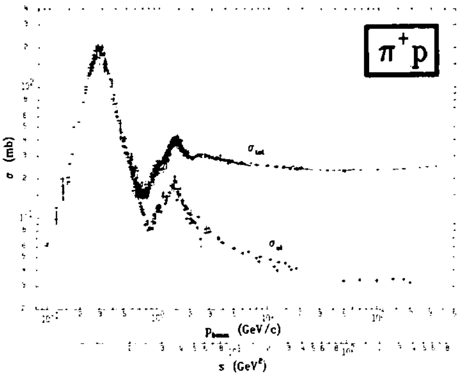


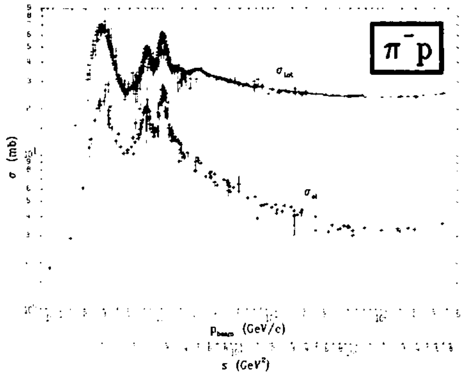
Lower figure: An expanded view of R measurements around charm threshold (no data points have been combined in this figure). We have arbitrarily added a horizontal line at R = 4 as an aid to visual comparison of the three sets of data.

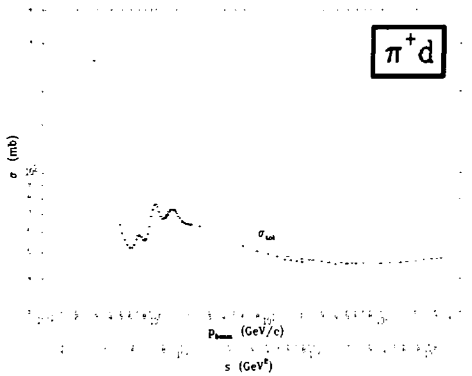


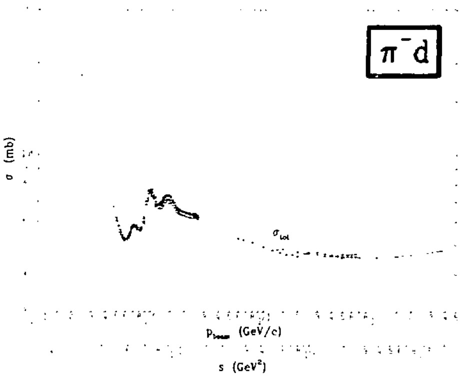
Phases of forward amplitudes for $K_L^0 p \to K_S^0 p$ (open symbols) and $K_L^0 d \to K_S^0 d$ (solid symbols). Courtesy S. Aronson, Brookhaven National Laboratory.

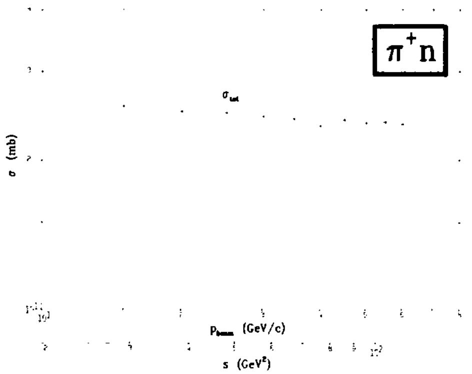
PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES (Cont'd)





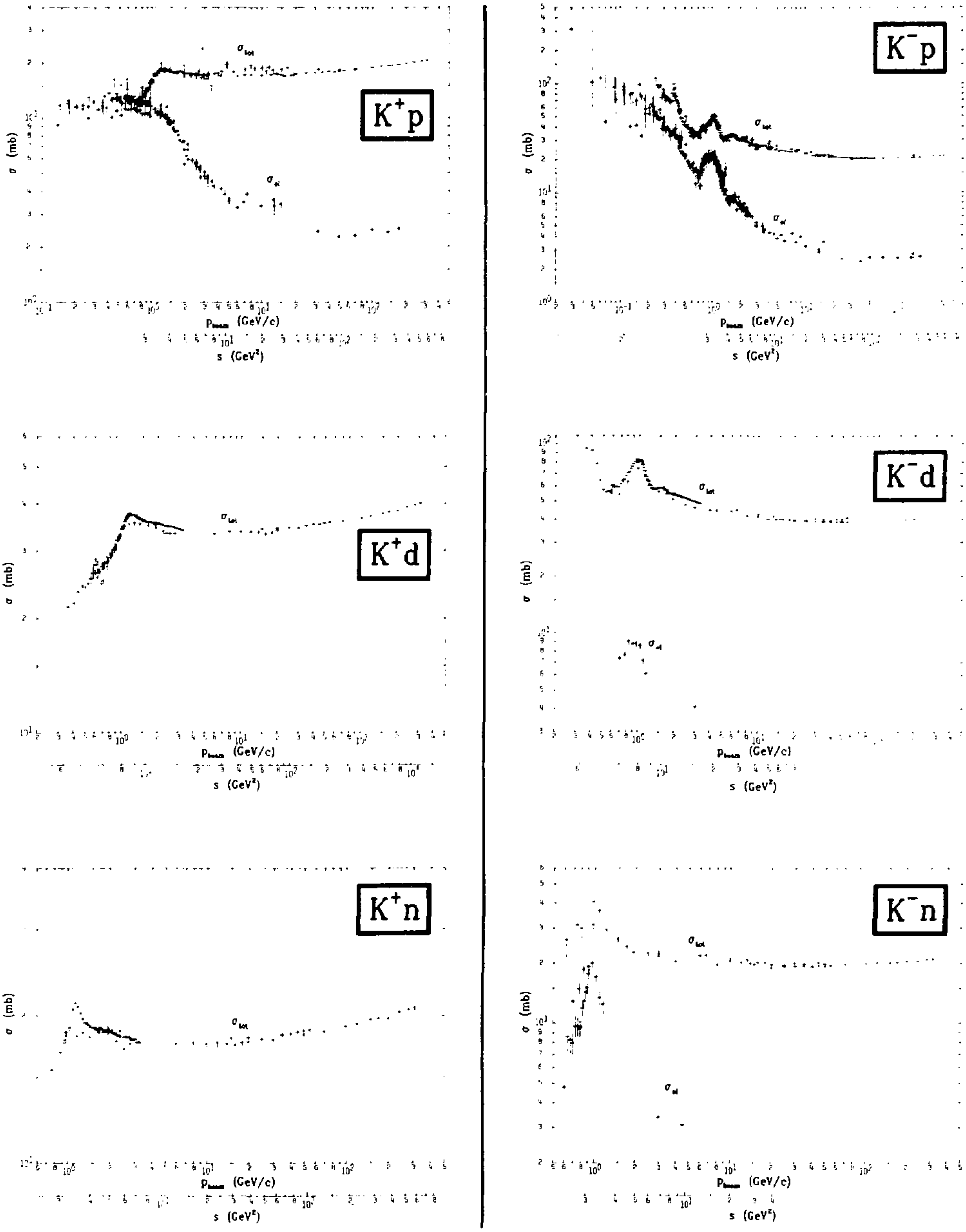






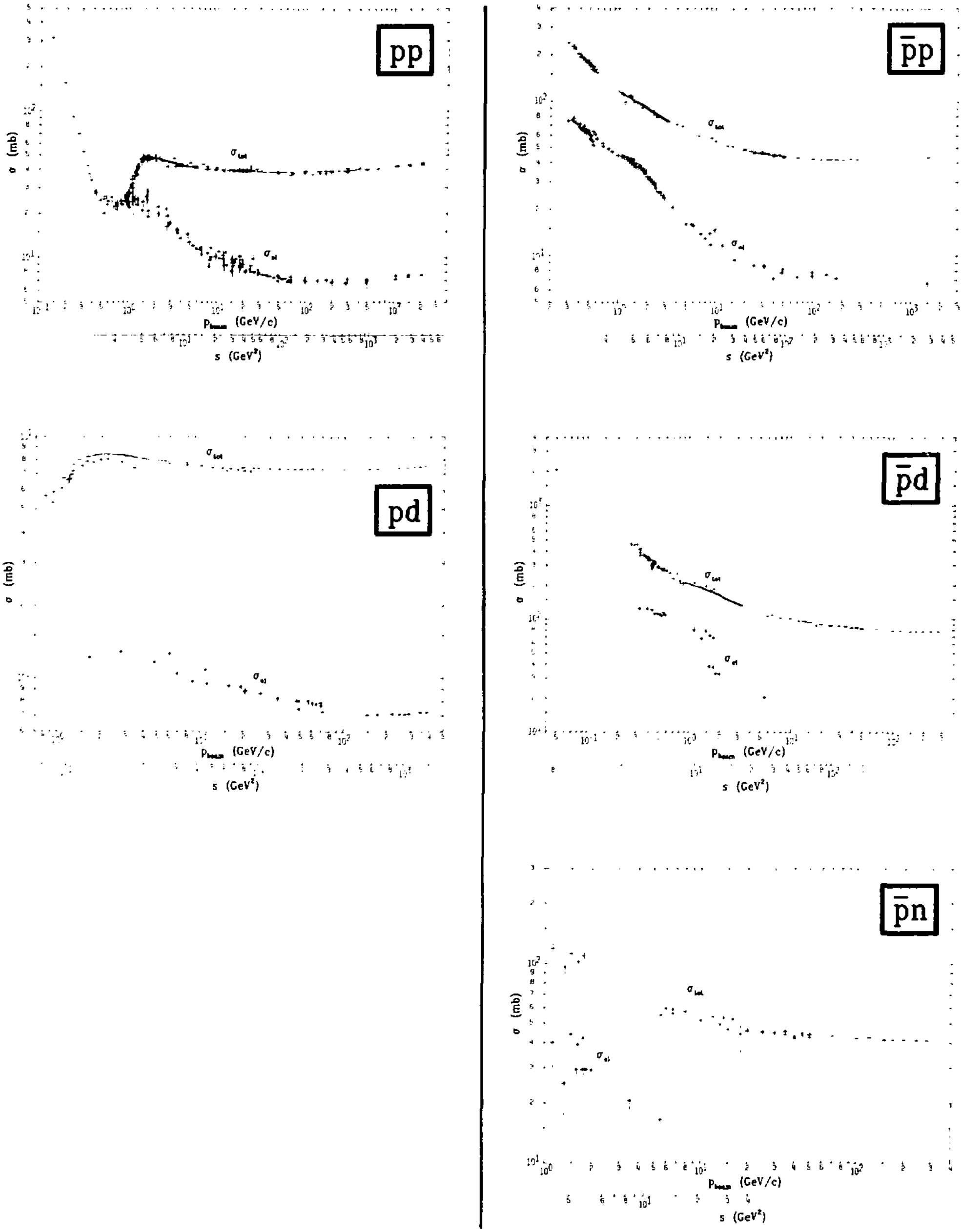
Hadronic total and elastic cross sections vs. laboratory beam momentum, p_{beam}, and center-of-mass energy squared, s. Figures courtesy V. Flaminio, W. G. Moorhead, and D. R. O. Morrison, CERN.

PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES (Cont'd)



Hadronic total and elastic cross sections vs. laboratory beam momentum, p_{beam}, and center-of-mass energy squared, s. Figures courtesy V. Flaminio, W. G. Moorhead, and D. R. O. Morrison, CERN.

PLOTS OF CROSS SECTIONS AND RELATED QUANTITIES (Cont'd)



Hadronic total and elastic cross sections vs. laboratory beam momentum, p_{beam}, and center-of-mass energy squared, s. Figures courtesy V. Flaminio, W. G. Moorhead, and D. R. O. Morrison, CERN.

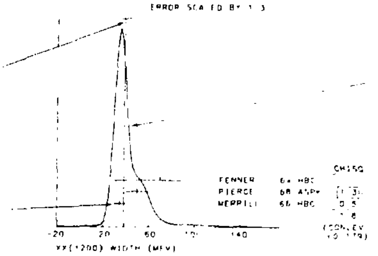
DATA CARD LISTINGS

Illustrative Key

XX(1200)

```
74  XX MESON (1200,JPG= - -) I=1)
    ORIGINALLY CALLED XXX,
    OMITTED FROM TABLE
------ --------- --------- --------- --------- --------- --------- --------
         74  XX(1200) MASS (MEV)
M          1216.        11.          MERRILL   66 HBC    0 3.2 K-P     7/66
M     150 (1192.)      (16.)         LYNCH     67 HBC   +- 2.7 PI-P    6/67
M    L    LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
M          198.         10.     7.   PIERCE    68 ASPK   + 2.1 K-P     9/68
M         (1208.)                    FENNER    69 HBC    0 4.2 PI+P    9/69
M      S   80 1210.      8.          SMITH     81 MMS    - 3.5 PI-P    1/82*
M      S  SUPERSEDES EARLIER RESULT
M
M     AVG  1206.9       5.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
------ --------- --------- --------- --------- --------- --------- --------
         74  XX(1200) WIDTH (MEV)
W           35.         5.           MERRILL   66 HBC    0 3.2 K-P     7/66
W           50.        10.           PIERCE    68 ASPK   + 2.1 K-P     9/68
W           70.        40.           FENNER    69 HBC    0 4.2 PI+P    9/69
W          (60.)     OR LESS         SMITH     81 MMS    - 3.5 PI-P    1/82*
W
W     AVG   38.4        6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                     (SEE IDEOGRAM BELOW)
```

WEIGHTED AVERAGE = 38.4 ± 6.0
ERROR SCALED BY 1.3

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         74  XX(1200) PARTIAL DECAY MODES
                                                  DECAY MASSES
P1     XX(1200) INTO 3PI                          139+ 139+ 139
P2     XX(1200) INTO K KBAR                       493+ 493
------ --------- --------- --------- --------- --------- --------- --------
         74  XX(1200) BRANCHING RATIOS
R1     XX(1200) INTO 3P/TOTAL                           (P1)
R1            .66        .02         MERRILL   66 HBC   0 3.2 K-P      7/66
R1    L      (.68)      (.03)        LYNCH     67 HBC  +- 2.7 PI-P     6/67
R1    L    LYNCH DATA HAS QUESTIONABLE BACKGROUND SUBTRACTION
R1
R1    FIT    0.675      0.012     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2     XX(1200) INTO KKBAR/TOTAL                        (P2)
R2            .35        .05         PIERCE    68 ASPK  +  2.1 K-P     9/68
R2
R2    FIT    0.325      0.012     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
R3     XX(1200) INTO KKBAR/3PI                       (P2)/(P1)
R3            .50        .03         FENNER    69 HBC   0 4.2 PI+P     9/69
R3            .41        .04         SMITH     81 MMS   - 3.5 PI-P     1/82*
R3
R3    AVG    0.468      0.043     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
R3    FIT    0.480      0.027     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
****** ********* ********* ********* ********* ********* ********* ********
                    REFERENCES FOR XX(1200)
MERRILL  66 PRL 16 143      A. MERRILL                (SACLAY+CERN) IJP
LYNCH    67 PR 155 610      B. LYNCH                          (BNL)
PIERCE   68 PL 27B 230      N. PIERCE                         (LRL)
FENNER   69 NC 61B 372      D. FENNER,B. BEANE          (NYSE+AMEX)
SMITH    81 PRL 46 14       J. SMITH                         (SLAC)
****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********
```

- Name of particle as it appears in table.
- Arrow indicates this particle omitted from table.
- Quantity tabulated below.
- Code for quantity tabulated (M=mass, W=width, etc.).
- Symbol used to key together data card and related comments.
- Number of events above background.
- Measured value (parentheses indicate value not used in average).
- ± error in measured value (- field blank if error symmetric; parentheses on error only indicate data not used in average due to problems with error estimation).
- Average value (and error) of quantity tabulated.
- Vertical bar indicates average; width of horizontal bar on top is (scaled) error on average.
- Value and error for each experiment.
- Partial decay mode (labeled by P_i).
- Branching ratio (labeled by R_j).
- Value (and error) of quantity tabulated, as determined from constrained fit (using all measured branching ratios for this particle).
- References, listed by year, then author.
- Abbreviated reference form used on data cards above.
- Journal, report, preprint, etc. (see abbreviations on next page).

- Particle name, and quantum numbers (if known).
- Particle code (for internal use only).
- General comments on particle.
- Abbreviated reference for this result; full reference given below.
- Measurement technique (see abbreviations on next page).
- Charge(s) of particle(s) detected.
- Reaction producing particle, or comments.
- Date this result entered (asterisk indicates results added or changed since previous edition).
- Scale factor > 1 indicates inconsistent data.
- Ideogram to display inconsistent data; curve is sum of Gaussians, one for each experiment (area of Gaussian = 1/error, width of Gaussian = ± error).
- Contribution of experiment to χ^2 (if no entry present, experiment not used in calculating χ^2 or scale factor because of very large error).
- Representative masses of decay products (used for calculating last column of Particle Property Tables).
- Branching ratio R_j in terms of partial decay mode fractions P_i above.
- Author(s).
- Quantum number determinations in this reference.
- Institution(s) of author(s) (see abbreviations on next page).

Illustrative Key *(cont'd)*

Abbreviations

Journals

APAH	Acta Phys. Acad. Hungarica
ADVP	Advances in Physics
ANP	Annals of Physics
APJ	Astrophysical Journal
ARNS	Annual Review of Nuclear Science
BAPS	Bulletin of the Amer. Phys. Soc.
CJP	Canadian Journal of Physics
JAP	Journal of Applied Physics
JETP	English Transl. of Soviet Physics JETP
JETPL	Letters of Soviet Physics JETP
JPA	Journal of Physics A
JPG	Journal of Physics G
JPSJ	Journal of the Phys. Soc. of Japan
LNC	Letters to Nuovo Cimento
NC	Nuovo Cimento
NIM	Nuclear Instruments and Methods
NP	Nuclear Physics
PL	Physics Letters
PN	Particles and Nuclei
PPSL	Proc. of the Phys. Soc. of London
PR	Physical Review
PRAM	Pramana
PRL	Physical Review Letters
PRPL	Physics Reports (Physics Letters C)
PRSE	Proc. of the Royal Soc. of Edinburgh
PRSL	Proc. of the Royal Soc. of London
PTP	Progress of Theoretical Physics
RA	Radiochimica Acta
RMP	Reviews of Modern Physics
RRP	Revue Romaine de Physique
SJNP	Soviet Journal of Nuclear Physics
SPU	Soviet Physics - Uspekhi
ZNAT	Zeitschrift fur Naturforschung
ZPHY	Zeitschrift fur Physik

Conferences

Conferences are referred to by the location in which they were held (e.g., DUBNA, BOULDER, LUND, etc.).

Measurement Techniques (i.e., Detectors and Methods of Analysis)

ASPK	Automatic spark chambers
BONA	Bonanza non-magnetic detector at DORIS
BPWA	Barrelet-zero partial-wave analysis
CALO	Calorimeter
CBAL	SLAC-SPEAR Crystal Ball detector
CC	Cloud chamber
CLEO	Cornell magnetic detector at CESR
CNTR	Counters
COSM	Cosmology and Astrophysics
CUSB	Columbia U. - Stony Brook segmented NaI detector at CESR
DASP	DESY double-arm spectrometer
DBC	Deuterium bubble chamber
DLCO	SLAC-SPEAR DELCO detector
DPWA	Energy-dependent partial-wave analysis
ELEC	Electronic combination
EMUL	Emulsions
FBC	Freon bubble chamber
FRAB	AFS/NaI $\pi\pi$ group detector
FRAG	AFS/NaI $\gamma\gamma$ group detector
FRAM	AFS/NaI MCA group detector
GOLI	CERN Goliath spectrometer
HBC	Hydrogen bubble chamber
HEBC	Helium bubble chamber
HLBC	Heavy-liquid bubble chamber
HYBR	Hybrid: BC + electronics
INDC	Magnetic induction
IPWA	Energy-independent partial-wave analysis
LASS	Large-angle superconducting solenoid spectrometer at SLAC
LENA	Non-magnetic lead-glass NaI detector at DORIS
MMS	Missing mass spectrometer
MPWA	Model-dependent partial-wave analysis
MRS	Magnetic resonance spectrometer
NEUL	Neuland large-angle neutrino spectrometer
OMEG	CERN OMEGA spectrometer
OSPK	Optical spark chamber
PBC	Propane bubble chamber
PLAS	Plastic detector
PLUT	DESY PLUTO detector
PWA	Partial-wave analysis
RVUE	Review of previous data
SFM	CERN split-field magnet
SILI	Silicon detector
SMAG	SPEAR magnetic detector
SMK2	SLAC Mark II detector
SPEC	Spectrometer
SPRK	Spark chamber
STRC	Streamer chamber
TASS	DESY TASSO detector
WIRE	Wire chamber
XEBC	Xenon bubble chamber

Institutions

AACH	Technische Univ. Aachen	Aachen, Germany
AARH	Aarhus Univ.	Aarhus, Denmark
ABO	Abo Akademi	Abo, Finland
ADEL	Adelphi Univ.	Garden City, N. Y., USA
AERE	Atomic Energy Res. Estab.	Harwell, Berks., England
AICH	Aichi Educational Univ.	Toyota, Aichi Pref., Japan
AIKO	Inst. Kernphys. Onderzoek	Amsterdam, Netherlands
ALBA	State Univ. of New York at Albany	Albany, N. Y., USA
ALBE	Alberta Univ., NRC	Edmonton, Canada
AMST	Univ. of Amsterdam	Amsterdam, Netherlands
ANIK	Amsterdam NIKHEF	Amsterdam, Netherlands
ANKA	Middle East Tecnical Univ.	Ankara, Turkey
ANL	Argonne National Lab.	Argonne, Ill., USA

Institutions (cont'd)

ARIZ	Univ. of Arizona	Tucson, Ariz., USA
ARZS	Arizona State Univ.	Tempe, Ariz., USA
ATEN	Nuclear Res. Centre Demokritos	Athens, Greece
ATHU	Univ. of Athens	Athens, Greece
AUCK	Univ. of Auckland	Auckland, New Zealand
BARC	Univ. de Barcelona	Barcelona, Spain
BARI	Univ. di Bari	Bari, Italy
BART	Bartol Research Foundation	Swarthmore, Pa., USA
BASL	Basel Univ.	Basel, Switzerland
BEDF	Bedford College	London, England
BELG	Inst. Interuniv. des Sci. Nuc.	Bruxelles, Belgium
BELL	Bell Labs.	Murray Hill, N. J., USA
BERG	Univ. of Bergen	Bergen, Norway
BERL	Inst. Hochenergiephys. DAW	Zeuthen/Berlin, DDR
BERN	Univ. Bern	Bern, Switzerland
BGNA	Univ. di Bologna	Bologna, Italy
BHEP	Inst. of High Energy Physics	Beijing, China
BING	State Univ. of New York at Binghamton	Binghamton, N. Y., USA
BIRM	Birmingham Univ.	Birmingham, England
BNL	Brookhaven National Lab.	Upton, L.I., N. Y., USA
BOHR	Niels Bohr Inst.	Copenhagen, Denmark
BOIS	Boise State Univ.	Boise, Idaho, USA
BONN	Univ. Bonn	Bonn, Germany
BORD	Univ. de Bordeaux	Bordeaux, France
BOST	Boston Univ.	Boston, Mass., USA
BRAN	Brandeis Univ.	Waltham, Mass., USA
BRCO	Univ. of British Columbia	Vancouver, Canada
BRIS	H. H. Wills Phys. Lab., U. of Bristol	Bristol, England
BROW	Brown Univ.	Providence, R. I., USA
BRUX	Univ. Libre de Bruxelles	Bruxelles, Belgium
BUCH	Bucharest State Univ.	Bucharest, Romania
BUDA	Central Research Inst. of Physics	Budapest, Hungary
BUFF	State Univ. of New York at Buffalo	Buffalo, N. Y., USA
BURE	Inst. des Hautes Etudes Sci.	Bures-sur-Yvette, France
CAEN	Lab. de Phys. Corpusculaire	Caen, France
CAIW	Carnegie Inst. of Washington	Washington, D. C. USA
CAMB	Cambridge Univ.	Cambridge, England
CANB	Australian National Univ.	Canberra, Australia
CARL	Carleton Univ.	Ottawa, Canada
CARN	Carnegie-Mellon Univ.	Pittsburgh, Pa., USA
CASE	Case Western Reserve Univ.	Cleveland, Ohio, USA
CATH	Catholic Univ. of America	Washington, D. C., USA
CAVL	Cavendish Lab., Cambridge Univ.	Cambridge, England
CCAC	Community College of Allegheny County	Pittsburgh, Penn., USA
CDEF	College de France	Paris, France
CEA	Cambridge Electron Accel.	Cambridge, Mass., USA
CENG	CEN, Grenoble	Grenoble, France
CERN	European Org. for Nuclear Research	Geneva, Switzerland
CHIC	Univ. of Chicago	Chicago, Ill., USA
CINC	Univ. of Cincinnati	Cincinnati, Ohio, USA
CIT	Calif. Inst. of Technology	Pasadena, Calif., USA
CNR	Canadian National Research Council	Ottawa, Canada
COLO	Univ. of Colorado	Boulder, Colo., USA
COLU	Columbia Univ.	New York, N. Y., USA
CORN	Cornell Univ.	Ithaca, N. Y., USA
COSU	Colorado State Univ.	Fort Collins, Colo., USA
CRAC	Inst. for Nuclear Research	Cracow, Poland
CUNY	City Univ. of New York	New York, N. Y., USA
CURI	Laboratoire Joliot-Curie	Paris, France
DARE	Daresbury Nuclear Physics Lab.	Daresbury, England
DART	Dartmouth College	Hanover, N. H., USA
DELF	Univ. of Technology	Delft, Netherlands
DELH	Univ. of Delhi	Delhi, India
DESY	Deutsches Elektronen-Synchrotron	Hamburg, Germany
DOE	U.S. Department of Energy	Washington, D. C., USA
DORT	Univ. Dortmund	Dortmund, Germany
DUKE	Duke Univ.	Durham, N. C., USA
DURH	Univ. of Durham	Durham, England
DUUC	University College	Dublin, Ireland
EDIN	Univ. of Edinburgh	Edinburgh, Scotland
EFI	Enrico Fermi Inst. for Nucl. Studies	Chicago, Ill., USA
ELMT	Elmhurst College	Elmhurst, Ill., USA
EPOL	Ecole Polytechnique	Palaiseau, France
ERLA	Univ. Erlangen-Nurnberg	Erlangen, Germany
ETH	Swiss Federal Inst. of Technology	Zurich, Switzerland
FIRZ	Univ. di Firenze	Firenze, Italy
FISK	Fisk Univ.	Nashville, Tenn., USA
FLOR	Univ. of Florida	Gainesville, Fla., USA
FNAL	Fermi National Accelerator Lab.	Batavia, Ill., USA
FOM	Found. for Fundamental Res. on Matter	Utrecht, Netherlands
FRAS	Lab. Nazionali del C.N.E.N.	Frascati, Italy
FREI	Univ. of Freiburg	Freiburg, Germany
FSU	Florida State Univ.	Tallahassee, Fla., USA
GENO	Univ. di Genova	Genova, Italy
GESC	General Electric Res. and Dev. Center	Schenectady, N. Y., USA
GEVA	Univ. de Geneve	Geneva, Switzerland
GLAS	Univ. of Glasgow	Glasgow, Scotland
GRAZ	Univ. Graz	Graz, Austria
GREN	Inst. des Sci. Nuc., Univ. de Grenoble	Grenoble, France
GSCO	Geological Survey of Canada	Ottawa, Canada
GUEL	Guelph Univ.	Guelph, Ontario, Canada
HAIF	Technion - Israel Inst. of Technology	Haifa, Israel
HAMB	Univ. Hamburg	Hamburg, Germany
HARV	Harvard Univ.	Cambridge, Mass., USA
HAWA	Univ. of Hawaii	Honolulu, Hawaii, USA
HEBR	Hebrew Univ.	Jerusalem, Israel
HEID	Univ. Heidelberg	Heidelberg, Germany
HELS	Helsingin Yliopisto	Helsinki, Finland
HIRO	Hiroshima Univ.	Hiroshima, Japan
HOUS	Univ. of Houston	Houston, Texas, USA
IAS	Inst. for Advanced Study	Princeton, N. J., USA
IBM	International Business Machines	Palo Alto, Calif., USA
IFRJ	Inst. de Fisica, Rio de Janeiro	Rio de Janeiro, Brazil
IIT	Illinois Inst. of Tech.	Chicago, Ill., USA
ILL	Univ. of Illinois	Urbana, Ill., USA
ILLC	Univ. of Illinois at Chicago	Chicago, Ill., USA
ILLG	Inst. Laue-Langevin	Grenoble, France
IND	Univ. of Indiana	Bloomington, Ind., USA
INNS	Phys. Inst., Univ. Innsbruck	Innsbruck, Austria
INRM	Inst. for Nuclear Research	Moscow, USSR
INUS	Inst. for Nuclear Study at Tokyo Univ.	Tokyo, Japan
IOWA	Univ. of Iowa	Iowa City, Iowa, USA
IPN	Inst. de Phys. Nucleaire	Orsay, France

Illustrative Key *(cont'd)*

Abbreviations *(cont'd)*

Institutions (cont'd)

IPNP	Inst. de Physique Nucleaire	Paris, France
IPP	Inst. for Particle Physics of Canada	Montreal, Canada
IRAD	Inst. du Radium	Paris, France
ISU	Iowa State Univ.	Ames, Iowa, USA
ITEP	Inst. for Theor. and Expt. Phys.	Moscow, USSR
ITHA	Ithaca College	Ithaca, N. Y., USA
IUPU	Indiana U. - Purdue U. at Indianapolis	Indianapolis, Ind., USA
JAGL	Jagellonian Univ.	Cracow, Poland
JHU	Johns Hopkins Univ.	Baltimore, Md., USA
JINR	Joint Inst. for Nucl. Research	Dubna, USSR
KAGO	Kagoshima Univ.	Kagoshima, Japan
KANS	Univ. of Kansas	Lawrence, Kansas, USA
KARL	Univ. Karlsruhe	Karlsruhe, Germany
KEK	Natl. Lab. for High Energy Phys., Japan	Tsukuba-gun, Japan
KENT	Kent Univ. at Canterbury, Kent	Canterbury, England
KEYN	Open Univ.	Milton Keynes, England
KHAR	Physico-Techn. Inst., Acad. Sci., Ukraine SSR	Kharkov, USSR
KIAE	Kurchatov Inst. of Atomic Energy	Moscow, USSR
KIEV	[illegible]-Technical Inst.	Kiev, USSR
KINK	Kinki Univ.	Osaka, Japan
KNTY	Univ. of Kentucky	Lexington, Ky., USA
KOBE	Kobe Univ.	Kobe, Japan
KONA	Konan Univ.	Kobe, Japan
KPNI	B. P. Konstantinov Inst. of Nucl. Phys.	USSR
KYOT	Kyoto Univ.	Kyoto, Japan
LAL	Lineair Accelerator Lab., Orsay	Orsay, France
LANC	Lancaster Univ.	Lancaster, England
LANL	Univ. Los Alamos National Lab.	Los Alamos, N. M., USA
LAPP	LAPP Univ.	Annecy, France
LASL	Univ. Los Alamos Scientific Lab.	Los Alamos, N. M., USA
LAUS	Univ. of Lausanne	Lausanne, Switzerland
	Univ. Calif. Lawrence Berkeley Lab.	Berkeley, Calif., USA
LCGT	Lab. di Cosmo-Geofisica del CNR	Torino, Italy
LEBD	Lebedev Physics Inst.	Moscow, USSR
LEED	Univ. of Leeds	Leeds, England
LEHI	Lehigh Univ.	Bethlehem, Pa., USA
LEHM	Herbert H. Lehman College	Bronx, N. Y., USA
LEID	Inst. Lorentz	Leiden, Netherlands
LEMO	LeMoyne College	Syracuse, N. Y., USA
LENI	Inst. of Nucl. Phys., USSR Acad. Sci.	Leningrad, USSR
[illegible]	Inst. Interuniv. Belge Hts. Eng.	Bruxelles, Belgium
LINZ	Linz Inst. fur Physik, Kepler Hoch.	Linz, Austria
LIVP	Liverpool Univ.	Liverpool, England
LLL	Lawrence Livermore Lab.	Livermore, Calif., USA
LOIC	Imperial Coll. of Sci. and Tech.	London, England
LOQM	Queen Mary College	London, England
LOUC	University College	London, England
LOWC	Westfield College	London, England
LPNP	Lab. de Phys. Nucl. et Hautes Energies	Paris, France
LPTP	Lab. de Phys. Theor. et Hautes Energies	Paris, France
LRL	Univ. Lawrence Berkeley Lab.	Berkeley, Calif., USA
LSU	Louisiana State Univ.	Baton Rouge, La., USA
LUND	Univ. of Lund	Lund, Sweden
LYON	Univ. de Lyon	Villeurbanne, France
MADR	Junta de Energia Nuclear	Madrid, Spain
[illegible]	Univ. Autonoma de Madrid	Madrid, Spain
MANH	Manhattan College	New York, N. Y., USA
MANI	Univ. of Manitoba	Winnipeg, Canada
MANZ	Univ. Mainz	Mainz, Germany
MARS	Center National de la Recherche Sci.	Marseille, France
MASA	Univ. of Massachusetts	Amherst, Mass., USA
MASB	Univ. of Massachusetts	Boston, Mass., USA
MCGI	McGill Univ.	Montreal, Canada
MCHS	Univ. Manchester	Manchester, England
MELB	Univ. of Melbourne	Parkville, Australia
MHOL	Mount Holyoke College	South Hadley, Mass., USA
MICH	Univ. of Michigan	Ann Arbor, Mich., USA
MILA	Univ. di Milan	Milano, Italy
MINN	Univ. of Minnesota	Minneapolis, Minn., USA
MINR	Inst. for Nuclear Research	Moscow, USSR
MIOH	Miami Univ.	Oxford, Ohio, USA
MIT	Massachusetts Inst. of Technology	Cambridge, Mass., USA
MODE	Ist. di Fisica dell'Univ.	Modena, Italy
MONP	Univ. de Montpellier	Montpellier, France
MONS	Univ. de l'Etat, Mons	Mons, Belgium
MONT	Univ. de Montreal	Montreal, Canada
MOSU	Moscow State Univ.	Moscow, USSR
MPEI	Moscow Phys. Engr. Inst.	Moscow, USSR
MPIH	Max Planck Inst. fur Phys.-Astrophys.	Heidelberg, Germany
MPIM	Max Planck Inst. fur Phys.-Astrophys.	Munich, Germany
MESS	Ist. di Fisica dell'Univ.	Messina, Italy
MSU	Michigan State Univ.	East Lansing, Mich., USA
MTHO	Mt. Holyoke College	South Hadley, Mass., USA
MULH	Centre Univ. du Haut-Rhin	Mulhouse, France
MUNI	Univ. of Munich	Munich, Germany
MURA	Midwestern Univs. Research Assoc.	Stoughton, Wisc., USA
NAGO	Nagoya Univ.	Nagoya, Japan
NAPL	Univ. di Napoli	Napoli, Italy
NARA	Nara Women's Univ.	Nara, Japan
NASA	NASA, Goddard Space Flight Center	Greenbelt, Md., USA
NBS	U.S. National Bureau of Standards	Washington, D. C., USA
NDAM	Univ. of Notre Dame	Notre Dame, Ind., USA
NEAS	Northeastern Univ.	Boston, Mass., USA
NEUC	Univ. de Neuchatel	Neuchatel, Switzerland
NEVI	Nevis Labs.	Irvington-on-Hudson, N. Y., USA
NIJM	K. U. Univ. Nijmegen	Nijmegen, Netherlands
NIU	Northern Illinois Univ.	De Kalb, Ill., USA
NORD	Nordisk Inst. for Teor. Atomfys.	Copenhagen, Denmark
NOVO	Inst. of Nucl. Phys.	Novosibirsk, USSR
NPOL	Northern Polytechnic	London, England
NRL	Naval Research Laboratory	Washington, D. C., USA
NSF	U.S. National Science Foundation	Washington, D. C., USA
NTUA	National Technical Univ.	Athens, Greece
NWES	Northwestern Univ.	Evanston, Ill., USA
NYU	New York Univ.	New York, N. Y., USA
OHIO	Ohio Univ.	Athens, Ohio, USA
OKAY	Okayama Univ.	Okayama, Japan
OREG	Univ. of Oregon	Eugene, Ore., USA
ORNL	Oak Ridge National Lab.	Oak Ridge, Tenn., USA
ORSA	Univ. de Paris, Fac. des Sci.	Orsay, France
OSAK	Osaka Univ.	Osaka, Japan
OSKC	Osaka City Univ.	Osaka, Japan
OSLO	Oslo Univ.	Oslo, Norway

Institutions (cont'd)

OSU	Ohio State Univ.	Columbus, Ohio, USA
OTTA	Univ. of Ottawa	Ottawa, Canada
OXF	Oxford Univ.	Oxford, England
PADO	Univ. di Padova	Padova, Italy
PATR	Univ. of Patras	Patras, Greece
PAVI	Univ. di Pavia	Pavia, Italy
PENN	Univ. of Pennsylvania	Philadelphia, Pa., USA
PERU	Univ. di Perugia	Perugia, Italy
PHIL	Philipps Univ.	Marburg, Germany
PISA	Univ. di Pisa	Pisa, Italy
PITT	Univ. of Pittsburgh	Pittsburgh, Pa., USA
PPA	Princeton-Penn. Proton Accel.	Princeton, N. J., USA
PRAG	Inst. of Physics, CSAV	Prague, Czechoslovakia
PRIN	Princeton Univ.	Princeton, N. J., USA
PSL	Physical Science Lab.	Las Cruces, N. M., USA
PURD	Purdue Univ.	Lafayette, Ind., USA
REGE	Univ. Regensburg	Regensburg, Germany
REHO	Weizmann Inst. of Sci.	Rehovoth, Israel
RHEL	Rutherford High Energy Lab.	Chilton, Didc., Berks., England
RICE	William Marsh Rice Univ.	Houston, Texas, USA
RISO	Research Establ. Riso	Roskilde, Denmark
RL	Rutherford Lab. (formerly RHEL)	Chilton, Didc., Berks., England
RMC	Royal Military College of Science	Shrivenham, England
ROCH	Univ. of Rochester	Rochester, N. Y., USA
ROCK	Rockefeller Univ.	New York, N. Y., USA
ROMA	Univ. di Roma	Roma, Italy
ROSE	Rose Polytechnic Inst.	Terre Haute, Ind., USA
RUTG	Rutgers Univ.	New Brunswick, N. J., USA
SACL	Centre d'Etudes Nucleaires	Gif-sur-Yvette, France
SAGA	Saga Univ.	Saga, Japan
SANI	Ist. Superiore di Sanita	Roma, Italy
SBER	San Bernardino State College	San Bernardino, Calif., USA
SEAT	Seattle Pacific College	Seattle, Wash., USA
SEIB	Research Center Seibersdorf	Vienna, Austria
SEOU	Seoul Univ.	Seoul, Korea
SERP	Inst. of High Energy Physics	Serpukhov, USSR
SETO	Seton Hall Univ.	South Orange, N. J., USA
SFLA	Univ. of South Florida	Tampa, Fla., USA
SFSC	San Francisco State College	San Francisco, Calif., USA
SHEF	Univ. of Sheffield	Sheffield, England
SHMP	Univ. of Southampton	Southampton, England
SIBR	Inst. of Nucl. Phys., USSR Acad. Sci.	Siberia, USSR
SIEG	Gesamthochschule Siegen	Huttental, Germany
SIN	Swiss Inst. of Nuclear Research	Villigen, Switzerland
SLAC	Stanford Linear Accel. Center	Stanford, Calif., USA
SMAS	Southeastern Massachusetts Univ.	North Dartmouth, Mass., USA
SOFI	Bulgarian Acad. of Sci.	Sofia, Bulgaria
STAN	Stanford Univ.	Stanford, Calif., USA
STEV	Stevens Inst. of Tech.	Hoboken, N. J., USA
STLO	St. Louis Univ.	St. Louis, Mo., USA
STOH	Stockholm Univ.	Stockholm, Sweden
STON	State Univ. of New York at Stony Brook	Stony Brook, L. I., N. Y., USA
STRB	Centre de Rech. Nucleaires	Strasbourg, France
SURR	Univ. of Surrey	Surrey, England
SUSX	Univ. of Sussex	Falmer, Brighton, England
SYRA	Syracuse Univ.	Syracuse, N. Y., USA
TAMU	Texas A and M Univ.	College Station, Texas, USA
TELA	Univ. of Tel-Aviv	Tel-Aviv, Israel
TEMP	Temple Univ.	Philadelphia, Pa., USA
TENN	Univ. of Tennessee	Knoxville, Tenn., USA
TEXA	Univ. of Texas	Austin, Texas, USA
TIFR	Tata Inst. of Fundamental Research	Bombay, India
TMSK	Nucl. Phys. Inst., Tomsk Polytech. Inst.	Tomsk, USSR
TMU	Tokyo Metropolitan Univ.	Tokyo, Japan
TNTO	Univ. of Toronto	Toronto, Canada
TOHO	Tohoku Univ.	Sendai, Japan
TOKY	Univ. of Tokyo	Tokyo, Japan
TORI	Univ. di Torino	Torino, Italy
TRIU	TRIUMF, Univ. of British Columbia	Vancouver, Canada
TRST	Univ. di Trieste	Trieste, Italy
TUFT	Tufts Univ.	Medford, Mass., USA
TWAS	Waseda Univ.	Tokyo, Japan
UBR	Univ. of Belgrade	Belgrade, Yugoslavia
UCB	Univ. of Calif. at Berkeley	Berkeley, Calif., USA
UCD	Univ. of Calif. at Davis	Davis, Calif., USA
UCI	Univ. of Calif. at Irvine	Irvine, Calif., USA
UCLA	Univ. of Calif. at Los Angeles	Los Angeles, Calif., USA
UCND	Union Carbide Nuclear Division	Oak Ridge, Tenn., USA
UCR	Univ. of Calif. at Riverside	Riverside, Calif., USA
UCSB	Univ. of Calif. at Santa Barbara	Santa Barbara, Calif., USA
UCSC	Univ. of Calif. at Santa Cruz	Santa Cruz, Calif., USA
UCSD	Univ. of Calif. at San Diego	La Jolla, Calif., USA
UMD	Univ. of Maryland	College Park, Md., USA
UNCS	Union College	Schenectady, N. Y., USA
UNH	Univ. of New Hampshire	Durham, N. H., USA
UNM	Univ. of New Mexico	Albuquerque, N. M., USA
UPSL	Upsala College	East Orange, N. J., USA
[illegible]	Gustaf Werner Inst.	Uppsala, Sweden
USC	Univ. of Southern California	Los Angeles, Calif., USA
USTL	Univ. Sci. et Tech. du Languedoc	Montpellier, France
UTAH	Univ. of Utah	Salt Lake City, Utah, USA
UTRE	Univ. of Utrecht	Utrecht, Netherlands
VAND	Vanderbilt Univ.	Nashville, Tenn., USA
VICT	Univ. of Victoria	Victoria, Canada
VIEN	Inst. for High Energy Physics, A. A. S.	Vienna, Austria
VIRG	Univ. of Virginia	Charlottesville, Va., USA
VPI	Virginia Polytechnic Inst.	Blacksburg, Va., USA
WARS	Univ. of Warsaw	Warsaw, Poland
WASH	Univ. of Washington	Seattle, Wash., USA
WIEN	Univ. Wien	Wien, Austria
WILL	College of William and Mary	Williamsburg, Va., USA
WISC	Univ. of Wisconsin	Madison, Wisc., USA
WITW	Univ. of the Witwatersrand	Johannesburg, S. Africa
WOOD	Woodstock College	Woodstock, Md., USA
WUPG	Gesamthochschule Wuppertal	Wuppertal, Germany
WUPP	Univ. Wuppertal	Wuppertal, Germany
WUSL	Washington Univ.	St. Louis, Mo., USA
WYOM	Univ. of Wyoming	Laramie, Wyoming, USA
YALE	Yale Univ.	New Haven, Conn., USA
YOKO	Yokohama Univ.	Yokohama, Japan
YORK	York Univ.	Toronto, Canada
ZEEM	Zeeman Lab., Univ. of Amsterdam	Amsterdam, Netherlands
ZURI	Univ. Zurich	Zurich, Switzerland

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γ            0  GAMMA(0,J=1)

             0  GAMMA MASS (IN UNITS OF 10**-21 MEV)

M  F       (6.1   CR LESS               PATEL     65          SATELLITE DATA   10/69
M          (6.1   CR LESS               GINTSBURG 64          SATELLITE DATA   10/69
M          (2.3)  OR LESS               GOLDHABER 68          SATELLITE DATA   10/69
M  F       (0.06) CR LESS               FRANKEN   71          LOW FREQ RES CIR  3/72
M         (10.1   OR LESS               WILLIAMS  71 CNTR     TESTS GAUSS LAW   3/71
M         (4.E-13)MEV OR LESS           LOWENTHAL 73          GENL RELATIVITY   8/77
M          (0.73) OR LESS               HOLLWEG   74          ALFVEN WAVES      7/74
M           0.6   OR LESS  CL=.997      DAVIS     75          JUPITER MAGFIELD  1/78
M  F   VALIDITY QUESTIONABLE. SEE CRITICISM IN KROLL 71 AND GOLDHABER 71.       3/78

                        REFERENCES FOR GAMMA

GINTSBUR 64 SOV. ASTR.AJ7 536 M. A. GINTSBURG                 (ACAD SCI.USSR)
PATEL    65 PL     14  105    V. L. PATEL                           (DURHAM)
GOLDHABE 68 PRL    21  567    A. GOLDHABER,M. NIETO             (STONY BROOK)
FRANKEN  71 PRL 26 115        P A FRANKEN, G W AMPULSKI               (MICH)
WILLIAMS 71 PRL 26 721        +FALLER,HILL                        (WESLEYAN)

LOWENTHA 73 PR D8 2349        D.D.LOWENTHAL                            (UCI)
HOLLWEG  74 PRL 32 961        J V HOLLWEG  (NATL CENTER FOR ATMOS RESRCH)
DAVIS    75 PRL 35 1402       +GOLDHABER,NIETO              (CIT+STON+LASL)

                        PAPERS NOT REFERRED TO IN DATA CARDS

GOLDHABE 71 RMP 43 277        A S GOLDHABER, M M NIETO   (STON+BOHR+UCSB)
KROLL    71 PRL 26 1395       N M KROLL                               (SLAC)
BYRNE    77 AS'.'?-SCI.46 115 J.C.BYRNE                               (LOIC)
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Neutrinos

(by R. E. Shrock, State Univ. of New York, Stony Brook)

With this issue the section on neutrino properties has been expanded and reorganized. As before, there are listings which deal specifically with ν_e, ν_μ, and ν_τ. In addition, in the category of searches near the end of the Stable Particle Listings, we include sections which deal with correlated bounds on neutrino masses and lepton mixing but which do not pertain to any one weak eigenstate individually. Furthermore, we include constraints from cosmological and astrophysical data. (Since this Review is a compendium of particle properties, traditionally derived more or less directly from particle and nuclear physics, we treat astrophysical data on a different footing from particle physics data and have been somewhat less comprehensive in our coverage of the former.)

In contrast to the other particles in this Review, the neutrinos ν_e, ν_μ, and ν_τ are defined as weak eigenstates (that is, states which couple weakly with unit strength to e, μ, and τ) and are not, in general, states of definite mass. In the conventional case, where all neutrinos were assumed to be massless and hence degenerate, it was possible to define the weak eigenstates to be simultaneously mass eigenstates. However, in the general case of massive (non-degenerate) neutrinos, the weak eigenstates have no well-defined masses, but instead are linear combinations of mass eigenstates. Thus, if one considers this general case, as, of course, one does in quoting mass limits, it is inconsistent to assume that the weak and mass eigenstates coincide. Let us denote the charged leptons as the set $\{\ell_a\}$, a = 1,...,n, where n $\geq$ 3 is the number of generations, with $\ell_1 \equiv e$, $\ell_2 \equiv \mu$, and $\ell_3 \equiv \tau$. In the standard $SU(2)_L \times U(1)$ electroweak theory[1] the mixing of the left-handed components of the mass eigenstates $(\nu_j)_L$ to form the weak gauge-group eigenstates $(\nu_{\ell_a})_L$ is specified by the transformation

$$(\nu_{\ell_a})_L = \sum_{j=1}^{n} U_{aj}(\nu_j)_L$$

where $U^+ = U^{-1}$. (In the case of Dirac neutrinos there are right-handed components of the ν_j, but they are singlets under the gauge group; in the case of Majorana neutrinos in the standard theory there are no right-handed components.) The ordering of the mass eigenbasis is defined such that U is as nearly diagonal as possible, i.e. $|U_{jj}|$ (no sum on j) $\geq |U_{jk}|$, $k \neq j$. This does not imply that $m(\nu_j) > m(\nu_k)$ if $j > k$, although this ordering might be regarded as natural in view of the similar one that obtains in the quark sector. The virtue of this convention is that a mass limit on "$m(\nu_{\ell_a})$" can be used as a definite limit on ν_j, j = a, the dominantly coupled mass eigenstate in ν_{ℓ_a}.

Thus, in this general case of n massive (Dirac or Majorana) neutrinos, decays such as $H^3 \rightarrow He^3 + e^- + \bar{\nu}_e$ and $\pi^+ \rightarrow \mu^+ \nu_\mu$, which have been used to set the best bounds on the respective neutrino masses, really consist of incoherent sums of the separate decay modes $H^3 \rightarrow He^3 + e^- + \bar{\nu}_j$ and $\pi^+ \rightarrow \mu^+ + \nu_k$, where the ν_j, ν_k are mass eigenstates, and the indices j and k range over the subset $\{1,...,n\}$ allowed by phase space in these two respective decays.[2] The coupling strengths for the j'th modes are given for the two decays by the factors $|U_{1j}|^2$ and $|U_{2j}|^2$, respectively. There are, in addition, certain kinematic factors depending on the $m(\nu_j)$ which enter in determining the branching ratio for the j'th decay mode. Assuming that the off-diagonal elements of the lepton mixing matrix U are small relative to the diagonal elements, the dominantly coupled decays are the ones with coupling strength $|U_{aj}|^2$, $a = j$, i.e. $H^3 \rightarrow He^3 + e^- + \bar{\nu}_1$ and $\pi^+ \rightarrow \mu^+ \nu_2$.

It follows that the old neutrino mass limits quoted in the literature for "$m(\nu_e)$", "$m(\nu_\mu)$", and "$m(\nu_\tau)$" are meaningful only insofar as they are reinterpreted as limits on the corresponding mass eigenstates. Specifically, a bound such as the Bergkvist limit,[3] "$m(\nu_e)$" < 60 eV (90% CL), really constitutes a weighted limit on each of the mass eigenstates ν_j in the weak eigenstate ν_e which are kinematically allowed to occur in tritium decay and which are coupled with strength $|U_{1j}|^2$ sufficiently large to make a significant contribution to the observed spectrum. It is thus certainly a limit on ν_1. If leptonic mixing is hierarchical as quark mixing is known to be (as least for the first three generations), i.e. $|U_{jj}|^2 >> |U_{jk}|^2$, $k \neq j$, then ν_1 is the only mass eigenstate significantly constrained by a bound on "$m(\nu_e)$." Furthermore, a neutrino mass limit cannot be stated in isolation; it always contains some implicit dependence on the relevant lepton mixing angles. Fortunately, this dependence is relatively unimportant for the dominantly coupled decay modes, i.e. $e\bar{\nu}_1$, $\mu\bar{\nu}_2$, and $\tau\bar{\nu}_3$. Since these modes were the ones responsible for the mass limits given previously, the latter can be reinterpreted without significant complication as proper limits on $m(\nu_j)$, j = 1, 2, and 3, respectively.

In addition to mass and lifetime limits, we have added data on neutrino magnetic dipole moments. These are of interest because a massless, purely chiral (empirically, left-handed) Dirac neutrino cannot have a magnetic (or electric) dipole moment. The same is true for a Majorana neutrino, whether massless or massive, because of its defining property of being self-conjugate.

If one considers the possibility of nonzero masses for neutrinos, for consistency one must also consider the leptonic mixing which would in general occur concomitantly. Accordingly we have devoted one category in the searches section to correlated bounds on neutrino masses and lepton mixing angles. These can be divided into two types. First, there are those due to decays involving neutrinos in the final state, which must be recognized to have the general multi-mode structure pointed out above. In the two most sensitive cases suggested as tests for neutrino masses and mixing,[2] one obtains a limit on $m(\nu_j)$ and $|U_{aj}|^2$ individually for each j. Second, there are those due to processes involving the propagation and subsequent interaction of neutrinos. The latter are often called neutrino "oscillation"[3] limits, although this term is correct only if the differences in neutrino masses are sufficiently small relative to their momenta that the propagation is effectively coherent in a quantum mechanical sense; otherwise, the individual ν_j from a given decay such as $\pi_{\mu 2}$ or $K_{\mu 2}$ propagate in a measurably incoherent manner and there is no "oscillation". Experimentalists usually present their results in terms of a simplifying model in which mixing is assumed to occur only between two neutrino species. Then the transformation equation becomes

$$\begin{pmatrix} \nu_{\ell_a} \\ \nu_{\ell_b} \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} \nu_i \\ \nu_j \end{pmatrix} .$$

Let the distance between the source of the neutrinos and their point of interaction be labeled as x, and their energy as E. Assume furthermore that the $m(\nu_j)$ are such that the coherence assumption is valid. Then, the probability of an initial ν_{ℓ_a} being equal to ν_{ℓ_b} at time t or equivalently (given the above assumption) at distance x = t, is

$$|\langle \nu_{\ell_b}(0)|\nu_{\ell_a}(t)\rangle|^2 = \sin^2 2\theta \, \sin^2\left(\frac{\Delta m^2 x}{4E}\right),$$

where

$$\Delta m^2 = m(\nu_i)^2 - m(\nu_j)^2 .$$

Thus, neutrino oscillation experiments cannot measure individual neutrino masses, but only differences of masses squared, and indeed these are generally weighted in a more complicated way by mixing-matrix coefficients than in the two-species model. Experimental results are presented as allowed regions on a plot, the axes of which are $|\Delta m^2|$ and $\sin^2 2\theta$. These are often summarized in terms of the asymptotic limits $|\Delta m^2|_{max}$ for $\sin^2 2\theta = 1$, and $\sin^2 2\theta$ for "large" $|\Delta m^2|$, i.e., sufficiently large $|\Delta m^2|$ that the detector averages over many cycles of oscillation (or there ceases to be any coherence). We refer the reader to the original papers for the two-dimensional plots; for the purpose of these Listings we shall give only the asymptotic limits.

An important question has to do with whether neutrinos are Dirac or Majorana (self-conjugate) particles. In the former case neutrinoless double beta decay, $(Z,A) \rightarrow (Z+2,A) + e^- + e^-$, is forbidden from occurring.[4] In the Majorana case it may occur, if (a) neutrinos are massive and/or (b) there are right-handed leptonic currents. In the light-neutrino case an upper limit on neutrinoless double beta decay yields a correlated upper bound on the quantity

$$\bar{m} \equiv \left| \sum_{j=1}^{n} U_{1j}^{\,2}\, m(\nu_j) \right|$$

and η, the fractional admixture of right-handed leptonic current.

Further explanatory notes are included in the Listings.

<u>References</u>

1. S. Weinberg, Phys. Rev. Lett. 19, 1264 (1967); A. Salam, In Elementary Particle Theory: Relativistic Groups and Analyticity, edited by N. Svartholm (Alqvist and Wiksell, Stockholm, 1968), p. 367. See also S. Glashow, Nucl. Phys. 22, 579 (1961); S. Glashow, J. Iliopoulos, and L. Maiani, Phys. Rev. D2, 1285 (1970); and, for the n=3 case, M. Kobayashi, and T. Maskawa, Prog. Theor. Phys. 49, 652 (1973).
2. R. E. Shrock, Phys. Lett. 96B, 159 (1980); Phys. Rev. D24, 1232 (1981); Phys. Rev. D24, 1275 (1981).
3. Z. Maki, M. Nakagawa, and S. Sakata, Prog. Theor. Phys. 28, 870 (1962); B. Pontecorvo, Sov. Phys. JETP 6, 429 (1957); 7, 172 (1958); Zh. Ek. Theor. Fiz. 53, 1717 (1967) Sov. Phys. JETP 26, 984 (1968) ; V. Gribov and B. Pontecorvo, Phys. Lett. 28B, 493 (1969).
4. For recent studies of neutrinoless double beta decay see H. Primakoff and S. P. Rosen, Ann. Rev. Nucl. Sci. 31, 145 (1981); S. P. Rosen, Proc. of 1981 Intl. Conf. on Neutrino Physics and Astrophysics (Maui, Hawaii), eds. R. J. Sens et al., v.2, p. 76; W. C. Haxton, G. L. Stephenson, Jr., and D. Strottman, Phys. Rev. Lett. 47, 153 (1981); M. Doi, T. Kotani, H. Nishiura, K. Okuda, and E. Takasugi, Phys. Lett. 103B, 219 (1981), and Prog. Theor. Phys. 66, 1739 and 1765 (1981).

ν_e

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                  I  NU-E(J=1/2)
      NOT IN GENERAL A MASS EIGENSTATE
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                  I  NU-E **MASS** (EV)

      APPLIES TO NU-1, THE PRIMARY MASS EIGENSTATE IN NU-E.  WOULD ALSO
      APPLY TO ANY OTHER NU-J WHICH MIXES STRONGLY IN NU-E AND HAS
      SUFFICIENTLY SMALL MASS THAT IT CAN OCCUR IN THE RESPECTIVE DECAYS.

      NOTE -- THE ABBREVIATION ANU IS USED BELOW FOR ANTINU

M          (250.)   OR LESS            LANGER    52 CNTR   ANU-E, TRITIUM
M          (500.)   OR LESS            HAMILTON  53 CNTR   ANU-E, TRITIUM   11/73
M          (550.)   (280.)             FRIEDMAN  58 CNTR   ANU-E, TRITIUM
M         (4100.)   OR LESS  CL=.67    BECK      68 CNTR   NU, SODIUM 22    11/73
M   D      (500.)   OR LESS  CL=.90    DARIS     69 CNTR   ANU-E, TRITIUM   11/73
M          (320.)   OR LESS  CL=.90    SALGO     69 CNTR   ANU-E, TRITIUM   11/73
M           (60.)   OR LESS  CL=.90    BERGKVIS  72 CNTR   ANU-E, TRITIUM   11/73
M           (86.)   OR LESS  CL=.90    RODE      72 CNTR   ANU-E, TRITIUM   11/73
M          (100.)   OR LESS            PIEL      73 CNTR   ANU-E, TRITIUM    1/81*
M          (4.5E5)OR LESS    CL=.90    CLARK     74 ASPK   KE3 DECAY        11/75
M     L     (35.)   OR LESS  CL=.90    TRETYAKOV 76 SPEC   ANU-E, TRITIUM    4/82*
M     L     (14.)   TO 46.   CL=.99    LUBIMOV   80 SPEC   ANU-E, TRITIUM    9/81*
M           (65.)   OR LESS  CL=.95    SIMPSON   81 CNTR   ANU-E, TRITIUM    1/82*
M   D   DARIS 69 VALUE 75EV(CL=.67) DISAGREES WITH THEIR FIG.6. WE USE      11/73
M   D   FIG.6.                                                              11/73
M     L TRETYAKOV 76 DATA INCLUDED, AT LEAST IN PART, IN LUBIMOV 80.         4/82*
M     L SEE THE DISCUSSION OF THE LUBIMOV 80 RESULT BY BERGKVIST 80.         1/82*
M     L WE USE UPPER LIMIT FROM LUBIMOV 80 IN THE STABLE PARTICLE TABLE.     4/82*
M     L THEIR LOWER LIMIT NEEDS CONFIRMATION.                                4/82*

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                  I  (NU-1) - (ANU-1) MASS DIFF. (EV)

      TEST OF CPT FOR A DIRAC NEUTRINO

DM         (4.5E5)OR LESS  CL=.90   CLARK     74 ASPK   KE3 DECAY         11/75

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                  I  NU-1 MEAN LIFE/MASS  (UNITS SEC/EV)

T     R       3. E 2  OR MORE          REINES    74 CNTR   ANTI-NEUTRINO     3/78
T     R REINES 74 LOOKED FOR NU-E OF NON-ZERO MASS DECAYING TO A NEUTRAL     3/78
T     R OF LESSER MASS + GAMMA.  USED LIQUID SCINT. DETECTOR NEAR FISSION    3/78
T     R REACTOR.  FINDS LAB LIFETIME 6.E7 SEC OR MORE.  ABOVE VALUE OF       3/78
T     R MEAN LIFE/MASS ASSUMES AVG. EFFECTIVE NEUTRINO ENERGY OF 0.2MEV.     3/78

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                  I  NU-1 MAGNETIC MOMENT  (UNITS EV/GAUSS)

      MUST VANISH FOR MAJORANA NEUTRINO OR PURELY CHIRAL MASSLESS
      DIRAC NEUTRINO

MM  B       (1.1E-17)OR LESS            BERNSTEIN 63                          1/82*
MM  B   BERNSTEIN 63 IS A THEORETICAL ANALYSIS OF REACTOR ANTINU-E            1/82*
MM  B   SCATTERING DATA.                                                     1/82*

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                          REFERENCES FOR NU-E

LANGER   52 PR  88  689      L M LANGER,R J D MOFFAT                 (INDIANA)
HAMILTON 53 PR  92  1521     D HAMILTON,W P ALFORD,L GROSS         (PRINCETON)
FRIEDMAN 58 PR 109  2214     LEWIS FRIEDMAN,LINCOLN G SMITH              (BNL)
BECK     68 ZPHY 216 229     E BECK,H DANIEL                            (MPIH)
BERNSTEI 63 PR 132 1227      BERNSTEIN,RUDERMAN,FEINBERG            (NYU+COLU)
DARIS    69 NP A138 545      P DARIS,C ST-PIERRE                (LAVAL-QUEBEC)
SALGO    69 NP A138 417      R C SALGO,H H STAUB                      (ZURICH)

BERGKVIS 72 NP B39 317       KARL-ERIK BERGKVIST              (UNIV STOCKHOLM)
RODE     72 LNC 5 139        B RODE,H DANIEL                     (MUNICH+MPIH)
PIEL     73 NP A203 369      WILLIAM F. PIEL, JR.                        (IND)
CLARK    74 PR D9 533        +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN+          (LBL)
REINES   74 PRL 32 180       +SOBEL,GURR                                 (UCI)
   ALSO  78  PRIVATE COMM.   V. BARNES                                  (PURD)

TRETYAKO 76 BASUP 40 10-1    TRETYAKOV+ (BULL.ACAD.SCI.USSR,PHY.) (ITEP)
   ALSO  76 NU CONF. AACHEN  TRETYAKOV,MYASOEDOV,APALIKOV,KONYAEV+(ITEP)
BERGKVIS 80 NEUTRINO 80,ERICE K.E.BERGKVIST                             (STOH)
LUBIMOV  80 PL 94B 266       +NOVIKOV,NOZIK,TRETYAKOV,KOSIK             (ITEP)
   ALSO  80 SJNP 32 154      KOZIK,LUBIMOV,NOVIKOV,NOZIK,TRETYAKOV(ITEP)
SIMPSON  81 PR D23 649       J.J.SIMPSON                                (GUEL)

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e

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                    3  ELECTRON(0.5,J=1/2)
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                    3  ELECTRON MASS (MEV)

M           (0.511006 0.00002)          COHEN     65 RVUE
M           (0.5110041 .0000016)        TAYLOR    69 RVUE    USING NEW E/H     7/70
M            0.5110034 .0000014         COHEN     73 RVUE                      3/74

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                    3  ELECTRON MEAN LIFE / BRANCHING FRACTION (UNITS YRS)

                    TEST OF CHARGE CONSERVATION

T    M      (2. E21) CR MORE            MOE       65 CNTR    SEE NOTE S BELOW  6/66
T           (4. E22) CR MORE            MOE       65 CNTR    E- --> NEU GAMMA  6/66
T           (5.3E21) CR MORE            STEINBERG 75 CNTR    SEE NOTE S BELOW  2/76
T            2. E22  CR MORE   CL=.68   KOVALCHUK 79 CNTR    SEE NOTE S BELOW  1/81*
T           (3.5E23) CR MORE   CL=.68   KOVALCHUK 79 CNTR    E- --> NEU GAMMA  1/81*
T    M   SEE MOE 65 FOR DISCUSSION OF EARLIER EXPERIMENTS.                     1/81*
T    M   MOE 65 LIMIT REESTIMATED BY STEINBERG 75 TO BE (1. E20).              1/81*
T     S  THESE LIMITS ARE FOR ALL MODES IN WHICH DECAY PARTICLES ESCAPE        1/81*
T     S  FROM THE DETECTOR WITHOUT DEPOSITING ENERGY.                          1/81*

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                    3  ELECTRON MAGNETIC MOMENT(E/2ME)

MM      ELECTRON OR POSITRON G/2-VALUE
MM       THIS IS MAGNETIC MOMENT IN UNITS (E/2ME-) FOR E-, (E/2ME+) FOR E+.
MM       FOR REVIEWS OF THEORY AND EXPERIMENTS, SEE KINOSHIA 78, LAUTRUP 72,
MM       AND RICH 72.
MM       FOR MOST ACCURATE THEORETICAL CALCULATION, SEE KINOSHITA 81.
MM         (1.0011609)    +-(24)E-7      SCHUPP    61 CNTR -
MM         (1.001159622)  +-(27)E-9      WILKINSON 63 CNTR -                   8/66
MM         (1.0011681)    +-(22)E-6      RICH      66 CNTR +  POSITRON         8/66
MM R       (1.001159557)  +-(30)E-9      RICH      68 CNTR -                   6/68
MM         (1.0011596389)+-(31)E-10      TAYLOR    69 RVUE                     2/71
MM         (1.001159644)  +-(7)E-9       WESLEY    70 CNTR                     6/70
MM         (1.0011596577)+-(35)E-10      WESLEY    71 CNTR -                   2/72
MM         (1.0011603)    +-(12)E-7      GILLELAND 72 CNTR +                   2/72
MM         (1.0011596567)+-(35)E-10      COHEN     73 RVUE                     3/74
MM         (1.00115966)   +-(24)E-9      WALLS     73 CNTR -  BOLOMETRIC TECHN 11/77
MM         (1.00115965241)+-(20)E-11     VANDYCK   77 CNTR -  RPL.BY VANDYCK79 12/77
MM V        1.001159652200+-(40)E-12     VANDYCK   79 CNTR -  PENNING TRAP     1/82*
MM          1.001159652222+-(50)E-12     SCHWINBER 81 CNTR +  PENNING TRAP     1/82*
MM R     RICH 68 IS REEVALUATION OF WILKINSON 63.
MM V     VANDYCK 79 CONFIRMED FINAL BY H. DEHMELT, PRIV. COMM.                 1/82*
MM          . . . . . . . . . . . . . .
MM  AVG     1.001159652209+-(31)E-12 AVERAGE (ERROR INCL. SCALE FACTOR 1.0)    1/82*
MM       AVERAGE ASSUMING EQUAL G/2-VALUES FOR E+ AND E- BY CPT.

MMR      POSITRON TO ELECTRON G-FACTOR RATIO MINUS ONE, (G+/G-)-1
MMR       TEST OF CPT
MMR        (1.6E-8) OR LESS  CL=.95     SEREDNYAK 77 CNTR ME+=ME- ASSUMED      4/82*
MMR         2.2E-11  6.4E-11            SCHWINBER 81 ELEC     PENNING TRAP     4/82*

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                    3  ELECTRON ELECTRIC DIPOLE MOMENT(UNITS 10**-23 E-CM)

                 FORBIDDEN BY BOTH T INVARIANCE AND P INVARIANCE

EDM          0.3   CR LESS  CL=.90   WEISSKOPF 68 MRS     CESIUM               12/79
EDM         (0.07)  (0.22) CL=.90    PLAYER    70 MRS     XENON                 4/82*
EDM         (0.19)  (0.34) CL=.90    SANDARS   75 MRS     THALLIUM              4/82*
EDM         (8.1)   (11.6)           VASILEV   78                              12/79

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REFERENCES FOR ELECTRON

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SCHUPP   61 PR  121   1        A A SCHUPP,R W PIDD,H R CRANE            (MICH)
WILKINSO 63 PR 130 852         D T WILKINSON,H R CRANE                  (MICH)
COHEN    65 RMP 37 537         COHEN,DUMOND  (N.A.AVIATION SCI.CENTER+CIT)
MOE      65 PR 140 B 992       M K MOE,F REINES     (CASE INST TECHNOLOGY)

RICH     66 PRL  17  271       A RICH, H R CRANE                        (MICH)
RICH     68 PRL 20 967         A RICH                                   (MICH)
WEISSKOP 68 PRL 21 1645        WEISSKOPF,CARRICO,GOULD,LIPWORTH+        (BRAN)
TAYLOR   69 RMP 41 375         +PARKER,LANGENBERG              (PRIN+UCI+PENN)

PLAYER   70 JP B3 1620         H.A.PLAYER,P.G.H.SANDARS                  (OXF)
WESLEY   70 PRL 24 1320        J C WESLEY,A.RICH                        (MICH)
WESLEY   71 PR A4 1341         J C WESLEY,A RICH                        (MICH)
GILLELAN 72 PR A5 38           J GILLELAND,A RICH                       (MICH)
LAUTRUP  72 PRPL 3 193         B.LAUTRUP,A.PETERMAN,E.DE RAFAEL(CERN+BURE)
RICH     72 RMP 44 250         A RICH,J C WESLEY                        (MICH)

COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
WALLS    73 PRL 31 975         F.L.WALLS,T.S.STEIN                      (WASH)
SANDARS  75 PR A11 473         P.G.H.SANDARS,R.M.STERNHEIMER        (OXF+BNL)
STEINBER 75 PR D12 2582        R.I.STEINBERG,KWIATKOWSKI,MAENHAUT+       (UMD)
SEREDNYA 77 PL 66B 102         SEREDNYAKOV,SIDOROV,SKRINSKY+            (NOVO)
VANDYCK  77 PRL 38 310         +SCHWINBERG,DEHMELT                      (WASH)
KINOSHIT 78  TOKYO HEP P.571   T. KINOSHITA                             (CORN)

VASILEV  78 JETP 47 243        +KOLYCHEVA                               (JINR)
KOVALCHU 79 JETPL 29 145       KOVALCHUK,POMANSKY,SMOLNIKOV             (INRM)
VANDYCK  79 BULL. APS 24 758   +SCHWINBERG,DEHMELT                      (WASH)
    ALSO 81 AT.PHYS. 7, P.337 H.DEHMELT(EDS.KLEPPNER+,PLENUM,NY,81)(WASH)
KINOSHIT 81 PRL 47 1573        T.KINOSHITA, W.B.LINDQUIST               (CORN)
SCHWINBE 81 PRL 47 1679        SCHWINBERG,VAN DYCK,DEHMELT              (WASH)

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ν_μ

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                    2  NU-MU(J=1/2)

        NOT IN GENERAL A MASS EIGENSTATE.  SEE NOTE ON NEUTRINOS
        IN THE ELECTRON NEUTRINO SECTION ABOVE.

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                    2  NU-MU **MASS** (MEV)

        APPLIES TO NU-2, THE PRIMARY MASS EIGENSTATE IN NU-MU.  WOULD ALSO
        APPLY TO ANY OTHER NU-J WHICH MIXES STRONGLY IN NU-MU AND HAS
        SUFFICIENTLY SMALL MASS THAT IT CAN OCCUR IN THE RESPECTIVE DECAYS.
        (THIS WOULD BE NONTRIVIAL ONLY FOR J .GE. 3, GIVEN THE NU-E **MASS**
        LIMIT ABOVE.)

M           (3.5)  OR LESS             BARKAS    56 EMUL
M           (4.0)  OR LESS             DUDZIAK   59 CNTR
M           (3.6)  OR LESS             FEINBERG  63 RVUE                       7/66
M           (3.0)  OR LESS             ALLCOCK   65 RVUE                       7/66
M           (2.5)  OR LESS             BARDON    65 ASPK
M           (2.8)  OR LESS  CL=.90     SHAFER    65 CNTR                       5/71
M           (1.6)  OR LESS  CL=.90     BOOTH     67 CNTR                       3/66
M           (2.2)  OR LESS  CL=.90     HYMAN     67 HEBC    O, K- HE          11/67
M   B M     (1.2)  OR LESS  CL=.90     BACKENSTO 71 CNTR    M**2=-1.28+-1.24 10/71
M   S       (1.15) OR LESS  CL=.90     SHRUM     71 CNTR    M**2=-1.35+-1.14 12/71
M   B M     (1.15) OR LESS  CL=.90     BACKENSTO 73 CNTR    M**2=-3.29+-0.90  1/73
M           (0.65) OR LESS  CL=.90     CLARK     74 ASPK    KMU3 DECAY        7/74
M           (0.57) OR LESS  CL=.90     DAUM      79 SPEC    M**2= 0.13+-0.14 10/81*
M     L      0.52  OR LESS  CL=.90     LU        80 CNTR    M**2=0.102+-.119  1/81*
M     M  WE CALCULATE UPPER LIMIT AT CL=.90 FROM M**2.                        1/76
M   B    BACKENSTOSS 73 REPLACES BACKENSTOSS 71 AND USES THEIR NEW PI- MASS.  1/73
M   S    SHRUM 71 USES SHAFER 67 PI- MASS VALUE AND CRANE 71 MU MASS VALUE.   1/73
M     L  LU 80 COMBINES DAUM 79 PI+ --> MU+ NUMU MEASUREMENT WITH NEW LU 80   1/82*
M     L  PI- MASS AND REPLACES DAUM 79.                                       1/82*

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                    2  (NU-2) - (ANU-2) MASS DIFF. (MEV)

        TEST OF CPT FOR A DIRAC NEUTRINO

DM              (0.45) OR LESS  CL=.90    CLARK      74 ASPK KMU3 DECAY       11/75

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                    2  NU-2 MEAN LIFE/MASS  (UNITS SEC/EV)

T     B    0 (3. E-3) CR MORE  CL=.90    BELLOTTI  76 HLBC NU, CERN GGM        1/78
T     B    1 (1.3E-2) CR MORE  CL=.90    BELLOTTI  76 HLBC ANTINU, CERN GGM    1/78
T     B    0 (2.2E-3) CR MORE  CL=.90    BARNES    77 DBC  NU, ANL 12FT.       1/78
T     B    0 (1.0E-2) CR MORE  CL=.90    BLIETSCHA 78 HLBC NU-MU CERN GGM      1/82*
T     B    0 (1.7E-2) CR MORE  CL=.90    BLIETSCHA 78 HLBC ANU-MU CERN GGM     1/82*
T     B    0    0.11  CR MORE  CL=.90    FRANK     81 CNTR NU, ANU LAMPF       1/82*
T     B  THESE EXPERIMENTS LOOK FOR NU(MU) --> NU(E)+GAMMA OR ANU(MU) -->      1/78
T     B  ANU(E)+GAMMA.                                                        1/78

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                    2  C - (NU-2 VELOCITY): ABS((V-C)/C) (UNITS 10**-6)
                         EXPECTED TO BE ZERO FOR MASSLESS NEUTRINO

V        77   (2.0)  OR LESS  CL=.99   ALSPECTOR 76 SPEC >50GEV NU             1/78
V        26   (4.0)  OR LESS  CL=.99   ALSPECTOR 76 SPEC <50GEV NU             1/78
V      9800   (0.4)  OR LESS  CL=.95   KALBFLEIS 79 SPEC                      12/79

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                    2  NU-2 MAGNETIC MOMENT  (UNITS EV/GAUSS)

        MUST VANISH FOR MAJORANA NEUTRINO OR PURELY CHIRAL MASSLESS
        DIRAC NEUTRINO

MM   K      (4.7 E-17)OR LESS           KIM        74                          1/82*
MM   K   KIM 74 IS A THEORETICAL ANALYSIS OF ANTINU-MU REACTION DATA.          1/82*

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REFERENCES FOR NU-MU

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BARKAS   56 PR 101  778        W H BARKAS,W BIRNBAUM,F M SMITH          (LRL)
DUDZIAK  59 PR 114  336        W F DUDZIAK,R SAGANE,J VEDDER            (LRL)
FEINBERG 63 ARNS 13 431        G FEINBERG, L M LEDERMAN            (COLUMBIA)
ALLCOCK  65 PPSL  85  875      G R ALLCOCK                        (LIVERPOOL)
BARDON   65 PRL  14 449        BARDON,NORTON,PEOPLES +  (COLU+STONY BROOK)

SHAFER   65 PRL  14 923        R F SHAFER,CROWE,JENKINS                 (LRL)
BOOTH    67 PL 26B  39         BOOTH,JOHNSON,WILLIAMS,WORMALD  (LIVERPOOL)
HYMAN    67 PL 25B 376         +LOKEN,PEWITT,MCKENZIE+        (ANL+CARN+NWES)
BACKENST 71 PL 36B 403         BACKENSTOSS,DANIEL,KOCH+    (CERN,KARL,HEID)
SHRUM    71 PL 37B 114         E V SHRUM,K O H ZIOCK     (UNIV OF VIRGINIA)
BACKENST 73 PL 43B 539         BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)

CLARK    74 PR D9 533          +ELIOFF,FRISCH,JOHNSON,KERTH,SHEN +      (LBL)
KIM      74 PR D9 3050         J.E.KIM,V.S.MATHER,S.OKUBO               (ROCH)
ALSPECTO 76 PRL 36 837         ALSPECTOR +          (BNL+PURD+CIT+FNAL+ROCK)
BELLOTTI 76 LNC 17 553         +CAVALLI,FIORINI,ROLLIER                 (MILA)
BARNES   77 PRL 38 1049        +CARMONY,DAUWE,FERNANDEZ +           (PURD+ANL)
BLIETSCH 78 NP B133 205        BLIETSCHAU+(AACH+LIBH+CERN+EPOL+MILA+ORSA+)

KALBFLEI 79 PRL 43 1361        KALBFLEISCH,BAGGETT,FOWLER+(FNAL+PURO+BELL)
DAUM     79 PR D20 2692        +EATON,FROSCH,HIRSCHMANN,MCCULLOCH+      (SIN)
    ALSO 76 PL 60B 380         DAUM,DUBAL,EATON,FROSCH,MCCULLOCH+(SIN+ETH)
    ALSO 78 PL 74B 126         DAUM,EATON,FROSCH,HIRSCHMANN,+           (SIN)
LU       80 PRL 45 1066        +DELKER,DUGAN,WU,CAFFREY+     (YALE+COLU+JHU)
FRANK    81 PRD 24 2001        +BURMAN+ (LASL+YALE+MIT+SACL+SIN+CNRC+BERN)

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              4  MUON(106,J=1/2)
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              4  MUON MASS (MEV)

M          (105.659)  (0.002)           FEINBERG  63 RVUE
M          (105.6599) (0.0014)          TAYLOR    69 RVUE    USING NEW E/H     7/70
M    C     (105.6597) (0.0005)          CRANE     71 CNTR INCLUDED IN COHEN73  1/73
M    D     (105.6594) (0.0004)          CROWE     72 CNTR INCLUDED IN COHEN73  2/72
M           105.65948  0.00035          COHEN     73 RVUE                      3/74
M    A      105.65945  0.00033          CASPERSON 77 CNTR +                   12/77
M    K      105.65933  0.00029          KLEMPT    82 CNTR +                    2/82*
M    C  CRANE 71 GIVES MU/ME=206.76879(85).  WE USE ME=.5110041(16)MEV.        1/73
M    D  CROWE 72 GIVES MU/ME=206.7682(5) AND USES ME=.5110041(16)MEV.          1/73
M    A  CASPERSON 77 GIVES MU/ME=206.76859(29).  WE USE ME=.5110034(14)MEV.  12/77
M    K  KLEMPT 82 GIVES MU/ME=206.76835(11).  WE USE ME=.5110034(14)MEV.       2/82*
M           . . . . . . . . . .
M    AVG    105.65943  0.00018  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT    105.65943  0.00018 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

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              4  MUON MEAN LIFE (UNITS 10**-6 SEC)

T            2.198     0.001     0.001    FARLEY    62 CNTR
T            2.203     0.004              LUNDY     62 CNTR    CONLEV=.98      11/67
T            2.202     0.003     0.003    ECKHAUSE  63 CNTR
T            2.197     0.005     0.012    MEYER     63 CNTR +
T            2.198     0.002     0.002    MEYER     63 CNTR -                  7/56
T    W      (2.20926)(0.00081)            WILLIAMS  72 CNTR +                  2/76
T            2.1973    0.0003             DUCLOS    73 CNTR +                  1/76
T            2.19711   0.00008            BALANDIN  74 CNTR +                  1/76
T            2.1948    0.0010             BAILEY2   77 CNTR -  STORAGE RINGS   2/79
T            2.1966    0.0020             BAILEY2   77 CNTR +  STORAGE RINGS   2/79
T           (2.19710)(0.00022)            ZAVATTINI 80 CNTR -  PRELIMINARY-CONF 4/82*
T            2.197187  0.000121           BARDIN    81 CNTR +                  1/82*
T    W  WILLIAMS 72 MEAN LIFE MEASUREMENT WAS NOT THE PRIMARY PURPOSE OF       1/76
T    W  THEIR EXPERIMENT AND DISAGREES STRONGLY WITH LATER EXP'S. NOT AVGD.    1/76
T            . . . . . . . . . .
T    AVG     2.197138 0.000065 0.000065 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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              4  MU+/MU- MEAN LIFE RATIO

DT           1.000     0.001             MEYER     63 CNTR  MEAN LIFE MU+/MU-  7/66
DT           1.0008    0.0010            BAILEY    79 CNTR    STORAGE RING     7/79
DT          (1.00001) (0.00011)          ZAVATTINI 80 CNTR -  PRELIMINARY-CONF 4/82*
DT           . . . . . . . . . .
DT   AVG     1.00040   0.00071  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              4  MUON ANOMALOUS MAGN. MOMENT (10**-6*E/(2*MU MASS))

MM       FOR REVIEWS OF THEORY AND EXPERIMENTS, SEE FARLEY 79, KINOSHITA 78,
MM       CALMET 77, COMBLEY 74, LAUTRUP 72, AND RICH 72.
MM        (1162.0)    (5.0)              CHARPAK   62 CNTR +
MM   B    (1165.75)   (0.71)             BAILEY    68 CNTR +  STOR. RINGS      5/69
MM   B    (1166.25)   (0.24)             BAILEY    68 CNTR -  STOR. RINGS      5/69
MM   B     ERRORS STATISTICAL. VALUES COMBINED TO GIVE MU+- VALUE BELOW        5/69
MM         1165.16     0.31              BAILEY    68 CNTR +- STOR. RINGS      5/69
MM         1060.       +7.               HENRY     69 CNTR +                   1/77
MM   IA   (1165.855)  (0.027)            BAILEY    75 CNTR +  STORAGE RING    11/75
MM   IA   (1165.922)  (0.009)            BAILEY    77 CNTR +- STORAGE RING    11/77
MM   I    (1165.911)  (0.011)            BAILEY    79 CNTR +  STORAGE RING     7/79
MM   I    (1165.937)  (0.012)            BAILEY    79 CNTR -  STORAGE RING     7/79
MM   I     1165.924    0.0085            BAILEY    79 CNTR +- STORAGE RING     7/79
MM   A  BAILEY 77 INCLUDES RESULTS OF BAILEY 75.                              11/77
MM   I  BAILEY 79 IS FINAL RESULT. INCLUDES BAILEY 75 AND 77 DATA.             7/79
MM   I  THIRD BAILEY 79 RESULT IS FIRST TWO COMBINED.                          7/79
MM          . . . . . . . . . .
MM   AVG   1165.9242   0.0085  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              4  MUON ELECTRIC DIPOLE MOMENT (UNITS 10**-19 E-CM)

                 FORBIDDEN BY BOTH T INVARIANCE AND P INVARIANCE

EDM B       (5.6)      (4.5)             BAILEY    78 CNTR +  STORAGE RINGS    2/79
EDM B       (3.4)      (4.3)             BAILEY    78 CNTR -  STORAGE RINGS    2/79
EDM  B       3.7        3.4              BAILEY    78 CNTR +- STORAGE RING     2/79
EDM  B  BAILEY 78 YIELDS EDM < 1.05*10**-18 WITH CL=.95.  THIRD RESULT IS      2/79
EDM  B  FIRST TWO COMBINED ASSUMING CPT.                                       2/79

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              4  MUON TO PROTON MAGNETIC MOMENT RATIO

MMR      THIS RATIO IS USED TO OBTAIN PRECISE VALUES OF THE MUON MASS.         3/72
MMR      SEE CROWE 72.                                                         3/72
MMR        (3.1865) (0.0022)            COFFIN    58 CNTR +  SPIN RESONANCE    2/72
MMR        (3.1830) (0.0011)            LUNDY     58 CNTR +  PRECESSION STROB  2/72
MMR        (3.176)  (0.013)             LUNDY     58 CNTR -  PRECESSION STROB  2/72
MMR        (3.1834) (0.0002)            GARWIN    60 CNTR +  PRECESSION PHASE  2/72
MMR        (3.18336)(0.00007)           BINGHAM   63 CNTR +  PRECESSION STROB  2/72
MMR        (3.1808) (0.0004)            BINGHAM   63 CNTR -  PRECESSION STROB  2/72
MMR        (3.18338)(0.00004)           HUTCHINS  63 CNTR +  PRECESSION PHASE  2/72
MMR D      (3.183351 0.000016)          EHRLICH   69 CNTR    HFS SPLITTING     2/72
MMR C      (3.183314 0.000034)          THOMPSON  69 CNTR    HFS SPLITTING     2/72
MMR        (3.183330 0.000044)          HUTCHINS  70 CNTR +  PRECESSION PHASE  2/72
MMR H      (3.183347 0.000009)          HAGUE     70 CNTR +  PRECESSION PHASE  2/72
MMR  C     (3.183336 0.000013)          CRANE     71 CNTR    HFS SPLITTING     2/72
MMR  D     (3.183349 0.000015)          DEVOE     71 CNTR    HFS SPLITTING     1/73
MMR F      (3.183326 0.000013)          FAVART    71 CNTR    HFS SPLITTING     2/72
MMR  H     (3.1833467 .0000082)         CROWE     72 CNTR +  PRECESSION PHASE  2/72
MMR  R  THE RESULTS THROUGH 1972 ARE INCLUDED IN COHEN 73.                     3/74
MMR  R      3.1833402 .0000072          COHEN     73 RVUE                      3/74
MMR E      (3.1833299 .0000025)         CASPERSON 75 CNTR                      2/76
MMR         3.1833403 .0000044          CASPERSON 77 CNTR +  HFS SPLITTING    12/77
MMR        (3.1833448 .0000029)         CAMANI    78 CNTR +  REPL.BY KLEMPT82  7/79
MMR         3.1833441 .0000017          KLEMPT    82 CNTR +  PRECESSION STROB  2/82*
MMR  D  DEVOE 71 SUPERCEDES EHRLICH 69.  THIS IS NOT A DIRECT MEASUREMENT.     1/73
MMR  D  WE GIVE A NEW VALUE WHICH CONTAINS A THEORETICAL CORRECTION OF         1/73
MMR  D  -7.9+-2.3 PPM, AS DISCUSSED IN FOOTNOTE 35A OF CROWE 72.               1/73
MMR C   CRANE 71 SUPERSEDES THOMPSON 69. THIS IS NOT A DIRECT MEASUREMENT.     1/73
MMR H   CROWE 72 SUPERSEDES HAGUE 70.
MMR F   FAVART 71 ASSUMES A ZERO VALUE FOR THE PROTON POLARIZABILITY.          1/73
MMR  E  USES INCORRECT THEO. EXPRESSION FOR NU(HFS). SEE KLEMPT 82, TBL.XI.    2/82*
MMR         . . . . . . . . . .
MMR AVG     3.1833434 .0000015  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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              4  MUON PARTIAL DECA  MODES

                                                                   DECAY MASSES
P1       MUON INTO E ANUE NUMU                                     .5+  0+   0
P2       MUON INTO E ANUE NUMU GAMMA                               .5+  0+   0+   0
P3       MUON INTO E NUE ANUMU                                     .5+  0+   0
P4       MUON INTO E GAMMA                                         .5+  0
P5       MUON INTO 3ELECTRONS                                      .5+  .5+  .5
P6       MUON INTO E 2GAMMA                                        .5+  0+   0

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              4  MUON BRANCHING RATIOS

R1       MUON INTO (E ANUE NUMU GAMMA)/TOTAL                  (P2)
R1        27 EVENTS SEEN                  ASHKIN    59 CNTR                    1/78
R1              1.4E-2   0.4E-2           CRITTENDE 61 CNTR T(GAM) GT 10 MEV   1/78
R1             (3.3E-3) (1.3E-3)          CRITTENDE 61 CNTR T(GAM) GT 20 MEV   1/78
R1       862 EVENTS SEEN                  BOGART    67 CNTR T(GAM) GT 14.5 MEV 1/78

R2       MUON+ INTO (E+ ANUE NUMU)/TOTAL                      (P3)
R2        FORBIDDEN BY ADDITIVE CONSERVATION LAW FOR MUON NUMBER.
R2        MULTIPLICATIVE LAW PREDICTS THIS BRANCHING RATIO TO BE 1/2.
R2        FOR A RECENT REVIEW SEE NEMETHY 81.
R2            (0.25) OR LESS  CL=.90      EICHTEN   73 HLBC +                 11/75
R2            (0.13)    (0.15)            BLIETSCHA 78 HLBC +- AVG. OF 4 VALUES 1/82*
R2    A        0.09  OR LESS  CL=.90      JONKER    80 CALO CERN SPS NU,ANUE E- 2/82*
R2           (-0.001)  (0.061)            WILLIS    80 CNTR +                  8/81*
R2    A  JONKER 80 GIVES LIMIT ON INVERSE MUON DECAY CROSS SECTION RATIO       2/82*
R2    A  SIGMA(ANUMU E- --> MU- ANUE) / SIGMA(NUMU E- --> MU- NUE), WHICH      2/82*
R2    A  IS ESSENTIALLY EQUIVALENT TO R2 FOR SMALL VALUES LIKE THAT QUOTED.    2/82*

R3       MUON INTO (E GAMMA)/TOTAL (UNITS 10**-8)             (P4)
R3        FORBIDDEN BY LEPTON FLAVOR CONSERVATION
R3            (4.3)  OR LESS  CL=.90      FRANKEL1  63 OSPK
R3            (2.2)  OR LESS  CL=.90      PARKER    64 CSPK
R3            (2.9)  OR LESS  CL=.90      KORENCH1  71 OSPK +  DUBNA          10/71
R3            (0.36) OR LESS  CL=.90      DEPOMMIER 77 CNTR +  TRIUMF         12/77
R3            (0.11) OR LESS  CL=.90      POVEL     77 ELEC REPL. BY SCHAAF 80 1/79
R3             0.019 OR LESS  CL=.90      BOWMAN    79 SPEC +  LAMPF           7/79
R3            (0.10) OR LESS  CL=.90      SCHAAF    80 ELEC +  SIN             3/82*

R4       MUON INTO (3ELECTRONS)/TOTAL (UNITS 10**-7)          (P5)
R4        FORBIDDEN BY LEPTON FLAVOR CONSERVATION
R4 F          (5.0)  OR LESS  CL=.90      PARKER    62 CNTR
R4 F          (1.3)  OR LESS  CL=.90      ALIKHANOV 62 OSPK
R4 F          (1.5)  OR LESS  CL=.90      FRANKEL2  63 CNTR
R4 F          (1.2)  OR LESS  CL=.90      BABAEV    63 OSPK
R4 K          (0.062)OR LESS  CL=.90      KORENCH2  71 CSPK    DUBNA           2/72
R4 K           0.019 OR LESS  CL=.90      KORENCHEN 76 SPEC +  DUBNA           6/77
R4 F      FOUR ABOVE EXPERIMENTS EVALUATED UPPER LIMITS ASSUMING A SECOND
R4 F      ORDER V-A NEUTRINO LOOP DIAGRAM. LIMITS NOT SIGNIFICANTLY CHANGED
R4 F      BY ASSUMING A CONSTANT MATRIX ELEMENT.
R4 K      THESE EXPERIMENTS ASSUME A CONSTANT MATRIX ELEMENT.                 10/77

R5       MUON INTO (E 2GAMMA)/TOTAL (UNITS 10**-5)            (P6)
R5        FORBIDDEN BY LEPTON FLAVOR CONSERVATION
R5            (1.6)  OR LESS  CL=.90      FRANKEL1  63 OSPK +
R5 P          (0.4)  OR LESS  CL=.90      POUTISSOU 74 CNTR +  CBL            12/75
R5    A        0.005 OR LESS  CL=.90      BOWMAN    78 CNTR DEPOMMIER 77 DATA  4/82*
R5 P      POUTISSOU 74 LIMIT APPLIES TO SUM OF ALL NEUTRINOLESS MU+ DECAYS.    1/76
R5    A  BOWMAN 78 ASSUMES INT. LAGRANG. LOCAL ON SCALE OF INVERSE MU MASS.    4/82*

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              4  LIMIT ON MUON --> ELECTRON CONVERSION

        FORBIDDEN BY LEPTON FLAVOR CONSERVATION

RE       (MU- SULFUR32 --> E- SULFUR32)/(MU-SULFUR32    NUMU PHOSPHORUS32*)
RE       CROSS SECTION RATIO
RE          (4. E-10)OR LESS  CL=.90      BADERTSCH 77  HC      SIN            1/82*
RE          (2.7E-10)OR LESS  CL=.90      BADERTSCH 80  HC      SIN            1/82*

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              4  LIMIT ON MUON --> POSITRON CONVERSION

        FORBIDDEN BY LEPTON FLAVOR CONSERVATION

RP1      (MU- SULFUR32 --> E+ SILICON32*)/(MU-SULF32 --> NUMU PHOSPHORUS32*)
RP1         (1.5E-9) OR LESS  CL=.90      BADERTSCH 78 STRC     SIN            1/82*
RP1         (0.9E-9) OR LESS  CL=.90      BADERTSCH 80 STRC     SIN            1/82*

RP2      (MU- IODINE127 --> E+ ANTIMONY127*)/(M   IODINE127 --> ANYTHING)      4/82*
RP2   A       (0.3E-9) OR LESS  CL=.90    ABELA     80 CNTR RADIOCHEMICAL TECH. 4/82*
RP2   A  ABELA 80 IS UPPER LIMIT FOR MU- E+ CONVERSION LEADING TO PARTICLE-    4/82*
RP2   A  STABLE STATES OF SB127. LIMIT FOR TOTAL CONVERSION RATE IS HIGHER     4/82*
RP2   A  BY AN UNKNOWN FACTOR.                                                 4/82*

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              4  MUON DECAY PARAMETERS

        RELATED TEXT SECTION VI A


RHO      RHO PARAMETER                   (V-A THEORY PREDICTS RHO=0.75)
RHO C         (0.741)  (0.027)            DUDZIAK   59 CNTR +  20-53 MEV E+   10/69
RHO  P9213     0.745    0.025             PLANO     60 HBC  +  WHOLE SPECTRUM 10/69
RHO  P  TWO PARAMETER FIT TO RHO AND ETA.
RHO C 2276    (0.751)  (0.034)            BLOCK     62 HEBC -  WHOLE SPECTRUM 10/69
RHO D         (0.64)   (0.04)             BARLOW    64 CNTR -  WHOLE SPECTRUM 10/69
RHO D         (0.661)  (0.016)            BARLOW    64 CNTR +  WHOLE SPECTRUM 10/69
RHO D         (0.867)  (0.035)            PONTECORV 64 CC   -                 10/69
RHO D   RESULTS IN DOUBT.                                                     10/69
RHO C 800K    (0.7503) (0.0026)           PEOPLES   66 ASPK +  20-53 MEV E+   10/69
RHO C 280K    (0.760)  (0.009)            SHERWOOD  67 ASPK +  25-53 MEV E+   10/69
RHO C 170K    (0.762)  (0.008)            FRYBERGER 68 ASPK +  25-53 MEV E+   10/69
RHO C   ETA CONSTRAINED =0. THESE VALUES INCORPORATED INTO A TWO PARAMETER
RHO C   FIT TO RHO AND ETA BY DERENZO 69.
RHO            0.7518   0.0026            DERENZO   69 RVUE                   10/69
RHO           . . . . . . . . . .
RHO AVG        0.7517   0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

ETA      ETA PARAMETER                   (V-A THEORY PREDICTS ETA=0)
ETA P 9213  (-2.0)     (0.9)              PLANO     60 HBC  +  WHOLE SPECTRUM 10/69
ETA P   TWO PARAMETER FIT TO RHO AND ETA- PLANO 60 DISCOUNTS VALUE FOR ETA    10/69
ETA C 800K  (0.05)     (0.5)              PEOPLES   66 ASPK +  20-53 MEV E+   10/69
ETA C 280K  (-0.7)     (0.6)              SHERWOOD  67 ASPK +  25-53 MEV E+   10/69
ETA C 170K  (-0.7)     (0.5)              FRYBERGER 68 ASPK +  25-53 MEV E+   10/69
ETA C   RHO CONSTRAINED =0.75.
ETA   6346   -0.12      0.21              DERENZO   69 HBC  +  1.6-6.8 MEV E+ 10/69
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KSI     (KSI PARAMETER)*(MUON LONGITUDINAL POLARIZATION)
KSI                                   (V-A THEORY PREDICTS KSI=1, LONG.POL.=1)
KSI      9K     0.97      0.05         BARDON    59 CNTR    BROMOFORM TARGET 10/69
KSI    8354     0.93      0.06         PLANO     60 HBC  +  8.8 KGAUSS       10/69
KSI A          (0.903)   (0.027)       ALT-ZADE  61 EMUL +  27 KGAUSS        10/69
KSI A   DEPOLARIZATION BY MEDIUM NOT KNOWN SUFFICIENTLY WELL.
KSI     66K    (0.975)   (0.030)       GUREVICH  64 EMUL REPL.BY AKHMANOV 68 10/69
KSI             0.975     0.015        AKHMANOV  68 EMUL     140 KGAUSS        9/81*
KSI             . . . . . . . . . .
KSI AVG         0.972     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DEL     DELTA PARAMETER                (V-A THEORY PREDICTS DELTA=0.75)
DEL    8354     0.78      0.05         PLANO     60 HBC  +  WHOLE SPECTRUM   10/69
DEL             0.782     0.031        KRUGER    61                          10/69
DEL    490K     0.752     0.009        FRYBERGER 68 ASPK +  25-53 MEV E+     10/69
DEL      VOSSLER 69 HAS MEASURED THE ASYMMETRY BELOW 10 MEV                  11/69
DEL             . . . . . . . . . .
DEL AVG         0.7551    0.0085  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

HEL     HELICITY OF DECAY ELECTRON.
HEL      (V-A THEORY PREDICTS HELICITY=+-1 FOR E+-, RESPECTIVELY)
HEL      WE HAVE FLIPPED THE SIGN FOR E- SO OUR PROGRAMS CAN AVERAGE
HEL D          (0.28)    (0.16)        DICK      63 CNTR +  ANNIHILATION     10/69
HEL D   IN DOUBT- POSITRONS POSSIBLY DEPOLARIZED IN BE MODERATOR.
HEL             1.05      0.30         BUHLER    63 CNTR +  ANNIHILATION     10/69
HEL             0.94      0.38         BLOOM     64 CNTR +  BREMS TRANSMISS  10/69
HEL             1.04      0.18         DUCLOS    64 CNTR +  BHABHA SCATT     10/69
HEL     29K     0.89      0.29         SCHWARTZ  67 OSPK  - MOLLER SCATT     10/69
HEL    500K     1.010     0.064        CORRIVEAU 81 CNTR +  BHABHA + ANNIHIL  1/82*
HEL             . . . . . . . . . .
HEL AVG         1.009     0.057   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

GS      SCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GS             (0.33) OR LESS          DERENZO   69 RVUE                     10/69

GA      AXIAL VECTOR COUPLING CONSTANT IN MUON DECAY (IN UNITS OF GV)
GA              0.86      0.33    0.11 DERENZO   69 RVUE                     10/69

FAV     PHASE BETWEEN VECTOR AND AXIAL VECTOR COUPLINGS  (DEGREES)
FAV        180.       15.              DERENZO   69 RVUE                     10/69

GT      TENSOR COUPLING CONSTANT IN MUON DECAY    (IN UNITS OF GV)
GT             (0.28) OR LESS          DERENZO   69 RVUE                     10/69

GP      PSEUDOSCALAR COUPLING CONSTANT IN MUON DECAY  (IN UNITS OF GV)
GP             (0.33) OR LESS          DERENZO   69 RVUE                     10/69

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REFERENCES FOR MUON


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COFFIN   58 PR 109 973          +GARWIN,PENMAN,LEDERMAN,SACHS     (COLUMBIA)
LUNDY    58 PRL 1 38            +SENS,SWANSON,TELEGDI,YOVANOVITCH (CHICAGO)
ASHKIN   59 NC 14 1266          +FAZZINI,FIDECARO,LIPMAN,MERRISON +  (CERN)
BARDON   59 PRL   2   56        M BARDON, D BERLEY, L LEDERMAN    (COLUMBIA)
DUDZIAK  59 PR  114  336        W DUDZIAK,R SAGANE, J VEDDER          (LRL)
GARWIN   60 PR 118 271          GARWIN,HUTCHINSON,PENMAN,SHAPIRO (COLUMBIA)
PLANO    60 PR  119 1400        R J PLANO                         (COLUMBIA)

ALI-ZADE 61 JETP  13  313       ALI-ZADE,GUREVICH,NIKOLSKI            (USSR)
CRITTEND 61 PR 121 1823         CRITTENDEN,WALKER,BALLAM          (MSU+MICH)
KRUGER   61 UCRL-9322 (UNPUB)   H KRUGER                              (LRL)
ALIKHANO 62 CERN CONF 423       A I ALIKHANOV,A BABAEV +       (ITEP MOSCOW)
BLOCK    62 NC   23  1114       BLOCK,FIORINI,KIKUCHI+(DUKE,BOLOGNA,MILANO)
CHARPAK  62 PL    1  16         G CHARPAK,F J M FARLEY,R L GARWIN +  (CERN)
FARLEY   62 CERN CONF 415       FARLEY,MASSAM,MULLER,ZICHICHI        (CERN)

LUNDY    62 PR 125 1686         RICHARD A LUNDY                       (EFI)
PARKER   62 NC  23  485         S PARKER,S PENMAN                     (EFI)
BABAEV   63 JETP 16 1397        BABAEV,BALATS,KAFTANOV,LANDSBERG +   (ITEP)
BINGHAM  63 NC 27 1352          G.MCD.BINGHAM                         (LRL)
BUHLER   63 PL    7  368        +CABIBBO,FIDECARO,MASSAM,MULLER+     (CERN)
DICK     63 PL    7  150        DICK,FEUVRAIS,SPIGHEL                (CERN)

ECKHAUSE 63 PR 132  422         M ECKHAUSE,T A FILIPPAS +        (CARNEGIE)
FEINBERG 63 ARNS 13 431         GERALD FEINBERG, L M LEDERMAN     (COLUMBIA)
FRANKEL1 63 NC  27  994         S FRANKEL,W FRATI,J HALPERN +        (PENN)
FRANKEL2 63 PR 130  351         S FRANKEL,W FRATI,J HALPERN +        (PENN)
HUTCHINS 63 PR 131 1351         HUTCHINSON,MENES,PATLACH,SHAPIRO (COLUMBIA)
MEYER    63 PR  132  2693       S L MEYER,ANDERSON,BLESER,LEDERMAN+  (COLU)

BARLOW   64 PPS   84  239       +BOOTH,CARROL,COURT,DAVIES,EDWARDS-  (LIVP)
BLOOM    64 PL    8   87        +DICK,FEUVRAIS,HENRY,MACQ,SPIGHEL    (CERN)
DUCLOS   64 PL    9   62        +HEINTZE,DE RUJULA,SOERGEL           (CERN)
GUREVICH 64 PL   11  195        GUREVICH,MAKARIYNA+                  (KIAE)
PONTECOR 64 DUBNA CONF          PONTECORVO,SULYAEV                 (MOSCOW)
PARKER   64 PR 133B 768         S PARKER,H L ANDERSON,C REY           (EFI)

PEOPLES  66 NEVIS-147 (UNPUB)   J PEOPLES                         (COLUMBIA)
BOGART   67 PR 156 1405         +DICAPUA,NEMETHY,STRELZOFF           (COLU)
SCHWARTZ 67 PR  162 1306        D M SCHWARTZ                          (EFI)
SHERWOOD 67 PR  156 1475        B A SHERWOOD                          (EFI)
AKHMANOV 68 SJNP 6 230          +GUREVICH,DOBRETSOV,MAKARINA+        (KIAE)
BAILEY   68 PL    28B  287      +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
   ALSO  72 NC 9A 369           +BARTL,VON BOCHMANN,BROWN,FARLEY+    (CERN)
FRYBERGE 68 PR  166 1379        D FRYBERGER                           (EFI)

DERENZO  69 PR  181 1854        S DERENZO                             (EFI)
EHRLICH  69 PRL 23 513          +HOFER,MAGNON,STOWELL,SWANSON+    (CHICAGO)
HENRY    69 NC 63A 955          +SCHRANK,SWANSON             (STAN+UCSB+UCSD)
TAYLOR   69 RMP 41 375          +PARKER,LANGENBERG           (PRIN+UCI+PENN)
THOMPSON 69 PRL 22 163          +AMATO,CRANE,HUGHES,MOBLEY+          (YALE)
HAGUE    70 PRL 25 628          +ROTHBERG,SCHENCK,WILLIAMS+     (WASH+LRL)
HUTCHINS 70 PRL 24 1254         HUTCHINSON,LARSON,SCHOEN,SOBER,+     (PPA)

CRANE    71 PRL 27 474          +CASPERSON,CRANE,EGAN,HUGHES+        (YALE)
DEVOE    71 PRL 25 1779(ER)     +MCINTGRE,MAGNON,STOWELL,SWANSON+ (CHICAGO)
   ALSO  71 PRL 26 213          DEVOE,MCINTGRE,MAGNON,STOWELL+    (CHICAGO)
FAVART   71 PRL 27 1336         +MCINTYRE,STOWELL,TELEGDI,DEVOE+  (CHICAGO)
KORENCH1 71 SJNP 13 190         KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)
KORENCH2 71 SJNP 13 728         KORENCHENKO,KOSTIN,MICELMACHER+      (JINR)

CROWE    72 PR D5 2145          +HAGUE,ROTHBERG,SCHENCK+        (LBL+WASH)
WILLIAMS 72 PR D6 737           R W WILLIAMS,D L WILLIAMS      (WASHINGTON)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DUCLOS   73 PL 47B 491          +MAGNON,PICARD                       (SACL)
FICHTEN  73 PL 46B 281          +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LAL+ORSA+TUBI)

BALANDIN 74 JETP 40 811         +GREBENYUK,ZINOV,KONIN,PONOMAREV     (JINR)
POUTISSO 74 NP B80 221          POUTISSOU,FELAWKA,INGRAM +       (MONT+BRIT)
BAILEY   75 PL 55B 420          +BOREK+(CERN+DARE+BERN+SHEF+MANZ+RMCS+BIRM)
CASPERSO 75 PL 59B 397          CASPERSON,CRANE+ (YALE+LASL+HEID+BERN+WYOM)
KORENCHE 76 JETP 43 1           KORENCHENKO,KOSTIN,MITSELMAKHER+     (JINR)
BADERTSC 77 PRL 39 1385         BADERTSCHER,BORER,CZAPEK,FLUECKIGER+ (BERN)

BAILEY   77 PL 67B 225          +BORER+(CERN+DARE+BERN+SHEF+MANZ+RMCS+BIRM)
      OR 77 PL 68B 191          +BOREK+(CERN+DARE+BERN+SHEF+MANZ+RMCS+BIRM
BAILEY2  77 NATURE 268 301          (DARE+BERN+SHEF+CERN+MANZ+RMCS+BIRM)
   ALSO  79 BAILEY
CASPERSO 77 PRL 38 956          CASPERSON,CRANE+ (BERN+HEID+LASL+WYOM+YALE)
DEPOMMIE 77 PRL 39 1113         DEPOMMIER,MARTIN+(MONT+BRCO+TRIU+VICT+MELB)
POVEL    77 PL 72B 183          +DEY,WALTER,PFEIFFER +         (ZURI+ETH+SIN)

BADERTSC 78 PL 79B 371          BADERTSCHER,BORER,CZAPEK,FLUECKIGER+ (BERN)
BAILEY   78 JPG 4 345               (DARE+BERN+SHEF+MANZ+RMCS+CERN+BIRM)
   ALSO  79 BAILEY
BLIETSCH 78 NP B133 205         BLIETSCHAU+(AACH+LIBH+CERN+EPOL+MILA+ORSA+)
BOWMAN   78 PRL 41 442          +CHENG,LI,MATIS             (LASL+TAS+CARN+EFI)
CAMANI   78 PL 77B 326          +GYGAX,KLEMPT,SCHENCK,SCHULZE+     (ETH+MANZ)
BAILEY   79 NP B150 1             (DARE+BERN+SHEF+MANZ+RMCS+CERN+BIRM+LBL+)
BOWMAN   79 PRL 42 556          +COOPER,HAMM,HOFFMAN +        (LASL+EFI+STAN)

ABELA    80 PL 55B 318          +BACKENSTOSS,KOWALD,WUEST +      (BASL+KARL)
BADERTSC 80 LNC 28 401          BADERTSCHER,BORER,CZAPEK,FLUECKIGER+ (BERN)
JONKER   80 PL 93B 203          CHARM COLLAB.      (AMST+[illegible]+HAMB+ITEP+ROMA)
SCHAAF   80 NP A340 249         +ENGFER,POVEL,DEY+             (ZURI+ETH+SIN)
WILLIS   80 PRL 44 522          +HUGHES+ (YALE+LBL+LASL+SACL+SIN+CNRC+BERN)
   ALSO  80 PRL 45 1370         WILLIS+  (YALE+LBL+LASL+SACL+SIN+CNRC+BERN)
ZAVATTIN 80 TRIUMF MU. WKSHP.   E.ZAVATTINI - PROCEEDINGS P.42       (CERN)

BARDIN   81 NP A352 365         +DUCLOS,MAGNON+        (SACL+CERN+BGNA+TRIU)
CORRIVEA 81 PR D24 2004         CORRIVEAU,EGGER,FETSCHER +     (ETH+SIN+MANZ)
NEMETHY  81 CNPP 10 147         P.NEMETHY,V.W.HUGHES               (LBL+YALE)
KLEMPT   82 PR D25 652          +SCHULZE,WOLF,CAMANI,GYGAX          (MANZ+ETH)

                                PAPERS NOT REFERRED TO IN DATA CARDS

FISHER   59 PRL   3  349        FISHER,LEONTIC,LUNDBY,MEUNIER,STROOT (CERN)
ASTBURY  60 ROCH CONF 60 542    ASTBURY,HATTERSLEY,HUSSAIN +    (LIVERPOOL)
DEVONS   60 PRL   5  330        DEVONS,GIDAL,LEDERMAN,SHAPIRO     (COLUMBIA)
LATHROP  60 NC    17 109        J LATHROP,R A LUNDY,V L TELEGDI +     (EFI)
LATHROP  61 NC    17 114        J LATHROP,R A LUNDY,S PENMAN +        (EFI)
REITER   60 PRL    5  22        REITER,ROMANOWSKI,SUTTON +        (CARNEGIE)
TELEGDI  60 ROCH CONF 60 713    V L TELEGDI                          (CERN)

CHARPAK  61 PRL    6 128        CHARPAK,FARLEY,GARWIN,MULLER,SENS +  (CERN)
HUTCHINS 61 PRL    7 129        D P HUTCHINSON,J MENES +          (COLUMBIA)
SHAPIRO  62 PR 125 1022         G SHAPIRO,L M LEDERMAN            (COLUMBIA)
FAIRLEY  66 NC 45A 781          FAIRLEY,BAILEY,BROWN,CIESCH +        (CERN)
VOSSLER  69 NC 63A 423          C VOSSLER                             (EFI)

LAUTRUP  72 PRPL 3 193          B.LAUTRUP,A.PETERMAN,E.DE RAFAEL(CERN+BURE)
RICH     72 RMP 44 250          A RICH,J C WESLEY                    (MICH)
COMBLEY  74 PRPL 14 1           F.COMBLEY,E.PICASSO                  (CERN)
CALMET   77 RMP 49 21           J.CALMET,S.NARISON,M.PERROTTET+      (MARS)
KINOSHIT 78  TOKYO HEP P.571    T. KINOSHITA                         (CORN)
FARLEY   79 ARNPS 29 243        F.J.M.FARLEY,E.PICASSO           (RMCS+CERN)
DEPOMMIE 80 NP A335 97          P.DEPOMMIER                          (MONT)
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                36  NU-TAU(? 1/2)

                EXISTENCE INDIRECTLY ESTABLISHED FROM TAU DECAY DATA
                COMBINED WITH NU REACTION DATA.  SEE FOR EXAMPLE
                FELDMAN 81   KIRKBY 79 RULES OUT J=3/2 USING
                TAU --> PI NUTAU BRANCHING RATIO.

      NOT IN GENERAL A MASS EIGENSTATE.  SEE NOTE ON NEUTRINOS
      IN THE ELECTRON NEUTRINO SECTION ABOVE.

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                36  NU-TAU **MASS** (MEV)

      APPLIES TO NU-3, THE PRIMARY MASS EIGENSTATE IN NU-TAU.  WOULD ALSO
      APPLY TO ANY OTHER NU-J WHICH MIXES STRONGLY IN NU-TAU AND HAS
      SUFFICIENTLY SMALL MASS THAT IT CAN OCCUR IN THE RESPECTIVE DECAYS.
      (THIS WOULD BE NONTRIVIAL ONLY FOR A HYPOTHETICAL J .GE. 4, GIVEN
      THE NU-E AND NU-MU **MASS** LIMITS ABOVE.)

M    P 144 (600.)   OR LESS  CL=.95   PERL      77 SMAG E+E-3.8-7.8GEV ECM  12/77
M         (740.)    OR LESS  CL=.90   BRANDELIK 78 DASP ASSUMES V-A DECAY     3/78
M    B 594  250.    OR LESS  CL=.95   BACINO    79 DLCO E+E- ECM=3.5-7.4GEV   7/79
M           250.    OR LESS  CL=.95   BLOCKER   82 SMKZ E+E- ECM=5.2 GEV      2/82*
M    P  PERL 77 IS E+E- TO TAU+ TAU- EXPT, VALUE QUOTED ASSUMES V-A DECAY  12/77
M    P  AND TAU MASS=1900 MEV.                                              12/77
M    B  BACINO 79 EXPT RULES OUT V+A DECAY, DISFAVORS PURE V OR A, AND IS   7/79
M    B  IN GOOD AGREEMENT WITH V-A.                                          1/82*

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REFERENCES FOR NU-TAU


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PERL     77 PL 70B 487          +FELDMAN,ABRAMS,ALAM,BOYARSKI+   (SLAC+LBL)
BRANDELI 78 PL 73B 109          BRANDELIK +       (AACH+DESY+HAMB+MPIM+TOKY)
BACINO   79 PRL 42 749          +FERGUSON,NODULMAN+     (UCLA+SLAC+UCI+STON)
KIRKBY   79  SLAC-PUB-2419      J.KIRKBY(LEPTON PHOTON SYMP. BATAVIA)(SLAC)J
FELDMAN  81  SLAC-PUB-2839      G.J.FELDMAN(SANTA CRUZ APS 1981)(SLAC+STAN)
BLOCKER  82 PL B (TO BE PUB.)   +DORFAN,ABRAMS,ALAM,BLONDEL+       (LBL+SLAC)
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          35  TAU+-(1785,J=1/2) HEAVY LEPTON

          E+E- --> TAU+TAU- CROSS SECTION THRESHOLD BEHAVIOR
          AND MAGNITUDE CONSISTENT WITH POINTLIKE SPIN 1/2
          DIRAC PARTICLE.  BRANDELIK 78 RULES OUT POINTLIKE
          SPIN 0 OR SPIN 1 PARTICLE.  FELDMAN 78 RULES OUT
          J=3/2.  KIRKBY 79 ALSO RULES OUT J=INTEGER, J=3/2.

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          35  TAU MASS (MEV)

M   P   64(1800.)   (200.)            PERL       75 SMAG    INCL. IN PERL 77  2/78
M   B 220(1910.)    (30.)             BURMEST1   77 PLUT ASSUMES V-A DECAY   12/77
M   P 144(1900.)   (100.)             PERL       77 SMAG E+E- 3.8-7.8GEV ECM 12/77
M   A 692 1783.       3.        4.    BACINO     78 DLCO E+E- 3.1-7.4GEV ECM  2/82*
M   R 299 1787.      10.       18.    BARTEL     78 SPEC E+E- 3.6-4.4GEV ECM  7/79
M         1807.      20.              BRANDELIK  78 DASP E+E- 3.1-5.2GEV ECM  3/78
M         1787.      10.              BLOCKER    80 SMK2 E+E- 3.5-6.7GEV ECM  2/82*
M    1138(1803.)    (16.)             BLOCKER    82 SMK2 INCL. IN BLOCKER 80  2/82*
M
M   B  BURMESTER 77 MASS VALUE ARE FROM EVENTS CONTAINING MU+- PLUS ONE      12/77
M   B  OTHER PRONG, ORIGINATING FROM E+ E- --> TAU+ TAU-. THE MASS           12/77
M   B  VALUES COME FROM A FIT TO THE SHAPE AND ECM DEPENDENCE OF THE         12/77
M   B  MU+- SPECTRA, ASSUMING THAT THE TAU SPIN IS 1/2 AND ITS ASSOC         12/77
M   B  NEUTRINO HAS M=0.                                                     12/77
M
M   P  PERL 77 VALUE COMES FROM E+ E- TO E+- MU-+ AND NO OTHER DETECTED      12/77
M   P  PARTICLES. ASSUMES V-A COUPLING AND ZERO MASS FOR ASSOC NEUTRINO.     12/77
M
M   A  BACINO 78 VALUE COMES FROM E+- X-+ THRESHOLD. PUBLISHED MASS 1782      2/82*
M   A  MEV INCREASED BY 1 MEV USING THE HIGH PRECISION PSI-PRIME MASS         2/82*
M   A  MEASUREMENT OF ZHOLENTZ 80 TO ELIMINATE THE ABSOLUTE SPEAR ENERGY      2/82*
M   A  CALIBRATION UNCERTAINTY.                                               2/82*
M
M   R  BARTEL 78 FITS ENERGY DEPENDENCE OF CS FOR E+- AND MU+- EVENTS.        7/79
M   R  MASS VALUE NOT DEPENDENT ON WHETHER V-A OR V+A DECAY ASSUMED.          7/79
M           . . . . . . . . . .
M  AVG    1784.2        3.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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          35  TAU MEAN LIFE  (UNITS 10**-13 SEC)

T        77  (90.)    OR LESS  CL=.95   ALEXANDER 79 PLUT E+E- 3.9-5 GEV ECM   7/79
T       594  (23.)    OR LESS  CL=.95   BACINO2   79 DLCO E+E- ECM=3.5-7.4GEV  7/79
T        38  (14.)    OR LESS  CL=.95   BRANDELIK 80 TASS E+E- ECM=30GEV       8/81*
T       102    4.6      1.9             FELDMAN   82 SMK2 E+E- ECM=29 GEV      1/82*

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          35  TAU PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      TAU+- INTO MU+- NUMU NUTAU                            105+   0+   0
P2      TAU+- INTO E+- NUE NUTAU                               .5+   0+   0
P7      TAU+- INTO HADRON+- NEUTRAL(S)
P8      TAU+- INTO 3 HADRONS+- NEUTRAL(S)
P9      TAU+- INTO NUTAU RHO0 PI+-                              0+ 769+ 139
P10     TAU+- INTO NUTAU A1(1100)+-                             0+1275
P11     TAU+- INTO K+- NEUTRAL(S)
P12     TAU+- INTO NUTAU PI+-                                   0+ 139
P13     TAU+- INTO NUTAU 2PI+- PI-+ (INCL. P9, P10)             0+ 139+ 139+ 139
P14     TAU+- INTO NUTAU 2PI+- PI-+ (PI0S) (INCL. P13)          0+ 139+ 139+ 139
P15     TAU+- INTO NUTAU .GE.3HADRONS+- NEUTRAL(S)
P16     TAU+- INTO NUTAU RHO+-                                  0  769
P17     TAU+- INTO 3 HADRONS+- NUTAU
P18     TAU+- INTO 3 HADRONS+- NUTAU GAMMA(S)
P19     TAU+- INTO HADRON+- (NOT RHO+-, PI+-) NEUTRAL(S)
P20     TAU+- INTO 5 HADRONS+- NEUTRAL(S)
P21     TAU+- INTO NUTAU K*(892)                                0+ 891
P22     TAU+- INTO NUTAU K*(1430)                               0+1434

        LEPTON NUMBER VIOLATING MODES.
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P31     TAU+- INTO MU+- GAMMA                                 105+   0
P32     TAU+- INTO E+- GAMMA                                   .5+   0
P33     TAU+- INTO MU+- CHARGED PARTICLES
P34     TAU+- INTO E+- CHARGED PARTICLES
P35     TAU+- INTO MU+- MU+ MU-                               105+ 105+ 105
P36     TAU+- INTO E+- MU+ MU-                                 .5+ 105+ 105
P37     TAU+- INTO MU+- E+ E-                                 105+  .5+  .5
P38     TAU+- INTO E+- E+ E-                                   .5+  .5+  .5
P39     TAU+- INTO MU+- PI0                                   105+ 134
P40     TAU+- INTO E+- PI0                                     .5+ 134
P41     TAU+- INTO MU+- K0                                    105+ 497
P42     TAU+- INTO E+- K0                                      .5+ 497
P43     TAU+- INTO MU+- RHO0                                  105+ 769
P44     TAU+- INTO E+- RHO0                                    .5+ 769

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows. The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P12	P16	P17	P18	P19	
P 1	.1848+-.0124							
P 2	-.1212	.1617+-.0099						
P12	.0207	-.1706	.1065+-.0156					
P16	-.1767	-.1722	.0277	.2162+-.0359				
P17	-.0141	-.0106	.0018	.0048	.1338+-.0760			
P18	.0000	-.0000	-.0000	-.0000	-.9213	.1500+-.0700		
P19	-.0844	.0105	-.3174	-.6819	-.2364	.0000	.0470+-.04	3/68

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                 35  TAU BRANCHING RATIOS

R1      TAU+- INTO (MU+- NUMU NUTAU)/TOTAL                      (P1)
R1     220     0.15      0.03              BURMEST1   77 PLUT ASSUMES V-A DECAY   12/77
R1             0.175     0.040             PERL       77 SMAG   E+E- TO MU+- X-+  12/77
R1             0.22      0.10      0.07    CAVALLISF  77 SPEC   E+E- TO MU+- X-+   1/78
R1      11     0.22      0.07      0.08    SMITH      78 SPEC   E+E- TO MU+MU-X0   7/79
R1             0.35      0.14              BRANDELIK  80 TASS   E+E- ECM=30GEV     6/81*
R1             0.178     0.027             BERGER     81 PLUT   E+E- 9-32GEV ECM   1/82*
R1            . . . . . . . . . .
R1  AVG        0.175     0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT        0.185     0.012   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      TAU+- INTO (E+- NUE NUTAU)/TOTAL                        (P2)
R2   B 459     0.160     0.013             BACINO     78 DLCO E+E- ECM=3.1-7.4GEV  1/79
R2             0.19      0.09              BRANDELIK  80 TASS E+E- ECM=30GEV       6/81*
R2   B  BACINO 78 VALUE COMES FROM FIT TO EVENTS WITH E+- AND 1 OTHER              1/79
R2   B  NONELECTRON CHARGED PRONG.                                                 1/79
R2            . . . . . . . . . .
R2  AVG        0.161     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT        0.1617    0.0099 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      TAU+- INTO (L+- NUL NUTAU)/TOTAL                        SQRT(P1*P2)
R3       WHERE L MEANS E OR MU.  EQUALITY OF E AND MU MODES IS ASSUMED.
R3   P 105     0.17      0.06      0.03    PERL       76 SMAG                        3/77
R3   B 144     0.186     0.030             PERL       77 SMAG                       12/77
R3   B  21     0.224     0.055             BARBARO-G  77 SMAG                       11/77
R3   B  13     0.182     0.031             BRANDELIK  78 DASP ASSUMES V-A DECAY      3/78
R3   B  WE HAVE COMBINED STATISTICAL AND SYSTEMATIC ERRORS QUADRATICALLY.            3/78
R3   P  ASSUMES V-A COUPLING, TAU MASS=1.8 GEV, TAU NEUTRINO MASS=0.
R3   B  ASSUMES V-A COUPLING, TAU MASS=1.9 GEV, TAU NEUTRINO MASS=0.
R3            . . . . . . . . . .
R3  AVG        0.186     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT        0.1728    0.0074 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      TAU+- INTO E+- NUE NUTAU/MU+- NUMU NUTAU                (P2)/(P1)
R4       PREDICTED TO BE 1 FOR SEQUENTIAL LEPTON, 2 FOR PARAELECTRON,
R4       AND 1/2 FOR PARAMUON. PARAELECTRON ALSO RULED OUT BY HEILE 78.
R4      21     0.92      0.37              BURMEST2   77 PLUT ASSUMES V-A DECAY   12/77
R4   B  18     1.09      0.38              BRANDELIK  78 DASP E+E- 3.1-5.2GEV ECM 12/78
R4   L 154     0.75      0.23              BLOCKER    82 SMK2 E+E- ECM=3.5-6.7GEV  2/82*
R4   B  BRANDELIK 78 QUOTES THE INVERSE OF THIS RATIO AS .92+-.32 .               12/78
R4   L  BLOCKER 82 GIVES THE INVERSE OF THIS RATIO AS 1.33+-.18+-.36 .             2/82*
R4            . . . . . . . . . .
R4  AVG        0.86      0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  FIT        0.875     0.084   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      TAU+- INTO (MU+- NUMU NUTAU)*(E+- NUE NUTAU)            (P1)*(P2)
R5            (0.034)   (0.006)            ABRAMS     79 SMK2 REPL. BY BLOCKER 82  12/79
R5   B  20     0.034     0.009             BACINO1    79 DLCO E+E- ECM=3.6-7.4GEV  1/79
R5     257     0.030     0.005             BLOCKER    82 SMK2 E+E- ECM=3.5-6.7GEV  2/82*
R5   B  BACINO1 79 QUOTES BR(MU)=0.21+-0.058(STAT.+SYST. ERRORS COMBINED IN        1/79
R5   B  QUADRATURE) ASSUMING BR(E)=0.16.  WE MPY. BY 0.16 TO GET ABOVE VAL.        1/79
R5            . . . . . . . . . .
R5  AVG        0.0309    0.0044  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT        0.0299    0.0025 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      TAU+- INTO (HADRON+- NEUTRAL(S))/(TOTAL)                (P12+P16+P19)    11/77
R8      15     0.45      0.19              BARBARO-G  77 SMAG                       11/77
R8             0.29      0.11              BRANDELIK  78 DASP ASSUMES V-A DECAY      3/78
R8   B        (0.22)    (0.14)             BRANDELIK  80 TASS E+E- ECM=30GEV         6/81*
R8   B  NOT INDEPENDENT OF BRANDELIK 80 R1, R2 AND R21 VALUES.                       6/81*
R8            . . . . . . . . . .
R8  AVG        0.330     0.095   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT        0.370     0.032   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      TAU+- INTO (K+- NEUTRAL(S))/TOTAL                       (P11)
R9   B        SMALL                        BRANDELIK  77 DASP    3.6-5.2ECM E+E      1/78
R9   B  BRANDELIK 77 FINDS 0.07+-0.06 K+- PER EVT IN E+E- --> E+- PRONG-+.           1/78

R10     TAU+- INTO (3 HADRONS+- NEUTRAL(S))/TOTAL               (P17+P18)
R10            0.35      0.11              BRANDELIK  78 DASP ASSUMES V-A DECAY      3/78
R10     35     0.24      0.06              BRANDELIK  80 TASS E+E- ECM=30 GEV        6/81*
R10           . . . . . . . . . .
R10 AVG        0.265     0.053   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 FIT        0.284     0.030   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     TAU+- INTO (NUTAU RHO0 PI+-)/TOTAL                      (P9)
R11     21    (0.0045)  (0.0013)           ALEXAND1   78 PLUT REPL. BY WAGNER 80    3/78
R11     27     0.0054    0.0017            WAGNER     80 PLUT E+E- 4-5 GEV ECM      2/82*

R12     TAU+- INTO (NUTAU A1(1100)+-)/TOTAL                     (P10)
R12     21    (0.10)    (0.03)             ALEXAND1   78 PLUT REPL. BY WAGNER 80   12/78
R12 W   27    (0.108)   (0.034)            WAGNER     80 PLUT E+E- 4-5 GEV ECM      2/82*
R12 W   NOT INDEPENDENT OF WAGNER 80 R11 VALUE ABOVE.  ASSUMES THAT ALL              2/82*
R12 W   (NU RHO0 PI+-) EVENTS ARE (NU A1+-) AND BR(L+- NU NU)=                       2/82*
R12 W   .173+-.013 .                                                                 2/82*

R13     TAU+- INTO (NUTAU 2PI+- PI-+ (PI0S))/TOTAL              (P14)
R13     33     0.18      0.065             JAROS      78 SMAG E+E- ECM > 6 GEV      1/79

R14     TAU+- INTO (NUTAU 2PI+- PI-+)/TOTAL                     (P13)
R14  J  13     0.07      0.05              JAROS      78 SMAG E+E- ECM > 6 GEV      1/79
R14  J  JAROS 78 EVENTS CONSISTENT WITH BEING RHO PI OR A1.                         1/79

R15     TAU+- INTO (NUTAU .GE.3HADRONS+- NEUTRAL(S))            (P17+P18)
R15    692     0.32      0.05              BACINO     78 DLCO E+E- ECM=3.1-7.4GEV  1/79
R15      FOR THE FIT WE ASSUME THAT THIS EQUALS THE BRANCHING FRACTION FOR
R15      (3HADRONS+- NEUTRALS), I.E. THAT THE BRANCHING FRACTION FOR 5 OR
R15      MORE CHARGED HADRONS IS ZERO.
R15           . . . . . . . . . .
R15 FIT        0. -.     0.030   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R16     TAU+- INTO (NUTAU PI+-)*(E+- NUE NUTAU)                 (P12)*(P2)
R16  A  23     0.015     0.006             ALEXAND2   78 PLUT E+E- ECM=3.6-5 GEV    2/79
R16  B  10     0.013     0.006             BACINO1    79 DLCO E+E- ECM=3.6-7.4GEV   1/79
R16  A  ALEXANDER2 78 QUOTE BR(PI)=.090+-.039(STAT.+SYST.ERRORS COMBINED IN          2/79
R16  A  QUADRATURE) USING BR(E)=.167+-.010. WE MPY. BY .167 TO GET ABV.VAL.          2/79
R16  B  BACINO1 79 QUOTES BR(PI)=0.080+-0.035(STAT.+SYST.ERRORS COMBINED IN          1/79
R16  B  QUADRATURE) ASSUMING BR(E)=0.16.  WE MPY. BY 0.16 TO GET ABOVE VAL.          1/79
R16           . . . . . . . . . .
R16 AVG        0.0140    0.0042  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R16 FIT        0.0172    0.0026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R17     TAU+- INTO (NUTAU RHO+-)*(E+- NUTAU NUE)                (P16)*(P2)       12/79
R17           (0.0421)  (0.0092)           ABRAMS     79 SMK2 REPL. BY BLOCKER 80  12/79
R17    139     0.034     0.008             BLOCKER    80 SMK2 E+E- ECM=3.5-6.7GEV   2/82*
R17           . . . . . . . . . .
R17 FIT        0.0350    0.0059 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R18     TAU+- INTO (NUTAU RHO+-)*(MU+- NUTAU NUMU)              (P16)*(P1)       12/79
R18           (0.0329)  (0.0100)           ABRAMS     79 SMK2 REPL. BY BLOCKER 80  12/79
R18    103     0.041     0.009             BLOCKER    80 SMK2 E+E- ECM=3.5-6.7GEV   2/82*
R18           . . . . . . . . . .
R18 FIT        0.0399    0.0067 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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R19      TAU+- INTO (3 HADRONS+- NOTAU)/TOTAL                  (P17)             6/81*
R19 R           (0.09)    (0.16)          BRANDELIK 80 TASS E+E- ECM=30GEV      6/81*
R19 R   NOT INDEPENDENT OF BRANDELIK 80 R19 AND R20 VALUES.                     6/81*
R19             . . . . . . . . . . .
R19 FIT          0.134     0.076  FROM FIT

R20      TAU+- INTO (3 HADRONS+- NOTAU GAMMA(S))/TOTAL         (P18)
R20              0.15      0.07           BRANDELIK 80 TASS E+E- ECM=30GEV      6/81*
R20             . . . . . . . . . . .
R20 FIT          0.159     0.070  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R21      TAU+- INTO (1 CHARGED NEUTRAL(S))/TOTAL               (P1+P2+P12+P16+P19)  6/81*
R21       37     0.76      0.06           BRANDELIK 80 TASS E+E- ECM=30GEV      8/81*
R21             . . . . . . . . . . .
R21 FIT          0.716     0.030  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R22      TAU+- INTO (5 HADRONS+- NEUTRAL(S))/TOTAL             (P20)             6/81*
R22              0.06 OR LESS  CL=.95    BRANDELIK 80 TASS E+E- ECM=30GEV       6/81*

R23      TAU+- INTO (NUTAU K*(892)+-)/TOTAL                    (P21)            12/81*
R23       11     0.017     0.007          DORFAN     81 SMK2 E+E- 4.2-6.7GEV ECM 12/81*

R24      TAU+- INTO (NUTAU K*(1430)+-)/TOTAL                   (P22)            12/81*
R24        0     0.009 OR LESS  CL=.95    DORFAN     81 SMK2 E+E- 4.2-6.7GEV ECM 12/81*

R25      TAU+- INTO (NUTAU PI-)/TOTAL                          (P12)
R25      1138    0.117     0.019          BLOCKER    82 SMK2 E+E- ECM=3.5-6.7GEV  2/82*
R25             . . . . . . . . . . .
R25 FIT          0.107     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R26      TAU+- INTO (NUTAU 2PI+- K+-+ NON-RES.)/TOTAL         (P13-P9)
R26             (0.014)OR LESS  CL=.95    WAGNER     80 PLUT E+E- 4-5 GEV ECM    2/82*

R51      TAU+- INTO(MU+- GAMMA(S) + E+- GAMMA(S))/TOTAL        (P31+P32)
R51       VIOLATES LEPTON NUMBER CONSERVATION
R51  R          (0.12) OR LESS  CL=.90    BURMESTER 77 PLUT E+E- 4-5 GEV ECM    12/77
R51  R   ASSUMES SAME MU,E MOM. SPEC. AS (MU E ) NOTHING DETECTED).              12/77

R52      TAU+- INTO(MU+- CHGD. PARTS. + E+- CHGD. PARTS.)/TOTAL (P33+P34)
R52       VIOLATES LEPTON NUMBER CONSERVATION
R52  R           0.04  OR LESS  CL=.90    BURMESTER 77 PLUT E+E- 4-5 GEV ECM    12/77
R52  R   ASSUMES SAME MU,E MOM. SPEC. AS (MU E ) NOTHING DETECTED).              12/77

R53      TAU+- INTO (MU+- GAMMA)/TOTAL                         (P31)
R53       VIOLATES LEPTON NUMBER CONSERVATION
R53             5.5E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R54      TAU+- INTO (E+- GAMMA)/TOTAL                          (P32)
R54       VIOLATES LEPTON NUMBER CONSERVATION
R54             6.4E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R55      TAU+- INTO (MU+- MU+ MU-)/TOTAL                       (P35)
R55       VIOLATES LEPTON NUMBER CONSERVATION
R55             4.9E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R56      TAU+- INTO (E+- MU+ MU-)/TOTAL                        (P36)
R56       VIOLATES LEPTON NUMBER CONSERVATION
R56             4.3E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R57      TAU+- INTO (MU+- E+ E-)/TOTAL                         (P37)
R57       VIOLATES LEPTON NUMBER CONSERVATION
R57             4.4E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R58      TAU+- INTO (E+- E+ E-)/TOTAL                          (P38)
R58       VIOLATES LEPTON NUMBER CONSERVATION
R58             4.0E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R59      TAU+- INTO (MU+- PIO)/TOTAL                           (P39)
R59       VIOLATES LEPTON NUMBER CONSERVATION
R59             8.2E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R60      TAU+- INTO (E+- PIO)/TOTAL                            (P40)
R60       VIOLATES LEPTON NUMBER CONSERVATION
R60             2.1E-3  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R61      TAU+- INTO (MU+- KO)/TOTAL                            (P41)
R61       VIOLATES LEPTON NUMBER CONSERVATION
R61             1.0E-3  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R62      TAU+- INTO (E+- KO)/TOTAL                             (P42)
R62       VIOLATES LEPTON NUMBER CONSERVATION
R62             1.3E-3  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R63      TAU+- INTO (MU+- RHOO)/TOTAL                          (P43)
R63       VIOLATES LEPTON NUMBER CONSERVATION
R63             4.4E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

R64      TAU+- INTO (E+- RHOO)/TOTAL                           (P44)
R64       VIOLATES LEPTON NUMBER CONSERVATION
R64             3.7E-4  OR LESS  CL=.90   HAYES      82 SMK2 E+E- 3.8-6.8GEV ECM  4/82*

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                    REFERENCES FOR TAU(1785) HEAVY LEPTON

PERL       75 PRL 35 1489           +ABRAMS,BOYARSKI,BREIDENBACH +    (LBL+SLAC)
PERL       76 PL 63B 466            +FELDMAN,ABRAMS,ALAM,BOYARSKI +   (SLAC+LBL)

BARBARO-   77 PRL 39 1058           BARBARO-GALTIERI+        (LBL+NWES+SLAC+HAWA)
BRANDELI   77 PL 70B 125            BRANDELIK +          (AACH+DESY+HAMB+MPIM+TOKY)
BURMESTI   77 PL 68B 297            BURMESTER,CRIEGEE +    (DESY+HAMB+STEG+WUPG)
BURMESTZ   77 PL 68B 301            BURMESTER,CRIEGEE +    (DESY+HAMB+STEG+WUPG)
CAVALLIS   77 LNC 20 337            CAVALLI-SFORZA,GOGGI +     (PAVI+PRIN+UMD)
PERL       77 PL 70B 487            +FELDMAN,ABRAMS,ALAM,BOYARSKI+    (SLAC LBL)

ALEXANDI   78 PL 73B 95             ALEXANDER,CRIEGEE+      (DESY+AACH+STEG+WUPG)
ALEXAND2   78 PL 78B 162            ALEXANDER+          (DESY+AACH+HAMB+STEG+WUPG)
BACINO     78 PRL 41 13             +FERGUSON,NODULMAN +   (UCLA+SLAC+UCI+STON)J
  ALSO     78 TOKYO CONF. P.249     J.KIRZ(19TH INTL.CONF. ON HEP)          (STON)
  ALSO     80 PL 96B 214            ZHOLENTZ,KURDADZE,LELCHUK,MISHNEV+      (NOVO)
BARTEL     78 PL 77B 331            +DITTMANN,DUINKER,OLSSON,ONEILL+(DESY+HEID)

BRANDELI   78 PL 73B 109            BRANDELIK +        (AACH+DESY+HAMB+ MPIM+TOKY)J
HEILE      78 NP B138 189           +PERL,ABRAMS,ALAM,BOYARSKI+       (SLAC+LBL)
JAROS      78 PRL 40 1120           +ABRAMS,ALAM+              (SLAC+LBL+NWES+HAWA)
SMITH      78 PR D18 1              +FORD,MORSE,MANN,RESVANIS+ (COLO+PENN+WISC)

ABRAMS     79 PRL 43 1555           +ALAM,BLOCKER,BOYARSKI+           (SLAC+LBL)
ALEXANDE   79 PL 81B 84             ALEXANDER +         (DESY+AACH+HAMB+STEG+WUPP)
BACINOI    79 PRL 42 6              +FERGUSON,NODULMAN +   (UCLA+SLAC+UCI+STON)
BACINO2    79 PRL 42 749            +FERGUSON,NODULMAN+    (UCLA+SLAC+UCI+STON)

BLOCKER    80 LBL-10801,THESIS      C.A.BLOCKER                           (LBL)
BRANDELI   80 PL 92B 199            BRANDELIK + (AACH+BONN+DESY+HAMB+LOIC+DXF+)
WAGNER     80 ZPHY C3 193           +ALEXANDER+         (AACH+DESY+HAMB+STEG+WUPG)
ZHOLENTZ   80 PL 96B 214            +KURDADZE,LELCHUK,MISHNEV,NIKITIN+     (NOVO)
  ALSO     81 YAD.PHYS.34 1471      ZHOLENTZ +                             (NOVO)

BERGER     81 PL 99B 489            +GENZEL+(AACH+BERG+DESY+HAMB+UMD+SIEG+WUPG)
DORFAN     81 PRL 46 215            +BLOCKER,ABRAMS,ALAM +           (SLAC+LBL)
BLOCKER    82 PL B (TO BE PUB.)     +DORFAN,ABRAMS,ALAM,BLONDEL+     (LBL+SLAC)J
FELDMAN    82 PRL 48 66             +TRILLING,ABRAMS,AMIDEI+     (SLAC+LBL+HARV)
HAYES      82 PR (SUBMITTED)        +PERL,ALAM,BOYARSKI,BREIDENBACH+ (SLAC+LBL)

                                    REVIEWS

PERL2      77 HAMBURG SYMP.         ALSO ISSUED AS SLAC-PUB-2022, M.PERL (SLAC)
FLUGGE     77 MESON CONF.,BOSTON    ALSO ISSUED AS DESY 77 35, G.FLUGGE  (DESY)

AZIMOV     78 SPU 21 225            + ZAKHAROV,KHOZE                      (LENI)
FELDMAN    78 TOKYO CONF.,P.777     G.J.FELDMAN (19TH INTL. CONF. ON HEP)(SLAC)J
PERL       78 SLAC-PUB-2219         M.L.PERL (KARLSRUHE SUMMER INST.1978)(SLAC)

FLUGGE     79 ZPHY C1 121           G.FLUGGE                              (DESY)
KIRKBY     79  SLAC-PUB-2419        J.KIRKBY(LEPTON PHOTON SYMP. BATAVIA)(SLAC)J
PERL       80 ARNPS 30 299          M.L.PERL                              (SLAC)
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         B  CHARGED PION(140,JPG=0--1 I=1

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         B  CHARGED PION MASS (MEV)

M                139.37       0.20          CROWE       54 CNTR  -
M                139.68       0.15          BARKAS      56 EMUL  +
M     S         (139.577)    (0.013)        SHAFER      67 CNTR  - MESONIC ATOMS     6/66
M     B         (139.549)    (0.008)        BACKENSTO   71 CNTR  - MESONIC ATOMS     1/71
M     S          139.566      0.013         SHAFER      72 CNTR  - MESONIC ATOMS     1/73
M     B          139.569      0.008         BACKENSTO   73 CNTR  - MESONIC ATOMS     1/73
M                139.571      0.010         BRANDAODD   76 CNTR  - MESONIC ATOMS     1/78
M                139.5686     0.0020        CARTER      76 CNTR  - MESONIC ATOMS     6/77
M     M          139.5667     0.0024        MARUSHENKO  76 CNTR  - MESONIC ATOMS    12/77
M     D         (139.5658)   (0.0018)       DAUM        79 SPEC  + PI+ --> MU+ NEU  10/81*
M                139.5675     0.0009        LU          80 CNTR  - MESONIC ATOMS     1/81*
M     S   SHAFER 72 UPDATES SHAFER67 WITH NEW ALPHA AND NEW CALIB. LINE ENER.        1/73
M     B   BACKENSTOSS 73 CORRECTS BACKENSTOSS 71 WITH NEW VACUUM POL. CALC.          1/73
M     M   THIS MARUSHENKO 76 VALUE USED AT AUTHORS REQUEST BECAUSE IT USES          3/78
M     M   ACCEPTED SET OF CALIBRATION GAMMA ENERGIES.  ERROR INCREASED FROM         3/78
M     M   .0017 TO INCLUDE QED CALC. ERROR OF .0017 (12 PPM).                       3/78
M     D   DAUM 79 VALUE DEPENDS ON ASSUMED MU+ MASS M(MU)=105.65948+-.00035 .      2/78
M     D   ENTERS OUR FIT VIA PI-MU MASS DIFF. BELOW WHICH IS INDEP. OF M(MU).       2/78
M               . . . . . . . . . . .
M     AVG        139.5676     0.0007   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
M     FIT        139.5671     0.0007   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

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         B  (PI+) - (MU+) MASS DIFFERENCE (MEV)

D                 34.05       0.076         BARKAS      56 EMUL
D                 33.85       0.076         BARKAS      56 EMUL
D          145    33.881      0.035         HYMAN       67 HEBC  + K-HE               2/71
D                 33.925      0.025         BOOTH       75 CNTR  + MAGNETIC SPECT.    2/71
D                 33.9063     0.0018        DAUM        79 SPEC  +  SEE NOTE D ABOVE 10/81*
D               . . . . . . . . . . .
D     AVG         33.9064     0.0018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D     FIT         33.90790    0.00072  FROM FIT(ERROR INCLUDES SCALE FACTOR OF 1.0)   3/82*

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         B  ((PI+) - (PI-))/AVG.. MASS DIFFERENCE (PERCENT)

DM                0.02        0.05          AYRES       71 CNTR                       3/71

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         B  CHARGED PION MEAN LIFE (UNITS 10**-9 SEC)

T                 25.6        0.5      0.5  CROWE       57 RVUE
T                 25.6        0.8      0.8  ANDERSON    60 CNTR
T        8000     25.46       0.32     0.32 ASHKIN      60 CNTR +
T                 26.02       0.04          ECKHAUSE    65 CNTR +                     9/66
T                 25.6        0.3           BARDON      66 CNTR                       6/66
T                 25.9        0.3           DUNAITSEV   66 CNTR                       6/68
T     N          (26.40)     (0.08)         KINSEY      66 CNTR +                     6/66
T     N   SYSTEMATIC ERRORS IN CALIBR. IN THIS EXP. DISCUSSED BY NORDBERG 67         6/67
T                 26.67       0.24          LOBKOWICZ   66 CNTR                       9/66
T                 26.04       0.05          NORDBERG    67 CNTR +                     8/67
T                 26.02       0.04          AYRES       71 CNTR +-                    3/71
T                 26.09       0.08          DUNAITSEV   73 CNTR +                     3/74
T               . . . . . . . . . . .
T     AVG         26.030      0.023    0.023 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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         B  ((PI+) - (PI-))/AVG.. MEAN LIFE DIFF. (PERCENT)

DT    N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT                0.23        0.40          LOBKOWICZ 66 CNTR        SEE NOTE L       9/66
DT    L   ABOVE IS THE MOST CONSERVATIVE VALUE QUOTED BY AUTHORS                      9/66
DT                0.4         0.7           BARDON      66 CNTR                       7/66
DT               -0.14        0.29          PETRUKHIN 68 CNTR                         8/68
DT                0.055       0.071         AYRES       71 CNTR                       3/71
DT              . . . . . . . . . . .
DT    AVG         0.053       0.068    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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         B  CHARGED PION PARTIAL DECAY MODES

                                                             DECAY MASSES
P1       CHAR. PION INTO MU (MU-NEU)                         105+   0
P2       CHAR. PION INTO E ( E-NEU)                           .5+   0
P3       CHAR. PION INTO MU (MU-NEU) GAMMA                   105+   0+    0
P4       CHAR. PION INTO PIO E (E-NEU)                       134+  .5+    0
P5       CHAR. PION INTO E NEU GAMMA                          .5+   0+    0
P6       CHAR. PION INTO E NEU E+ E-                          .5+   0+   .5+  .5

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         B  CHARGED PION BRANCHING RATIOS

R1       CHAR. PION INTO MU NEU GAMMA (UNITS 10**-4)       (P3)/(P1)
R1        26    1.24       0.25            CASTAGNOL 58 EMUL    E(MU).LT.3.38 MV
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R2      CHAR. PION INTO E NEU (UNITS 10**-4)               (P2)/(P1)
R2              1.21      0.07          ANDERSON  60 CNTR
R2  D          (1.247)   (0.028)        DI CAPUA  64 CNTR                11/75
R2 D            1.274     0.024         BRYMAN    75 RVUE                 9/75
R2 D     BRYMAN 75 IS A RECALC. OF DICAPUA 64 EXPT USING LATEST PI LIFETIME.  9/75
R2             . . . . . . . . .
R2  AVG         1.267     0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      CHAR. PION INTO PIO E NEU (UNITS 10**-8)           (P4)/(P1)
R3  D   52    (1.15)    (0.22)          DEPOMMI1  63 CNTR +                2/72
R3   D  36     0.97      0.20           BARTLETT  64 OSPK +
R3   D  38     1.07      0.21           BACASTOW  65 OSPK +
R3   D         1.10      0.26           BERTRAM   65 OSPK +                6/66
R3   D  43     1.1       0.2            DUNAITSEV 65 CNTR +                7/66
R3     332     1.00      0.08     0.10  DEPOMMIER 68 CNTR +                3/66
R3             . . . . . . . . .
R3  AVG        1.023     0.069    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
    D   DEPOMMIER 68 STATES THAT THE RESULT OF DEPOMMIER 63 IS AT LEAST    2/72
    D   10 PERCENT TOO LARGE BECAUSE OF A SYSTEMATIC ERROR IN THE PIO      2/72
    D   DETECTION EFFICIENCY.  THIS MAY BE TRUE OF ALL THE PREVIOUS        2/72
    D   MEASUREMENTS ACCORDING TO DEPOMMIER 68 AND V.SOERGEL, PRIVATE      2/72
    D   COMMUNICATION, 1972.

R4      CHAR. PION INTO E NEU GAMMA (UNITS 10**-8)         (P5)/(P1)
R4      143    (3.0)                    DEPOMMI2  63 CNTR + E+, GAM KE >48MEV  3/82*
R4    S 226     5.6      0.7            STETZ     78 SPEC + E MOM >56 MEV/C.  12/79
R4    S  STETZ 78 IS FOR E-GAMMA OPENING ANGLE >132DEG.  OBTAINS 3.7 WHEN     12/79
R4    S  USING SAME CUTOFFS AS DEPOMMIER.                                     12/79

R5      CHAR. PION INTO E NEU E+ E- (UNITS 10**-8)         (P6)/(P1)
R5            (3.4)  OR LESS  CL=.90   KORENCHEN 71 OSPK +                10/71
R5             0.48  OR LESS  CL=.90   KORENCHEN 76 SPEC +                 1/78

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REFERENCES FOR CHARGED PION

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CROWE     54 PR  96  470       K M CROWE,R H PHILLIPS                  (LRL)
BARKAS    56 PR 101  779       W H BARKAS,W BIRNBAUM,F M SMITH         (LRL)
CROWE     57 NC   5  541       K M CROWE                     (STANFORD HEPL)
CASTAGNO  58 PR 112 1779       C CASTAGNOLI,M MUCHNIK                 (ROMA)

ANDERSON  60 PR 119 2050       H L ANDERSON,T FUJII,R H MILLER +       (EFI)
ASHKIN    60 NC  16  490       ASHKIN,FAZZINI,FIDECARO,LIPMAN +       (CERN)
DEPOMMI1  63 PL 5 61           DEPOMMIER,HEINTZE,RUBBIA,SOERGEL       (CERN)
DEPOMMI2  63 PL 7 285          P DEPOMMIER,HEINTZE,RUBBIA,SOERGEL     (CERN)
BARTLETT  64 PR 136B 1452      BARTLETT,DEVONS,MEYER,ROSEN        (COLUMBIA)
DI CAPUA  64 PR 133B 1333      DI CAPUA,GARLAND,PONDROM,STRELZOFF     (COLU)

BACASTOW  65 PR 139 B407       +GHESQUIERE,WIEGAND,LARSEN         (LRL+SLAC)
BERTRAM   65 PR 139 B 617      BERTRAM,MEYER,CARRIGAN+       (MICH+CARNEGIE)
DUNAITSE  65 JETP 20 58        DUNAITSEV,PETRUKHIN,PROKOSHKIN +      (DUBNA)
ECKHAUSE  65 PL 19 348         ECKHAUSE,HARRIS,SHULER+  (WILLIAM AND MARY)

BARDON    66 PRL 16 775        BARDON,DORE,DORFAN,KRIEGER +       (COLUMBIA)
DUNAITSE  66 PL 23 283         +KUTYIN,PROKOSHKIN,RASUVAEV,SIMONOV (DUBNA)
KINSEY    66 PR 144   1132     KINSEY,LOBKOWICZ,NORDBERG  (ROCHESTER UNIV)
LOBKOWIC  66 PRL  17  548      LOBKOWICZ,MELISSINOS,NAGASHIMA+  (ROCH+BNL)

HYMAN     67 PL 25B 376        +LOKEN,PEWITT,DERRICK +        (ANL+CARN+NWES)
NORDBERG  67 PL 24B  594       NORDBERG,LOBKOWICZ,BURMAN  (ROCHESTER UNIV)
SHAFER    67 PR 163 1451       ROBERT E. SHAFER                        (LRL)
    ALSO  65 PRL 14 923        SHAFER,CROWE,JENKINS                    (LRL)

DEPOMMIE  68 NP B4 189         DEPOMMIER,DUCLOS,HEINTZE,KLEINKNECHT+(CERN)
PETRUKHI  68 JINR-P1-3862      PETRUKHIN,RYKALIN,KHAZINS,CISEK       (DUBNA)
BOOTH     70 PL 32B 723        +JOHNSON,WILLIAMS,WORMALD              (LIVP)
AYRES     71 PR 3D 1051        +CORMACK,GREENBERG,KENNEY +        (LRL,UCSB)
    ALSO  67 PR   157  1288    AYRES CALDWELL,GREENBERG,KENNEY,KURZ+ (LRL)
    ALSO  68 PRL 21 261        AYRES,CORMACK,GREENBERG,KENNEY+  (LRL,UCSB)
    ALSO  69 UCRL-18369        DAVID S AYRES (THESIS)                  (LRL)
    ALSO  69 PRL 23 1267       GREENBERG,AYRES,CORMACK,KENNEY+  (LRL,UCSB)

BACKENST  71 PL 36B 463        BACKENSTOSS,DANIEL,KOCH+    (CERN,KARL,HEID)
    ALSO  70 THESIS            C. VON DER MALSBURG              (HEIDELBERG)
KORENCHE  71 SJNP 13 189       KORENCHENKO,KOSTIN,MICELMACHER+        (JINR)
SHAFER    72 PRIVATE COMM.     R. SHAFER, 1972                        (FNAL)
BACKENST  73 PL 43B 539        BACKENSTOSS,DANIEL,KOCH+ (CERN+KARL+MUNICH)
    ALSO  73 SUBMITTED TO NP   L. TAUSCHER
DUNAITSE  73 SJNP 16 292       DUNAITSEV,PROKOSHKIN,RAZUVAEV+         (SERP)

BRYMAN    75 PR D11 1337       +PICCIOTTO                (UNIV OF VICTORIA)
BRANDAOD  76 ZNAT 31A 1150     BRANDAO D'OLIVERA,DANIEL,VON EGIDY+    (MUNI)
CARTER    76 PRL 37 1380       +DIXIT,SUNDARESAN+        (CARL+CNRC+CHIC+CIT)
KORENCHE  76 JETP 44 35        KORENCHENKO,KOSTIN,MICELMACHER+        (JINR)
MARUSHEN  76 JETPL 23 72       MARUSHENKO,MEZENTSEV,PETRUNIN+         (LENI)
    ALSO  76  PRIVATE COMM.    R. SHAFER                              (FNAL)
    ALSO  78  PRIVATE COMM.    A. I. SMIRNOV                          (LENI)

STETZ     78 NP B138 285       +CARROLL,ORTENDAHL,PEREZ-MENDEZ+ (LBL+UCLA)
DAUM      79 PR D20 2692       +EATON,FROSCH,HIRSCHMANN,MCCULLOCH+     (SIN)
    ALSO  78 PL 74B 126        DAUM,EATON,FROSCH,HIRSCHMANN,+          (SIN)
LU        80 PRL 45 1066       +DELKER,DUGAN,WU,CAFFREY+    (YALE+COLU+JHU)

                               PAPERS NOT REFERRED TO IN DATA CARDS

CARTWRIG  63 PR 91 677         CARTWRIGHT,RICHMAN,WHITEHEAD,WILCOX   (LRL)J
MERRISON  62 ADVP 11 1         A W MERRISON                     (LIVERPOOL)
SHAPIRO   62 PR 125 1022       G SHAPIRO,L M LEDERMAN            (COLUMBIA)
CZIRR     63 PR 130 341        JOHN B CZIRR                            (LRL)
CARRIGAN  68 NP B6 662         R.A.CARRIGAN JR.                       (CARN)J
DEPOMMIE  80 NP A335 57        P.DEPOMMIER                            (MONT)
WILKIN    80 JPG 6 L5          C. WILKIN                             (CO)CIP

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                   9  NEUTRAL PION(135,JPG=0--) I=1
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                   9  (PI+-) - (PIO) MASS DIFFERENCE (MEV)

D            (5.37)    (1.0)         PANOFSKY  51 CNTR  -
D             4.50      0.31         CHINOWSKY 54 CNTR  -
D             4.62      0.05         HADDOCK   59 CNTR  -
D             4.60      0.04         HILLMAN   59 CNTR
G             4.55      0.07         CASSELS   59 CNTR
D             4.69      0.07         SAMIOS    60 HBC                    2/72
D             4.6056    0.0055       CZIRR     63 CNTR
D             4.59      0.03         PETRUKHIN 63 CNTR  -
D             4.6034    0.0052       VASILEVSK 66 CNTR  -                9/66
D            . . . . . . . . . .
D   AVG       4.6043    0.0037  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                   9  NEUTRAL PION MEAN LIFE (UNITS 10**-16 SEC)

T   N   76   (1.9)    (0.5)    (0.5)  GLASSER   61 EMUL
T   N   45   (2.3)    (1.1)    (1.0)  TIETGE    62 EMUL
T   N   88   (2.8)    (0.9)    (0.9)  KOLLER    63 EMUL    SEE STAMER 66
T             1.05     0.18     0.18  VON DARDE 63 CNTR
T   N   75   (1.7)    (0.5)           SHWE      64 EMUL
T             0.730    0.105          BELLETTIN 65 CNTR                  6/66
T   N   67   (1.6)    (0.6)    (0.5)  EVANS     65 EMUL                  6/66
T  K   232    1.0      0.5            STAMER    66 EMUL                  6/67
T             0.56     0.06           BELLETTIN 70 CNTR    PRIM.EFF. ON NUC  7/70
T             0.9      0.068          KRYSHKIN  70 CNTR    PRIMAKOFF EFFECT 12/70
T  B          0.82     0.04           BROWMAN   74 CNTR    PRIMAKOFF EFFECT  7/75
T   N   OLD EMULSION MEASUREMENTS NOT USED BECAUSE OF POSSIBLE SYSTEMATIC
T   N   SHIFT TO LARGER MEAN LIFE VALUES.
T  K    INCLUDES EVENTS OF KOLLER 63.                                    8/67
T  B    BROWMAN GIVES PIO WIDTH=8.02+-.42EV.  MEAN LIFE IS HBAR/WIDTH.  11/75
T            . . . . . . . . . .
T   AVG       0.828    0.057    0.053  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.8)
                       (SEE IDEOGRAM BELOW )
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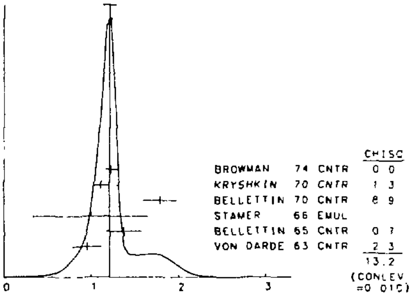
WEIGHTED AVERAGE = 1.207 ± 0.080
ERROR SCALED BY 1 8



NEUTRAL PI DECAY RATE(UNITS 10**16SEC-1)

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                   9  NEUTRAL PION PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      PIO INTO 2GAMMA                                   0+   0
P2      PIO INTO E+ E- GAMMA                              .5+  .5+  0
P3      PIO INTO 4ELECTRONS                               .5+  .5+  .5+  .5
P4      PIO INTO 3 GAMMA                                  0+   0+   0
P5      PIO INTO 4 GAMMA                                  0+   0+   0+   0
P6      PIO INTO E+ E-                                    .5+  .5
P7      PIO INTO 2 NEUTRINOS                              0+   0

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                   9  NEUTRAL PION BRANCHING RATIOS

R1      PIO INTO (GAMMA E+ E-)/(2GAMMA) (PERCENT)          (P2)/(P1)
R1            (1.196)  THEORET. CALC.  JOSEPH    60        QUANTUM ELECT.    9/66
R1       27    1.17      0.15          BUDAGOV   60 HBC
R1     3071    1.166     0.047         SAMIOS    61 HBC    PI- P --> PIO N
R1             1.25      0.04          SCHARDT   81 SPEC   PI- P --> PIO N   1/82*
R1  S   SAMIOS VALUE USES PANOFSKY RATIO = 1.62
R1            . . . . . . . . . .
R1  AVG        1.213     0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      PIO INTO (3 GAMMA)/TOTAL       (UNITS 10**-6)      (P4)
R2  D    0   (4.9)  OR LESS  CL=.90   DUCLOS    65 CNTR                  6/66
R2  D        (4.9)  OR LESS  CL=.90   KUTIN     65 CNTR                  3/68
R2  D  THESE EXPTS. GIVE BR(3GAMMA/2GAMMA)<5.0*10**-6.
R2       0   (1.5)  OR LESS  CL=.90   AUERBAC1  78 CNTR                  1/79
R2       0    0.38  OR LESS  CL=.90   HIGHLAND  80 CNTR                  1/81*

R3      PIO INTO (E+E+E-E-)/(2 GAMMA) (UNITS 10**-5)       (P3)/(P1)
R3  N  146   (3.18)   (0.30)          SAMIOS    62 HBC     SEE NOTE N BELOW  6/66
R3             3.28    THEORET. CALC.  MIYAZAKI  73        QUANTUM ELECT.    2/76
R3  N   ABOVE VALUE USES PANOFSKY RATIO = 1.62

R4      PIO INTO (4 GAMMA)/TOTAL       (UNITS 10**-5)      (P5)              8/73
R4   A   0   (6.0)  OR LESS  CL=.90   ABRAMS    73 ASPK                  8/73
R4   A  ABRAMS 73 GIVES BR(4GAMMA/2GAMMA)<6.1*10**-5.
R4       0   (3.8)  OR LESS  CL=.90   AUERBAC2  78 CNTR                  2/79
R4       0    0.44  OR LESS  CL=.90   AUERBACH  80 CNTR                  6/81*

R5      PIO INTO (E+ E-)/TOTAL  (UNITS 10**-6)             (P6)/(P1)        12/75
R5   D       (2.0)  OR LESS  CL=.90   DAVIES    74 RVUE                 12/75
R5       8    0.223    0.240    0.110 FISCHER2  78 SPRK    K+ EXPT. CL=.90   6/78
R5   D  DAVIES 74 EXTRACTS THIS INFORMATION FROM BLOCH 75 K+ EXPERIMENT.   12/75

R6      PIO INTO (2 NEU)/TOTAL    (UNITS 10**-5)           (P7)              2/82*
R6       0    2.4   OR LESS  CL=.90   HERCZEG   81 RVUE                  2/82*

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                   9  NEUTRAL PION ELECTROMAGNETIC FORM FACTOR

     THE AMPLITUDE FOR THE PROCESS PIO --> E+ E- GAMMA CONTAINS A
     FORM FACTOR GAMMA(X**2) AT THE (PIO GAMMA GAMMA) VERTEX
     WHERE X=MASS(E+E-)/MASS(PIO).  THE PARAMETER  A  IN THE LINEAR
     EXPANSION  GAMMA(X**2)=1+A*(X**2) IS LISTED BELOW.

A        LINEAR COEFFICIENT OF PIO ELECTROMAGNETIC FORM FACTOR
A             (-0.15)   (0.10)          KOBRAK    61 HBC     NO RAD. CORR.    2/80
A      3071   (-0.24)   (0.16)          SAMIOS    61 HBC     NO RAD. CORR.    2/80
A      2200   (+0.01)   (0.11)          DEVONS    69 OSPK    NO RAD. CORR.    2/80
A     F 30K   +0.10      0.03           FISCHER1  78 SPEC    RAD. CORR.       2/80
A     F  ERROR STATISTICAL ONLY.  RESULT WITHOUT RAD. CORR.=+0.05+-0.03.      2/80

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                              REFERENCES FOR NEUTRAL PION

PANOFSKY 51 PR    61  565      W K H PANOFSKY,R L AAMODT,J HADLEY     (LRL)
CHINOWSK 54 PR    93  586      W CHINOWSKY,J STEINBERGER         (COLUMBIA)
CASSELS  59 PPS  74   92       CASSELS,JONES,MURPHY,O.NEILL     (LIVERPOOL)
HADDOCK  59 PRL    3  478      HADDOCK,ABASHIAN,CROWE,CZIRR           (LRL)
HILLMAN  59 NC    14  887      HILLMAN,MIDDELKOOP,YAMAGATA,ZAVATTINI(CERN)

BUDAGOV  60 JETP 11   755      BUDAGOV,VIKTOR,DZHELEPOV,ERMOLOV +    (JINR)
JOSEPH   60 NC 16 997          D W JOSEPH                             (EFI)
SAMIOS   60 NC 18 154          N P SAMIOS                        (COLUMBIA)
GLASSER  61 PR   123 1314      R G GLASSER,N SEEMAN,B STILLER         (NRL)
KOBRAK   61 NC 20 1115         H.KOBRAK                               (EFI)
SAMIOS   61 PR   121  275      N P SAMIOS                    (COLUMBIA+BNL)
SAMIOS   62 PR 126 1844        SAMIOS,PLANO,PRODELL +        (COLUMBIA+BNL)
TIETGE   62 PR   127 1324      J TIETGE,W PUESCHEL         (MAX PLANCK INST)

CZIRR    63 PR   130  341      JOHN B CZIRR                           (LRL)
KOLLER   63 NC    27 1405      E L KOLLER,S TAYLOR,T HUETTER      (STEVENS)
   ALSO 66 STAMER
PETRUKHI 63 SIENA CONF 208     V I PETRUKHIN,YU D PROKOSHKIN         (JINR)
VON DARD 63 PL     4   51      VON DARDEL,DEKKERS,MERMOD,VAN PUTTEN+(CERN)

SHWE     64 PR   136B 1839     H SHWE,F M SMITH,W H BARKAS            (LRL)
BELLETTI 65 NC 40 A 1139       BELLETTINI,BEMPORAD,BRACCINI+(PISA+FIRENZE)
DUCLOS   65 PL 19 253          DUCLOS,FREYTAG,HEINTZE +  (CERN+HEIDELBERG)
EVANS    65 PR 139 B 982       D A EVANS                           (OXFORD)
KUTIN    65 JETP LETT 2 243    KUTIN,PETRUKHIN,PROKOSHKIN            (JINR)

STAMER   66 PR 151  1108       STAMER,TAYLOR,KOLLER,HUETTER+      (STEVENS)
VASILEVS 66 PL   23  281       VASILEVSKY,VISHNYAKOV,DUNAITSEV +    (DUBNA)
DEVONS   69 PR 184 1356        +MEMENTHY,NISSIM-SABAT,DI CAPUA+(COLU+ROMA)
BELLETTI 70 NC 66A 243         BELLETTINI,BEMPORAD,LUBELSKEY+  (PISA+BONN)
KRYSHKIN 70 JETP 30 1037       +STERLIGOV,USOV        (TOMSK POLYTECH.INST.)

ABRAMS   73 PL 45B 66          +CARROLL,KYCIA,LI,MICHAEL,MOCKETT +    (BNL)
MIYAZAKI 73 PR D8 2051         T.MIYAZAKI,E.TAKASUGI                 (TOKY)
BROWMAN  74 PRL 33 1400        +DEWIRE,GITTELMAN,HANSON+        (CORN+BING)
DAVIES   74 NC 24A 324         +GUY,ZIA                    (BIRM+RHEL+SHMP)

AUERBAC1 78 PRL 41 275         AUERBACH,HIGHLAND,JOHNSON,  +    (TEMP+LASL)
AUERBAC2 78 PL 78B 353         AUERBACH,HIGHLAND,JOHNSON,  +    (TEMP+LASL)
FISCHER1 78 PL 73B 359         +EXTERMANN,GUISAN,MERMOD,+       (GEVA+SACL)
FISCHER2 78 PL 73B 364         +EXTERMANN,GUISAN,MERMOD,MOREL+  (GEVA+SACL)

AUERBACH 80 PL 90B 317         +HAIK,HIGHLAND,MCFARLANE,MACEK+  (TEMP+LASL)
HIGHLAND 80 PRL 44 628         +AUERBACH,HAIK,MCFARLANE,MACEK+  (TEMP+LASL)
HERCZEG  81 PL 100B 347        P. HERCZEG, C. M. HOFFMAN             (LANL)
SCHARDT  81 PRD 23 639         +FRANK,HOFFMANN,MISCHKE,MOIR +   (ARZS+LANL)
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η

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                14  ETA(549,JPG=0-+) I=0
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                14  ETA MASS (MEV)

M          53  549.0        1.2          BASTIEN    62 HBC
M          35  546.0        4.0          PICKUP     62 HBC
M          91  548.0        1.0          ALFF       62 HBC
M              549.3        2.9          DELCOURT   63 CNTR
M         148  549.0        0.7          FOELSCHE   64 HBC
M         325  552.0        3.0          KRAEMER    64 DBC
M              548.2        0.65         FOSTER3    65 HBC          7/66
M         250  555.0        2.0          JAMES      66 HBC          6/66
M              . . . . . . . . .
M   AVG        548.82       0.56    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                            (SEE IDEOGRAM BELOW )
```

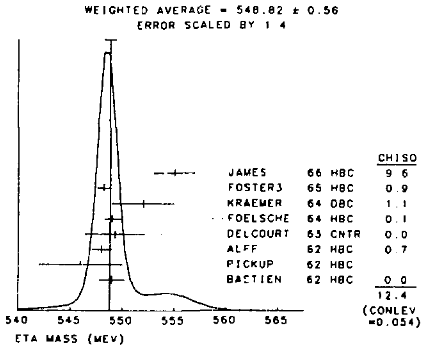


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                14  ETA WIDTH

W       ETA WIDTH DETERMINED FROM MASS SPECTRUM (UNITS MEV)
W        91  (10.0)  OR LESS             ALFF       62 HBC
W       148  (10.0)  OR LESS             FOELSCHE   64 HBC
W        31  (12.0)  OR LESS             JAMES      66 HBC          6/66
W             (4.0)  OR LESS             BALTAY     66 DBC          7/66
W             10.9)  OR LESS  CL=.95     JONES      66 CNTR         8/67

W       ETA WIDTH DETERMINED FROM DECAY RATE (UNITS KEV)
W        THIS IS THE PARTIAL DECAY RATE (W1) FOR THE MODE (ETA INTO 2GAMMA)
W        DIVIDED BY THE FITTED BRANCHING FRACTION (P1) FOR THAT MODE.
W             . . . . . . . . .
W   FIT        0.83      0.12   FROM FIT

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                14  ETA PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      ETA INTO 2GAMMA                                0+   0
P2      ETA INTO 3PI0                                134+ 134+ 134
P3      ETA INTO PI+ PI- PI0                         139+ 139+ 134
P4      ETA INTO PI+ PI- GAMMA                       139+ 139+   0
P5      ETA INTO E+ E- PI0                           134+  .5+  .5
P6      ETA INTO E+ E- PI+ PI-                       139+ 139+  .5+  .5
P7      ETA INTO PI0 2GAMMA                          134+   0+   0
P8      ETA INTO E+ E- GAMMA                          .5+  .5+   0
P9      ETA INTO 2PI0 GAMMA (VIOLATES C)             134+ 134+   0
P10     ETA INTO PI+ PI- PI0 GAMMA                   139+ 139+ 134+   0
P11     ETA INTO PI+ PI- 2GAMMA                      139+ 139+   0+   0
P12     ETA INTO MU+ MU-                             105+ 105
P13     ETA INTO MU+ MU- GAMMA                       105+ 105+   0
P14     ETA INTO MU+ MU- PI0                         105+ 105+ 134
P15     ETA INTO PI+ PI-                             139+ 139
P16     ETA INTO E+ E-                                .5+  .5
P17     ETA INTO MU+ MU- PI0 GAMMA                   105+ 105+ 134+   0

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4          P 8
P 1  .3505+-.0054
P 2   -.6894   .3184+-.0080
P 3   -.4322    -.3365   .2369+-.0054
P 4   -.3760    -.2549     .8016   .0491+-.0013
P 8   -.0520    -.0461    -.0547    -.0540   .0050+-.0012
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space, i.e., $G_i = \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

```
        G 1          G 2          G 3          G 4          G 8
G 1  .3240+-.0460
G 2    .9553   .2647+-.0393
G 3    .9696     .9649   .1965+-.0288
G 4    .9654     .9607     .9986   .0408+-.0060
G 8    .5151     .5119     .5151     .5119   .0041+-.0011

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                14  ETA DECAY RATES

W1      ETA INTO 2GAMMA (UNITS KEV)                        (G1)
W1  B        (1.00)    (0.22)       BEMPORAD  67 CNTR    PRIMAKOFF EFFECT 11/75
W1            0.324     0.046       BROWMAN   74 CNTR    PRIMAKOFF EFFECT  7/74
W1  B   BEMPORAD 67 GIVES W1=1.21+-.26 KEV ASSUMING THAT W1/TOTAL=0.314.    11/75
W1  B   BEMPORAD PRIVATE COMMUNICATION GIVES MORE GENERAL RESULT AS         11/75
W1  B   W1*W1/TOTAL=.380+-.083.  WE EVALUATE THIS USING W1/TOTAL=.38+-.01.  11/75
W1  B   NOT INCLUDED IN AVERAGE BECAUSE THE UNCERTIANTY RESULTING FROM THE   2/76
W1  B   SEPARATION OF THE COULOMB AND NUCLEAR AMPLITUDES HAS APPARENTLY      2/76
W1  B   BEEN UNDERESTIMATED.                                                 2/76
W1            . . . . . . . . . .
W1  FIT       0.324     0.046   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                14  ETA BRANCHING RATIOS

R1      ETA INTO NEUTRALS/CHARGED                      (P1+P2)/(P3+P4+P8)
R1  N   10   (2.5)     (1.0)        PICKUP    62 HBC
R1  N   53   (3.20)    (1.26)       BASTIEN   62 HBC
R1  N  280   (4.5)     (1.0)        JAMES     66 HBC                       6/66
R1  N   THESE EXPERIMENTS HAVE NOT BEEN USED IN COMPUTING THE AVERAGES
R1  N   AS THEY WERE UNABLE TO SEPARATE CLEARLY PARTIAL MODES (3) AND (4)
R1  N   FROM EACH OTHER.  THE REPORTED VALUES THUS PROBABLY CONTAIN
R1  N   SOME (UNKNOWN) FRACTION OF MODE (4).
R1            2.64      0.23        BALTAY2   67 DBC                      11/67
R1            . . . . . . . . . .
R1  FIT       2.436     0.076   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      ETA INTO 2GAMMA/CHARGED                        (P1)/(P3+P4+P8)
R2            0.99      0.48        CRAWFORD  63 HBC
R2       75   1.51      0.93        KENDALL   74 OSPK                     12/75
R2            . . . . . . . . . .
R2  AVG       1.10      0.43     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       1.342     0.050   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Note on $\eta \to \pi^0\gamma\gamma$

(by A. V. Barnes, Lawrence Berkeley Laboratory)

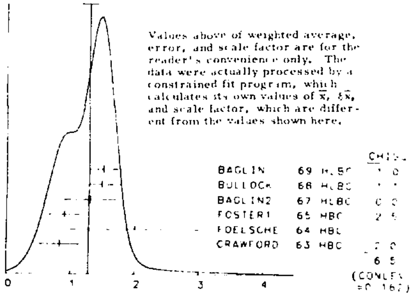
For several years the measurements of the branching ratio $(\eta \to \pi^0\gamma\gamma)/(\eta \to \text{neutrals})$ have been in disagreement. The recent upper limit measurement reported in DAVYDOV 81 is far below the previous positive results. The earlier positive results are each suspect. The earliest report (DIGIUGNO 66) was a photon spectrum measurement. It depends on a Monte Carlo to fit the observed spectrum with that expected from a combination of photons from the decays $\eta \to \gamma\gamma$, $\eta \to \pi^0\gamma\gamma$, and $\eta \to \pi^0\pi^0\pi^0$. Their result is of course sensitive to the assumptions of this Monte Carlo. FELDMAN 67 is an optical spark chamber experiment. The scanning efficiency for the 5- and 6-photon events is hard to measure and critical to their result. STRUGALSK 71 does not address the problem of contamination from the $\eta \to \pi^0\pi^0\pi^0$ decay mode. Assuming that the $\pi^0\gamma\gamma$ mode is absent and that the decay ratio $(\eta \to \gamma\gamma)/(\eta \to \pi^0\pi^0\pi^0)$ is approximately 0.9 implies there are ≈700 $3\pi^0$ events in the $\leqslant 4\gamma$ sample of their data. The 40 ± 10 $\eta \to \pi^0\gamma\gamma$ decays observed could easily be misidentified $\eta \to \pi^0\pi^0\pi^0$ decays. DAVYDOV 81 accounts for the $\eta \to \pi^0\pi^0\pi^0$ decays properly and is much more sensitive than previous measurements.

The $\pi^0\gamma\gamma$ branching fraction is now assumed to be zero in our branching ratio fit. As a result, the fitted $\gamma\gamma$ and $3\pi^0$ branching fractions have increased by 1.1% and 1.9%, respectively.

```
R3      ETA INTO (PI0 2GAMMA)/NEUTRALS                           (P7)/(P1+P2)
R3       OTHER RESULTS ARE IN SECTIONS R14, R22(DAVYDOV 81), AND R26.
R3             (0.375)   (0.077)            DIGIUGNO  66 CNTR    ERROR DOUBLED     6/66
R3             (0.27)    (0.10)             GRUNHAUS  66 OSPK                      8/67
R3             (0.028)   (0.044)            BUNIATOV  67 OSPK REPL. BY SCHMITT 70 11/67
R3             (0.244)   (0.05)             FELDMAN   67 OSPK                      8/67
R3             (0.026)   (0.019)            BUTTRAM   70 OSPK                     12/70
R3             (0.122)   (0.052)  (0.044)COX        70 HBC                         6/70
R3             (0.07) OR LESS  CL=.90       DEVONS    70 OSPK                     12/70
R3        16   (0.016)   (0.047)            SCHMITT   70 OSPK REANAL. BUNIATOV 67 12/70
R3             (0.11)    (0.03)             STRUGALSK 71 HLBC                      5/71
R3             (0.04) OR LESS  CL=.90       ABROSIMOV 80 HLBC                     10/81*

R4      ETA INTO (PI+ PI- GAMMA)/(PI+ PI- PI0)                   (P4)/(P3)
R4              0.14      0.08              FOELSCHE  64 HBC
R4        24   (0.73)    (0.25)             PAULI     64 DBC
R4              0.30      0.06              CRAWFORD  66 HBC                       6/66
R4              0.10      0.10              KRAEMER   64 DBC                       7/66
R4              0.196     0.041             FOSTER3   65 HBC                       7/66
R4              0.25      0.035             LITCHFIEL 67 DBC                       8/67
R4              0.28      0.04              BALTAY2   67 DBC                      11/67
R4      7250    0.201     0.006             GORMLEY   70 ASPK                      6/70
R4       18K    0.209     0.004             THALER    73 ASPK                      6/73
R4            . . . . . . . . . . .
R4   AVG        0.2074    0.0037   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R4   FIT        0.2074    0.0033 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      ETA INTO 3PI0/2GAMMA                                     (P2)/(P1)
R6             (0.90) OR MORE               CHRETIEN  62 HBC
R6             (1.25)    (0.39)             BACCI     63 CNTR INVERSE BR REPORTED  7/66
R6              0.88      0.16              BALTAY1   67 DBC                      11/67
R6              1.1       0.2               CENCE     67 OSPK                      1/68
R6              0.91      0.14              COX       70 HBC                       6/70
R6              0.75      0.09              DEVONS    70 OSPK                     12/70
R6            . . . . . . . . . . .
R6   AVG        0.842     0.065    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6   FIT        0.815     0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      ETA INTO 2GAMMA/(PI+ PI- P0)                             (P1)/(P3)
R7              1.61      0.39              FOSTER1   65 HBC
R7       401    1.72      0.25              BAGLIN    69 HLBC                      7/69
R7            . . . . . . . . . . .
R7   AVG        1.69      0.21     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7   FIT        1.649     0.061  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      ETA INTO NEUTRAL/(PI+ PI- PI0)                           (P1+P2)/(P3)
R8        50    3.6       0.8               KRAEMER   64 DBC
R8              3.6       1.1               PAULI     64 DBC                       7/66
R8              2.89      0.56              ALFF-STEI 66 HBC                       9/66
R8       244    3.6       0.6               FLATTE2   67 HBC                       1/68
R8        29    3.4       1.1               AGUILAR-B 72 HBC                      11/72
R8 B      70    2.83      0.80              BLOODWORT 72 HBC                      11/72
R8        74    2.54      1.89              KENDALL   74 OSPK                     12/75
R8 B   ERROR INCREASED FROM PUBLISHED VALUE 0.5 BY BLOODWORTH, PRIV. COMM.  1/73
R8            . . . . . . . . . . .
R8   AVG        3.26      0.30     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8   FIT        2.993     0.095  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
R9      ETA INTO (E+E-PI0)/(PI+PI-PI0) (UNITS 10**-4)            (P5)/(P3)
R9       SINGLE PHOTON PROCESS FORBIDDEN BY C-PARITY
R9            (110.)   OR LESS              PRICE     65 HBC
R9         0  (77.)    OR LESS              FOSTER2   65 HBC
R9            (42.)    OR LESS  CL=.90      BAGLIN1   67 HLBC                      8/67
R9         0  (16.)    OR LESS  CL=.90      BILLING   67 HLBC                     11/67
R9              1.9    OR LESS  CL=.90      JANE1     75 OSPK                     12/75

R10     ETA INTO (E+E-PI+PI-)/TOTAL (UNITS 10**-2)               (P6)
R10            (0.7)   OR LESS              RITTENBER 65 HBC                       6/66

R11     ETA INTO (E+E-PI+PI-)/(PI+PI-GAMMA)                      (P6)/(P4)
R11        1    0.026     0.026             GROSSMAN  66 HBC                       6/66

R12     ETA INTO 2 GAMMA/NEUTRALS                                (P1)/(P1+P2)
R12            (0.416)   (0.044)            DIGIUGNO  66 CNTR    ERROR DOUBLED     6/66
R12            (0.44)    (0.07)             GRUNHAUS  66 OSPK                      8/67
R12            (0.579)   (0.052)            FELDMAN   67 OSPK                      8/67
R12 I          (0.39)    (0.06)             JONES     66 CNTR                      8/67
R12 I    THIS RESULT FROM COMBINING CROSS SECTIONS FROM TWO DIFFERENT EXPTS.
R12             0.59      0.033             BUNIATOV  67 OSPK                     11/67
R12             0.535     0.018             BUTTRAM   70 OSPK                     12/70
R12            (0.57)    (0.09)             STRUGALSK 71 HLBC                      5/71
R12      113    0.60      0.14              KENDALL   74 OSPK                     12/75
R12       88    0.52      0.09              ABROSIMOV 80 HLBC                     10/81*
R12           . . . . . . . . . . .
R12 AVG         0.547     0.016    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R12 FIT         0.551     0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R13     ETA INTO 3PI0/NEUTRALS                                   (P2)/(P1+P2)
R13            (0.209)   (0.054)            DIGIUGNO  66 CNTR    ERROR DOUBLED     6/66
R13            (0.29)    (0.10)             GRUNHAUS  66 OSPK                      8/67
R13            (0.177)   (0.035)            FELDMAN   67 OSPK                      8/67
R13            (0.41)    (0.033)            BUNIATOV  67 OSPK NOT INDEP. OF R12   11/67
R13             0.439     0.024             BUTTRAM   70 OSPK                     12/70
R13            (0.32)    (0.09)             STRUGALSK 71 HLBC                      5/71
R13       75    0.44      0.08              ABROSIMOV 80 HLBC                     10/81*
R13           . . . . . . . . . . .
R13 AVG         0.439     0.023    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 FIT         0.449     0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14     ETA INTO (PI0 2GAMMA)/2GAMMA                             (P7)/(P1)
R14            (0.5)   OR LESS  CL=.90      WAHLIG    66 SPRK                      7/66
R14            (0.28)  OR LESS  CL=.95      BALTAY1   67 DBC                      11/67

R15     ETA INTO (E+E-PI0)/TOTAL (UNITS 10**-2)                  (P5)
R15      SINGLE PHOTON PROCESS FORBIDDEN BY C-PARITY
R15            (0.7)   OR LESS              RITTENBER 65 HBC                       6/66
R15            (0.084)OR LESS  CL=.90       BAZIN     68 DBC                       6/68
R15        0   (0.016)OR LESS  CL=.90       MARTYNOV  76 HLBC                      6/77

R17     ETA INTO (PI+PI-PI0 GAMMA)/(PI+PI-PI0) (UNITS 10**-2)
R17                                                              (P10)/(P3)
R17            (7.0)   OR LESS              FLATTE    67 HBC                       6/67
R17            (0.9)   OR LESS              PRICE     67 HBC                       6/67
R17            (1.6)   OR LESS  CL=.95      BALTAY2   67 DBC                      11/67
R17            (1.7)   OR LESS  CL=.90      ARNOLD2   68 HLBC                      9/68
R17        0    0.24   OR LESS  CL=.90      THALER    73 ASPK                      6/73

R18     ETA INTO (PI+PI- 2GAMMA)/(PI+PI-PI0)                     (P11)/(P3)
R18             0.009 OR LESS               PRICE     67 HBC                       8/67
R18            (0.016)OR LESS  CL=.95       BALTAY2   67 DBC                      11/67

R19     ETA INTO 3PI0/(PI+ PI- PI0)                              (P2)/(P3)
R19             0.83      0.32              CRAWFORD  63 HBC                       7/66
R19             2.0       1.0               FOELSCHE  64 HBC                       7/66
R19             0.90      0.24              FOSTER1   65 HBC                       7/66
R19             1.3       0.4               BAGLIN2   67 HLBC                      8/67
R19             1.47      0.20      0.17    BULLOCK   68 HLBC                      9/68
R19      199    1.50      0.15      0.29    BAGLIN    69 HLBC                      7/69
R19           . . . . . . . . . . .
R19 AVG         1.28      0.14     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R19 FIT         1.344     0.057  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                          (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 1.28 ± 0.14
ERROR SCALED BY 1.3



ETA INTO (3PI0)/(PI+ PI- PI0)

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R21     ETA INTO NEUTRALS/TOTAL                                  (P1+P2)
R21             0.79      0.08              BUNIATOV  67 OSPK                     11/67
R21      16K    0.705     0.008             BASILE    71 CNTR MM SPECTROMETER      6/71
R21           . . . . . . . . . . .
R21 AVG         0.7048    0.0080   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R21 FIT         0.7090    0.0065 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22     ETA INTO (PI0 2GAMMA)/TOTAL                              (P7)
R22            (0.12) OR LESS  CL=.95       JACQUET   69 HLBC                      6/70
R22        0    0.003 OR LESS  CL=.90       DAVYDOV   81 CNTR PI- P-->ETA N        1/82*

R23     ETA INTO MU+MU-/TOTAL (UNITS 10**-5)                     (P12)
R23        0   (2.)    OR LESS  CL=.95      HEHMANN   68 OSPK                      4/68
R23       27    0.65      0.21              DZHELYA2  80 SPEC PI- P-->ETA N        9/81*
```

```
R24     ETA INTO MU+MU-PIO/TOTAL (UNITS 10**-4)          (P14)
R24      SINGLE PHOTON PROCESS FORBIDDEN BY C-PARITY
R24          (5.)    CR LESS            WEHMANN   68 OSPK                        4/68
R24           0.05   CR LESS  CL=.90    DZHELYADI 81 SPEC PI- P-->ETA N          1/82*

R25     ETA INTO MU+MU-/2GAMMA (UNITS 10**-5)            (P12)/(P1)
R25          (5.9)    (2.2)             HYAMS     69 OSPK                        7/69

R26     ETA INTO (PIO 2GAMMA)/(3PIO + PIO 2GAMMA)        (P7)/(P2+P7)
R26          (0.1)    (0.3)             KANOFSKY  70 CSPK                        2/71

R27     ETA INTO (PI+ PI-)/TOTAL (UNITS 10**-2)          (P15)                   6/73
R27      VIOLATES P AND T INVARIANCE
R27       0    0.15  CR LESS            THALER    73 ASPK CON. LEV. NOT GIVEN   6/73

R28     ETA INTO (E+E-GAMMA)/(PI+PI-PIO) (UNITS 10**-2)  (P8)/(P3)
R28  J  80    2.1       0.5             JANE2     75 OSPK                        2/76
R28  J  VALUE CHANGED BY ERRATUM.                                                2/76
R28           . . . . . . . . . .
R28 FIT       2.11      0.50   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R29     ETA INTO (E+ E-)/TOTAL  (UNITS 10**-4)           (P16)
R29  D         3.     CR LESS  CL=.90   DAVIES    74 RVUE                        2/78
R29  D  DAVIES 74 EXTRACTS THIS INFORMATION FROM ESTEN 67.                       2/78

R30     ETA INTO (MU+ MU- GAMMA)/TOTAL   (UNITS 10**-4)  (P'3)                   2/79
R30     100    (1.5)    (0.75)          BUSHNIN   78 SPEC REPL.BY DZHELYAI 80   2/79
R30     600     3.1      0.4            DZHELYAI  80 SPEC PI- P-->ETA N          9/81*

R31     ETA INTO (MU+ MU- PIO GAMMA)/TOT (UNITS 10**-6)  (P17)                   1/82*
R31            3.     CR LESS  CL=.90   DZHELYADI 81 SPEC PI- P-->ETA N          1/82*
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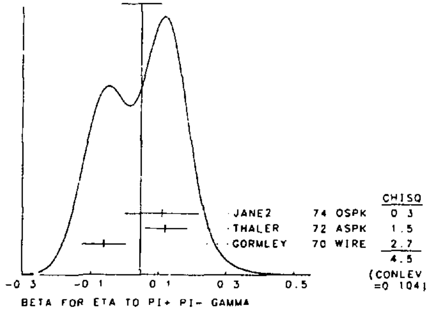
14 ETA C-NONCONSERVING DECAY PARAMETERS

RELATED TEXT SECTION VI C.1

```
A1      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
A1     1351     7.2      2.8            BALTAY    66 DBC                         6/66
A1     1300     5.8      3.4            CLPWY     66 HBC                         8/66
A1    10665    (0.3)    (1.0)           CNOPS     68 OSPK REPL BY MULLER 69      8/67
A1      705    -6.1      4.0            LARRIBE   66 HBC                         8/67
A1   G36800    (1.5)    (0.5)           GORMLEY3  68 ASPK                        6/68
A1    10709     0.3      1.1            MULLER    69 OSPK                        9/69
A1     1138    -1.4      3.             CARPENTR  70 HBC                         6/70
A1      349     3.2      5.4            DANBURG   70 DBC                         2/71
A1     220K    -0.05     0.22           LAYTER    72 ASPK                        8/72
A1     165K     3.28     0.26           JANE1     74 OSPK                        3/74
A1  G   GORMLEY3 68 ASYMMETRY PROBABLY DUE TO UNMEASURED (E X B) SPK. CH.        3/74
A1  G   EFFECTS.  NEW EXPTS. WITH (E X B) CONTROLS DONT OBSERVE ASYMMETRY.       3/74
A1           . . . . . . . . . .
A1  AVG         0.12      0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

A2      LEFT-RIGHT ASYMMETRY PARAMETER FOR PI+ PI- GAMMA (UNITS 10**-2)
A2       33    -2.       17.            CRAWFORD  66 HBC                        11/66
A2             -4.        8.            LITCHFIEL 67 DBC                         8/67
A2 N  1620      1.5       2.5           MULLER    69 OSPK                        9/69
A2     7257     1.22      1.56          GORMLEY   70 ASPK                        6/70
A2      36K     0.5       0.6           THALER    72 ASPK                        8/72
A2      35K     1.2       0.6           JANE2     74 OSPK                        3/74
A2 N  MULLER 69 IS SENSITIVE ONLY TO UPPER .4 OF GAMMA-RAY SPECTRUM,
A2           . . . . . . . . . .
A2  AVG         0.88      0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AS      SEXTANT ASYMMETRY PARAMETER FOR PI+ PI- PIO  (UNITS 10**-2)
AS     1300     6.8       3.3           CLPWY     66 HBC                        12/75
AS      705    -2.4       4.0           LARRIBE   66 HBC                        12/75
AS      37K     0.5       0.5           GORMLEY3  68 WIRE                       12/75
AS     220K     0.10      0.22          LAYTER    72 ASPK                       12/75
AS      65K     0.20      0.25          JANE1     74 OSPK                       12/75
AS           . . . . . . . . . .
AS  AVG         0.19      0.16    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AQ      QUADRANT ASYMMETRY PARAMETER FOR PI+ PI- PIO (UNITS 10**-2)
AQ     220K    -0.07      0.22          LAYTER    72 ASPK                       12/75
AQ     165K    -0.30      0.25          JANE1     74 OSPK                       12/75
AQ           . . . . . . . . . .
AQ  AVG        -0.17      0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

BET     BETA FOR ETA TO PI+ PI- GAMMA. SENSITIVE TO D-WAVE CONTRIBUTION.
BET     DN/DCOS THETA = SIN**2 THETA * (1 + BETA * COS**2 THETA)                12/75
BET    7250    -0.060     0.065         GORMLEY   70 WIRE                       12/75
BET  L          0.12      0.06          THALER    72 ASPK                       12/75
BET     35K     0.11      0.11          JANE2     74 OSPK                       12/75
BET  L  AUTHORS DONT BELIEVE THIS TO INDICATE D-WAVE BECAUSE DEPENDENCE OF      12/75
BET  L  BETA ON GAMMA ENERGY INCONSISTENT WITH THEOR. PREDICTION.               12/75
BET  L  COS**2 DEPENDENCE MAY ALSO COME FROM P AND F-WAVE INTERFERENCE.         12/75
BET          . . . . . . . . . .
BET AVG         0.047     0.062   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                                  (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0 047 ± 0.062
ERROR SCALED BY 1 5



14 ENERGY DEPENDENCE OF ETA DALITZ PLOT

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DP      RELATED TEXT SECTION VI C.2
DP      THE FOLLOWING EXPTS FIT TO ONE OR MORE OF THE COEFFICIENTS
DP      A,B,C,D, OR E FOR ETA TO PI+ PI- PIO
DP      MATRIX ELEMENT**2=1 + A*Y + B*(Y**2) + C*X + D*(X**2) + E*X*Y
DP    1300 SEE TEXT SEC VI C.2          CLPWY     66 HBC                        12/75
DP     705 SEE TEXT SEC VI C.2          LARRIBE   66 HBC                        12/75
DP    7170 SEE TEXT SEC VI C.2          CNOPS     68 OSPK                       12/75
DP     37K SEE TEXT SEC VI C.2          GORMLEY3  68 WIRE                       12/75
DP     526 SEE TEXT SEC VI C.2          BAGLIN    69 HLBC                       12/75
DP    1138 SEE TEXT SEC VI C.2          CARPENTR  70 HBC                        12/75
DP     349 SEE TEXT SEC VI C.2          DANBURG   70 DBC                        12/75
DP    7250 SEE TEXT SEC VI C.2          GORMLEY   70 WIRE                       12/75
DP    220K SEE TEXT SEC VI C.2          LAYTER    72 ASPK                       12/75
DP     81K SEE TEXT SEC VI C.2          LAYTER    73 ASPK                       12/75

AO      ALPHA PARAMETER FOR ETA TO 3 PIO
AO      MATRIX ELEMENT **2 = 1 + 2*ALPHA*Z (SEE TEXT SEC VI C.3)                12/75
AO     192   -0.32      0.37            BAGLIN    70 HLBC                       12/75
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REFERENCES FOR ETA


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PEVSNER  61 PRL 7 421          PEVSNER,KRAEMER,NUSSBAUM,RICHARDSON + (JHU)

ALFF     62 PRL 9 322          ALFF,BERLEY,COLLEY,BRUGGER + (COLU+RUTGERS)
BASTIEN  62 PRL 8 114          BASTIEN,BERGE,DAHL,FERRO-LUZZI +        (LRL)
CHRETIEN 62 PRL  9  127        CHRETIEN+    (BRAN+BROWN+HARVARD+MIT+PADOVA)
PICKUP   62 PRL 8 329          E PICKUP,ROBINSON,SALANT           (CNRC+BNL)

BACCI    63 PRL 11 37          BACCI,PENSO,SALVINI +              (ROMA+FRAS)
CRAWFORD 63 PRL 10 546         F S CRAWFORD,LLOYD,FOWLER          (LRL+DUKE)
    ALSO 66 PRL 16 907         F S CRAWFORD,L LLOYD,E FOWLER      (LRL+DUKE)
DELCOURT 63 PL 7 215           DELCOURT,LEFRANCOIS,PEREZ Y JORBA+    (ORSAY)

FOELSCHE 64 PR 134 B 1138      H W FOELSCHE,H L KRAYBILL              (YALE)
KRAEMER  64 PR 136 B 496       KRAEMER,MADANSKY,FIELDS +  (JHU+NWES+WOOD)
PAULI    64 PL 13 351          E PAULI,A MULLER                     (SACLAY)

FOSTER1  65 PR 138 B 652       FOSTER,PETERS,MEER,LOEFFLER + (WISC+PURDUE)
FOSTER2  65 ATHENS             FOSTER,GOOD,MEER                  (WISCONSIN)
FOSTER3  65 THESIS             M.C.FOSTER                        (WISCONSIN)
PRICE    65 PRL  15  123       L.R.PRICE,F.S.CRAWFORD                  (LRL)
RITTENBE 65 PRL 15 556         RITTENBERG,KALBFLEISCH              (LRL+BNL)

ALFF-STE 66 PR 145 1072        ALFF-STEINBERGER,BERLEY+ (COLUMBIA+RUTGERS)
BALTAY   66 PRL 16 1224        +FRANZINI,KIM,KIRSCH+(COLUMBIA+STONY BROOK)
CLPWY    66 PR 149  1044       COLUMBIA,LRL,PURDUE,WISCONSIN,YALE
CNOPS    66 PL 22 546          CNOPS,FINOCCHIARO,LASSALLE,+(CERN,ETH,SACL)
CRAWFORD 66 PRL  16  333       F.S.CRAWFORD,L.R.PRICE                  (LRL)

DIGIUGNO 66 PRL 16 767         DIGIUGNO,GIORGI,SILVESTRI+ (NAPL,TRST,FRAS)
GROSSMAN 66 PR 146  593        R GROSSMAN,L PRICE,F CRAWFORD           (LRL)
GRUNHAUS 66 THESIS             J.GRUNHAUS                         (COLUMBIA)
JAMES    66 PR 142   896       F E JAMES,H L KRAYBILL              (YALE+BNL)
JONES    66 PL 23  557         JONES,BINNIE,DUANE,HORSEY,MASON,(LOIC,RHEL)
LARRIBE  66 PL 23 600          LARRIBE,LEVEQUE,MULLER,PAULI,+  (SACL+RHEL)
WAHLIG   66 PRL   17  221      WAHLIG,SHIBATA,MANNELLI            (MIT+PISA)

BAGLIN1  67 PL 24B 637         BAGLIN,BEZAGUET,DEGRANGE,+        (EPOL+UCB)
BAGLIN2  67 BAPS 12 567        BAGLIN,BEZAGUET,DEGRANGE,+        (EPOL+UCB)
BALTAY1  67 PRL 19 1495        BALTAY,FRANZINI,KIM,NEWMAN+      (COLU+BRAN)
BALTAY2  67 PRL 19 1498        BALTAY,FRANZINI,KIM,NEWMAN+      (COLU+STON)
BEMPORAD 67 PL 25B 380         BEMPORAD,BRACCINI,FOA,LUBELSMEY+(PISA,BONN)
    ALSO     PRIVATE COMMUNICATION

BILLING  67 PL 25B 435         BILLING,BULLOCK,ESTEN,GOVAN,+     (LOUC+OXF)
BOWEN    67 PL 24B 206         BOWEN,CNOPS ,FINOCCHIARO,+ (CERN+ETH+SACL)
BUNIATOV 67 PL 25B 560         BUNIATOV,ZAVATTINI,DEINET,+     (CERN+KARL)
CENCE    67 PRL 19 1393        CENCE,PETERSON,STENGER,CHIU+  (HAWAII+LRL)
ESTEN    67 PL 24B 115         +GOVAN,KNIGHT,MILLER,TOVEY+       (LOUC+OXF)

FELDMAN  67 PRL 18 868         FELDMAN,FRATI,GLEESON,HALPERN,+      (PENN)
FLATTE   67 PRL 18 976         S.M.FLATTE                              (LRL)
FLATTE2  67 PR 163 1441        S.M.FLATTE AND C.G.WOHL                 (LRL)
LITCHFIE 67 PL 24B 486         LITCHFIELD,RANGAN,SEGAR,SMITH+(RHEL+SACLAY)
PRICE    67 PRL 18 1207        L.R.PRICE,F.S.CRAWFORD                  (LRL)

ARNOLD   68 PL 27B 466         +PATY,BAGLIN,BINGHAM+  (STRB+MADR+EPOL+UCB)
BAZIN    68 PRL 20 895         BAZIN,GOSHAW,ZACHER,+   (PRINCETON,QUEENS)
BULLOCK  68 PL 27B 402         +ESTEN,FLEMING,GOVAN,HENDERSON,OWEN+ (LOUC)
GORMLEY3 68 PRL 21 402         GORMLEY,HYMAN,LEE,NASH,PEOPLES+  (COLU+BNL)
WEHMANN  68 PRL 20 748         WEHMANN,ENGELS,+ (HARV+CASE+SLAC+CORN+MCGI)

BAGLIN   69 PL 29B 445         BAGLIN,BEZAGUET,+      (EPOL,UCB,MADR,STRB)
    ALSO 70 NP B22 66          +BEZAGUET,DEGRANGE,MUSSET +(EPOL,MADR,STRB)
HYAMS    69 PL 29B 128         HYAMS,KOCH,POTTER,VON LINDERN,+ (CERN,MPIM)
JACQUET  69 NC 58 743          JACQUET,NGUYEN-KHAC,HAATUFT+    (EPOL,BERG)
MULLER   69 THESIS             ARMAND MULLER                          (STRB)

BAGLIN   70 NP B22 66          +BEZAGUET,DEGRANGE,MUSSET+ (EPOL+MADR+STRB)
BUTTRAM  70 PRL 25 1358        +KREISLER,MISCHKE                      (PRIN)
CARPENTR 70 PR D1 1303         CARPENTER,BINKLEY,CHAPMAN,COX,DAGAN+ (DUKE)
COX      70 PRL 24 534         COX,FORTNEY,GOLSON                     (DUKE)

DANBURG  70 PR D2 2564         +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,+        (LRL)
DEVONS   70 PR D1 1936         +GRUNHAUS,KOZLOWSKI,NEMETHY +    (COLU,SYRA)
GORMLEY  70 PR D2 501          GORMLEY,HYMAN,LEE,NASH,PEOPLES+  (COLU+BNL)
    ALSO 70 NEVIS 181(THESIS)  MICHAEL GORMLEY                        (COLU)
KANOFSKY 70 NC 68 413          A. KANOFSKY                            (LEHI)
SCHMITT  70 PL 32B 633         +BUNIATOV,ZAVATTINI,DEINET+     (CERN,KARL)

BASILE   71 NC 3A 796          +BOLLINI,DALPIAZ,FRABETTI+ (CERN,BGNA,STRB)
STRUGALS 71 NP B27 429         +CHUVILO,GEMESY,IVANOVSKAYA+           (JINR)
AGUILAR- 72 PR D6 29           AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
BLOODWOR 72 NP B39 525         BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
LAYTER   72 PRL 29 316         +APPEL,KOTLENSKI,LEE,STEIN,THALER      (COLU)
THALER   72 PRL 29 313         +APPEL,KOTLENSKI,LAYTER,LEE,STEIN      (COLU)

LAYTER   73 PR D7 2565         +APPEL,KOTLENSKI,LEE,STEIN,THALER      (COLU)
THALER   73 PR D7 2569         +APPEL,KOTLENSKI,LAYTER,LEE,STEIN      (COLU)
BROWMAN  74 PRL 32 1067        +DEWIRE,GITTELMAN,HANSON,LOH + (CORN+BING)
DAVIES   74 NC 24A 324         +GUY,ZIA                  (BIRM+RHEL+SHMP)
JANE1    74 PL 48B 260         +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
JANE2    74 PL 48B 265         +JONES,LIPMAN,OWEN,PENNEY+ (RHEL+LOWC+SUSS)
KENDALL  74 NC 21A 387         +LANDU,MASSIMO,SHAPIRO +     (BROW+BART+MIT)

JANE1    75 PL 59B 99          +GRANNIS,JONES,LIPMAN,OWEN +    (RHEL+LOWC)
JANE2    75 PL 59B 103         +GRANNIS,JONES,LIPMAN,OWEN +    (RHEL+LOWC)
    ALSO 76 PL (TO BE PUBL.)   ERRATUM, M.R.JANE, PRIVATE COMMUNICATION.
MARTYNOV 76 SJNP 23 48         +SALTYKOV,TARASOV,UZHINSKII            (JINR)
BUSHNIN  78 PL 79B 147         +DZHELYADIN,GOLOVKIN,GRITSUCK +        (SERP)
    ALSO 78 SJNP 28 775        BUSHNIN,GOLOVKIN,GRITSUK,DZHELYADIN+   (SERP)
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ABROSIMO 80 SJNP 31 195        ABROSIMOV,ITINA,NISZCZ,OKHRIMENKO+    (JINR)
DZHELYA1 80 PL 94B 548         DZHELYADIN,GOLOVKIN,KACHANOV +        (SERP)
   ALSO  80 SJNP 32 516 (YF 32 998) VIKTOROV, GOLOVKIN +             (SERP)
DZHELYA2 80 PL 97B 471         DZHELYADIN,GOLOVKIN,KACHANOF +        (SERP)
   ALSO  80 SJNP 32 518 (YF 32 1002) VIKTOROV, GOLOVKIN +            (SERP)
DAVYDOV  81 LNC 32 45          +DONSKOV,INYAKIN +     (SERP+BELG+LAPP+CERN)
DZHELYAD 81 PL 105B 239        DZHELYADIN,GOLOVKIN,KONSTANTINOV +    (SERP)

       QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BASTIEN  62 PRL 8 114          BASTIEN,BERGE,DAHL,FERRO-LUZZI,MILLER+(LRL)
CARMONY  62 PRL 8 117          D CARMONY,A ROSENFELD,VAN DE WALLE    (LRL)
ROSENFEL 62 PRL 8 293          A ROSENFELD,D CARMONY,VAN DE WALLE    (LRL)

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$K^{\pm}$

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              10  CHARGED K(494,JP=0-) I=1/2

              10  CHARGED K MASS (MEV)

M          493.9       0.2           COHEN     57 RVUE +
M          493.7       0.3           BARKAS    63 EMUL  -
M          493.78      0.17          GREINER   65 EMUL +   VIA TAU DECAY     7/66
M         (493.87)    (0.19)         KUNSELMAN 71 CNTR REPL.BY KUNSELMAN74  10/71
M          493.691     0.040         BACKENSTO 73 CNTR  - KAONIC ATOMS       1/73
M          493.662     0.19          KUNSELMAN 74 CNTR  - KAONIC ATOMS       3/74
M          493.657     0.020         CHENG     75 CNTR -  KAONIC ATOMS       6/77
M          493.670     0.029         BARKOV    79 EMUL +- E+E- --> K+ K-     7/79
M          493.640     0.054         LUM       81 CNTR -  KAONIC ATOMS       1/82*
M          . . . . . . . . . .
M   AVG    493.666     0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT    493.667     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

              10  (K+) - (K-) MASS DIFFERENCE (MEV)

DM J  1.5M   -0.032    0.090             FORD      72 ASPK +-                4/72
DM F    FORD 72 USES M(PI+)-M(PI-) = +28+-70 KEV.                           1/73

              10  CHARGED K MEAN LIFE (UNITS 10**-8 SEC)

T          CHAR. K MEAN LIFE
T    U         (0.95)    (0.36)    (0.25) ILOFF     56 EMUL
T    U    52   (1.60)    (0.3)     (0.7)  EISENBERG 58 EMUL
T               1.21      0.06      0.06  BURROWES  59 CNTR
T    U    33   (1.38)    (0.24)    (0.24) FREDEN    60 EMUL
T    U         (1.25)    (0.22)    (0.17) BARKAS    61 EMUL
T    U    51   (1.27)    (0.36)    (0.23) BHOWMIK   61 EMUL
T        293    1.31      0.08      0.08  NORDIN    61 HBC   -
T              (1.24)    (0.07)           NORDIN    61 RVUE  -
T               1.231     0.011     0.011 BOYARSKI  62 CNTR +
T               1.2443    0.0036          FITCH     65 CNTR +   K AT REST      6/66
T               1.221     0.011           FORD      67 CNTR +-                8/67
T               1.2272    0.0036          LOBKOWICZ 69 CNTR +   K IN FLIGHT    9/66
T         3M    1.2380    0.0016          OTT       71 CNTR  +  STOPPING  K    2/71
T    U   OLD EXPERIMENTS WITH LARGE ERRORS EXCLUDED FROM AVERAGING             2/71
T          . . . . . . . . . .
T    AVG        1.2370    0.0032    0.0032 AVERAGE (ERROR INCL. SCALE FACTOR OF 2.4)
T    FIT        1.2371    0.0026 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.9)
                          (SEE IDEOGRAM BELOW )
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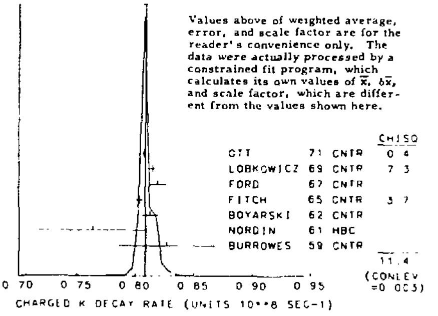
WEIGHTED AVERAGE = 0.8084 ± 0 0021
ERROR SCALED BY 2 4

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              10  ((K+) - (K-))/AVG., MEAN LIFE DIFFERENCE (PERCENT)

DT   N   THIS QUANTITY IS A MEASURE OF CPT INVARIANCE IN W.I.

DT             0.47       0.30             FORD      67 CNTR                  8/67
DT             0.090      0.078            LOBKOWICZ 69 CNTR                 12/70
DT          . . . . . . . . . .
DT   AVG       0.115      0.093   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
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              10  CHARGED K PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     CHAR. K INTO MU NEU                 K MU2          105+   0
P2     CHAR. K INTO PI PI0                 K PI2          139+ 134
P3     CHAR. K INTO PI PI+ PI-             TAU            139+ 139+ 139
P4     CHAR. K INTO PI 2PI0                TAU PRIME      139+ 134+ 134
P5     CHAR. K INTO MU PI0 NEU             K MU3          105+ 134+   0
P6     CHAR. K INTO E PI0 NEU              K E3            .5+ 134+   0
P7     K+ INTO PI+ PI- E+ NEU              K E+ 4         139+ 139+  .5+   0
P8     K+ INTO PI+ PI+ E- NEU              K E- 4         139+ 139+  .5+   0
P9     K+ INTO PI+ PI- MU+ NEU             K+MU+ 4        139+ 139+ 105+   0
P10    K+ INTO PI+ PI+ MU- NEU             K+MU- 4        139+ 139+ 105+   0
P11    CHAR. K INTO E NEU                  K E2            .5+   0
P12    CHAR. K INTO MU NEU GAMMA           K MU RAD       105+   0+   0
P13    CHAR. K INTO PI PI0 GAMMA           K PI RAD       139+ 134+   0
P14    CHAR. K INTO PI PI+ PI- GAMMA       TAU RAD        139+ 139+ 139+   0
P15    CHAR. K INTO PI E+ E-               PI E E         139+  .5+  .5
P16    CHAR. K INTO PI MU+ MU-             PI MU MU       139+ 105+ 105
P17    CHAR. K INTO PI GAMMA GAMMA         PI GAM GAM     139+   0+   0
P18    CHAR. K INTO PI0 E NEU GAMMA        PI E NEU GAM   134+  .5+   0+   0
P19    K+- INTO PI-+ E+- E+-               PI-+E+-E+-     139+  .5+  .5
P20    CHAR. K INTO PI NEU NEU             PI NEU NEU     139+   0+   0
P21    CHAR. K INTO E NEU GAMMA            K E2 RAD        .5+   0+   0
P22    CHAR. K INTO PI GAMMA               K PI GAM       139+   0
P23    CHAR. K INTO PI 3GAMMA              PI 3GAM        139+   0+   0+   0
P24    CHAR. K INTO PI0 PI0 E NEU          K E4 2PI0      134+ .34+  .5+   0
P25    K+ INTO PI- E+ MU+                  PI-E+MU+       139+  .5+ 105
P26    K+ INTO PI+ E+ MU-                  PI+E+MU-       139+  .5+ 105
P27    CHAR. K INTO MU NEU NEU NEUBAR      MU 3NEU        105+   0+   0+   0
P28    CHAR. K INTO PI0 MU NEU GAMMA       PI MU NEU GAM  134+ 105+   0+   0
P29    K+ INTO PI+ MU+ E-                  PI+MU+E-       139+ 105+  .5
P30    CHAR. K INTO MU NEU E+ E-           MU NEU E+E-    105+   0+  .5+  .5
P31    K+- INTO MU-+ NEU E+- E+-           MU-+ NEU 2E+-  105+   0+  .5+  .5
P32    CHAR. K INTO NEU E E E              NEU 3E           0+  .5+  .5+  .5
P33    CHAR. K INTO E NEU NEU NEUBAR       E 3NEU          .5+   0+   0+   0
P34    K+ INTO MU+ NEU(E)                                 105+   0

                CHARGED K CONSTRAINED FIT
           OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
           RATIOS USES 59 DATA POINTS TO DETERMINE SIX                  4/82*
           QUANTITIES.  OVERALL FIT HAS CHISQ=78.9.  MAIN               4/82*
           CONTRIBUTION (13.2) COMES FROM R19 OF HAILT                  4/82*
           (I THE SEE NO REASON TO REJECT THIS EXPERIMENT
           AT THIS TIME)
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived fr[illegible] matrix for the [illegible] partial decay mode branching fractions, P_i, as [illegible] diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\delta P_i \delta P_i}$, while the off-diagonal elements are the normalized [illegible] coefficients $\delta P_i \delta P_j / (\delta P_i \cdot \delta P_j)$ [illegible] the deviation of the individual P_i [illegible] above, only those P_i appearing in the matrix are assumed [illegible] are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4          P 5          P 6
P 1  .6350+-.0016
P 2   -.7384   .2116+-.0015
P 3   -.1925    -.0392   .0559+-.0003
P 4   -.1827     .0359     .2061   .0173+-.0005
P 5   -.2705    -.2318    -.1189    -.3284   .0320+-.0009
P 6   -.3391    -.1386     .1501     .0263     .2126  .0482+ .0005
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, trans[illegible] rate space, i.e., $G_i = \Gamma_i = \Gamma_{total} P_i$, in appropriate units. [illegible] analog[illegible] the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\delta G_i \delta G_i}$, while the off-diagonal elements are the normalized correlation coefficients [illegible] because of the error in Γ_{total}, the errors and correlations here are [illegible] from those above.

```
        G 1          G 2          G 3          G 4          G 5          G 6
G 1  .5133+-.0017
G 2   -.3278   .1719+-.0013
G 3   -.0997    -.0026   .0452+-.0002
G 4   -.1088     .0434     .2084   .0140+-.0004
G 5   -.1605     .1573    -.1239    -.3248   .0258+-.0007
G 6   -.1553    -.0805     .1512     .0313     .2198  .0390+ .0004

              10  CHARGED K DECAY RATES

W1     CHAR. K INTO MU NEU (UNITS 10**6 SEC-1)           (G1)
W1            51.2       0.8            FORD      67 CNTR +-                 8/67
W1         . . . . . . . . . .
W1   FIT      51.33      0.17   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

W2     CHAR. K INTO PI PI+ PI- (UNITS 10**6 SEC-1)       (G3)
W2   F       (4.496)    (0.030)         FORD      67 CNTR +- SEE NOTE F      8/67
W2   F 3.2M  (4.529)    (0.032)         FORD      70 ASPK    SEE NOTE F     11/70
W2            4.511      0.024          FORD      70 ASPK    SEE NOTE F     11/70
W2   F   THE LAST IS THE COMBINED RESULT OF FORD 67 AND FORD 70
W2         . . . . . . . . . .
W2   FIT      4.517      0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

              10  ((K+) - (K-))/AVG., DECAY RATE DIFFERENCE (PERCENT)

D1     DIFFERENCE IN K MU2 RATES      ((G1+)-(G1-))/G1        (PERCENT)
D1           -0.54       0.41           FORD      67 CNTR                    8/67

D2     DIFFERENCE IN TAU RATES        ((G3+)-(G3-))/G3        (PERCENT)
D2           -0.50       0.90           FLETCHER  67 OSPK                    8/67
D2   F      (-0.04)     (0.21)          FORD      67 CNTR    SEE NOTE F      8/67
D2   F 3.2M  (0.10)     (0.14)          FORD      70 ASPK    SEE NOTE F     11/70
D2   F        0.08       0.12           FORD      70 ASPK    SEE NOTE F     11/70
D2   S      (-0.07)     (0.16)          SMITH     73 ASPK +-                11/73
D2   F   SECOND FORD 70 VALUE IS FIRST FORD 70 COMBINED WITH FORD 67.
D2   S   SMITH 73 VALUE OF D2 IS DERIVED FROM SMITH 73 VALUE OF D3.         11/73
D2         . . . . . . . . . .
D2   AVG      0.07       0.12   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
 4      DIFFERENCE IN TAU PRIME RATES ((G4+)-(G4-))/AVERAGE    (PERCENT)
 4   1832   -1.1      1.8              HERZ       69 CSPK                            5/73
 4          0.08      0.58             SMITH      73 ASPK +-                        11/73
 4             . . . . . . . . . .
 4  AVG     0.03      0.55   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

 4      DIFFERENCE IN K PI2 RATES      ((G2+)-(G2-))/AVERAGE    (PERCENT)
 4          0.8       1.2              HERZ       69 CSPK                            5/73

 5      DIFFERENCE IN K PI RAD RATES  ((G13+)-(G13-))/AVERAGE (PERCENT)
 5     24   0.0      24.0              EDWARDS    72 OSPK     PI KE 58-90 MEV    6/72
 5   4002   1.0       4.0              ABRAMS     73 ASPK +-  PI KE 51-100 MEV   3/74
 5   2461   0.8       5.8              SMITH      76 WIRE +-  PI+-KE 55-90 MEV  11/76
 5             . . . . . . . . . .
 5  AVG     0.9       3.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

15 CHARGED K BRANCHING RATIOS

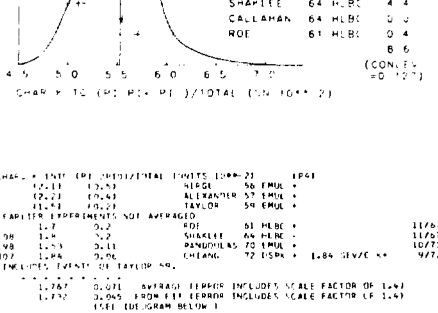
```
      C      LCD DATA EXCLUDED

R1      CHAR. K INTO (MU NEUT)/TOTAL (UNITS 10** 2)        (P1)
R1           (58.5)      (4.1)           BIRGE      56 EMUL +
R1           (56.5)      (2.6)           ALEXANDER  57 EMUL +
R1    C   THESE EXPERIMENTS NOT INCLUDED IN AVERAGING.                              1/71
R1     62K   63.24       0.44            CHIANG     72 OSPK +  1.84 GEV/C K+        9/72
R1             . . . . . . . . . .
R1  FIT      63.53       0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      CHAR. K INTO (PI PI0)/TOTAL (UNITS 10**-2)          (P2)
R2           (27.7)      (2.7)           BIRGE      56 EMUL +
R2    C      (23.2)      (2.2)           ALEXANDER  57 EMUL +
R2    D   EARLIER EXPERIMENTS NOT AVERAGED
R2           (21.3)      (5.6)           CALLAHAN   65 HLBC       [illegible]
R2           (21.6)      (5.4)           TRILLING   65 RVUE                             6/66
R2     16K   21.18       0.8             CHIANG     72 OSPK +  1.84 GEV/C K+            9/72
R2             . . . . . . . . . .
R2  FIT      21.17       0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      CHAR. K INTO (PI PI+ PI-)/TOTAL (UNITS 10**-2)     (P3)
R3           (5.6)       (0.4)           BIRGE      56 EMUL +
R3    D      (6.4)       (0.6)           ALEXANDER  57 EMUL +
R3           (5.2)       (0.8)           TAYLOR     59 EMUL +
R3    D   EARLIER EXPERIMENTS NOT AVERAGED
R3           5.7         0.3             ROE        61 HLBC +                           9/66
R3    1335   5.54        0.12            CALLAHAN   66 HLBC +
R3     560   5.1         0.2             SHAKLEE    64 HLBC +                           9/66
R3           5.71        0.15            DE MARCO   65 HBC                              6/66
R3      44   5.2         0.4             YOUNG      65 EMUL +                           6/66
R3 P   693   5.34        0.21            PANDOULAS  70 EMUL +                          10/71
R3  I 2330   (5.56)      (0.20)          CHIANG     72 OSPK +  1.84 GEV/C K+            9/72
R3    I   THIS VALUE IS NOT INDEPENDENT OF CHIANG 72 R1,R2,R4,R5, AND R6               9/72
R3 P      INCLUDES EVENTS OF TAYLOR 59.
R3             . . . . . . . . . .
R3  AVG      5.521       0.098   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
R3  FIT      5.584       0.035   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                               (SEE IDEOGRAM BELOW)
```

WEIGHTED AVERAGE = 5.521 ± 0.098
ERROR SCALED BY 1.1

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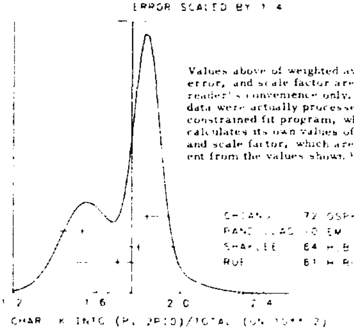
R4      CHAR. K INTO (PI 2PI0)/TOTAL (UNITS 10**-2)         (P4)
R4    D      (2.1)       (0.5)           BIRGE      56 EMUL +
R4    D      (2.2)       (0.4)           ALEXANDER  57 EMUL +
R4    D      (1.5)       (0.2)           TAYLOR     59 EMUL +
R4    D   EARLIER EXPERIMENTS NOT AVERAGED
R4           1.7         0.2             ROE        61 HLBC +                          11/67
R4     198   1.8         0.2             SHAKLEE    64 HLBC -                          11/67
R4 P   198   1.53        0.11            PANDOULAS  70 EMUL +                          10/73
R4    1307   1.84        0.06            CHIANG     72 OSPK +  1.84 GEV/C K+            9/72
R4 P      INCLUDES EVENTS OF TAYLOR 59.
R4             . . . . . . . . . .
R4  AVG      1.767       0.071   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R4  FIT      1.732       0.045   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)
                               (SEE IDEOGRAM BELOW)

R5      CHAR. K INTO (MU PI0 NEUT)/TOTAL (UNITS 10**-2)     (P5)
R5    D      (2.8)       (1.0)           BIRGE      56 EMUL +
R5    D      (5.9)       (1.3)           ALEXANDER  57 EMUL +
R5    C      (2.8)       (0.4)           TAYLOR     59 EMUL +
R5    C   EARLIER EXPERIMENTS NOT AVERAGED
R5    2345   3.33        0.16            CHIANG     72 OSPK +  1.84 GEV/C K+            9/72
R5             . . . . . . . . . .
R5  FIT      3.197       0.08   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)
```

WEIGHTED AVERAGE = 1.767 ± 0.071
ERROR SCALED BY 1.4

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R6      CHAR. K INTO (E PI0 NEUT)/TOTAL (UNITS 10** 2)      (P6)
R6           (3.2)       (1.3)           BIRGE      56 EMUL +
R6    D      (5.1)       (1.3)           ALEXANDER  57 EMUL +
R6    C   EARLIER EXPERIMENTS NOT AVERAGED
R6           5.0         0.5             ROE        61 HLBC +                          11/67
R6     429   4.7         0.3             SHAKLEE    64 HLBC +                          11/67
R6    3516   4.86        0.1             CHIANG     72 OSPK +  1.84 GEV/C K+            9/72
R6             . . . . . . . . . .
R6  AVG      4.849       0.093   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT      4.816       0.07    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R7      CHAR. K INTO (PI+ + MU+)/TOTAL (UNITS 10**-2)      (P2+P1)                    11/67
R7      WE COMBINE THESE TWO MODES FOR EXPTS MEASURING THE SUM ONLY, OR
R7      BECAUSE OF DIFFICULTIES OF SEPARATING THEM THERE
R7           23.4        1.1             ROE        61 HLBC +                          11/67
R7     886   25.6        0.9             SHAKLEE    64 HLBC +                          11/67
R7             . . . . . . . . . .
R7  AVG      24.69       0.95    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R7  FIT      24.36       0.1     FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R8      K+ INTO (PI+ PI+ E- NEUT)/TOTAL (UNITS 10**-7)     (P8)
R8           (2.5)    OR LESS   CL=.95   BIRGE      65 FBC  +                           6/66
R8      0    (6.9)    OR LESS   CL=.95   ELY        69 HLBC +                          10/69
R8      0    (9.0)    OR LESS   CL=.95   SCHWEINBE  71 HLBC +                           9/71

R9      K+ INTO (PI+ PI+ MU- NEUT)/TOTAL (UNITS 10**-5)    (P9)
R9      1    (0.77)    (0.54)    (1.50)  CLINE      65 FBC  +                           6/66

R10     K+ INTO (PI+ PI+ MU- NEUT)/TOTAL (UNITS 10**-6)    (P10)
R10     0    3.       OR LESS   CL=.95   BIRGE      65 FBC  +                           6/66

R11     CHAR. K INTO (E NEUT)/TOTAL (UNITS 10**-5)         (P11)
R11          (1.5)    OR LESS   CL=.95   BOTTERILL  66 HBC  +                          11/67
R11     4    (2.1)     (1.4)     (1.3)   BOWEN      67 CSPK +                           8/67

R12     CHAR. K INTO (PI GAMMA GAMMA)/TOTAL (UNITS 10**-4)
R12                                                        (P17)
R12     ALL VALUES GIVEN HERE ASSUME A PHASE SPACE PI+ ENERGY SPECTRUM                  1/72
R12          (0.1)     (0.6)             CHEN       68 OSPK +  TE(PI) 60-90 MEV         9/73
R12     3    (0.5)    OR LESS   CL=.90   KLEMS      71 OSPK +  TE(PI)GT 117 MEV         6/71
R12     0    3.5      OR LESS   CL=.90   LJUNG      73 HLBC +  5-102,114-127MEV         5/73
R12     0    (-0.42)   (0.52)            ABRAMS     77 SPEC +  TE(PI)LT 92 MEV         12/77

R13     CHAR. K INTO (PI PI0 GAMMA)/TOTAL (UNITS 10** 4) (P13)
R13 U   18   (2.2)     (0.7)             CLINE      64 FBC  +  PI+ KE 55-80 MEV         6/66
R13     0    (1.9)    OR LESS   CL=.90   EMMERSON   69 OSPK    PI+ KE 55-90 MEV        10/69
R13 M   3    (1.0)    OR LESS            MALTSEV    70 HLBC +  PI+ KE LT 55 MEV        12/75
R13  A2100   2.71      0.19              ABRAMS     72 ASPK +- PI+ KE 55-90 MEV         1/73
R13 U   24   (2.4)     (0.8)             EDWARDS    72 OSPK    PI+ KE 58-90 MEV         6/72
R13 L        (1.5)     (1.1)     (0.6)   LJUNG      73 HLBC +  PI+ KE 55-80 MEV         5/73
R13 L        (2.6)     (1.5)     (1.1)   LJUNG      73 HLBC +  PI+ KE 55-90 MEV         5/73
R13 UL  17   (6.8)     (3.7)     (2.1)   LJUNG      73 HLBC +  PI+ KE 55-102MEV         5/73
R13   2461   2.87      0.32              SMITH      76 WIRE +- PI+-KE 55-90 MEV        11/76
R13 C   ONLY HIGH STATISTICS EXPERIMENTS ARE AVERAGED.                                  3/78
R13 M   MALTSEV 70 SELECTS LOW PI+ ENERGY TO ENHANCE DIRECT EMISSION CONTR.             1/76
R13 L   THE LJUNG 73 VALUES ARE NOT INDEPENDENT.                                        5/73
R13 A   ABRAMS 72 OBSERVES DIRECT EMISSION BR. RATIO OF (1.56+-0.35)*10**-5            1/73
R13 A   +-0.5*10**-5 ADDNL. SYST. ERROR  AND INNER BREMSSTRAHLUNG BR. RATIO            1/73
R13 A   OF (2.55+-0.18)*10**-4.  WE QUOTE THE SUM OF THESE BR. RATIOS.                  1/73
R13            . . . . . . . . . .
R13 AVG      2.75      0.16     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14     CHAR. K INTO (PI PI+ PI- GAMMA)/TOTAL (UNITS 10**-4)
R14                                                        (P14)
R14          1.0       0.4               STAMER     65 EMUL +  EGAM GT 11MEV            6/66

R15     CHAR. K INTO (PI E+ E-)/TOTAL (UNITS 10**-6)       (P15)
R15     1    (2.45)   OR LESS   CL=.90   CAMERINI   64 FBC  +                           6/66
R15          (4.4)    OR LESS   CL=.90   BISI       67 DBC  +                          11/67
R15 C        (0.4)    OR LESS            CLINE1     67 FBC  +                          11/67
R15 C        (0.88)   OR LESS   CL=.90   CLINE2     67 FBC  +                           2/74
R15          (32.0)   OR LESS   CL=.90   BEIER      72 CSPK +-                          9/72
R15          (1.7)    OR LESS   CL=.90   CENCE      74 ASPK +  THREE TRACK EVTS        10/74
R15          (0.27)   OR LESS   CL=.90   CENCE      74 ASPK +  TWO TRACK EVENTS        10/74
R15 C   CLINE2 REPLACES CLINE1.  CLINE1 IS NOT FOR CL=.90 .                             2/74

R16     CHAR. K INTO (PI MU+ MU-)/TOTAL (UNITS 10**-6)     (P16)
R16          (3.0)    OR LESS   CL=.90   CAMERINI   65 FBC  +                           6/66
R16          2.4      OR LESS   CL=.90   BISI       67 DBC  +                          11/67

R17     CHAR. K INTO (PI PI0)/TAU                          (P2)/(P3)
R17     134   3.24     0.34              YOUNG      65 EMUL +                           8/66
R17    1045   3.96     0.15              CALLAHAN   66 FBC  +                           9/66
R17            . . . . . . . . . .
R17 AVG       3.84     0.27     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R17 FIT       3.787    0.034    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
```
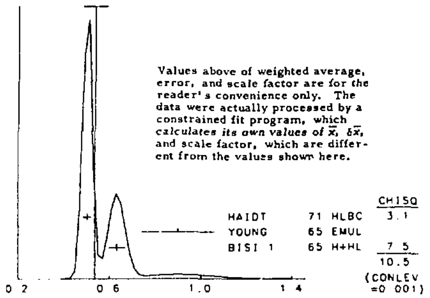

```
R18    CHAR. K INTO (PI 2PI0)/TAU                              (P4)/(P3)
R18   2027    0.303     0.009          BISI       65 H+HL +                  8/66
R18     17    0.393     0.099          YOUNG      65 EMUL +                  8/66
R18          . . . . . . . . . .
R18 AVG       0.3037    0.0090  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 FIT       0.3100    0.0080 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R19    CHAR. K INTO (MU PI0 NEU)/TAU                           (P5)/(P3)
R19   2845    0.632     0.035          BISI 1     65 H+HL +                  8/66
R19     38    0.90      0.16           YOUNG      65 EMUL +                  8/66
R19 H 1505   (0.510)   (0.017)         EICHTEN    68 HLBC +                 11/68
R19  H1505    0.503     0.019          HAIDT      71 HLBC +                 12/70
R19  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R19          . . . . . . . . . .
R19 AVG       0.536     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.2)
R19 FIT       0.572     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.536 ± 0.054
ERROR SCALED BY 3 2



CHARGED K INTO (MU PI0 NEU)/TAU

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R20    CHAR. K INTO (E PI0 NEU)/TAU                            (P6)/(P3)
R20    230    0.90      0.06           BORREANI   64 HBC  +                  8/66
R20     37    0.90      0.16           YOUNG      65 EMUL +                  8/66
R20    854    0.94      0.09           BELLOTT2   67 HLBC                   11/67
R20 H 4385   (0.846)   (0.021)         EICHTEN    68 HLBC +                 11/68
R20  H4385    0.850     0.019          HAIDT      71 HLBC +                 12/70
R20   2827    0.856     0.040          BRAUN      75 HLBC +                 12/75
R20  H  HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R20          . . . . . . . . . .
R20 AVG       0.858     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R20 FIT       0.8633    0.0098 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R21    K+ INTO (PI+ PI- E+ NEU)/TAU (UNITS 10**-4)             (P7)/(P3)
R21     69    5.7       1.5            BIRGE      65 FBC  +                  8/66
R21    269    5.83      0.63           ELY        69 HLBC +                 11/68
R21    500    7.36      0.68           BOURQUIN   71 ASPK                   12/71
R21    106    7.0       0.9            SCHWEINBE  71 HLBC +                  9/71
R21    30K    7.21      0.32           ROSSELET   77 SPEC +                 11/77
R21          . . . . . . . . . .
R21 AVG       6.98      0.26    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22    K+ INTO (PI+ PI- MU+ NEU)/TAU (UNITS 10**-4)            (P9)/(P3)
R22      1   (2.5)   APPROX            GREINER    64 EMUL +                  8/66
R22      7    2.57      1.55           BISI       67 DBC  +                 11/67

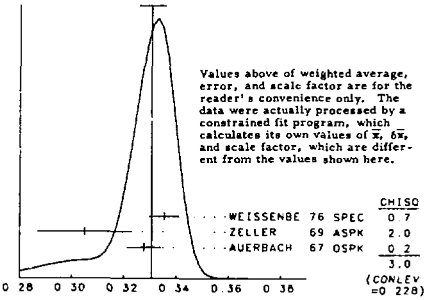
R23    CHAR. K INTO (E PI0 NEU)/(MU2+PI2) (UNITS 10**-2)(P6)/(P1+P2)
R23   1679    5.89      0.21           CESTER     66 OSPK +                  8/67
R23   5110    6.16      0.22           ESCHSTRUT  68 OSPK +                  3/68
R23  W        5.92      0.65           WEISSENBE  76 SPEC +                  1/78
R23  W  VALUE CALCULATED FROM WEISSENBERG 76 KE3, KMU2, KPI2 VALUES          1/78
R23  W  TO ELIMINATE DEPENDENCE ON OUR 1974 TAU AND TAU-PRIME FRACTIONS.     1/78
R23          . . . . . . . . . .
R23 AVG       6.01      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R23 FIT       5.698     0.067  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R24    CHAR. K INTO (PI PI0)/(MU NEU)                          (P2)/(P1)
R24  A4517    0.3277    0.0065         AUERBACH   67 OSPK +                  1/74
R24   1600    0.309     0.018          ZELLER     69 ASPK +                 10/69
R24 W  25K   (0.328)   (0.005)         WEISSENBE  74 STRC +                  7/74
R24  W        0.3355    0.0057         WEISSENBE  76 SPEC +                  1/78
R24  A  AUERBACH 67 CHANGED FROM .3253+-.0065.  SEE COMMENT WITH RATIO R26.  1/74
R24  W  WEISSENBERG 76 REVISES WEISSENBERG 74.                               1/78
R24          . . . . . . . . . .
R24 AVG       0.3307    0.0051  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R24 FIT       0.3332    0.0030 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
                        (SEE IDEOGRAM BELOW )

R25    CHAR. K INTO (E PI0 NEU)/(MU NEU)                       (P6)/(P1)
R25  A 295    0.0791    0.0054         AUERBACH   67 OSPK +                  1/74
R25    960    0.0775    0.0033         BOTTERI1   68 ASPK +                  5/68
R25    561    0.069     0.006          GARLAND    68 OSPK +                  4/68
R25    350    0.069     0.006          ZELLER     69 ASPK +                 10/69
R25  A  AUERBACH 67 CHANGED FROM .0797+-.0054.  SEE COMMENT WITH RATIO R26.  1/74
R25  A  THE VALUE .0785+-.0025 GIVEN IN AUERBACH 67 IS AN AVERAGE OF         3/74
R25  A  AUERBACH 67 R25 AND CESTER 66 R23.                                   3/74
R25          . . . . . . . . . .
R25 AVG       0.0752    0.0024  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R25 FIT       0.07597   0.00091 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R26    CHAR. K INTO (MU PI0 NEU)/(MU NEU)                      (P5)/(P1)
R26  A 307    0.0486    0.0040         AUERBACH   67 OSPK +                  1/74
R26  G 424    0.0480    0.0037         GARLAND    68 OSPK +                  1/74
R26    240    0.054     0.009          ZELLER     69 ASPK +                 10/69
R26  A  AUERBACH 67 CHANGED FROM .0602+-.0046 BY ERRATUM WHICH BRINGS THE    1/76
R26  A  MU-SPECTRUM CALCULATION INTO AGREEMENT WITH GAILLARD 70 APPENDIX B.  1/74
R26  G  GARLAND 68 CHANGED FROM .055+-.004 IN AGREEMENT WITH MU-SPECTRUM     1/74
R26  G  CALCULATION OF GAILLARD 70 APPENDIX B. L.G.PONDROM, PRIV.COMM.(73)   1/74
R26          . . . . . . . . . .
R26 AVG       0.0498    0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R26 FIT       0.0507    0.0014 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)
```

WEIGHTED AVERAGE = 0.3307 ± 0.0051
ERROR SCALED BY 1 2



CHAR. K INTO (PI PI0)/(MU NEU)

```
R27    CHAR. K INTO (MU NEU)/TAU                               (P1)/(P3)
R27 R  427  (10.38)    (0.82)          YOUNG      65 EMUL +                  9/66
R27 R   DELETED FROM OVERALL FIT BECAUSE YOUNG 65 CONSTRAINS HIS RESULTS.
R27 R   TO ADD UP TO 1.  ONLY YOUNG MEASURED MU2 DIRECTLY.
R27          . . . . . . . . . .
R27 FIT      11.364     0.072   FROM FIT

R28    CHAR. K INTO (E NEU)/(MU NEU) (UNITS 10**-5)       (P11)/(P1)
R28     10    1.9       0.7      0.5   BOTTERILL  67 ASPK +                 11/67
R28      8    1.8       0.8      0.6   MACEK      69 ASPK +                  4/69
R28    112    2.42      0.42           CLARK      72 OSPK +                  1/73
R28    534    2.37      0.17           HEARD2     75 SPEC +                 11/75
R28    404    2.51      0.15           HEINTZE    76 SPEC +                  2/76
R28          . . . . . . . . . .
R28 AVG       2.42      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R29    CHAR. K INTO (MU PI0 NEU)/(E PI0 NEU)                   (P5)/(P6)
R29  C1509    0.703     0.056          CALLAHA1   66 HLBC                    6/68
R29   5601    0.667     0.017          BOTTERI2   68 ASPK +                  6/68
R29 H 1398   (0.604)   (0.022)         EICHTEN    68 HLBC                   10/68
R29 H        (0.596)   (0.025)         HAIDT      71 HLBC +                 12/70
R29  D3480    0.698     0.025          CHIANG     72 OSPK +  1.84 GEV/C K+   9/72
R29  L 554    0.705     0.063          LUCAS2     73 HBC  -  DALITZ PRS ONLY 11/73
R29 B 1585   (0.608)   (0.014)         BRAUN      75 HLBC +                  1/76
R29           0.67      0.12           WEISSENBE  76 SPEC +                  1/78
R29 E        (0.670)   (0.014)         HEINTZE    77 SPEC +                 12/77
R29                  COMMENTS
R29  C  FROM CALLAHAN1 66 WE USE ONLY THE MU3/E3 RATIO AND DO NOT
R29  C  INCLUDE IN THE FIT THE RATIOS MU3/TAU AND E3/TAU, SINCE THEY SHOW
R29  C  LARGE DISAGREEMENTS WITH THE REST OF THE DATA.
R29 H   HAIDT 71 IS A REANALYSIS OF EICHTEN 68.
R29 H   ONLY INDIVIDUAL RATIOS INCLUDED IN FIT (SEE R19 AND R20).           11/68
R29  D  CHIANG 72 R29 IS STATISTICALLY INDEPENDENT OF CHIANG 72 R5 AND R6.   9/72
R29  L  LUCAS 73 GIVES N(MU3)=554+-7.6PCT, N(E3)=786+-3.1PCT.  WE DIVIDE.   11/73
R29 B   BRAUN 75 VALUE IS FROM FORM FACTOR FIT.  ASSUMES MU-E UNIVERSALITY.  1/76
R29 E   HEINTZE 77 VALUE FROM FIT TO LAMBDA0. ASSUMES MU-E UNIVERSALITY.    12/77
R29          . . . . . . . . . .
R29 AVG       0.679     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R29 FIT       0.663     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R30    CHAR. K INTO (PI0 E NEU GAMMA)/(PI0 E NEU) (UNITS 10**-2)
R30                                                       (P18)/(P6)
R30          (1.2)     (0.8)           BELLOTT1   67 HLBC +  EGAM GT 30MEV  11/67
R30  R  13    0.76      0.28           ROMANO     71 HLBC    EGAM GT 10MEV  10/71
R30 R        (0.53)    (0.22)          ROMANO     71 HLBC +  EGAM GT 30 MEV  9/73
R30 L   16   (0.48)    (0.20)          LJUNG      73 HLBC +  EGAM GT 30 MEV  9/73
R30 L        (0.22)    (0.15)  (0.10)  LJUNG      73 HLBC +  EGAM GT 30 MEV  9/73
R30 L   FIRST LJUNG VALUE IS FOR COS(ELECT-GAMMA)L.T. 0.9, SECOND VALUE IS   9/73
R30 L   FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9 FOR COMPARISON WITH ROMANO.    9/73
R30 R   BOTH ROMANO VALUES ARE FOR COS(ELECT-GAMMA) BETW 0.6 AND 0.9.        9/73
R30 R   SECOND VALUE IS FOR COMPARISON WITH SECOND LJUNG VALUE.              9/73
R30 R   WE USE LOWEST EGAM CUT FOR TABLE VALUE. SEE ROMANO FOR EGAM DEPEND.  9/73

R31    K- INTO (PI+ E- E-)/TOTAL (UNITS 10**-5)           (P19)
R31     TEST OF LEPTON NUMBER CONSERVATION.
R31          (1.5)  OR LESS            CHANG      68 HBC  -                  3/68

R32    CHAR. K INTO (PI NEU NEU)/TOTAL (UNITS 10**-6)     (P20)
R32 C        (1.4)  OR LESS  CL=.90    KLEMS      71 OSPK +  T(PI) 117-127MEV 3/74
R32 C        (0.94) OR LESS  CL=.90    CABLE      73 CNTR +  T(PI) 60-105 MEV 2/74
R32  C       (0.56) OR LESS  CL=.90    CABLE      73 CNTR +  T(PI) 60-127 MEV 2 [illegible]
R32  L   0  (57.0)  OR LESS  CL=.90    LJUNG      73 HLBC +                 [illegible]73
R32           0.14  OR LESS  CL=.90    ASANO      81 CNTR +  T(PI) 116-127MEV [illegible]
R32  C  KLEMS 71 AND CABLE 73 ASSUME PI SPECTRUM SAME AS KE3 DECAY.          3/74
R32  C  SECOND CABLE LIMIT COMBINES CABLE AND KLEMS DATA FOR VECTOR INT.     2/74
R32  L  LJUNG 73 ASSUMES VECTOR INTERACTION.                                 9/73

R33    CHAR. K INTO (E NEU GAMMA)/TOTAL  (UNITS 10**-5) (P21)
R33  M       (7.1)  OR LESS            MACEK      70 OSPK +  P(E) 234 TO 247 12/70
R33  M  ABOVE IS MEASUREMENT OF STRUCTURE-DEPENDENT DECAY ONLY.

R34    CHAR. K INTO (PI GAMMA)/TOTAL (UNITS 10**-6)       (P22)
R34     VIOLATES ANGULAR MOMENTUM CONSERVATION.  NOT LISTED IN TABLES.
R34  K       (4.0)  OR LESS  CL=.90    KLEMS      71 OSPK +                  8/71
R34  K  TEST OF MODEL OF SELLERI, NC 60A, 291(1969).

R36    CHAR. K INTO (PI 3GAMMA)/TOTAL (UNITS 10**-4)      (P23)
R36           3.0   OR LESS  CL=.90    KLEMS      71 OSPK +  T(PI) GT 117MEV  8/71

R37    K+ INTO (PI+ PI+ E- NEU)/(PI+ PI- E+ NEU) (UNITS 10**-4)  (P8)/(P7)
R37      0 (130.)   OR LESS  CL=.95    BOURQUIN   71 ASPK                    8/76
R37  B   3    3.6   OR LESS  CL=.95    BLOCH      76 SPEC                    8/76
R37  B  CORRESPONDS TO 3E10-4 AT CL=.90.                                     2/80

R38    CHAR. K INTO (PI0 PI0 E NEU)/KE3 (UNITS 10**-4)  (P24)/(P6)
R38      0  (37.0)  OR LESS  CL=.90    ROMANO     71 HLBC +                 12/71
R38      2    3.8       5.0      1.2   LJUNG      73 HLBC +                  9/73

R39    K+ INTO (PI- E+ MU+)/TOTAL (UNITS 10**-8)                (P25)
R39    K- INTO (PI+ E- MU-)/TOTAL IS ALSO INCLUDED HERE
R39          (2.8)  OR LESS  CL=.90    BEIER      72 OSPK +-                 9/72
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```
R40     K+ INTO (PI+ E+ MU-)/TOTAL (UNITS 10**-8)          (P26)
R40     K- INTO (PI- E- MU+)/TOTAL IS ALSO INCLUDED HERE
R40           (1.4)  CR LESS  CL=.90   BETER     72 OSPK +-                  9/72

R41     CHAR. K INTO (MU 3NEU)/TOTAL (UNITS 10**-6)        (P27)
R41  P    0    5.0   CR LESS  CL=.90   PANG      73 CNTR +                   11/73
R41  P  PANG 73 ASSUMES MU SPECTRUM FROM NEU-NEU INTERACTION OF BARDIN 70.   3/74

R42     CHAR. K INTO (PI0 MU NEU GAM)/TOTAL(UNITS 10**-5)(P28)               9/73
R42       0    6.1   CR LESS  CL=.90   LJUNG     73 HLBC +  EGAM GT 30 MEV   9/73

R43     CHAR. K INTO (E PI0 NEU)/(PI PI0)                  (P6)/(P2)
R43  L 786    0.221     0.012          LUCAS2    73 HBC  -  DALITZ PRS ONLY  11/73
R43  L  LUCAS 73 GIVES N(E3)=786+-3.1PCT, N(P12)=3564+-3.1PCT.  WE DIVIDE.   11/73
R43              . . . . . . . . . . .
R43 FIT        0.2290   0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R44     CHAR. K INTO (PI 2PI0)/(PI PI0)                    (P4)/(P2)
R44  L 574    0.081     0.005          LUCAS2    73 HBC  -  DALITZ PRS ONLY  11/73
R44  L  LUCAS 73 GIVES N(PI 2PI0)=574+-5.9 PCT, N(P12)=3564+-3.1 PCT.        11/73
R44  L  WE QUOTE 0.5*N(PI 2PI0)/N(PI2) WHERE 0.5 IS BECAUSE ONLY DALITZ      11/73
R44  L  PAIR PI0'S WERE USED.                                                11/73
R44              . . . . . . . . . . .
R44 FIT        0.0819   0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R45     CHAR. K INTO(PI NEU GAMMA)/TOTAL  (UNITS 10**-3) (P12)               7/74
R45      12    5.8       3.5           WEISSENBE 74 STRC +  E-GAMMA GT 9 MEV 7/74

R46     CHAR. K INTO (PI E+ E-)/(PI+ PI- E NEU) (UNITS 10**-3)  (P15)/(P7)
R46  B  41    7.0       1.3            BLOCH     75 SPEC +                   11/75
R46  B  BLOCH 75 QUOTES THIS RESULT MULTIPLIED BY OUR 1974 KE4 BR.FRAC.      11/75

R47     CHAR. K INTO (E NEU GAM)/(E NEU)                   (P21)/(P11)
R47      STRUCTURE DEPENDENT PART WITH + GAMMA HELICITY.
R47 H    56   (1.05)   (0.25)   (0.30) HEARD1    75 SPEC +  P(E) 236 TO 247  11/75
R47 H    THIS VALUE IS INCLUDED IN THE SECOND HEINTZE 79 VALUE IN SEC.R54    11/75
R47 H    BELOW.                                                              11/75

R48     K+ INTO (PI+-MU-+E+)/(PI+PI-E NEU) (UNITS 10**-4) (P25+P26)/(P7)     11/76
R48  D    0    1.9   CR LESS  CL=.90   DIAMANTBE 76 SPEC +                   11/76
R48  D  DIAMANTBE 76 QUOTES THIS RESULT TIMES OUR 1975 KE4 BR. RATIO.        11/76

R49     K+ INTO (PI+ MU+ E-)/(PI+PI- E NEU) (UNITS 10**-4)  (P29)/(P7)       11/76
R49  D    0    1.3   CR LESS  CL=.90   DIAMANTBE 76 SPEC +                   11/76
R49  D  DIAMANTBE 76 QUOTES THIS RESULT TIMES OUR 1975 KE4 BR RATIO.         11/76

R50     CHAR. K INTO (MU NEU E+E-)/(PI+PI-ENEU) (UNITS 10**-9) (P30)/(P7)    11/76
R50  D   14   (3.3)    (0.9)           DIAMANTBE 76 SPEC +  M(EE) GT 140     11/76
R50  D   14   27.       8.             DIAMANTBE 76 SPEC +  EXTRAPOLATED BR  11/76
R50  D  DIAMANTBE 76 QUOTES THESE RESULTS TIMES OUR 1975 KE4 BR RATIO.       11/76
R50  D  THE SECOND DIAMANTBE 76 VALUE IS THE FIRST VALUE EXTRAPOLATED TO 0   11/76
R50  D  TO INCLUDE LOW MASS E PAIRS.                                         11/76

R51     K+- INTO(PI-+E+-E+-)/(PI+PI-E NEU)  UNITS(10**-6) (P19)/(P7)         11/76
R51      TEST OF LEPTON NUMBER CONSERVATION
R51  D    0    2.5   CR LESS  CL=.90   DIAMANTBE 76 SPEC +                   11/76
R51  D  DIAMANTBE 76 QUOTES THIS RESULT TIMES OUR 1975 BR RATIO.             11/76

R52     K+- INTO(MU-+ NEU E+- E+-)/(PI+PI-E NEU)(UNITS 10**-3) (P31)/(P7)    11/76
R52  D    0    0.5   CR LESS  CL=.90   DIAMANTBE 76 SPEC +                   11/76
R52  D  DIAMANTBE 76 QUOTES THIS RESULT TIMES OUR 1975 KE4 BR RATIO.         11/76

R53     K+ INTO (NEU E+ E+ E-)/(PI+PI- E NEU) (UNITS 10**-2) (P32)/(P7)      11/76
R53       4    0.14      0.54     0.27 DIAMANTBE 76 SPEC +                   11/76
R53  D  DIAMANTBE 76 QUOTES THIS RESULT TIMES OUR 1975 KE4 BR RATIO.         11/76

R54     CHAR. K INTO (E NEU GAM)/(MU NEU)  (UNITS 10**-5)(P21)/(P1)
R54      STRUCTURE DEPENDENT PART WITH + GAMMA HELICITY
R54 H    51   (2.33)   (0.42)          HEINTZE   79 SPEC +                   7/79
R54 H   107    2.49      0.36          HEINTZE   79 SPEC +                   7/79
R54  H  SECOND HEINTZE 79 RESULT IS FIRST COMBINED WITH HEARD1 75 RESULT     7/79
R54  H  FROM SECTION R47 ABOVE.                                              7/79

R55     CHAR. K INTO (E NEU GAM)/TOTAL (UNITS 10**-4)      (P21)
R55      STRUCTURE DEPENDENT PART WITH - GAMMA HELICITY
R55  H         1.6   CR LESS  CL=.90   HEINTZE   79 SPEC +                   2/82*
R55  H  IMPLIES (AXIAL VEC./VECTOR) AMPL. RATIO OUTSIDE RANGE -1.8 TO -.54.  2/82*

R56     CHAR. K INTO (E NEU NEU NEUBAR)/(E NEU)            (P33)/(P11)       7/79
R56       0    3.8   CR LESS  CL=.90   HEINTZE   79 SPEC +                   7/79

R57     K+ INTO (MU+ NEU(E))/TOTAL                         (P34)             2/82*
R57       0    0.004 CR LESS  CL=.90   LYONS     81 HLBC 200GEV ++ N.A. BEAM 2/82*
```

Note on Slope Parameter for $K \to 3\pi$ Decays

As was discussed in Section VI B.1 of the text, for the 3π decays of the K mesons we list the slope parameter "g" which is defined, as in that section, by

$$|M|^2 \propto 1 + g\,\frac{(s_3 - s_0)}{m_{\pi+}^2} + h\left(\frac{s_3 - s_0}{m_{\pi+}^2}\right)^2 + j\,\frac{(s_2 - s_1)}{m_{\pi+}^2} + k\left(\frac{s_2 - s_1}{m_{\pi+}^2}\right)^2 + \ldots, \qquad (1)$$

where

$$s_i = (\underline{p}_K - \underline{p}_i)^2 = (m_K - m_i)^2 - 2m_K T_i \qquad (2)$$

$$s_0 = \frac{1}{3}\sum s_i = \frac{1}{3}\,(m_K^2 + m_1^2 + m_2^2 + m_3^2) \qquad (3)$$

$\underline{p}_K$, $\underline{p}_i$ are the four-vectors for the K and the i^{th} pion, and the index 3 refers to the odd pion, i.e., the third pion in the decays listed below. (4)

We refer to the three possible charged decays as τ, τ', and τ'':

$\tau^{\pm}$	$K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$
$\tau'^{\pm}$	$K^{\pm} \to \pi^0\pi^0\pi^{\pm}$
τ^0	$K_L^0 \to \pi^+\pi^-\pi^0$

The measurements of g vary considerably beyond the authors' quoted errors as can be seen in the ideograms associated with the GT+, GT-, and GTP subsections of the $K^{\pm}$ Data Card Listings and the GTO subsection of the K_L^0 Listings.

There is no indication of a CP-violating asymmetry in K_L^0 decay as measured by the coefficient j given in subsection JTO of the K_L^0 Listings.

The high-statistics τ^0-decay experiment of MESSNER 74 finds significant non-zero quadratic coefficients h and k. CHO 77, a lower-statistics τ^0 experiment, obtains results in agreement with MESSNER 74 but can also obtain good fits with a linear term (g) only. The correlation between the linear and quadratic coefficients changes the CHO 77 g_{τ^0} from 0.629 ± 0.017 (linear fit) to 0.681 ± 0.024 (quadratic fit). Another experiment, PEACH 77, does not observe this correlation and is in agreement only with the linear fit of CHO 77.

There is some evidence for a non-zero k coefficient from $\tau^{\pm}$ experiments. FORD 72 (1.5M events) have studied $K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$ and find that the χ^2/DF goes from 1.38 to 1.20 for DF ≈ 150 when the second order and CP-violation terms are added.

However, the authors state that since their Coulomb correction is larger than the experimental errors and is not well known, it is difficult to interpret these results. DEVAUX 77 also finds a non-zero k.

Because of the above evidence for quadratic terms, and for consistency in our treatment of τ^0 and $\tau^{\pm}$ decay, we now include in our averages only those τ^0 and $\tau^{\pm}$ experiments for which we have information on the three coefficients g, h, and k. Correlations prevent us from comparing fits which do not include these three parameters. For $\tau'^{\pm}$ decays we compile g and h only since no experiments measure k.

Parametrizations

In the literature *other definitions* of slope parameters have appeared. We have converted to the definitions of g, h, j and k in Eq. (1) from whatever experimental quantity has been reported. We give the conversion to the definition (1) for the most widely used parametrizations and tabulate the conversion factors for the reader's convenience.

a) For analysis of charged K's and some K^0 experiments, the expression often used is:

$$|M|^2 = 1 + a_y Y + b_y Y^2 + d_y X + e_y X^2$$

with

$$Y = \frac{3T_3 - Q}{Q} ,$$

$$X = \frac{\sqrt{3}\,(T_1 - T_2)}{Q} ,$$

$$Q = m_K - \sum m_i .$$

The relevant formulae are:

$$Y = -\frac{3}{2}\,\frac{s_3 - s_0}{m_K Q} + \Delta , \quad X = \frac{\sqrt{3}}{2}\,\frac{s_2 - s_1}{m_K Q}$$

with

$$\Delta = \frac{m_{\pm} - m_3}{Q}\left(2 - \frac{m_3 + m_1}{m_K}\right)$$

and

$$g = \frac{-c_y(a_y + 2b_y\Delta)}{1 + a_y\Delta + b_y\Delta^2} ,$$

$$h = \frac{c_y^2\, b_y}{1 + a_y\Delta + b_y\Delta^2} ,$$

$$j = \frac{c_y\, d_y}{\sqrt{3}\,(1 + a_y\Delta + b_y\Delta^2)} ,$$

$$k = \frac{c_y^2\, e_y}{3(1 + a_y\Delta + b_y\Delta^2)} ,$$

with

$$c_y = \frac{3}{2}\,\frac{m_{\pi^+}^2}{m_K Q} .$$

b) For the analysis of some K^0 experiments the expression used is

$$|M|^2 = 1 + 2a_t \frac{m_K}{m_{\pi^+}^2}(2T_3 - T_{3max}) + b_t\left(\frac{m_K}{m_{\pi^+}^2}\right)^2 (2T_3 - T_{3max})^2 ,$$

with

$$T_{3max} = \frac{(m_K - m_3)^2 - (m_1 + m_2)^2}{2m_K} .$$

The relevant transformations are

$$T_3 = -\frac{s_3 - s_0}{2m_K} + \frac{Q}{3}(1 + \Delta)$$

and

$$g = \frac{-2a_t - b_t c_t}{1 + a_t c_t + \frac{b_t c_t^2}{4}} ,$$

$$h = \frac{b_t}{1 + a_t c_t + \frac{b_t c_t^2}{4}} ,$$

with

$$c_t = \frac{2m_K}{m_{\pi^+}^2}\left[\frac{2}{3}Q(1 + \Delta) - T_{3max}\right] .$$

c) Other K^0 authors use the same form of matrix element as given in b) above with a linear term only, but define

$$T_{max} = \frac{2}{3} Q .$$

The relevant transformation is then

$$\boxed{g = \frac{-2a_u}{1 + a_u c_u}} ,$$

with

$$c_u = \frac{4m_K}{3m_{\pi+}^2} Q\Delta .$$

d) Older K^0 analyses were done using

$$|M|^2 = 1 + a_v \frac{T_3}{m_K} .$$

The relevant transformation is then

$$\boxed{g = \frac{-c_v a_v}{1 + d_v a_v}} ,$$

with

$$c_v = \frac{m_{\pi+}^2}{2m_K^2}$$

and

$$d_v = \frac{Q}{3m_K} (1 + \Delta) .$$

e) The CP-violating term in $|M|^2$ for $K_L^0 \to \pi^+\pi^-\pi^0$ experiments has been parametrized in several ways. BLANPIED 68 and SCRIBANO 70 use the parametrization given in (b) above with no quadratic term and with an additional CP violating term. BLANPIED 68 parametrizes the CP-violating term as

$$2\sigma_B \frac{m_K}{m_{\pi+}^2} (T_1 - T_2) .$$

The relevant transformation is then

$$\boxed{j = \frac{\sigma_B}{1 + c_t a_t}}$$

with c_t as defined in (b) above. SCRIBANO 70 parametrizes the CP-violating term as

$$\frac{2}{\sqrt{3}} \sigma_S \frac{T_1 - T_2}{T_{12max}}$$

where T_{12max} is the maximum kinetic energy of particle 1 or 2, the charged π's, given by

$$T_{12max} = \frac{(m_K - m_1)^2 - (m_2 + m_3)^2}{2m_K} .$$

The resulting transformation is then

$$\boxed{j = \frac{m_{\pi+}^2}{\sqrt{3}\, m_K T_{12max}} \frac{\sigma_S}{(1 + c_t a_t)}} .$$

SMITH 70 gives the asymmetry

$$\alpha = \frac{N_+ - N_-}{N_+ + N_-}$$

where N_+ is the number of events with $T_1 > T_2$ and N_- is the converse. BLANPIED 68 gives the relation $\sigma_B = \alpha/1.16$ which allows us to use the transformation to j given above for BLANPIED 68.

For the reader's convenience we give a table of numerical values for Q, T_{3max}, T_{12max}, Δ, c_y, c_t, c_u, c_v, and d_v, obtained using the masses from the current edition.

	$\tau^{\pm}$	$\tau'^{\pm}$	τ^0
Q	74.97	84.17	83.57
T_{3max}	48.08	53.20	53.89
T_{12max}	48.08	53.99	53.12
Δ	0.0000	-0.0790	0.0798
c_y	0.7895	0.7032	0.7025
c_t	0.0962	-0.0769	0.3204
c_u	0.0000	-0.2246	0.2272
c_v	0.0400	0.0400	0.0393
d_v	0.0506	0.0523	0.0604

References

See the reference sections of the $K^{\pm}$ and K_L^0 Data Card Listings.

See also the review of T. J. Devlin and J. O. Dickey, Rev. Mod. Phys. 51, 237 (1979), which contains an analysis of $K \to 2\pi$ and $K \to 3\pi$ data in terms of transition amplitudes with appropriate energy dependence.

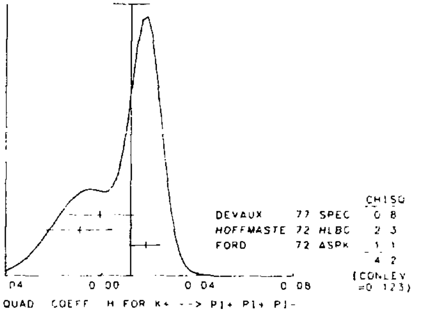
```
             10  CHARGED + ENERGY DEPENDENCE OF DALITZ PLOT

      RELATED TEXT SECTION VI B.1 AND MINI-REVIEW ABOVE

      MATRIX ELEMENT SQUARED = 1 + G*U + H*U**2 + K*V**2                       1/79
      WHERE U=(S3-S0)/(MPI**2) AND V=(S1-S2)/(MPI**2)                          1/79

GT+     LINEAR COEFFICIENT G FOR TAU DECAYS K+ --> PI+ PI+ PI-                 1/79
GT+        SOME  EXPTS USE DALITZ VARIABLES X AND Y. WE GIVE AY=COEFF OF Y     1/79
GT+        TERM AT RIGHT. SEE MINI-REVIEW ABOVE.                               1/79
GT+ZL 5428  (-0.221)  (0.024)       ZINCHENKO 67 HBC  +  AY=0.28+-.03        10/69
GT+ L 9994  (-0.218)  (0.016)       BUTLER    68 HBC  +  AY=0.277+-.020      10/69
GT+ G17898  (-0.196)  (0.012)       GRAUMAN   70 HLBC +  AY=0.228+-.030       8/70
GT+   750K   -0.2157   0.0028       FORD      72 ASPK +  AY=0.2734+-.0035     1/79
GT+H 39819   -0.200    0.009        HOFFMASTE 72 HLBC +                       1/79
GT+   225K   -0.2221   0.0065       DEVAUX    77 SPEC +  AY=0.2814+-.0062     1/79
GT+ L   EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.                 3/78
GT+ Z   ALSO INCLUDES DBC EVENTS
GT+ G   EMULS. DATA ADDED - ALL EVENTS INCLUDED BY HOFFMASTER 72               1/71
GT+H    HOFFMASTER 72 INCLUDES GRAUMAN 70 DATA.                                1/79
GT+            . . . . . . . . . .
GT+ AVG        -0.2154   0.0035  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                 (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.0122 ± 0.0076
ERROR SCALED BY 1.4

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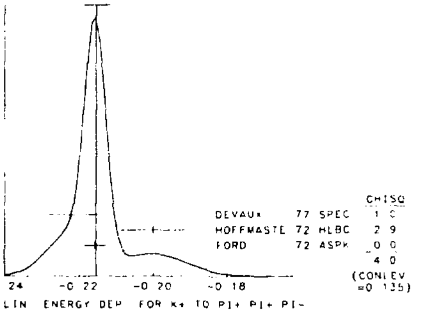
HT+     QUADRATIC COEFF. H FOR K+ --> PI+ PI+ PI-                              1/79
HT+   750K    0.0187   0.0067       FORD      72 ASPK +                        1/79
HT+  39819   -0.009    0.014        HOFFMASTE 72 HLBC +                        1/79
HT+   225K   -0.0006   0.0141       DEVAUX    77 SPEC +                        1/79
HT+            . . . . . . . . . .
HT+ AVG         0.0122   0.0076  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                 (SEE IDEOGRAM BELOW )
```

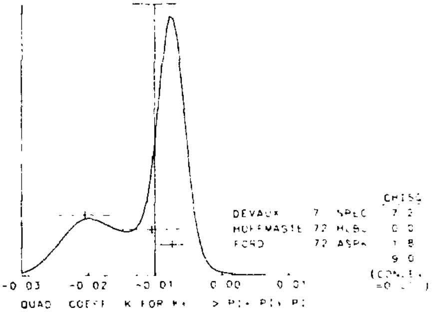
WEIGHTED AVERAGE = -0.2154 ± 0.0035
ERROR SCALED BY 1.4




```
KT+     QUADRATIC COEFF. K FOR K+ --> PI+ PI+ PI-                              1/79
KT+   750K   -0.0075   0.0019       FORD      72 ASPK +                        1/79
KT+  39819   -0.0105   0.0045       HOFFMASTE 72 HLBC +                        1/79
KT+   225K   -0.0205   0.0039       DEVAUX    77 SPEC +                        1/79
KT+            . . . . . . . . . .
KT+ AVG        -0.0101   0.0034  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
                                 (SEE IDEOGRAM BELOW )

GT-     LINEAR COEFFICIENT G FOR TAU DECAYS K- --> PI- PI- PI+
GT-        FOR DEFINITION OF AY SEE NOTE IN SECTION GT+ ABOVE.
GT- F 1347  (-0.220)  (0.035)       FERRO-LUZ 61 HBC  -  AY=0.28+-.045       10/69
GT-ML 5778  (-0.190)  (0.023)       MOSCOSO   68 HBC  -  AY=0.242+-.029      10/69
GT-  50919   -0.193    0.010        MAST      69 HBC  -  AY=0.244+-.013       1/79
GT-   750K   -0.2196   0.0028       FORD      72 ASPK -  AY=0.2770+-.0035     1/79
GT- Q  81K  (-0.199)  (0.008)       LUCAS1    73 HBC  -  AY=0.252+-.011      10/72
GT- F   NO RADIATIVE CORRECTIONS INCLUDED.
GT- L   EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.                 3/78
GT- M   ALSO INCLUDES DBC EVENTS.
GT- Q  QUADRATIC DEPENDENCE IS REQUIRED BY KL EXPTS.  FOR COMPARISON WE        1/79
GT- Q  AVERAGE ONLY THOSE K+- EXPERIMENTS WHICH QUOTE QUADRATIC FIT VALUES.    1/79
GT-            . . . . . . . . . .
GT- AVG        -0.2167   0.0066  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)
```

WEIGHTED AVERAGE = -0.0101 ± 0.0034
ERROR SCALED BY 2.1



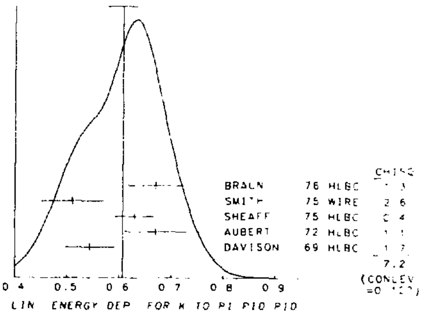

```
HT-     QUADRATIC COEFF H FOR K- --> PI- PI- PI+                               1/79
HT-  50919   -0.001    0.012        MAST      69 HBC  -                        1/79
HT-   750K    0.0125   0.0062       FORD      72 ASPK -                        1/79
HT-            . . . . . . . . . .
HT- AVG         0.0097   0.0055  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.[illegible])

KT-     QUADRATIC COEFF K FOR K- --> PI- PI- PI+                               1/79
KT-  50919   -0.014    0.012        MAST      69 HBC  -                        1/79
KT-   750K   -0.0083   0.0019       FORD      72 ASPK -                        1/79
KT-            . . . . . . . . . .
KT- AVG        -0.0084   0.0019  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.[illegible])

DG  ((GT+)-(GT-))/((GT+)+(GT-)) IN PERCENT
DG       A NON-ZERO VALUE FOR THIS QUANTITY INDICATES CP VIOLATION
DG     3.2M   -0.70      0.53               FORD      72 ASPK                 11/72

GTP     LINEAR COEFFICIENT G FOR TAU PRIME DECAYS CHAR. K --> PI PI0 PI0.
GTP     UNLESS OTHERWISE STATED, ALL EXPTS INCLUDE TERMS QUADRATIC IN
GTP     (S3-S0)/(MPI**2). SEE MINI-REVIEW ABOVE.
GTP K 1792   (0.48)   (0.34)        KALMUS    64 HLBC +                        1/79
GTP K 1874   (0.586)  (0.098)       BISI      65 HLBC +   ALSO HBC             1/79
GTP   4048    0.544    0.048        DAVISON   69 HLBC +   ALSO EMUL            1/79
GTP L  198   (0.527)  (0.107)       PANDOULAS 70 EMUL +                        1/79
GTP   1365    0.67     0.06         AUBERT    72 HLBC +                        1/79
GTP K  574   (0.484)  (0.084)       LUCAS2    73 HBC  -   DALITZ PRS ONLY      1/79
GTP   5635    0.630    0.038        SHEAFF    75 HLBC +                        1/79
GTP    27K    0.510    0.060        SMITH     75 WIRE +                        1/79
GTP L 4639   (0.896)  (0.223)       BERTRAND  76 EMUL +                        1/79
GTP   3263    0.670    0.054        BRAUN     76 HLBC +                        1/79
GTP K   AUTHORS GIVE LINEAR FIT ONLY.
GTP L   EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.
GTP            . . . . . . . . . .
GTP AVG         0.607    0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.[illegible])
                                 (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.607 ± 0.030
ERROR SCALED BY 1.3




```
HTP     QUADRATIC COEFF H FOR CHAR K --> PI PI0 PI0. SEE MINI-REVIEW ABOVE.
HTP   4048    0.026    0.050        DAVISON   69 HLBC +   ALSO EMUL            1/79
HTP L  198   (0.018)  (0.124)       PANDOULAS 70 EMUL +                        1/79
HTP   1365   -0.01     0.08         AUBERT    72 HLBC +                        1/79
HTP   5635    0.041    0.030        SHEAFF    75 HLBC +                        1/79
HTP    27K    0.009    0.040        SMITH     75 WIRE +                        1/79
HTP L 4639   (0.164)  (0.121)       BERTRAND  76 EMUL +                        1/79
HTP   3263    0.152    0.082        BRAUN     76 HLBC +                        1/79
HTP L   EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.                 1/79
HTP            . . . . . . . . . .
HTP AVG         0.034    0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

------ --------- --------- --------- --------- --------- --------- --------

Note on $K_{\ell 3}^{\pm}$ and $K_{\ell 3}^{0}$ Form Factors

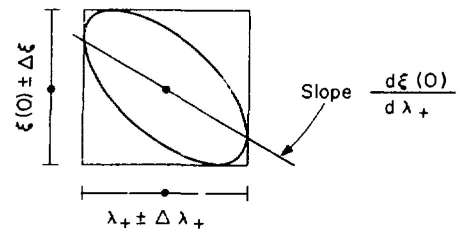
Definitions of the parameters λ_+, $\xi(0)$, λ_0, $|f_S/f_+|$ and $|f_T/f_+|$ and a general discussion of the methods of analysis are given in Section VI B.2 of the text.

This note describes the contents of the Data Card Listings for the two $K_{\mu 3}$ parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0), which were discussed in the text. Problems related to our data entries for individual experiments are discussed and a comparison of results is given.

$K_{\mu 3}$ Experiments

The matrix element for $K_{\mu 3}$ decay, assuming a pure vector current, is given by Eq. (2) in Section VI B.2 of the text. Most experiments appear to be compatible with the assumption that f_+ depends linearly on t and that f_- is constant. Only DALLY 72 ($K_{\mu 3}^{\pm}$) appears to require $\lambda_- \neq 0$ (by about three standard deviations). A single data bin at low q^2 seems to be responsible. The effect is not observed in the high-statistics experiment of DONALDSON2 74 (also $K_{\mu 3}^{0}$).

$\lambda_+, \xi(0)$ Parametrization: λ_+ data from $K_{\mu 3}$ decay are entered into the $K^{\pm}$ and K_L^0 sections of the Data Card Listings in subsection L+M. The corresponding $\xi(0)$ values are entered in subsection XIA, XIB, or XIC, depending on whether Method A, B, or C, discussed below and in the text, was used. The data cards contain the values, one-standard-deviation errors $\Delta\lambda_+$ and $\Delta\xi(0)$, as well as the correlation $d\xi(0)/d\lambda_+$, all indicated on the $e^{-1/2}$ likelihood contour below. The correlations are given on the right side of the $\xi(0)$ data cards.



XBL 743-2682

λ_+, λ_0 Parametrization: This parametrization is used in recent $K_{\mu 3}$ analyses. To facilitate comparison between experiments, we convert earlier experiments from the $(\lambda_+, \xi(0))$ parametrization to (λ_+, λ_0) whenever possible (i.e., when λ_+ and $\xi(0)$ values, errors, and correlations are given). The transformation between these parametrizations is:

$$\lambda_0 = \lambda_+ + a\xi(0) \ ,$$

$$\Delta\lambda_0^2 = \left(1 + 2a\,\frac{d\xi(0)}{d\lambda_+}\right)\Delta\lambda_+^2 + a^2\Delta\xi^2 \ ,$$

$$\frac{d\lambda_0}{d\lambda_+} = 1 + a\,\frac{d\xi(0)}{d\lambda_+} \ ,$$

where $a = m_\pi^2/(m_K^2 - m_\pi^2)$. The λ_0 value, the one-standard-deviation error $\Delta\lambda_0$, and the correlation $d\lambda_0/d\lambda_+$ are given in subsection L0 of the data cards.

We also convert (λ_+, λ_0) results into the $(\lambda_+, \xi(0))$ parametrization whenever possible so that subsection L0 is essentially equivalent to the three subsections XIA, XIB, and XIC.

Individual analyses have used a variety of parametrizations. Problems arise when trying to express their results in terms of the parametrizations used here. The discussion of these problems is divided into three sections corresponding to the three methods of analyses discussed in the text.

Method A: Dalitz plot analyses and pion spectrum analyses usually determine λ_+ and $\xi(0)$ (or λ_0) values, errors, and correlation. Such measurements are entered in the L+M, XIA, and L0 subsections. They give rise to the error ellipses shown in Figs. 1 and 2. These are approximations to likelihood contours.

Some analyses of this type fix λ_+ and determine $\xi(0)$, e.g., CARPENTER 66 and PEACH 73 (both $K_{\mu 3}^{\pm}$). We enter $\xi(0)$ and $d\xi(0)/d\lambda_+$ in the XIA section and give the fixed λ_+ value in the data card footnote. The $\xi(0)$ error is parenthesized because it does not include the uncertainty in the value of λ_+. These results, transformed to λ_0 measurements, give rise to bands in Fig. 2. These bands are also approximations to the likelihood contours. The actual likelihood bands would not be straight.

In some cases, we alter an error from its published value in order to obtain an error ellipse with a width which matches the error in $\xi(0)$ for fixed λ_+. These adjustments are noted in the $\xi(0)$ data card footnotes, e.g., for CALLAHAN1 66 and HAIDT 71 (K^+ subsection XIA), where the published errors and correlation violate the constraint $|C_{\lambda\xi}| < 1$ on the normalized correlation coefficient $C_{\lambda\xi}$ given by

$$C_{\lambda\xi} = \frac{\Delta\lambda_+}{\Delta\xi}\,\frac{d\xi(0)}{d\lambda_+} \ .$$

BIRULEV 81 ($K_{\mu 3}$) gives a correlation $d\xi/d\lambda_+$ which, while not unphysical, is so large that the resulting error ellipse is unreasonably narrow. As a result, in the fit to be discussed, BIRULEV 81 would dominate even DONALDSON2 74 which has 10 times the BIRULEV 81 statistics. To prevent this, we make the assumption $d\xi/d\lambda_+ = 0$, giving the broad error ellipse shown in Fig. 2.

In some cases, e.g., BRAUN1 73, the parametrization used is λ_+, $\xi(0)$, $\xi(t^*)$, where t^* is the weighted average of t with weighting according to the sensitivity to ξ. In this case we do not use $\xi(0)$. It is a badly determined parameter comparable to λ_- or the slope of $\xi(t)$. Instead, we use

$$\xi(0) = \xi(t^*)(1 + \lambda_+ t^*) \ ,$$

$$\frac{d\xi(0)}{d\lambda_+} = \frac{d\xi(t^*)}{d\lambda_+}(1 + \lambda_+ t^*) + \xi(t^*)t^* \ .$$

With the BRAUN1 73 values, $\lambda_+ = 0.027$, $\xi(6.6) = -0.34 \pm 0.20$, and $d\xi(6.6)/d\lambda_+ = -14$, we obtain

$$\xi(0) = (-0.40 \pm 0.24) - 19(\lambda_+ - 0.027) \ ;$$

or for their fitted $\lambda_+ = 0.025 \pm 0.017$, we get $\xi(0) = -0.36 \pm 0.40$.

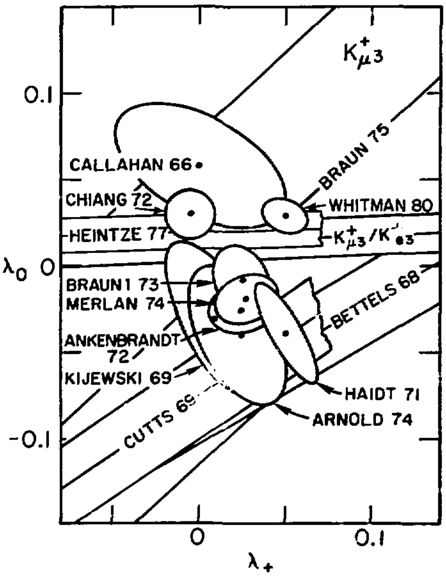


Fig. 1. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^+_{\mu 3}$.

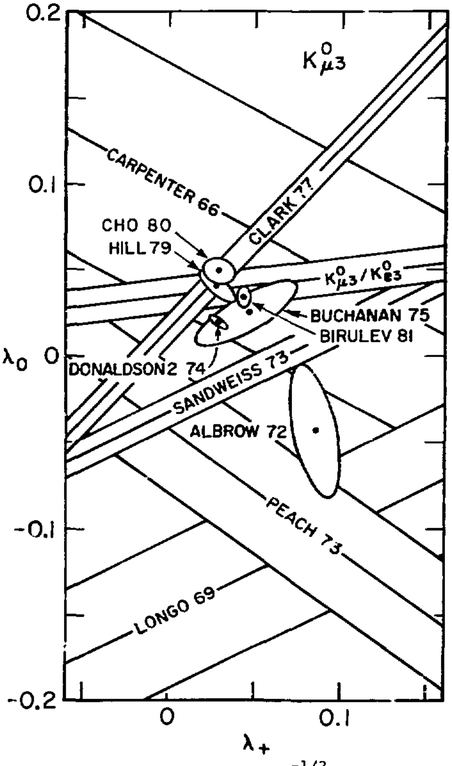


Fig. 2. One-standard-deviation ($e^{-1/2}$) likelihood contours in the (λ_+,λ_0) plane for $K^0_{\mu 3}$.

Method B: Branching ratio experiments cannot determine λ_+ and $\xi(0)$ simultaneously, but simply fix a relationship between them, given in Section VI B.2 of the text. Results are usually quoted as values of $\xi(0)$ at fixed λ_+. We list these results in subsection XIB, but we do not average them because the λ_+ values differ. Instead, we compute a combined result by using the relations in the text and our fitted values of $\Gamma(K^{\pm}_{\mu3})/\Gamma(K^{\pm}_{e3})$ and $\Gamma(K^0_{\mu3})/\Gamma(K^0_{e3})$, which include the branching ratios from these experiments. The branching ratios from our 1980 edition and the results for $\xi(0)$ and λ_0 evaluated at $\lambda_+ = 0.030$ are

	$K^{\pm}$	K^0_L
$\Gamma(K_{\mu3})/\Gamma(K_{e3})$	0.663 ± .018 (S=1.7)	0.695 ± .017
$\xi(0)$	−0.20 ± .15 (S=1.7)	+0.08 ± .13
$d\xi(0)/d\lambda_+$	−11.9	−10.3
λ_0	+0.014 ± .012 (S=1.7)	+0.037 ± .011
$d\lambda_0/d\lambda_+$	+0.04	+0.12

The current (1982 edition) values differ only in the addition of the CHO 80 K^0_L branching ratio measurement. We include their Dalitz-plot-analysis results in our overall form factor fit, and since their branching ratio measurement is not an independent result, we do not include it here. The scale factor S in the above table is the amount by which the error has been multiplied in order to compensate for discrepancies in the branching ratios. These λ_0 results give rise to the $K_{\mu3}/K_{e3}$ bands in Figs. 1 and 2.

Method C: Polarization experiments measure $\langle\xi(t)\rangle$, the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$. Such measurements are entered in subsection XIC.

To reinterpret these results in the $(\lambda_+,\xi(0))$ parametrization, we recognize that $\lambda_+ = 0$ corresponds to $\xi(t)$ constant (always assuming $\lambda_- = 0$) so that

$$\xi(0)\Big|_{\lambda_+=0} \equiv \langle\xi(t)\rangle \ .$$

The correlation with λ_+ is given by the following relations (valid for small λ_+):

$$\xi(0) \approx \langle\xi(t)\rangle\left(1 + \lambda_+\left\langle\frac{t}{m_\pi^2}\right\rangle\right) \ ,$$

$$\frac{d\xi(0)}{d\lambda_+} \approx \langle\xi(t)\rangle\left\langle\frac{t}{m_\pi^2}\right\rangle \ ,$$

where $\langle t/m_\pi^2\rangle$ is the average value of t weighted by the sensitivity to $\xi(t)$. These results, transformed to λ_0 and $d\lambda_0/d\lambda_+$ values, are entered in subsection L0 and give rise to bands in Figs. 1 and 2.

In Figs. 1 and 2, we do not include those polarization measurements for which $d\xi(0)/d\lambda_+$ is not obtainable. Also we do not include the MERLAN 74 ($K^+_{\mu3}$) polarization result because the signs of $\xi(0)$ and $d\xi(0)/d\lambda_+$ are opposite, whereas the above equation requires them to be the same (since $t > 0$).

Comparison of $K_{\mu3}$ Experiments: Figures 1 and 2 show the likelihood contours in the (λ_+,λ_0) plane for $K^+_{\mu3}$ and $K^0_{\mu3}$ respectively.

Most $K^+_{\mu3}$ Dalitz plot results (ellipses) shown are fairly consistent and appear to cluster between the $K_{\mu3}/K_{e3}$ result and the polarization results of BETTELS 68 and CUTTS 69. However, the latest experiment, WHITMAN 80, finds larger values of λ_0 and λ_+ than most others.

The $K^0_{\mu3}$ results are even less consistent. The latest results, HILL 79, CHO 80, and BIRULEV 81, are not in very good agreement with the earlier high-precision experiment of DONALDSON2 74.

χ^2 fits to the results shown in Fig. 1 and Fig. 2 yield the following values for λ_+ and λ_0. The corresponding values of $\xi(0)$ are also given.

	$K^+_{\mu3}$	$K^0_{\mu3}$
λ_+	$+0.032 \pm 0.008^*$	$+0.034 \pm 0.005^*$
λ_0	$+0.004 \pm 0.007^*$	$+0.025 \pm 0.006^*$
$d\lambda_0/d\lambda_+$	-0.16	-0.16
χ^2/DF	56/21	88/16
S^*	1.6	2.3
. . . .	. . . .	. . . .
$\xi(0)$	$-0.35 \pm 0.15^*$	$-0.11 \pm 0.09^*$
$d\xi(0)/d\lambda_+$	$-14.$	$-14.$

*All errors have been increased by the scale factor $S = (\chi^2/DF)^{1/2}$ to take into account the discrepancies between measurements.

In view of the large χ^2/DF, the fit results should be taken with a grain of salt. The largest contributors to χ^2 in the $K^+_{\mu3}$ case are WHITMAN 80 with 12, CHIANG 72 with 8.3, the polarization results, BETTELS 68 with 7.4 and CUTTS 69 with 5.9, and the π spectrum result of ANKENBRANDT 72 with 5.3. In the $K^0_{\mu3}$ case the largest contributors are the polarization results of SANDWEISS 73 with 21, LONGO 69 with 14, and CLARK 77 with 8.4, and the Dalitz plot results of ALBROW 72 with 12, CHO 80 with 10, DONALDSON2 74 with 6.0, BIRULEV 81 with 5.8, and PEACH 73 with 5.8. All other χ^2 values were less than 5.

The DONALDSON2 74 result

$$\lambda_+ = 0.030 \pm 0.003$$

$$\lambda_0 = 0.019 \pm 0.004$$

clearly dominates the statistics in the $K^0_{\mu3}$ case. The λ_+ value is consistent with the K_{e3} value of λ_+, and with the pole approximation

$$f_+(t) = f_+(0)\,\frac{m^2_{K^*}}{m^2_{K^*} - t} \ .$$

Their $f_0(t)$ extrapolates linearly to the Callan-Treiman point. It is less than two standard deviations from the $K_{\mu3}/K_{e3}$ result.

K_{e3} Experiments

The f_- term of the matrix element [Eq. (2) text Section VI B.2] can be neglected for K_{e3} because it is proportional to the lepton mass. The f_+ term is usually assumed to be linear in $t = q^2 = (P_K - P_\pi)^2$, the square of the four-momentum transfer, i.e., the effective mass of the lepton pair. We quote the linear coefficient λ^e_+ (L+E on the data cards). There has been some suggestion of departure from linearity [CHIEN 71 (K^0_{e3}) and Chounet, Gaillard, and Gaillard[1] — Review] but no compelling evidence. The λ_+ results are fairly consistent and the average values are

$$K^+_{e3}: \quad \lambda_+ = 0.0285 \pm 0.00[illegible]$$

$$K^0_{e3}: \quad \lambda_+ = 0.0300 \pm 0.0016 \quad (S = 1.2)$$

where the K^0_{e3} error has been multiplied by the scale factor 1.2 to compensate for inconsistencies (see ideogram in K^0_L section L+E).

See also the excellent reviews of Gaillard and Chounet,[1] Chounet, Gaillard, and Gaillard,[2] and Pondrom.[3]

References

1. M. K. Gaillard and L. M. Chounet, "$K_{\ell3}$ Form Factors," CERN 70-14 (May 1970), and Phys. Letters 32B, 505 (1970).
2. L. M. Chounet, J. M. Gaillard, and M. K. Gaillard, Physics Reports 4C, 199 (1972).
3. L. G. Pondrom, "Weak Decay Processes," Proc. Particles and Fields 1976, BNL, Oct. 6-8, 1976.

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                 10  CHARGED K FORM FACTORS

        RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ABOVE.

        IN THE FORM FACTOR COMMENTS, THE FOLLOWING ABBREVIATIONS ARE USED.
        F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
        FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
        F0 = (F+) + (F-)*T/(MK**2-MPI**2)
        L+, L- AND L0 ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND F0.
        L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
        DXI/DL IS THE CORRELATION BETWEEN XI(0) AND L+ IN KMU3.
        DL0/DL+ IS THE CORRELATION BETWEEN L0 AND L+ IN KMU3.
        T   = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
        DP  = DALITZ PLOT ANALYSIS
        PI  = PI SPECTRUM ANALYSIS
        MU  = MU SPECTRUM ANALYSIS
        POL = MU POLARIZATION ANALYSIS
        BR  = KMU3/KE3 BRANCHING RATIO ANALYSIS
        E   = POSITRON OR ELECTRON SPECTRUM ANALYSIS
        RC  = RADIATIVE CORRECTIONS

XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA)   --------------------------
XIA      76  (+1.8)     (0.6)             BROWN     62 XEBC +  DP+BR, L+=0         1/74
XIA      87  (+0.7)     (0.5)             GIACOMELL 64 EMUL +  MU+BR RVUE, L+=0    1/74
XIA J        (-0.08)    (0.7)             JENSEN    64 XEBC +  DP+BR(KMU3,KE3)     1/74
XIA    2648  (0.0)      (1.1)      (0.9)  CALLAHAN  66 FRBC +  MU, L+=0, T UNKN    1/74
XIA  C 444   +0.72       0.93             CALLAHAN  66 FRBC +  PI, DXI/DL=-17      1/74
XIA      78  (-0.5)     (0.9)             EISLER    68 HLBC +  PI,L+=0,NO DX/DL    1/74
XIA  K2041   -0.5        0.8              KIJEWSKI  69 OSPK +  PI, DXI/DL=-26      1/74
XIA  H3240   -1.1        0.56             HAIDT     71 HLBC +  DP, DXI/DL=-29      1/74
XIA  A4025   -0.62       0.28             ANKENBRAN 72 ASPK +  PI, DXI/DL=-12      1/74
XIA  B3480   +0.45       0.28             CHIANG    72 OSPK +  DP, DXI/DL=-15      1/74
XIA  D1897   -0.36       0.40             BRAUN     73 HLBC +  DP, DXI/DL=-19      3/74
XIA  N 490   -0.8        0.8              ARNOLD    74 HLBC +  DP, DXI/DL=-20     11/75
XIA  M6527   -0.57       0.24             MERLAN    74 ASPK +  DP, DXI/DL= -9      3/74
XIA    3973  -0.27       0.25             WHITMAN   80 SPEC +  DP, DXI/DL=-17      4/82*
XIA          . . . . . . . . . .
XIA AVG      -0.32       0.15     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
XIA FIT      -0.35       0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIA       FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
XIA J     JENSEN 64 GIVES L+M=L+E=-.020+-.027. DXI/DL UNKNOWN. INCLUDES          1/74
XIA J     SHAKLEE 64 XI(BR(KMU3/KE3)).                                           1/74
XIA  C    CALLAHAN 66 TABLE 1 (PI ANAL) GIVES DXI/DL=(.72-.05)/(0-.04)=-17.      1/74
XIA  C    ERROR RAISED FROM .80 TO AGREE WITH DXI0=.37 FOR FIXED L+.             1/74
```

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XIA   K  KIJEWSKI 69 FIG. 17 WAS USED TO OBTAIN DXI/DL AND ERRORS.          1/74
XIA   H  HAIDT 71 TABLE 8 (DP ANAL) GIVES DXI/DL=(-1.1+0.5)/(.050-.029)=-29.  1/74
XIA   H  ERROR RAISED FROM .50 TO AGREE WITH DXI0=.20 FOR FIXED L+.         1/74
XIA   A  ANKENBRANDT 72 FIG. 3 WAS USED TO OBTAIN DXI/DL.                   1/74
XIA   B  CHIANG 72 FIG. 10 WAS USED TO OBTAIN DXI/DL.                       1/74
XIA   B  FIT HAD L-=L+ BUT WOULD NOT CHANGE FOR L-=0.  L.PONDROM,PRIV.COM.74  1/74
XIA   D  BRAUN1 73 GIVES XI(T)=-.34+-.20, DXI(T)/DL+=-14 FOR L+=.027, T=6.6.  3/74
XIA   D  WE CALCULATE ABOVE XI(0) AND DXI(0)/DL+ FOR THEIR L+=.025+-.017 .  3/74
XIA   N  ARNOLD 74 FIG. 4 WAS USED TO OBTAIN XIA AND DXI/DL.               11/75
XIA   M  MERLAN 74 FIG.5 WAS USED TO OBTAIN DXI/DL.                         3/74

XIB      XIB = F-/F+ (DETERMINED FROM KMU3/KE3)  ------------------------
XIB      THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(0)    1/74
XIB      AND L+.  WE QUOTE THE AUTHORS XI(0) AND ASSOCIATED L+ BUT DO NOT   1/74
XIB      AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE    1/74
XIB      FACTOR GIVEN IN THE ABOVE NOTE ON KL3 FORM FACTORS ARE NOT OBTAINED 2/76
XIB      FROM THESE XIB VALUES.  INSTEAD THEY ARE OBTAINED DIRECTLY FROM THE 2/76
XIB      FITTED KMU3/KE3 RATIO (R29), WITH THE EXCEPTION OF HEINTZE 77.     4/82*
XIB           (-0.17)   (0.75)   (0.99) SHAKLEE   64 XEBC +  BR, L+=0       1/74
XIB           (+0.6)    (0.5)           BISI 1    65 HBC  +  BR, L+=0       1/74
XIB      500  (+0.8)    (0.6)           CUTTS     65 OSPK +  BR, L+=0       1/74
XIB      636  (+0.4)    (0.4)           CALLAHA1  66 FRBC +  BR, L+=0       1/74
XIB      306  (+0.75)   (0.50)          AUERBACH  67 OSPK +  BR, L+=0       1/74
XIB B 5601    (-0.08)   (0.15)          BOTTERIL2 68 ASPK +  BR,L+=.023+-.008 1/74
XIB E 1398    (-0.60)   (0.20)          EICHTEN   68 HLBC +  BR, SEE NOTE E 1/74
XIB      986  (+1.0)    (0.6)           GARLAND   68 OSPK +  BR, L+=0       1/74
XIB           (+0.91)   (0.82)          ZELLER    69 ASPK +  BR, L+=.023    1/74
XIB   B       (-0.35)   (0.22)          BOTTERIL  70 OSPK +  BR,L+=.045+-.015 1/74
XIB   E1505   (-0.81)   (0.27)          HAIDT     71 HLBC +  BR,L+=.028,FIG.8 1/74
XIB    5825   (0.0)     (0.15)          CHIANG    72 OSPK +  BR,L+=.03,FIG.10 1/74
XIB   H 55K   -0.12      0.12           HEINTZE   77 CNTR +  BR,L+=.029     3/78
XIB           . . . . . . . . . .
XIB FIT       -0.35      0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIB      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
XIB   B  BOTTERIL 70 IS REEVALUATION OF BOTTERIL 2 68 WITH DIFFERENT L+.    1/74
XIB E    EICHTEN 68 HAS L+=.023+-.008, T=4, INDEP. OF L-. REPL. BY HAIDT 71.  1/74
XIB   H  CALCULATED BY US FROM L0 AND L+ GIVEN BELOW.                       3/78

XIC      XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)  -----------
XIC      THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC      NECESSARY, T (WEIGHTED BY SENSITIVITY TO XI0) SHOULD BE SPECIFIED.
XIC      IN L+.XI(0) PARAMETERIZATION THIS IS XI(0) FOR L+=0.  DXI/DL=XI*T.
XIC      FOR RAD. CORR. TO MUON POLARIZATION IN KMU3 SEE GINSBERG 71.
XIC T 2100  (+1.2)    (2.4)    (1.8)  BORREANI  65 HLBC +  POLARIZATION     8/67
XIC T  500 BTWN -4.0 AND +1.7         CUTTS     65 OSPK +  LONG. POL.       1/74
XIC T  397  (-1.4)    (1.8)           CALLAHA1  66 FRBC +  TOTAL POL.       8/67
XIC T 2950  (-0.7)    (0.9)    (3.3)  CALLAHA1  66 FRBC +  LONG. POL.       8/67
XIC  B6000   -1.0      0.3            BETTELS      HLBC +  TOTAL POL. T=4.9 1/74
XIC  C3133   -0.95     0.3            CUTTS     69 OSPK +  TOTAL POL. T=4.0 1/74
XIC M  40K  (-0.44)   (0.27)          MERLAN    74 ASPK +  POL,DXI/DL=+1.7  3/74
XIC  D1585   -0.25     1.20           BRAUN     75 HLBC +  POL. T=4.2       1/76
XIC          . . . . . . . . . .
XIC AVG      -0.95     0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
XIC FIT      -0.35     0.15   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIC      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
XIC T    T VALUE NOT GIVEN.
XIC   B  BETTELS 68 DXI/DL=XI*T=-1.0*4.9=-4.9 .
XIC   C  CUTTS 69 T=4.0 WAS CALCULATED FROM FIG.8. DXI/DL=XI*T=-.95*4=-3.8 .  1/74
XIC M    MERLAN 74 POLARIZATION RESULT (FIG.5) NOT POSSIBLE.  SEE DISCUSSION 1/76
XIC M    OF POLARIZATION EXPERIMENTS IN NOTE ON KL3 FORM FACTORS ABOVE.     1/76
XIC   D  BRAUN 75 DXI/DL=XI*T=-.25*4.2=-1.0 .                               1/76

IXI          IMAGINARY PART OF XI (TEST OF T REVERSAL)  ----- ------------
IXI    2648    0.0      1.0             CALLAHA1  66 FRBC +  MU             1/74
IXI     397   +1.6      1.3             CALLAHA1  66 FRBC +  TOTAL POL.     1/74
IXI    2950    0.5      1.4      0.5    CALLAHA1  66 FRBC +  LONG. POL.     1/74
IXI    6000   -0.1      0.3             BETTELS   68 HLBC +  TOTAL POL.     1/74
IXI    3133   -0.3      0.3      0.4    CUTTS     69 OSPK +  TOTAL POL. FIG.7 1/74
IXI     20M   -0.016    0.025           CAMPBELL  81 CNTR +  POL.           1/82*
IXI          . . . . . . . . . .
IXI AVG       -0.017    0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

L+M      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)  ---------
L+M      SEE ALSO THE CORRESPONDING ENTRIES AND FOOTNOTES IN SECTIONS XIA,
L+M      XIC, AND L0.
L+M      FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.         3/74
L+M     444    0.0       0.05             CALLAHA1  66 FRBC +  PI           1/74
L+M    2041    0.003     0.026            KIJEWSKI  69 OSPK +  PI           1/74
L+M    3240    0.050     0.019            HAIDT     71 HLBC +  DP           1/74
L+M  A4025     0.024     0.019            ANKENBRAN 72 ASPK +  PI           1/74
L+M    3480   -0.006     0.015            CHIANG    72 OSPK +  DP           1/74
L+M    1897    0.025     0.017            BRAUN1    73 HLBC +  DP           3/74
L+M     490    0.025     0.030            ARNOLD    74 HLBC +  DP           7/74
L+M    6527    0.027     0.019            MERLAN    74 ASPK +  DP           3/74
L+M    3973   +0.050     0.013            WHITMAN   80 SPEC +  DP          10/81*
L+M          . . . . . . . . . .
L+M AVG        0.0272    0.0072  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
L+M FIT        0.032     0.008  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

L+M      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
L+M   A  ANKENBRANDT 72 L+ FROM FIG.3 TO MATCH DXI/DL. TEXT GIVES .024+-.022  1/74

L0       LAMBDA 0 (LINEAR ENERGY DEPENDENCE OF F0 IN KMU3 DECAY)  ----------
L0       WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
L0       VALUES OF L0 USING THE ASSOCIATED L+M AND DXI/DL.
L0 M    444   +0.058     0.036            CALLAHA1  66 FRBC +  PI,DL0/DL+=-0.37  1/74
L0 L   6000   -0.063    (0.024)           BETTELS   68 HLBC +  POL,DL0/DL+=+.60  1/74
L0 L   3133   -0.056    (0.024)           CUTTS     69 OSPK +  POL,DL0/DL+=+.69  1/74
L0 M   2041   -0.031     0.045            KIJEWSKI  69 OSPK +  PI,DL0/DL+=-1.10  1/74
L0 L   3240   -0.039     0.029            HAIDT     71 HLBC +  DP,DL0/DL+=-1.34  1/74
L0 M   4025   -0.026     0.013            ANKENBRAN 72 ASPK +  PI,DL0/DL+=+0.03  1/74
L0 M   3480   +0.030     0.014            CHIANG    72 OSPK +  DP,DL0/DL+=-0.21  1/74
L0    D1897   -0.008     0.020            BRAUN1    73 HLBC +  DP,DL0/DL+=-0.53  1/76
L0      490   -0.040     0.040            ARNOLD    74 HLBC +  DP,DL0/DL+=-0.62  7/74
L0  B         (-0.017)  (0.011)           BRAUN     74 HLBC +  KMU3/KE3 VS. T   11/75
L0 M   6527   -0.019     0.015            MERLAN    74 ASPK +  DP,DL0/DL+=+0.27  3/74
L0 L   1585   +0.008     0.097            BRAUN     75 HLBC +  POL,DL0/DL+=+.92  1/76
L0    H 55K   +0.019    (0.010)           HEINTZE   77 SPEC +  BR,DL0/DL+=+0.03 12/77
L0     3973   +0.029     0.011            WHITMAN   80 SPEC +  DP,DL0/DL+=-0.37 10/81*
L0            . . . . . . . . . .
L0  AVG        0.0032    0.0099  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
L0  FIT       +0.004     0.007  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

L0       FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS ABOVE.
L0 M     L0 CALCULATED BY US FROM XI0, L+M, AND DXI/DL.                     1/74
L0 L     L0 VALUE IS FOR L+=0.03  CALCULATED BY US FROM XI0 AND DXI/DL.     1/74
L0    D  THIS VALUE AND ERROR ARE TAKEN FROM BRAUN 75 BUT CORRESPOND TO THE 1/76
L0    D  BRAUN1 73 L+M RESULT.  DL0/DL+ IS FROM BRAUN1 73 DXI/DL IN XIA ABV. 1/76
L0  B    BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF  11/75
L0  B    BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.          11/75
L0 M     MERLAN 74 L0 AND DL0/DL+ WERE CALCULATED BY US FROM XIA, L+M, AND   3/74
L0 M     DXI/DL.  THEIR FIG.6 GIVES L0=-0.025+-0.012 AND NO DL0/DL+.         3/74
L0    H  HEINTZE 77 USES L+=0.029+-0.003.  DL0/DL+ ESTIMATED BY US.         12/77
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L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KE3 DECAY)  ---------
L+E      FOR RAD.COR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.                3/74
L+E     217   +0.036    0.045            BROWN     62 XEBC +  PI, NO RC
L+E     407   -0.010    0.029            JENSEN    64 XEBC +  PI, NO RC            6/67
L+E     230   -0.04     0.05             BORREANI  64 HBC  +  E+, NO RC            8/67
L+E     854    0.045    0.017     0.018  BELLOTT2  67 FBC  +  DP, USES RC         11/67
L+E    1393   +0.016    0.016            IMLAY     67 OSPK +  DP, NO RC            8/67
L+E     515   +0.028    0.013     0.014  KALMUS    67 FBC  +  E+, PI, NO RC        8/67
L+E     960    0.08     0.04             BOTTERIL1 68 ASPK +  E+, USES RC          6/68
L+E      90   -0.02     0.08      0.12   EISLER    68 HLBC +  PI, USES RC          6/68
L+E    1458    0.045    0.015            BOTTERIL  70 OSPK    PI, USES RC         10/69
L+E    2707    0.027    0.010            STEINER   71 HLBC +  DP, USES RC         11/71
L+E    4017    0.029    0.011            CHIANG    72 OSPK +  DP, RC NEGLIGBLE     5/72
L+E  A         0.027    0.008            BRAUN2    73 HLBC +  DP, NO RC            3/74
L+E B         (0.025)  (0.007)           BRAUN     74 HLBC +  KMU3/KE3 VS. T      11/75
L+E  A   BRAUN2 73 STATES THAT RC OF GINSBERG 67 WOULD LOWER L+E BY .002 BUT  3/74
L+E  A   THAT RC OF BECHERRAWY DISAGREES AND WOULD RAISE L+E BY .005 .        1/76
L+E B    BRAUN 74 IS A COMBINED KMU3-KE3 RESULT.  IT IS NOT INDEPENDENT OF   11/75
L+E B    BRAUN1 73 (KMU3) AND BRAUN2 73 (KE3) FORM FACTOR RESULTS.           11/75
L+E           . . . . . . . . . .
L+E AVG        0.0285   0.0043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

FS       FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS              (0.18) OR LESS  CL=.99   BELLOTT2  67 HLBC                       10/69
FS              (0.30) OR LESS  CL=.95   KALMUS    67 HLBC +                     10/69
FS              (0.23) OR LESS  CL=.90   BOTTERIL1 68 ASPK                        8/66
FS     2707      0.14      0.03     0.04 STEINER   71 HLBC +  L+,FS,FT,PHI FIT    2/72
FS     4017     (0.13) OR LESS  CL=.90   CHIANG    72 OSPK +                      5/72
FS     2827      0.00      0.10          BRAUN     75 HLBC +                     12/75
FS            . . . . . . . . . .
FS  AVG          0.125     0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

FT       FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT              (0.58) OR LESS  CL=.90   BELLOTT2  67 HLBC                       10/69
FT              (1.1)  OR LESS  CL=.95   KALMUS    67 HLBC +                     10/69
FT              (0.58) OR LESS  CL=.90   BOTTERIL1 68 ASPK                        8/66
FT     2707      0.24      0.16     0.14 STEINER   71 HLBC +  L+,FS,FT,PHI FIT    2/72
FT     4017     (0.75) OR LESS  CL=.90   CHIANG    72 OSPK +                      9/72
FT     2827      0.07      0.37          BRAUN     75 HLBC +                     12/75
FT            . . . . . . . . . .
FT  AVG          0.22      0.14    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

FTM      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KMU3 DECAY  ------------
FTM    1585      0.02      0.12          BRAUN     75 HLBC                        1/76

KE4      KE4 DECAY FORM FACTORS ARE GIVEN IN THE FOLLOWING PAPERS
KE4                                      BASILE    71 ASPK +                     11/75
KE4                                      BEIER     73 OSPK +-                    11/75
KE4                                      BOSSELET  77 SPEC +                      2/80

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REFERENCES FOR CHARGED K


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BIRGE     56 NC    4   834       BIRGE,PERKINS,PETERSON,STORK,WHITEHEA (LRL)
ILOFF     56 PR 107   927        ILOFF,GOLDHABER,LANNUTTI,GILBERT +    (LRL)
ALEXANDE  57 NC    6   478       ALEXANDER,JOHNSTON,OCEALLAIGH (DUBLIN INST)
COHEN     57 FUND.CONS.PHYS.     +CROWE,DUMOND       (ATOMICS INTER.+LRL+CIT)
EISENBER  58 NC    9   663       EISENBERG,KOCH,LOHRMANN,NIKOLIC +      (BERN)
BURROWES  59 PRL   2   111       BURROWES,CALDWELL,FRISCH,HILL +         (MIT)
TAYLOR    59 PR 114   359        S TAYLOR,HARRIS,OREA       BAUMEL (COLUMBIA)

FREDEN    60 PR 118   564        S C FREDEN,F C GILBERT,R  WHITE         (LRL)
BARKAS    61 PR 124 1209         BARKAS,DYER,MASON,NORRIS,NICKOLS,SMIT (LRL)
BHOWMIK   61 NC   20   857       B BHOWMIK,P C JAIN,P C MATHUR  (DELHI UNIV)
FERRO-LU  61 NC   22  1087       FERRO-LUZZI,MILLER,MURRAY,ROSENFELD+  (LRL)
NORDIN    61 PR 123 2168         PAUL NORDIN JR                          (LRL)
ROE       61 PRL   7   346       ROE,SINCLAIR,BROWN,GLASER +        (MICH+LRL)
BOYARSKI  62 PR 128 2398         BOYARSKI,LOH,NIEMELA,RITSON             (MIT)
BROWN     62 PRL   8   450       BROWN,KADYK,TRILLING,ROE+          (LRL,MICH)
BARKAS    63 PRL  11    26       W H BARKAS,J N DYER,H H HECKMAN         (LRL)

BORREANI  64 PL    12 123        G BORREANI,G RINAUDO,A WERBROUCK      (TURIN)
CALLAHAN  64 PR   136 B 1463     A CALLAHAN,R MARCH,R STARK        (WISCONSIN)
CAMERINI  64 PRL   13 318        CAMERINI,CLINE,FRY,POWELL    (WISCONSIN+LRL)
CLINE     64 PRL   13 101        D CLINE, W F FRY                  (WISCONSIN)
GIACOMEL  64 NC 34  1134         GIACOMELLI,MONTI,QUARENI+   (BOLOGNA,MUNICH)
GREINER   64 PRL   13 284        D GREINER, W OSBORNE, W BARKAS          (LRL)
JENSEN    64 PR   136 B1431      JENSEN,SHAKLEE,ROE,SINCLAIR            (MICH)
KALMUS    64 PRL   13    99      +KERNAN,PU,POWELL,DOWD             (LRL,WISC)
SHAKLEE   64 PR   136 B 1423     SHAKLEE,JENSEN,ROE,SINCLAIR            (MICH)

BIRGE     65 PR 139 B 1600       BIRGE,ELY,GIDAL,CAMERINI,CLINE + (LRL+WISC)
BISI      65 NC    35  768       BISI,BORREANI,CESTER,FERRARO +       (TORINO)
BISI 1    65 PR 139 B 1068       BORREANI,MARZARI-CHIESA,RINAUDO+     (TORINO)
BORREANI  65 PR 140 B1686        BORREANI,GIDAL,RINAUDO,CAFORIO+ (BARI,TORI)
CALLAHAN  65 PRL   15  129       A CALLAHAN,D CLINE                (WISCONSIN)
CAMERINI  65 NC 37 1795          +CLINE,GIDAL,KALMUS,KERNAN         (WISC+LRL)
CLINE     65 PL    15  293       A CLINE,W F FRY                   (WISCONSIN)
CUTTS     65 PR 138 B969         CUTTS,ELIOFF,STIENING                   (LRL)

DE MARCO  65 PR 140 B 1430       DE MARCO,GROSSO,RINAUDO         (TORINO+CERN)
FITCH     65 PR 140 B 1088       FITCH,QUARLES,WILKINS(PRINCETON+MT HOLYOKE)
GREINER   65 ARNS  15   67       QUOTED BY BARKAS                        (LRL)
STAMER    65 PR   138 B 440      STAMER,HUETTER,KOLLER,TAYLOR,GRAUMAN (STEV)
TRILLING  65 UCRL 16473          GEORGE H TRILLING                       (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 5.
YOUNG     65 UCRL 16362          POH-SHIEN YOUNG (THESIS,BERKELEY)        (LRL)
    ALSO  67 PR 156 1464         P-S YOUNG,W.Z.OSBORNE,W.H.BARKAS        (LRL)

CALLAHA1  66 PR 150 1153         CALLAHAN,CAMERINI+(WISC,LRL,RIVERSIDE,BARI)
CALLAHAN  66 NC  44A 90          A C CALLAHAN                      (WISCONSIN)
CESTER    66 PL 21 343           CESTER,ESCHSTRUTH,ONEILL+  (PRINCETON-PENN)
    ALSO  67 AUERBACH, FOOTNOTE 1.

AUERBACH  67 PR 155  1505        +DOBBS,MANN,MCFARLANE,WHITE+     (PENN,PRIN)
    ALSO  74 PR D9 3216          ERRATUM
BELLOTT1  67 HEIDELBERG CONF     BELLOTTI,PULLIA                       (MILAN)
BELLOTT2  67 NC 52A  1287        BELLOTTI,FIORINI,PULLIA               (MILAN)
    ALSO  66 PL   20   690       BELLOTTI,FIORINI,PULLIA+              (MILAN)
BISI      67 PL 25B  572         BISI,CESTER,CHIESA,VIGONE            (TORINO)

BOTTERIL  67 PRL   19  982       BOTTERILL,BROWN,CORBETT,CULLIGAN + (OXFORD)
    ALSO  68 BOTTERIL
BOWEN     67 PR 154 1314         BOWEN,MANN,MCFARLANE,HUGHES+(PENN-PRINCETO)
CLINE1    67 HEIDELBERG CONF     CLINE,HAGGERTY,SINGLETON,FRY+   (WISCONSIN)
CLINE2    67 HERCEG NOVI TBL.4 D.CLINE,PROC.INTL.SCH.ON ELEM.PART.PHYSICS

FLETCHER  67 PRL   19   98       FLETCHER,BEIER,EDWARDS,+          (ILLINOIS)
FORD      67 PRL 18 1214         +LEMONICK,NAUENBERG,PIROUE      (PRINCETON)
IMLAY     67 PR 160  1203        IMLAY,ESCHSTRUTH,FRANKLIN+      (PRINCETON)
KALMUS    67 PR   159  1187      KALMUS,KERNAN                           (LRL)
ZINCHENK  67 RUTGERS(THESIS)     ZINCHENKO                           (RUTGERS)
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BETTELS  68 NC 56A 1106        AACHEN-BARI-BERGEN-CERN-EP-NIJMEGEN-ORSAY+
    ALSO 71 HAIDT
BOTTERIL 68 PR 171 1402        BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BOTTERI1 68 PR 174 1661        BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BOTTERI2 68 PRL 21 766         BOTTERILL,BROWN,CLEGG,CORBETT +     (OXFORD)
BUTLER   68 UCRL-18420         +BLAND,GOLDHABER,GOLDHABER,HIRATA+     (LRL)
CHANG    68 PRL 20  510        CHANG,YODH,EHRLICH,PLANO+(MARYLAND,RUTGERS)

CHEN     68 PRL 20 73          CHEN,CUTTS,KIJEWSKI,STIENING +     (LRL,MIT)
EICHTEN  68 PL 27B 586         AACHEN-BARI-CERN-EP-ORSAY-PADOVA-VALENCIA
EISLER   68 PR  169  1090      EISLER,FUNG,MARATECK,MEYER,PLANO  (RUTGERS)
ESCHSTRU 68 PR  165  1487      ESCHSTRUTH,FRANKLIN,HUGHES+(PRINCETON,PENN)
GARLAND  68 PR  167  1225      +TSIPIS,DEVONS,ROSEN+  (COLUMBIA,RUTG,WISC)
MOSCOSO  68  THESIS            M L MOSCOSO              (UNIV PARIS ORSAY)

CUTTS    69 PR 184 1380        +STIENING,WIEGAND,DEUTSCH          (LRL,MIT)
    ALSO 68 PRL  20 955        CUTTS,STIENING,WIEGAND,DEUTSCH     (LRL,MIT)
DAVISON  69 PR   180 1333      +BACASTOW,BARKAS,EVANS,FUNG,PORTER+    (UCR)
ELY      69 PR   180 1319      ELY,GIDAL,HAGOPIAN,KALMUS+  (LOUC+WISC+LRL)
EMMERSON 69 PRL 22 393         EMMERSON,QUIRK                      (OXFORD)

HERZO    69 PR 186 1403        +BANNER,BEIER,BERTRAM,EDWARDS +        (ILL)
KIJEWSKI 69 UCRL-18433 THESIS  P K KIJEWSKI                           (LBL)
LOBKOWIC 69 PR 185 1676        +MELISSINOS,NAGASHIMA,TEWKSBURY+  (ROCH,BNL)
    ALSO 66 PRL 17 548         LOBKOWICZ,MELISSINOS,NAGASHIM+    (ROCH+BNL)
MACEK    69 PRL   22   32      MACEK,MANN,MC FARLANE,ROBERTS+(PENN,TEMPLE)
MAST     69 PR   183 1200      +GERSHWIN,ALSTON-GARNJOST,BANGERTER+   (LRL)
ZELLER   69 PR   182 1420      ZELLER,MADDOCK,HELLAND,PAHL+      (UCLA,LRL)

BOTTERIL 70 PL 31B 325         +BROWN,CLEGG,CORBETT,CULLIGAN+         (OXF)
FORD     70 PRL  25 1370       +PIROUE,REMMEL,SMITH,SOUDER           (PRIN)
GRAUMAN  70 PR D1 1277         +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
    ALSO 69 PRL 23 737         +KOLLER,TAYLOR,PANDOULAS+  (STEV,SETO,LEHI)
MACEK    70 PR D1 1249         +MANN,MCFARLANE,ROBERTS               (PENN)
MALTSEV  70 SJNP 10 678        +PESTOVA,SOLODOVNIKOVA,FADEEV +       (JINR)
PANDOULA 70 PR D2 1205         +TAYLOR,KOLLER,GRAUMAN +         (STEV,SETO)

BASILE   71 PL 36B 619         +BREHIN,DIAMANT-BERGER,RUNZ+     (SACL+GEVA)
BOURQUIN 71 PL 36B 615         +BOYMOND,EXTERMANN,MARASCO+      (GEVA,SACL)
HAIDT    71 PR D3 10           AACHEN+BARI+CERN+EP+NIJMEGEN+ORSAY+PADOVA+
    ALSO 69 PL  29B 691        +(AACH,BARI,CERN,EPOL,NIJM,ORSAY,PADO,TORI)
KLEMS    71 PR D4 66           +HILDEBRAND,STIENING             (CHIC,LRL)
    ALSO 70 PRL 24 1086        KLEMS,HILDEBRAND,STIENING        (LRL,CHIC)
    ALSO 70 PRL 25 473         KLEMS,HILDEBRAND,STIENING        (LRL,CHIC)

KUNSELMA 71 PL 34B 485         R. KUNSELMAN                     (WYOMING)
OTT      71 PR D3 52           OTT,PRITCHARD                       (LOQM)
ROMANO   71 PL 36B 525         +RENTON,AUBERT,BURBAN-LUIZ (BARI,CERN,ORSA)
SCHWEINB 71 PL 36B 246         AACHEN+BELGIUM+CERN+NIJMEGEN+PADOVA COLLAB
STEINER  71 PL 36B 521         AACHEN+BARI+CERN+EPOL+ORSA+NIJM+PADO+TORIN

ABRAMS   72 PRL 29 1118        +CARROLL,KYCIA,LI,MENES,MICHAEL +      (BNL)
ANKENBRA 72 PRL 28 1472        ANKENBRANDT,LARSEN+     (BNL+LASL+FNAL+YALE)
AUBERT   72 NC 12A 509         +HEUSSE,PASCAUD,VIALLE+     (ORSA+BRUX+EPOL)
BEIER    72 PRL 29 678         +BUCHHOLZ,MANN,PARKER         (PENNSYLVANIA)
CHIANG   72 PR D6 1254         +ROSEN,SHAPIRO,HANDLER,OLSEN+    (ROCH+WISC)

CLARK    72 PRL 29 1274        +CORK,ELIOFF,KERTH,MCREYNOLDS,NEWTON+ (LBL)
EDWARDS  72 PR D5 2720         +BEIER,BERTRAM,HERZO,KOESTER +         (ILL)
FORD     72 PL 38B 335         +PIROUE,REMMEL,SMITH,SOUDER      (PRINCETON)
HOFFMAST 72 NP 836 1           HOFFMASTER,KOLLER,TAYLOR+  (STEV+SETO+LEHI)

ABRAMS   73 PRL 30 500         +CARROLL,KYCIA,LI,MENES,MICHAEL +      (BNL)
BACKENST 73 PL 43B 431         BACKENSTOSS,BAMBERGER+(CERN+KARL+HEID+STOH)
BEIER    73 PRL 30 399         +BUCHHOLZ,MANN,PARKER,ROBERTS         (PENN)
BRAUN1   73 PL 47B 182         AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
BRAUN2   73 PL 47B 185         AACHEN+BARI+BRUSSELS+CERN COLLABORATION
    ALSO 75 BRAUN
CABLE    73 PR D8 3807         +HILDEBRAND,PANG,STIENING          (EFI+LBL)

LJUNG    73 PR D8 1307         D.LJUNG,D.CLINE                       (WISC)
    ALSO 72 PRL 28 523         D.LJUNG                               (WISC)
    ALSO 72 PRL 28 1287        D.CLINE,D.LJUNG                       (WISC)
    ALSO 69 PRL 23 326         CAMERINI,LJUNG,SHEAFF,CLINE           (WISC)
LUCAS1   73 PR D8 719          LUCAS,TAFT,WILLIS                     (YALE)
LUCAS2   73 PR D8 727          LUCAS,TAFT,WILLIS                     (YALE)
PANG     73 PR D8 1989         +HILDEBRAND,CABLE,STIENING    (EFI+ARIZ+LBL)
    ALSO 72 PL 40B 699         CABLE,HILDEBRAND,PANG,STIENING     (EFI+LBL)
SMITH    73 NP B60 411         +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)

ARNOLD   74 PR D9 1221         C L ARNOLD,B P ROE,D SINCLAIR         (MICH)
BRAUN    74 PL 51B 393         +CORNELSSEN,MARTYN +  (AACH+BARI+BRUX+CERN)
CENCE    74 PR D10 776         +HARRIS,JONES,MONGADO +      (HAWA+LBL+WISC)
    ALSO 73 THESIS (UNPUBL.)   D B CLARKE                            (WISC)
KUNSELMA 74 PR C9 2469         R.KUNSELMAN                           (WYOM)
MERLAN   74 PR D9 107          +KASHA,WANDERER,ADAIR+      (YALE+BNL+LASL)
WEISSENB 74 PL 48B 474         WEISSENBERG,EGOROV,MINERVINA +  (ITEP+LEBD)

BLOCH    75 PL 56B 201         +BREHIN,BUNCE,DEVAUX+            (SACL+GEVA)
BRAUN    75 NP B89 210         +CORNELSSEN,MARTYN+   (AACH+BARI+BRUX+CERN)
CHENG    75 NP A254 381        +ASANO,CHEN,DUGAN,HU,WU,HUGHES+ (COLU+YALE)
HEARD1   75 PL 55B 324         +HEINTZE,HEINZELMANN+            (CERN+HEID)
HEARD2   75 PL 55B 327         +HEINTZE,HEINZELMANN+            (CERN+HEID)
SHEAFF   75 PR D12 2570        M. SHEAFF                             (WISC)
SMITH    75 NP B91 45          +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)

BERTRAND 76 NP B114 387        +SACTON +         (BRUX+UBEL+DUUC+LOUC+WARS)
BLOCH    76 PL 60B 393         +BUNCE,DEVAUX,DIAMANT-BERGER+    (GEVA+SACL)
BRAUN    76 LNC 17 521         +MARTYN,ERRIQUEZ +    (AACH+BARI+BELG+CERN)
DIAMANTB 76 PL 62B 485         DIAMANT-BERGER,BLOCH,DEVAUX +    (SACL+GEVA)
HEINTZE  76 PL 60B 302         +HEINZELMANN,IGO-KEMENES,MUNDHENKE+   (HEID)
SMITH    76 NP B109 173        +BOOTH,RENSHALL,JONES+ (GLAS+LIVP+OXF+RHEL)
WEISSENB 76 NP B115 55         WEISSENBERG,EGOROV,MINERVINA+   (ITEP+LEBD)

ABRAMS   77 PR D15 22          +CARROLL,KYCIA,LI,MICHAEL,MOCKETT +    (BNL)
DEVAUX   77 NP B126 11         +BLOCH,DIAMANT-BERGER,MAILLARD+ (SACL+GEVA)
HEINTZE  77 PL 70B 482         +HEINZELMANN,IGO-KEMENES,+       (HEID+CERN)
ROSSELET 77 PR D15 574         +EXTERMANN,FISCHER,GUISAN +      (GEVA+SACL)
BARKOV   79 NP B148 53         +VASSERMAN,ZOLOTOREV,KRUPIN+     (NOVO+KIAE)
HEINTZE  79 NP B149 365        +HEINZELMANN,IGO-KEMENES+        (HEID+CERN)

WHITMAN  80 PR D21 652         +ABRAMS,CARROLL,KYCIA,LI+    (ILLC+BNL+ILL)
ASANO    81 PL 107B 159        +KIKUTANI,KUROKAWA,MIYACHI+ (KEK+TOKY+OSAK)
CAMPBELL 81 PRL 47 1032        +BLACK,BLATT,KASHA,SCHMIDT +      (YALE+BNL)
LUM      81 PR D23 2522        +WIEGAND,KESSLER,DESLATTES,SEKI+ (LBL+NBS+)
LYONS    81 ZPHY C10 215       +ALBAJAR,MYATT                         (OXF)

         QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

BLOCK    62 CERN CONF 371      BLOCK,LENDINARA,MONARI       (NWES+BOLOGNA)

                           PAPERS NOT REFERRED TO IN DATA CARDS

BRENE    61 NP 22 553          BRENE,EGARDT,QVIST                    (NORD)
BIRGE    63 PRL  11  35        BIRGE,ELY,GIDAL,CAMERINI +  (LRL+WISC+BARI)
ADAIR    64 PL 12  67          ADAIR,LEIPUNER                    (YALE,BNL)
CABIBBO  64 PL   9 352         CABIBBO,MAKSYMOWICZ                   (CERN)
    ALSO 64 PL 11 360          CABIBBO,MAKSYMOWICZ                   (CERN)
    ALSO 65 PL 14  72          CABIBBO,MAKSYMOWICZ                   (CERN)

CABIBBO  66 BERKELEY CONF 33   CABIBBO                               (CERN)
GINSBERG 67 PR 162  1570       EDWARD S GINSBERG          (U. MASS BOSTON)
WILLIS   67 HEIDELBERG 273     W J WILLIS -RAPPORTEUR TALK           (YALE)
CRONIN   68 VIENNA CONF 241    RAPPORTEUR TALK                  (PRINCETON)
HAIDT 2  69 PL 29B 696         + (AACH,BARI,CERN,EPOL,NIJM,ORSA,PADO,TORI)

BARDIN   70 PL 32B 121         BARDIN,BILENKY,PONTECORVO             (JINR)
BECHERRA 70 PR D1 1452         T.BECHERRAWY                          (ROCH)
FEARING  70 PR D3 547          +FISCHBACK,SMITH                 (STON+BOHR)
GAILLARD 70 CERN 70-14         M K GAILLARD, L M CHOUNET        (CERN+ORSA)
GINSBERG 70 PR D1 229          E S GINSBERG                     (TIT HAIFA)

GINSBERG 71 PR D4 2893         E S GINSBERG                           (HIT)
CHOUNET  72 PL 4C 199          (PHYS. REPTS.)CHOUNET,2*GAILLARD(ORSA+CERN)
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K^0

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                    11  NEUTRAL K(498,JP=0-) I=1/2
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                    11  NEUTRAL K MASS (MEV)

M             498.1      0.4           CHRISTENS 64 OSPK
M      2223   497.44     0.33          KIM       65 HBC    K0 FROM PBAR P    6/66
M      4500   498.9      0.5           BALTAY    66 HBC    K0 FROM PBAR P    6/66
M             497.44     0.50          FITCH     67 OSPK                     11/67
M             . . . . . . . . . .
M   AVG       497.87     0.32     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
M   FIT       497.67     0.13    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  3/82*
                         (SEE IDEOGRAM BELOW )
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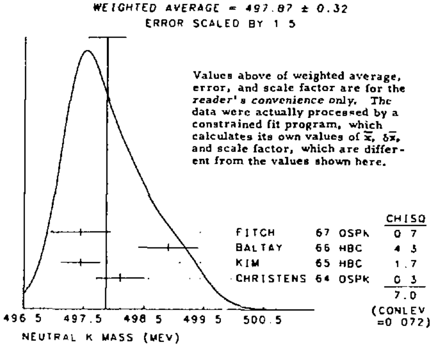
WEIGHTED AVERAGE = 497.87 ± 0.32

ERROR SCALED BY 1 5

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                    11  (K0) - (K+-) MASS DIFFERENCE (MEV)

D             3.9       0.6            ROSENFELD 59 HBC  -
D             5.4       1.1            CRAWFORD  59 HBC  +
D       9     3.90      0.25           BURNSTEIN 65 HBC  -
D       7     3.71      0.35           KIM       65 HBC  -  K- P TO K0 N     6/68
D     417     3.95      0.21           HILL      68 DBC  +  K+D TO K0PP      3/68
D             . . . . . . . . . .
D   AVG       3.92      0.14     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D   FIT       4.01      0.13    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)  3/82*

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                        REFERENCES FOR NEUTRAL K

CRAWFORD 59 PRL   2  112       CRAWFORD,CRESTI,GOOD,STEVENSON,TICHO  (LRL)
ROSENFEL 59 PRL   2  110       A H ROSENFELD,F SOLMITZ,R D TRIPP     (LRL)
CHRISTEN 64 PRL 13 138         CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
BURNSTE1 65 PR  138 B 895      R A BURNSTEIN,H A RUBIN         (MARYLAND)
KIM      65 PR 140 B 1334      J K KIM,L KIRSCH,D MILLER       (COLUMBIA)

BALTAY   66 PR 142   532       BALTAY,SANDWEISS,STONEHILL +     (YALE+BNL)
FITCH    67 PR 164  1711       FITCH,ROTH,RUSS,VERNON          (PRINCETON)
HILL     68 PR 169  1534       HILL,ROBINSON,SAKITT,CANTER (BNL,CARNEGIE)
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K^0_S

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                12  SHORT-LIVED NEUTRAL K(498), JP=0-1 I=1/2

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                12  KOS MEAN LIFE (UNITS 10**-10 SEC)

T       KOS MEAN LIFE (PRE-1971 EXPERIMENTS)
T   O    90   (1.07)    (0.13)    (0.13) BOLDT      58 CC
T        512    0.94      0.05      0.05  CRAWFORD  59 HBC
T   O    63   (1.09)    (0.18)    (0.15) BOWEN      60 CC
T   C   OLD EXPTS WITH LOW STATISTICS NOT INCLUDED IN AVERAGE.              6/68
T        378    0.94      0.05      0.05  BERTANZA  62 HBC
T        503    0.87      0.05              CHRETIEN  63 HLBC
T        545    0.86      0.04              KREISLER  64 OSPK
T               0.866     0.016             ALFF-STEI 66 OSPK               9/66
T        572    0.90      0.06      0.05  AUERBACH  66 OSPK                 8/67
T       4500    0.92      0.0-              BALTAY    66 HBC                6/66
T   B          (0.904)   (0.024)            BOTT-BODE 66 OSPK               9/66
T       5000    0.843     0.013             KIRSCH    66 HBC                6/66
T      19994    0.856     0.008             DONALD    68 HBC                6/68
T   H  20000    0.872     0.009             HILL      68 DBC               11/72
T           . . . . . . . . . . .
T   AVG         0.8641    0.0065    0.0065 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.3)

T       KOS MEAN LIFE (POST-1971 EXPERIMENTS)
T        THESE VALUES ARE USED TO DETERMINE THE STABLE PARTICLE TABLE
T        VALUES OF THE KOS MEAN LIFE AND RATES.
T   H    50K    0.8958    0.0045            SKJEGGEST 72 HBC                1/73
T    F 2173   (0.867)   (0.024)             FACKLER   73 OSPK              11/73
T         6M    0.8937    0.0048            GEWENIGER 74 ASPK               3/74
T   C           0.8513    0.0032            CARITHERS 75 SPEC               7/75
T        26K    0.881     0.009             ARONSON   76 SPEC              11/76
T           . . . . . . . . . . .
T   AVG         0.8923    0.0022    0.0022 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   FIT         0.8923    0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

                      COMMENTS
T   H    HILL 68 HAS BEEN CHANGED BY THE AUTHORS FROM THE PUBLISHED VALUE    11/72
T   H    (0.865+-0.009) BECAUSE OF A CORRECTION IN THE SHIFT DUE TO ETA+-.   11/72
T   H    SKJEGGESTAD 72 AND HILL 68 GIVE DETAILED DISCUSSIONS OF SYSTEMATICS
T   H    ENCOUNTERED IN THIS TYPE OF EXPERIMENT.
T    B   KOS MEAN LIFE NOT THE PRIMARY QUANTITY MEASURED IN THIS EXPT.        6/68
T    F   FACKLER 73 DOES NOT INCLUDE SYSTEMATIC ERRORS.                     11/73
T   C    CARITHERS 75 VALUE IS FOR KOL-KOS MASS DIFFERENCE DM=.5348+-.0021. 11/75
T   C    THE DM DEPENDENCE OF THE TOTAL DECAY RATE (INVERSE MEAN LIFE) IS    11/75
T   C    GAMMA(KOS)=((1.122+-.0041+.16*(DM-.5348)/DM)*10**10 /SEC.          11/75
T   C    VALUE WOULD NOT CHANGE WITH OUR CURRENT DM=.5349+-.0022.            2/76

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                12  KOS PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      KOS INTO PI+ PI-                                  139+ 139
P2      KOS INTO PIO PIO                                  134+ 134
P3      KOS INTO MU+ MU-                                  105+ 105
P4      KOS INTO E+ E-                                    .5+  .5
P5      KOS INTO PI+ PI- GAMMA                            139+ 139+    0
P6      KOS INTO GAMMA GAMMA                               0+   0
P7      KOS INTO 3PIO                                     134+ 134+ 134

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                12  KOS BRANCHING RATIOS

R1      KOS INTO (PI+ PI-)/TOTAL                              (P1)
R1             0.68      0.04            CRAWFORD  59 HBC
R1             0.70      0.08            COLUMBIA  60 HBC
R1  U         (0.740)   (0.024)          ANDERSON  62 HBC
R1 U  3447     0.670     0.010           DOYLE     69 HBC       PI- P TO LAM KO   1/76
R1  U   ANDERSON RESULT NOT PUBLISHED, EVENTS ADDED TO DOYLE SAMPLE                 2/71
R1          . . . . . . . . . . .
R1  AVG        0.6710    0.0096   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT        0.6861    0.0024 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R2      KOS INTO (PIO PIO)/TOTAL                              (P2)
R2             0.27      0.11            CRAWFORD  59 HBC
R2             0.26      0.06            BAGLIN    60 HLBC
R2             0.30      0.035           BROWN     61 HLBC
R2    1066     0.335     0.014           BROWN     63 HLBC
R2     198     0.288     0.021           CHRETIEN  63 HLBC
R2          . . . . . . . . . . .
R2  AVG        0.316     0.014    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  FIT        0.3139    0.0024 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)
                         (SEE IDEOGRAM BELOW )
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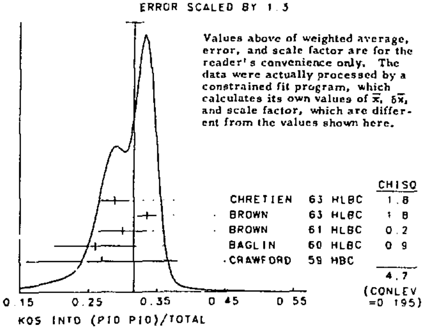

Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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R3      KOS INTO (PI+ PI-)/(PIO PIO)                                (P1)/(P2)
R3  N  267   (2.12)    (0.17)          BOZOKI    69 HLBC                        5/70
R3  G 3016   (2.265)   (0.055)         GOBBI     69 OSPK    K+N TO KOP          5/69
R3    3700    2.10      0.06           MORFIN    69 HLBC    K+N TO KOP         10/69
R3 G  7944    2.282     0.043          MOFFETT   70 OSPK    K+N TO KOP          2/72
R3 B  6150    2.22      0.095          BALTAY    71 HBC  K-P TO KO +NEUTRALS  12/71
R3 A  3068    2.22      0.10           ALITTI    72 HBC     K+P TO PI+ P KO     6/72
R3    6380    2.22      0.08           MORSE     72 DBC     K+N TO KOP          2/72
R3 N   701    2.10      0.11           NAGY      72 HLBC    K+N TO KOP          1/73
R3    4799    2.16      0.08           HILL      73 DBC     K+D TO KO P P       9/73
R3     16K    2.169     0.094          COWELL    74 OSPK    PI- P TO LAM KO     7/75
R3    1315    2.11      0.09           EVERHART  76 WIRE    PI- P TO LAM KO    11/76
R3 N    NAGY 72 IS A FINAL RESULT WHICH INCLUDES BOZOKI 69.                    11/73
R3 G    MOFFETT 70 IS A FINAL RESULT WHICH INCLUDES GOBBI 69.                   2/72
R3 B    THE DIRECTLY MEASURED QUANTITY IS KS TO PI+PI-/ALL KOBAR=.345+-.005   12/71
R3 A    THE DIRECTLY MEASURED QUANTITY IS KOS TO PI+ PI-/ALL KO=.345+-.005     6/72
R3          . . . . . . . . . . .
R3  AVG       2.197     0.026    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT       2.186     0.025  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      (KOS INTO PI+ PI- PIO, CP VIOLATING)/(KOL INTO PI+ PI- PIO)
R4       TEST OF CP VIOLATION - SEE TEXT SECTION VI B.3A FOR DEFINITIONS
R4       CPT ASSUMED VALID - (I.E. RE(A)=0) - ONLY (IM(A))**2 QUOTED HERE
R4  C   18    (3.8)  OR LESS  CL=.90   ANDERSON  65 HBC                        10/69
R4            (0.45) OR LESS  CL=.90   BEHR      66 HLBC                        8/66
R4  C   53    (1.7)  OR LESS  CL=.90   WEBBER    70 HBC                         8/70
R4 C    71    (3.8)  OR LESS  CL=.90   WEBBER    70 HBC                         8/70
R4      99    (1.2)  OR LESS  CL=.70   CHO       71 DBC                         4/71
R4  J   98    (1.0)  OR LESS  CL=.90   JAMES     71 HBC                         6/71
R4  M   50    (1.2)  OR LESS  CL=.95   METSNER   71 HBC     CL=.9 NOT AVAIL.   2/71
R4 J   180    ( 66)  OR LESS  CL=.90   JAMES     72 HBC                         1/73
R4      99    (1.2)  OR LESS  CL=.90   JONES     72 OSPK                       10/72
R4     384     0.12  OR LESS  CL=.90   METCALF   72 ASPK                        2/74
R4     148    (0.71) OR LESS  CL=.90   MALLARY   73 OSPK    RE(A)=-.05+-.17    8/73
R4     192    (1.2)  OR LESS  CL=.90   BALDOCEOL 75 HLBC                       12/75
R4 C    SECOND WEBBER 70 VALUE IS FIRST VALUE COMBINED WITH ANDERSON 65.
R4 J    JAMES 72 IS A FINAL RESULT WHICH INCLUDES JAMES 71.                    11/73
R4  M   THESE AUTHORS FIND REAL(A)= 2.75+-.65, ABOVE VALUE AT RE(A)=0           2/71

R5      KOS INTO (MU+ MU-)/CHARGED (UNITS 10**-5)            (P3)/(P1)
R5           (10.0)  OR LESS  CL=.90   BOTT-BODE 67 OSPK                       8/67
R5           (20.0)  OR LESS  CL=.90   BOHM      69 OSPK                       2/71
R5           (1.07)  OR LESS  CL=.90   HYAMS     69 OSPK                      10/69
R5   S       (32.6)  OR LESS  CL=.90   STUTZKE   69 OSPK                       5/69
R5            0.047  OR LESS  CL=.90   GJESDAL   73 ASPK                       7/73
R5   S  VALUE CALCULATED BY US, USING 2.3 INSTEAD OF 1 EVENT, 90 PERC.CL

R6      KOS INTO (PI+ PI- GAMMA)/(PI+ PI-) (UN.10**-3)   (P5)/(P1)
R6      27        NO RATIO GIVEN        BELLOTTI  66 HBC     PG GT 50 MEV/C   10/69
R6      10     3.3       1.2            WEBBER    70 HBC     PG GT 50 MEV/C   10/69
R6 B           2.8       0.6            BURGUN    73 HBC     PG GT 50 MEV/C   11/73
R6 C    29    (3.0)     (0.6)           BOBISUT   74 HLBC    PG GT 40 MEV/C   12/75
R6    T        2.68      0.15           TAUREG    76 SPEC    PG GT 50 MEV/C    6/77
R6 B    BURGUN 73 ESTIMATES THAT DIRECT EMISSION CONTRIBUTION IS .3+-.6 .     11/73
R6 C    BOBISUT 74 NOT INCLUDED IN AVERAGE BECAUSE P(GAMMA) CUT DIFFERS.       1/76
R6 C    ESTIMATES DIRECT EMISSION CONTRIBUTION TO BE 0.5 OR LESS, CL=.95.      1/76
R6    T TAUREG 76 FIND DIRECT EMISSION CONTRIB LT .06,CL=.90.                  6/77
R6          . . . . . . . . . . .
R6  AVG        2.70      0.14    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      KOS INTO (E+ E-)/CHARGED (UNITS 10**-5)               (P4)/(P1)
R7           50.0   OR LESS  CL=.90   BOHM       69 OSPK                       2/71

R8      KOS INTO 2 GAMMA/TOTAL (UNITS 10**-3)                 (P6)
R8 R     0  (21.0)  OR LESS  CL=.90   BANNER     69 OSPK                      12/71
R8 R     0  (2.2)   OR LESS  CL=.90   REPELLIN   71 OSPK                      12/71
R8 R     0  (0.71)  OR LESS  CL=.90   BANNER     72 OSPK                       8/72
R8       0  (2.0)   OR LESS  CL=.90   MORSE      72 DBC                        2/72
R8       0   0.4    OR LESS  CL=.90   BARMIN2    73 HLBC                       2/74
R8 R     THESE LIMITS ARE FOR MAXIMUM INTERFERENCE IN KS-KL TO 2 GAMMAS       12/71

R9      (KOS INTO PI+ PI- PIO, CP CONSERVING)/(KOL INTO PI+ PI- PIO)
R9      384   (0.42) OR LESS  CL=.90   METCALF   72 ASPK                      11/72

R10     (KOS INTO 3PIO,CP VIOLATING)/(KOL INTO 3PIO)
R10     SEE COMMENTS UNDER BRANCHING RATIO R4
R10      22   (1.2)  OR LESS  CL=.90   BARMIN1   73 HLBC                      11/73
R10  G          0.28 OR LESS  CL=.90   GJESDAL   74 SPEC                      11/75
R10  G  GJESDAL 74 USES K2PI, KMU3 AND KE3 DECAY RESULTS AND UNITARITY.       11/75
R10  G  CALCULATES ABS(ETA000)=.26+-.20. WE CONVERT TO CL=.90 UPPER LIMIT.    11/75

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REFERENCES FOR KOS


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BOLDT     58 PRL    1  150         E BOLDT,D O CALDWELL,Y PAL                 (MIT)
CRAWFORD  59 PRL    2  266         CRAWFORD,CRESTI,DOUGLASS,GOOD,TICHO +      (LRL)

BAGLIN    60 NC    18 1043         BAGLIN,BLOCH,BRISSON,HENNESSY +           (EPOL)
BOWEN     60 PR   119 2030         BOWEN,HARDY,REYNOLDS,SUN,MOORE+       (PRIN+BNL)
COLUMBIA  60 ROCH CONF 727         M SCHWARTZ +                          (COLUMBIA)

BROWN     61 NC    19 1155         BROWN,BRYANT,BURNSTEIN,GLASER,KADYK+      (MICH)
ANDERSON  62 CERN CONF 836         J A ANDERSON,F S CRAWFORD +                (LRL)
BERTANZA  62  PREPRINT 0105        BERTANZA,CONNOLLY,CULWICK,EISLER +         (BNL)
     UNPUBLISHED, BUT RECERTIFIED BY AUTHORS, AUGUST 66.

CHRETIEN  63 PR   131 2208         CHRETIEN+        (BRANDEIS+BROWN+HARVARD+ MIT)
BROWN     63 PR   130  769         BROWN,KADYK,TRILLING,ROE +            (LRL+MICH)
KREISLER  64 PR   136 B 1074       M KREISLER,O OVERSETH,J CRONIN     (PRINCETON)
ANDERSON  65 PRL  14 475           +CRAWFOR,GOLDEN,STERN,BINFORD +       (LRL+WISC)

ALFF-STE  66 PL 21 595             ALFF-STEINBERGER,HEUER,KLEINKNECHT +     (CERN)
AUERBACH  66 PR 149 1052           AUERBACH,DOBBS,LANDE,MANN,SCIULLI+       (PENN)
     ALSO 65 AUERBACH
BALTAY    66 PR 142   932          BALTAY,SANDWEISS,STONEHILL +         (YALE+BNL)
BEHR      66 PL   22  540          BEHR,BRISSON,PETIAU+ (EPOL,MILA,PADO,ORSAY)
BELLOTTI  66 NC 45A 737            +PULLIA,BALDO-CEOLIN +            (MILAN+PADUA)
BOTT-BOD  66 PL   23 277           BOTT-BODENHAUSEN,DE BOUARD +             (CERN)
KIRSCH    66 PR   147  939         L KIRSCH,P SCHMIDT                   (COLUMBIA)

BOTT-BOD  67 PL 24B 194            BOTT-BODENHAUSEN,DE BOUARD,CASSEL+       (CERN)
DONALD    68 PL 27B  58            DONALD,EDWARDS,NISAR+ (LIVP,CERN,IPNP,CDEF)
HILL      68 PR 171 1419           HILL,ROBINSON,SAKITT +           (BNL,CARNEGIE)

BANNER    69 PR 188 2033           +CRONIN,LIU,PILCHER                 (PRINCETON)
BOHM      69 THESIS                A. BOHM                                  (AACH)
BOZOKI    69 PL 30B 499            +FENYVES,GOMBOSI,NAGY,SURANYI+      (BUDAPEST)
DOYLE     69 UCRL 18139-THESIS     J.G. DOYLE                                (LRL)
GOBBI     69 PRL 22 682            GOBBI,GREEN,HAKEL,MOFFETT,ROSEN+(ROCHESTER)
HYAMS     69 PL   29B 521          +KOCH,POTTER,VON LINDERN,LORENZ+ CERN(MPIM)
MORFIN    69 PRL    23  660        MORFIN,SINCLAIR                          (MICH)
STUTZKE   69 PR    177  2009       +ABASHIAN,JONES,MANTSCH,ORR,SMITH(ILLINOIS)
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MOFFETT  70 BAPS 15 512          +GOBBI,GREEN,HAKEL,ROSEN          (ROCHESTER)
WEBBER   70 PR D1 1967           +SOLMITZ,CRAWFORD,ALSTON-GARNJOST     (LRL)
   ALSO 69 UCRL 19226 THESIS B R WEBBER                                (LRL)

BALTAY   71 PRL 27 1678          +BRIDGEWATER,COOPER,GERSHWIN,HABIBI+ (COLU)
   ALSO 71 NEVIS-187 THESIS WILLIAM A. COOPER                    (COLUMBIA)
CHO      71 PR D3 1557           +DRALLE,CANTER,ENGLER,FISK+ (CARN+BNL+CASE)
JAMES    71 PL 35B 265           +MONTANET,PAUL,PAULI+       (CERN+SACL+OSLO)
MEISNER  71 PR D3 59             +MANN,HERTZBACH,KOFLER +     (MASA+BNL+YALE)
REPELLIN 71 PL 36B 603           +WOLFF,CHOLLET,GAILLARD,JANE+  (ORSA+CERN)

ALITTI   72 PL 39B 568           J ALITTI,E LESQUOY,A MULLER         (SACLAY)
BANNER   72 PRL 29 237           +CRONIN,HOFFMAN,KNAPP,SHOCHET    (PRINCETON)
JAMES    72 NP B49 1             +M. TANET,PAUL,SAETRE+       (CERN+SACL+OSLO)
JONES    72 NC 9A 151            +ABASHIAN,GRAHAM,MANTSCH,ORR,SMITH+    (ILL)

METCALF  72 PL 40B 703           +NEUHOFER,NIEBERGALL+          (CERN+IPN+WIEN)
MORSE    72 PRL 28 388           +NAUENBERG,BIERMAN,SAGER+     (COLO+PRIN+UMD)
NAGY     72 NP B47 94            +TELBISZ,VESZTERGOMBI              (BUDAPEST)
   ALSO 69 PL 30B 498            BOZOKI,FENYVES,GOMBOSI,NAGY+       (BUDAPEST)
SKJEGGES 72 NP B48 343           SKJEGGESTAD,JAMES,MONTANET+(CSLO+CERN+SACL)

BARMINI  73 PL 46B 465           +BARYLOV,DAVIDENKO,DEMIDOV+           (ITEP)
BARMIN2  73 PL 47B 463           +BARYLOV,DAVIDENKO,DEMIDOV+           (ITEP)
BURGUN   73 PL 46B 481           +BERTRANET,LESQUOY,MULLER,PAULI+(SACL+CERN)
FACKLER  73 PRL 31 847           +FRISCH,MARTIN,SMOOT,SOMPAYRAC         (MIT)
GJESDAL  73 PL 44B 217           +PRESSER,STEFFEN,STEINBERGER+  (CERN+HEIDE)
HILL     73 PR D8 1290           +SAKITT,SAMIOS,BURRIS,ENGLER+     (BNL+CARN)
MALLARY  73 PR D7 1953           +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI+  (CIT)

BOBISUT  74 LNC 11 646           +HUZITA,MATTIOLI,PUGLIERIN           (PADO)
COWELL   74 PR D10 2083          +LEE-FRANZINI,ORCUTT,FRANZINI + (STON+COLU)
GEWENIGE 74 PL 48B 487           GEWENIGER,GJESDAL,PRESSER+     (CERN+HEID)
GJESDAL  74 PL 52B 119           +PRESSER,STEFFEN,STEINBERGER + (CERN+HEID)

BALDOCEO 75 NC 25A 688           BALDO-CEOLIN,BOBISUT,CALIMANI+ (PADO+WISC)
CARITHER 75 PRL 34 1244          CARITHERS,MODIS,NYGREN,PUN +   (COLU+NYU)
ARONSON  76 NC 32A 236           +MCINTYRE,ROEHRIG +        (WISC+EFI+UCSD+ILLC)
EVERHART 76 PR D14 661           +PAUS,LANDE,LONG,LOWENSTEIN +          (PENN)
TAUREG   76 PL 65B 92            +ZECH,DYDAK,NAVARRIA+        (HEID+CERN+DORT)

                                 PAPERS NOT REFERRED TO IN DATA CARDS

BIRGE    60 ROCH CONF 601        R W BIRGE,P P ELY +           (LRL+WISCONSIN)
MULLER   60 PRL  4  418          MULLER,BIRGE,FOWLER,GOOD,PICCIONI+(LRL+BNL)
FITCH    61 NC   22 1160         V FITCH,P PIROUE,R PERKINS        (PRIN+LASL)
GOOD     61 PR  124 1223         GOOD,MATSEN,MULLER,PICCIONI +          (LRL)

CRAWFORD 62 CERN CONF 827        F S CRAWFORD                           (LRL)
AUERBACH 65 PRL 14 192           AUERBACH,LANDE,MANN,SCIULLI,UTO +     (PENN)
TRILLING 65 UCRL 16473           GEORGE H TRILLING                      (LRL)
   UPDATED FROM 1965 ARGONNE CONF., PAGE 115.
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K^0_L

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          13  LONG-LIVED NEUTRAL K(498, JP=0-) I=1/2
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                 13  (KOL) - (KOS) MASS DIFFERENCE
     WE GIVE (KOL-KOS MASS DIFFERENCE / HBAR) IN UNITS OF 10**10 SEC-1

D  Tx        (2.20)   (0.35)           FITCH      61 CNTR
D   x        (0.84)   (0.29)   (0.27)GOOD       61 HLBC
D  TxC       (1.02)   (0.23)           CAMERINI   62 HLBC                   8/67
D  Tx        (0.55)   (0.24)           AUBERT     65 HLBC                   6/66
D   x        (0.26)   (0.30)   (0.26)BALDO-CEO  65 HLBC    ASSUMES CP CONS.
D  TxA       (0.64)   (0.12)           CHRISTENS  65 OSPK                   6/66
D  Tx        (0.70) CP LESS            FITCH      65 OSPK    CF. MEISNER 66 7/66
D   V  130   (0.89)   (0.15)           VISHNEVSK  65 OSPK    CU AND AL REGEN 6/67
D   x        (0.514)  (0.039)          ALFF-STEI  66 OSPK                   6/66
D   x   84   (0.42)   (0.24)   (0.36)BALDO-CEO  66 HLBC    KO+N INTO HYPER. 6/67
D   B        (0.531)  (0.027)          BOTT-BODE  66 OSPK    C REGEN        9/66
D  Tx   77   (0.58)   (0.17)           CAMERINI   66 HBC+ DBC KO+N INTO HYPER 8/67
D   N   72  (+0.64)   (0.18)           CANTER     66 CPC     KO SCATTER IN D2 11/66
D   x   95   (0.62)   (0.10)   (0.16)CHANG      66 HPC     KO+P INTO HYPER. 8/67
D   x        (0.81)   (0.17)           FUJII      66 OSPK    IRON REGENERATOR 9/66
D   x   59   (0.74)   (0.34)           MEISNER1   66 HBC                    6/66
D         + SIGN FAVORED               MEISNER2   66 HBC                    9/66
D   x        (0.38)   (0.16)           JOVANOVIC  66 OSPK    C+URANIUM REGEN. 11/66
D  Tx  136  (+0.64)   (0.19)           CANTER     67 DBC     KO+D INTO HYPER. 11/67
D   x        (0.65)   (0.11)           MISCHKE    67 OSPK                   11/67
D   x  590   (0.59)   (0.13)           BALATZ     68 OSPK    AL REGENERATOR  3/68
D   x        (0.520)  (0.044)          CARNEGIE   68 HBC     GAP METHOD      3/68
D  Tx       (+0.497)  (0.046)          MELHOP     68 OSPK    ST.STEEL REGEN  6/68
D  Bx        (0.547)  (0.024)          BOTT-BODE  69 OSPK    C REGEN         1/71
D  Fx        (0.555)  (0.020)          FAISSNER   69 ASPK    REGEN IN CU    10/69
D             0.542    0.006           CULLEN     70 CNTR                   1/71
D   R        (0.542)  (0.006)          ARONSON    70 A PK    GAP METHOD      1/71
D   x        (0.481)  (0.052)  (0.075)BALATS     71 OSPK                   9/71
D   R        (0.534)  (0.007)          CARNEGIE   71 ASPK    GAP METHOD      8/71
D  TH  119  (+0.67)   (0.14)           HILL       71 DBC                   10/71
D   S 1757   (0.557)  (0.038)          FACKLER    73 OSPK                  11/73
D             0.5340   0.0030          GEWENIG3   74 SPEC    GAP METHOD     11/75
D             0.5334   0.0040          GJESDAL    74 SPEC    CHG ASYMMETRY  11/75
D                 . . . . . . . . . .
D  AVG        0.5349   0.0022  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
                    COMMENTS
D   x   NO ATTEMPT HAS BEEN MADE TO CORRECT OLDER EXPERIMENTS WITH LARGE  11/75
D   x   ERRORS FOR THE SUBSEQUENT CHANGES IN THE KOS MEAN LIFE OR IN ETA+-. 2/76
D  T    A KOS MEAN LIFE OF 0.862 10**-10 SEC WAS USED IN CONVERTING THE    1/71
D  T    MASS DIFFERENCE FROM UNITS OF INVERSE KOS MEAN LIVES TO ABSOLUTE   1/71
D  T    UNITS. VALUES NOT BEARING THIS FOOTNOTE EITHER WERE GIVEN IN       1/71
D  T    ABSOLUTE UNITS OR WERE CONVERTED USING THE AUTHORS' VALUE OF THE   1/71
D  T    KOS MEAN LIFE.                                                     1/71
D    C  CAMERINI 62 VALUE CHANGED FROM 1.7 (SEE TABLE 1 OF CAMERINI 66)    8/67
D    A  CHRISTENSON 65 CORRECTED FOR INTERFERENCE BY FITCH 65 FOOTNOTE.    1/71
D   V   VISHNEVSKY 65 NOT CORRECTED FOR INTERFERENCE EFFECTS.              3/68
D   N   CANTER 66 ERROR IGNORES UNCERTAINTY OF PHASE SHIFTS.  THESE EVENTS 10/71
D   N   ARE USED IN HILL 71.                                              10/71
D  B    BOTT-BODENHAUSEN 69 IS A REEVALUATION OF BOTT-BODENHAUSEN 66.      1/71
D  F    FAISSNER 69 HAS ADDNL. SYSTEMATIC ERROR LESS THAN TWO PERCENT.     1/71
D   R   ARONSON 70 AND CARNEGIE 71 USE KOS MEAN LIFE=.862+-.006 E-10 SEC. 11/75
D   R   WE HAVE NOT ATTEMPTED TO ADJUST THESE VALUES FOR THE SUBSEQUENT    2/76
D   R   CHANGE IN THE KOS MEAN LIFE OR IN ETA+-.                           2/76
D   H   HILL 71 PRIMARY RESULT IS THAT DM IS POSITIVE.                    10/71
D   H   THE MAGNITUDE MAY HAVE AN ADDITIONAL SYSTEMATIC ERROR OF ABOUT 0.12 10/71
D   S   NOT AVERAGED BECAUSE ERROR IS LARGE AND SYSTEMATICS NOT DISCUSSED.  2/76
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                 13  KOL MEAN LIFE (UNITS 10**-8 SEC)

T       KOL MEAN LIFE
T      34    8.1       3.7       2.4    BARDON    58 CNTR
T      ASSUMED DS=DQ AND DELTA I=1/2 CRAWFORD  59 HBC
T      15    5.1       2.4       1.3    DARMON    62 FBC
T            5.3       0.6              FUJII     64 OSPK
T    1700    6.1       1.5       1.7    ASTBURY3  65 CNTR
T            5.15      0.14             DEVLIN    67 CNTR
T   L       (5.0)     (0.5)             LOWYS     67 HLBC
T    0.4M    5.154     0.044            VOSBURGH  72 CNTR                2/71
T   L   SUM OF PARTIAL DECAY RATES.
T            . . . . . . . . . . .
T   AVG      5.158     0.042     0.047  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
T   FIT      5.181     0.040   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

```
                 13  KOL PARTIAL DECAY MODES

                                                           DECAY MASSES
P1    KOL INTO 3PI0                       TAU 0 PRIME    134+ 134+ 134
P2    KOL INTO PI+ PI- PI0                TAU 0          139+ 139+ 134
P3    KOL INTO PI MU NEUTRINO             KL MU3         139+ 105+   0
P4    KOL INTO PI E NEUTRINO              KL E3          139+  .5+   0
P5    KOL INTO PI+ PI-                    KL PI+ PI-     139+ 139
P6    KOL INTO MU+ MU-                    KL 2MU         105+ 105
P7    KOL INTO E+ E-                      KL 2E           .5+  .5
P8    KOL INTO E MU                       KL EMU          .5+ 105
P9    KOL INTO TWO GAMMAS                 KL 2GAMMA        0+   0
P10   KOL INTO PI+ PI- GAMMA              KL PI+-G       139+ 139+   0
P11   KOL INTO PI0 PI0                    KL 2PI0        134+ 134
P12   KOL INTO PI E NEU GAMMA             KL E3GAM       139+  .5+   0+   0
P13   KOL INTO PI0 TWO GAMMAS             KL PI2GAMMA    134+   0+   0
P14   KOL INTO E+ E- GAMMA                KL 2EGAM        .5+  .5+   0
P15   KOL INTO MU+ MU- GAMMA              KL 2MUGAM      105+ 105+   0
P16   KOL INTO MU+ MU- PI0                KL 2MUPI0      105+ 105+ 134
P17   KOL INTO PI+ PI- E+ E-              KL 2PI2E       139+ 139+  .5+  .5
P18   KOL INTO PI0 PI+- E-+ NEU           KL 2PIENEU     134+ 139+  .5+   0
P19   KOL INTO (PI MU ATOM) NEU           KL (PIMU)NEU
P20   KOL INTO E+ E- PI0                  KL 2EPI0        .5+  .5+ 134
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                    NEUTRAL K CONSTRAINED FIT
             OVERALL FIT OF MEAN LIFE, WIDTHS AND BRANCHING
             RATIOS USES 65 DATA POINTS TO DETERMINE SIX                 3/78
             QUANTITIES.  OVERALL FIT HAS CHI-SQUARED=69.9               3/78
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4          P 5          P11
P 1  .2147+-.0099
P 2   -.6529   .1239+-.0029
P 3   -.8542       .4413   .2711+-.0042
P 4   -.9100       .4705       .6139   .3873+-.0015
P 5   -.4362       .5471       .3159       .3366  .0020+-.0001
P11    .2289      -.1623      -.7104      -.2243      -.1081  .0009+-.0007
```

FITTED PARTIAL DECAY MODE RATES

The matrix below is the branching fraction matrix above, transformed into rate space, i.e., $G_i = \Gamma_i = \Gamma_{total} P_i$, in appropriate units. In analogy to the matrix above, the diagonal elements are $G_i \pm \delta G_i$, where $\delta G_i = \sqrt{\langle \delta G_i \delta G_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta G_i \delta G_j \rangle / (\delta G_i \cdot \delta G_j)$. Note that, because of the error in Γ_{total}, the errors and correlations here are not directly derivable from those above.

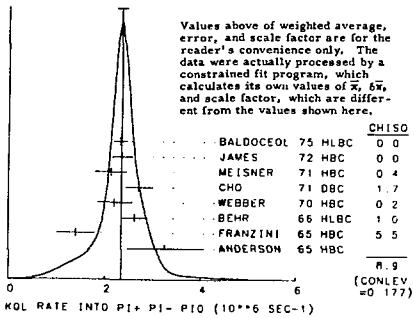
```
        G 1          G 2          G 3          G 4          G 5          G11
G 1  .0414+-.0020
G 2   -.4751   .0239+-.0004
G 3   -.6412       .4554   .0523+-.0009
G 4   -.6740       .5245       .6600   .0747+-.0011
G 5   -.3291       .5696       .3565       .3773  .0004+-.0000
G11    .2377      -.1238      -.1650      -.1736      -.0954  .0002+-.0003
```

```
                 13  KOL DECAY RATES

W1      KOL INTO PI0 PI0 PI0 (UNITS 10**6 SEC-1)            (G1)
W1       54     5.22     1.03     0.84  BEHR      66 HLBC    ASSUMES CP       8/66
W1              . . . . . . . . . .
W1  FIT         4.14     0.20   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

W2      KOL INTO PI+ PI- P0 (UNITS 10**6 SEC-1)             (G2)
W2       18     3.26     0.77           ANDERSON  65 HBC                      8/66
W2       14     1.4      0.4            FRANZINI  65 HBC                      6/66
W2      136     2.62     0.28     0.27  BEHR      66 HLBC    ASSUMES CP       8/66
W2       53     2.20     0.35           WEBBER    70 HBC     ASSUMES CP      10/71
W2       99     2.71     0.28           CHO       71 DBC     ASSUMES CP       4/71
W2  J    98    (2.51     (0.31)         JAMES     71 HBC     ASSUMES CP       6/71
W2       50     2.12     0.33           MEISNER   71 HBC     ASSUMES CP      10/71
W2 J    180     2.35     0.20           JAMES     72 HBC     ASSUMES CP       1/73
W2      192     2.32     0.13     0.15  BALDOCEOL 75 HLBC    ASSUMES CP       1/76
W2       IN THE OVERALL FIT THIS RATE IS WELL DETERMINED BY THE MEAN LIFE AN
W2       THE BRANCHING RATIO R2. FOR THIS REASON THE DISCREPANCY BETWEEN THE
W2       W2 MEASUREMENTS DOES NOT AFFECT THE SCALE FACTOR OF THE OVERALL FIT
W2 J     JAMES 72 IS A FINAL MEASUREMENT AND INCLUDES JAMES 71.               11/73
W2              . . . . . . . . . .
W2  AVG         2.34     0.11     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
W2  FIT         2.391    0.041  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                         (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 2.34 ± 0.11
ERROR SCALED BY 1 2

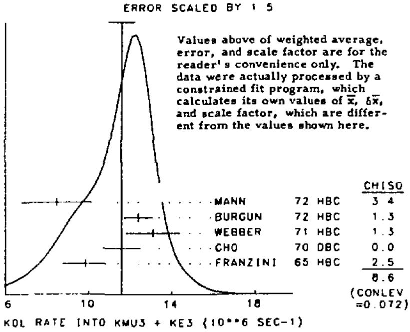



```
W3      KOL INTO PI E NEUTRINO (UNITS 10**6 SEC-1)          (G4)
W3              7.52       0.85      0.72  AUBERT     65 HLBC    DS=DQ.CP ASSUMED  8/67
W3     620      7.81       0.56            CHAN       71 HBC                       2/72
W3          . . . . . . . . . .
W3   AVG        7.71       0.46    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
W3   FIT        7.47       0.11   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

W4      KOL INTO CHARGED (3-BODY) (UNITS 10**6 SEC-1)      (G2+G3+G4)
W4      98   15.1        1.9               AUERBACH  66 CSPK                       8/67
W4          . . . . . . . . . .
W4   FIT       15.10       0.21   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

W5      KOL INTO LEPTONIC (KMU3+KE3) (UNITS 10**6 SEC-1) (G3+G4)
W5    0 109     9.85       1.15      1.05  FRANZINI   65 HBC                       2/72
W5   C  335   (10.3)      (0.8)            HILL       67 DBC     K+N TO KO P       8/67
W5    0 393    11.6        0.9             CHO        70 DBC     K+N TO KOP       10/70
W5    0 252    13.1        1.3             WEBBER     71 HBC     K- P TO KOBAR N   2/72
W5    0 410    12.4        0.7             BURGUN     72 HBC     K+P TO KOPPI+     1/73
W5    0 126     8.47       1.69            MANN       72 HBC     K- P TO KOBAR N   9/72
W5   C  CHO 70 INCLUDES EVENTS OF HILL 67
W5    0  ASSUMES DS=DQ RULE
W5          . . . . . . . . . .
W5   AVG       11.60       0.65    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
W5   FIT       12.70       0.18   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)
                           (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 11.60 ± 0.65
ERROR SCALED BY 1 5




```
W6      KOL INTO PI MU NEUTRINO UNITS 10**6 SEC-1)          (G3)
W6      19      4.54       1.24      1.08  LOWYS      67 HLBC                      8/67
W6          . . . . . . . . . .
W6   FIT        5.232      0.086  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
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13 KOL BRANCHING RATIOS

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R1      KOL INTO (PIO PIO PIO)/CHARGED                     (P1)/(P2+P3+P4)
R1      24      0.24       0.08            ANIKINA    64 CC                        6/66
R1     549      0.251      0.014           BUDAGOV    68 HLBC    ORSAY MEASUR.    10/68
R1     444      0.277      0.021           BUDAGOV    68 HLBC    EC. POLYTEC.MEAS 10/68
R1      29      0.31       0.07      0.06  KULYUKINA  68 CC                        2/71
R1          . . . . . . . . . .
R1   AVG        0.260      0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1   FIT        0.274      0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)
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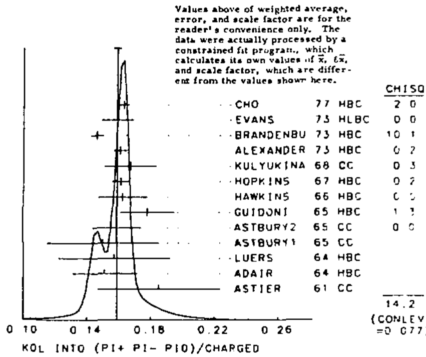
R2      KOL INTO (PI+ PI- PIO)/CHARGED                     (P2)/(P2+P3+P4)
R2      59      0.185      0.038           ASTIER     61 CC                        6/66
R2      79      0.151      0.020           ADAIR      64 HBC                       8/66
R2      75      0.157      0.03      0.04  LUERS      64 HBC                       8/66
R2      66      0.15       0.03      0.04  ASTBURY1   65 CC                        8/66
R2     326      0.159      0.015           ASTBURY2   65 CC                        6/66
R2     566      0.178      0.017           GUIDONI    65 HBC                       6/66
R2    1729     (0.144)    (0.004)          HOPKINS    65 HBC     SEE HOPKINS 67    6/66
R2     126      0.162      0.015           HAWKINS    66 HBC                       6/66
R2              0.161      0.005           HOPKINS    67 HBC                       8/67
R2    1402      0.167      0.016           KULYUKINA  68 CC                        2/71
R2    1590      0.1605     0.0038          ALEXANDER  73 HBC                       1/74
R2    3200      0.146      0.004           BRANDENBU  73 HBC                       1/74
R2     558      0.159      0.010           EVANS      73 HLBC                      1/73
R2    6499      0.163      0.003           CHO        77 HBC                      11/77
R2          . . . . . . . . . .
R2   AVG        0.1587     0.0024  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2   FIT        0.1584     0.0020 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                           (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.1587 ± 0.0024
ERROR SCALED BY 1 3

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R3      KOL INTO (PI MU NEUTRINO)/CHARGED                  (P3)/(P2+P3+P4)
R3   C  251    (0.356)    (0.07)           LUERS      64 HBC
R3   C  172    (0.39)     (0.08)    (0.10) ASTBURY1   65 CC                        7/66
R3   C  330    (0.335)    (0.055)          KULYUKINA  68 CC                        2/71
R3   C THIS MODE NOT MEASURED INDEPENDENTLY FROM R2 AND R4
R3          . . . . . . . . . .
R3   FIT        0.3466     0.0028 FROM FIT

R4      KOL INTO (PI E NEUTRINO)/CHARGED                   (P4)/(P2+P3+P4)
R4      24      0.46       0.11            NEAGU      61 CC                        2/76
R4     153      0.487      0.05            LUERS      64 HBC
R4     202      0.46       0.08      0.10  ASTBURY1   65 CC                        7/66
R4     500      0.498      0.052           KULYUKINA  68 CC                        2/71
R4          . . . . . . . . . .
R4   AVG        0.485      0.032   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4   FIT        0.4951     0.0029 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      KOL INTO (PI E NEU)/((PI E NEU)+(PI MU NEU))       (P4)/(P3+P4)
R5     320      0.415      0.120           ASTIER     61 CC
R5          . . . . . . . . . .
R5   FIT        0.5882     0.0032 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      KOL INTO (PI+ PI- PIO)/TOTAL                       (P2)
R6
R6          . . . . . . . . . .
R6   FIT        0.1239     0.0020 FROM FIT

R7      KOL INTO (LEPTON PI NEUTRINO)/TOTAL                (P3+P4)
R7
R7          . . . . . . . . . .
R7   FIT        0.6585     0.0087 FROM FIT

R8      KOL INTO (2 GAMMA)/TOTAL (UN. 10**-4)              (P9)
R8   C         (1.3)      (0.6)            CRIEGEE    66 CSPK                      8/66
R8      32      6.7        2.2             TODOROFF   67 OSPK    REPL. CRIEGEE66  11/68
R8   K  33     (7.4)      (1.6)            CRONIN     67 CSPK                     11/67
R8      90      5.5        1.1             KUNZ       68 OSPK    NORM.TO 3PI(C+N)  2/71
R8      23      4.5        1.0             ENSTROM    71 OSPK    KOL 1.5-9 GEV/C   2/72
R8 R            5.0       (1.0)            REPELLIN   71 CSPK                     11/71
R8 B            4.54       0.84            BANNER2    72 OSPK                      8/72
R8 B    THIS VALUE USES (E00/E+-)**2=1.05+-0.14. IN GENERAL. SIGMA =               8/72
R8 B    (4.32+-0.55)*((10**-4)*((E00/E+-)**2).                                     8/72
R8 R    ASSUMES REGEN AMPL IN COPPER AT 2GEV IS 22  MB. TO EVALUATE               11/71
R8 R    FOR A GIVEN REGEN AMPL AND ERROR, MULTIPLY BY (REGEN AMPL/22MB **2        11/71
R8   C     CRIEGEE 66 REPLACED BY TODOROFF 67                                     11/68
R8   K     CRONIN1 67 REPLACED BY KUNZ 68.                                         2/71
R8          . . . . . . . . . .
R8   AVG        4.89       0.54    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8      R21 BELOW GIVES (4.82+-.52)E-4. COMBINED AVG (4.85+-.37)E-4.               4/82*

R9      KOL INTO (PI+ PI-)/CHARGED (UNIT 10**-3)           (P5)/(P2+P3+P4)
R9   0  45     (2.0)      (0.4)            CHRISTENS 64 OSPK ETA +- = 1.95+-0.20  2/76
R9   0  54     (2.08)     (0.35)           GALBRAITH 65 OSPK ETA +- = 1.99+-0.16  2/76
R9   0         (1.93)     (0.26)           BASILE    66 OSPK ETA +- = 1.92+-0.13  2/76
R9   0         (1.993)    (0.080)          BOTT-BODE 66 CSPK ETA +- = 1.95+-0.04  2/76
R9   M 4200    (2.60)     (0.07)           MESSNER   73 ASPK ETA +- = 2.23+-0.05  6/73
R9   0  OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR          2/76
R9   0  AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.           2/76
R9   M  FROM SAME DATA AS R27 MESSNER 73.BUT WITH DIFFERENT NORMALIZATION.        6/73
R9          . . . . . . . . . .
R9   FIT        2.589      0.060  FROM FIT
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R10      KOL INTO (PI MU NEU)/(PI E NEU)                          (P3)/(P4)
R10            0.81      0.19              ADAIR      64 HBC                       6/66
R10            0.82      0.10              DEBOUARD   67 OSPK                     11/67
R10     273    0.7       0.2               HAWKINS    67 HBC                       8/67
R10            0.81      0.08              HOPKINS    67 HBC                       8/67
R10     770    0.71      0.05              BUDAGOV    68 HLBC                     10/68
R10 K         (0.67)    (0.13)             KULYUKINA  68 CC                        3/74
R10 B   569   (0.71)    (0.04)             BEILLIERE  69 HLBC                     10/69
R10    1309   (0.648)   (0.030)            EVANS      69 HLBC REPL. BY EVANS 73    1/73
R10    3548    0.68      0.08              BASILE     70 OSPK                     10/70
R10    6700    0.741     0.044             BRANDENBU  73 HBC                       1/74
R10    1309    0.662     0.030             EVANS      73 HLBC                      1/73
R10     10K    0.662     0.037             WILLIAMS   74 ASPK                     10/74
R10     33K    0.702     0.011             CHO        80 HBC                       2/82*
R10 K   KULYUKINA 68 R10 IS NOT MEASURED INDEPENDENTLY FROM R2 AND R4.             1/74
R10 B  BEILLIERE 69 IS A SCANNING EXPT USING SAME EXPOSURE AS BUDAGOV 68
R10          . . . . . . . . . .
R10 AVG        0.7001    0.0093  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 FIT        0.7001    0.0092 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11      KOL INTO (MU+MU-)/CHARGED (UNITS 10**-6)                (P6)/(P2+P3+P4)
R11         (100.0)  OR LESS               ANIKINA    65 CC                        6/66
R11         (250.0)  OR LESS  CL=.90       ALFF-STEI  66 OSPK                      9/66
R11           (2.0)  OR LESS  CL=.90       BOTT-BODE  67 OSPK                      8/67
R11          (35.0)  OR LESS  CL=.90       FITCH      67 OSPK                      3/68

R12      KOL INTO (PI+ PI- GAMMA)/TOTAL (UNITS 10**-3)      (P10)
R12          (15.0)  OR LESS               ANIKINA    65 CC                        6/66
R12       0   (5.0)  OR LESS               BELLOTTI   66 HLBC    GAM KE 40-130 MV  8/67
R12       1   (3.0)  OR LESS               NEFKENS    66 OSPK    GAM KE 120 MEV    6/66
R12           (0.4)  OR LESS  CL=.90       THATCHER   68 OSPK    GAM KE 20-170 MV  2/71
R12           (3.2)  OR LESS  CL=.90       BOBISUT    74 HLBC    GAM KE GT 40 MEV 12/75
R12  D  24   (0.062)  (0.021)              DONALDS1   74 SPEC                     10/74
R12          (0.46)  OR LESS  CL=.90       WOD        74 SPEC                     12/75
R12 H  516   (0.0152) (0.0016)             CARROLL2   80 SPEC +-0GAM KE GT 20 MEV 12/80*
R12 J  546   (0.0289) (0.0028)             CARROLL2   80 SPEC +-0                 12/80*
R12  K1062    0.0441   0.0032              CARROLL2   80 SPEC +-0GAM KE GT 20 MEV 12/80*
R12  D  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.126                              10/74
R12 H   INTERNAL BREMSSTRAHLUNG COMPONENT ONLY.                                  12/80*
R12 J   DIRECT GAMMA EMISSION COMPONENT ONLY.                                    12/80*
R12  K  BOTH COMPONENTS. USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.1239 .         12/80*

R13      KOL INTO (E+ E-)/CHARGED (UNITS 10**-6)                 (P7)/(P2+P3+P4)
R13        (1000.0)  OR LESS               ANIKINA    65 CC                        6/66
R13         (200.0)  OR LESS  CL=.90       ALFF-STEI  66 OSPK                      6/66
R13          (23.0)  OR LESS  CL=.90       BOTT-BODE  67 OSPK                      8/67

R14      KOL INTO (E MU)/CHARGED (UNITS 10**-4)                  (P8)/(P2+P3+P4)
R14          (10.0)  OR LESS               ANIKINA    65 CC                        6/66
R14           (1.0)  OR LESS  CL=.90       CARPENTER  66 OSPK                      8/66
R14           (0.1)  OR LESS  CL=.90       BOTT-BODE  67 OSPK                      8/67
R14            0.08  OR LESS  CL=.90       FITCH      67 OSPK                      3/68

R15      KOL INTO (E+ PI- NEU)/(E- PI+ NEU)
R15 O   97   (0.90)    (0.18)              NEAGU      61 CC
R15 O        (1.01)    (0.16)              LUERS      64 HBC                       8/66
R15 O  894   (0.99)    (0.023)             KULYUKINA  66 CC                        9/66
R15 O 1539   (1.06)    (0.05)              VERHEY     66 OSPK                      8/67
R15 O   LOW PRECISION EXPTS NOT AVERAGED.  FOR MORE PRECISE VALUE,
R15 O   SEE S13A2 IN THE CP VIOLATION SECTION BELOW.

R16      KOL INTO (MU+ PI- NEU)/(MU- PI+ NEU)
R16      1M    1.0081    0.0027            DORFAN     67 OSPK                     11/67
R16      SEE ALSO S13A2 AND S13AL IN THE CP VIOLATION SECTION BELOW.               2/71

R17      KOL INTO (PI0 PI0)/TOTAL (UNITS 10**-3)                  (P11)
R17 C     7  (1.2)     (1.5)     (1.2)  CRIEGEE    66 OSPK                          7/66
R17 C   CRIEGEE EXPT NOT DESIGNED TO MEASURE 2 PI0 DECAY MODE
R17 G  189   (2.5)     (0.8)               GAILLARD   69 OSPK   E00=3.6+-0.6       5/69
R17 G   LATEST RESULT OF THIS EXPERIMENT GIVEN BY FAISSNER 70 R19                  1/71
R17          . . . . . . . . . .
R17 FIT        0.94      0.19    FROM FIT

R18      KOL INTO (3PI0)/(PI+PI-PI0)                              (P1)/(P2)
R18     188    2.0       0.6               ALEKSANYA  64 FBC                       9/66
R18    1010    1.80      0.13              BUDAGOV    68 HLBC                     10/68
R18     883   (1.65)    (0.07)             BARMIN2    72 HLBC    ERROR STAT. ONLY  3/74
R18          . . . . . . . . . .
R18 AVG        1.81      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R18 FIT        1.73      0.10    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R19      KOL INTO (2PI0)/(3PI0) (UNITS 10**-2)                    (P11)/(P1)
R19 C  109   (1.89)    (0.31)              CRONIN 1   67 OSPK    ETA00=4.9+-0.5     8/67
R19 C        (1.36)    (0.18)              CRONIN 2   67 OSPK    ETA00=3.92+-0.3   11/67
R19 C       CRONIN2 IS FURTHER ANALYSIS OF CRONIN1 ,NOW BOTH WITHDRAWN             11/68
R19       NO EVENTS SEEN                   BARTLETT   68 OSPK    SEE E00 BELOW     11/68
R19      57    0.46      0.11              BANNER     69 OSPK    ETA00=2.2+-0.3     2/72
R19 R  133   (1.31)    (0.31)              CENCE      69 OSPK    ETA00=3.7+-0.5    10/69
R19      29    0.37      0.08              BARMIN     70 HLBC    ETA00=2.02+-0.23  12/70
R19      30    0.32      0.15              BUDAGOV    70 HLBC    ETA00=1.9+-0.5    10/70
R19  F 172    0.90      0.30              FAISSNER   70 OSPK    ETA00=3.2+-0.5    12/70
R19  R 150    1.21      0.30              REY        76 OSPK    ETA00=3.8+-0.5     8/76
R19  F FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69 R17
R19  R  CENCE 69 EVENTS ARE INCLUDED IN REY 76.                                    1/77
R19          . . . . . . . . . .
R19 AVG        0.437     0.092   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
R19 FIT        0.437     0.085  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)
                         (SEE IDEOGRAM BELOW )

R20      KOL INTO (PI+ PI-)/(KE3 + KMU3) (UNITS 10**-3)    (P5)/(P3+P4)
R20 O  309   (2.51)    (0.23)              DEBOUARD   67 OSPK    ETA+-=2.00+-0.09  2/76
R20 O  525   (2.35)    (0.19)              FITCH      67 OSPK    ETA+-=1.94+-0.08  2/76
R20    2703    3.04      0.14              DEVOE      77 SPEC    ETA+-=2.25+-0.05 11/77
R20 O   OLD EXPERIMENTS EXCLUDED FROM FIT.  SEE SUBSECTION E+- BELOW FOR           2/76
R20 O   AVERAGE ETA+- OF THESE EXPERIMENTS AND FOR NOTE ON DISCREPANCY.            2/76
R20          . . . . . . . . . .
R20 FIT        3.076     0.075  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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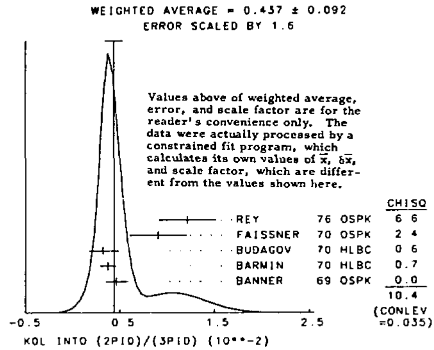


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R21      KOL INTO (2GAMMA)/(3 PI0) (UNITS 10**-3)             (P9)/(P1)
R21      16    2.5       0.7               ARNOLD     68 HLBC    VACUUM DECAY       11/68
R21      BANNER 69 IS NEW EXPT. NOT TO BE CONF WITH RB OF CRONIN1 67                 2/72
R21     115    2.24      0.28              BANNER     69 OSPK                       11/68
R21      28    2.13      0.43              BARMIN     71 HLBC                        8/71
R21          . . . . . . . . . .
R21 AVG        2.24      0.22    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R22      KOL INTO (MU+MU-)/(PI+PI-) (UNITS 10**-6)             (P6)/(P5)
R22       0 (140.)   OR LESS  CL=.90       FOETH      69 SPEC                        5/70
R22       0  (18.)   OR LESS  CL=.90       DARRIULAT  70 SPEC                       11/70
R22 A     0  (1.53)  OR LESS  CL=.90       CLARK      71 SPEC                        2/76
R22  C    9    5.8       2.3       1.5     CARITHERS  73 SPEC                        2/76
R22  F    3    4.2       5.1       2.6     FUKUSHIMA  76 SPEC                        2/76
R22      15    4.0       1.4       0.9     SHOCHET    79 SPEC                        7/79
R22 A   CLARK 71 LIMIT RAISED FROM 1.2 E-06 BY FIELD 74 REANALYSIS.                  2/76
R22 A   NOT IN AGREEMENT WITH SUBSEQUENT EXPTS. SO NOT AVERAGED.                     2/76
R22  C  CARITHERS 73 ERRORS ARE AT CL=0.68, W.CARITHERS, PRIV.COMM. 1979.            2/76
R22  F  FUKUSHIMA 76 ERRORS ARE AT CL=90 PERCENT.                                    2/76
R22          . . . . . . . . . .
R22 AVG        4.47      0.95    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R23      KOL INTO (E+ E- )/(PI+PI-) (UNITS 10**-5)             (P7)/(P5)
R23       0  (10.0)  OR LESS  CL=.90       FOETH      69 ASPK                        5/70
R23            0.10  OR LESS  CL=.90       CLARK      71 ASPK                        6/71

R24      KOL INTO (E MU)/(PI+PI-) (UNITS 10**-5)               (P8)/(P5)
R24  A       (0.10)  OR LESS  CL=.90       CLARK      71 ASPK                        6/71
R24  A  POSSIBLE (BUT UNKNOWN) SYSTEMATIC ERRORS.  SEE NOTE A IN R22 ABOVE.          4/82*

R25      KOL INTO (PI E NEU GAM)/(KL E3) (UNITS 10**-2)    (P12)/(P3)
R25      10    3.3       2.0               PEACH      71 HLBC GAM KE GT 15 MEV       6/71

R26      KOL INTO (PI0 TWO GAMMAS)/(3PI0) (UNITS 10**-3)  (P13)/(P1)
R26       0     1.1   OR LESS  CL=.90      BANNER     69 OSPK                        2/72

R27      KOL INTO (PI+ PI-)/TAU (UNITS 10**-2)                 (P5)/(P2)             6/73
R27    4200    1.64      0.04              MESSNER    73 ASPK    ETA +- = 2.23       6/73
R27          . . . . . . . . . .
R27 FIT        1.635     0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R28      KOL INTO (E+ E- GAMMA)/TOTAL  (UNITS 10**-5)          (P14)
R28  B    0   (2.7)  OR LESS  CL=.90       BARMIN1    72 HLBC                        3/74
R28  C    4    1.74      0.87              CARROLL1   80 SPEC +-0                   12/80*
R28  B  USES KOL TO 3PI0/TOTAL=0.214 .
R28  C  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.1239 .                             12/80*

R29      KOL INTO (MU+ MU- GAMMA)/TOTAL (UNITS 10**-6)         (P15)                12/75
R29  D       (7.81)  OR LESS  CL=.90       DONALDS3   74 SPEC                        6/77
R29  C    1    0.28      0.28              CARROLL1   80 SPEC +-0                   12/80*
R29  D  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.126 .                               6/77
R29  C  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.1239 .                             12/80*

R30      KOL INTO (MU+ MU- PI0)/TOTAL   (UNITS 10**-5)         (P16)                12/75
R30  D       (5.66)  OR LESS  CL=.90       DONALDS3   74 SPEC                        6/77
R30  C    0    0.12  OR LESS  CL=.90       CARROLL1   80 SPEC                       12/80*
R30  D  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.126 .                               6/77
R30  C  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.1239 .                             12/80*

R31      KOL INTO (PI+PI-E+E-) /TOTAL   (UNITS 10**-6)         (P17)                12/75
R31          (30.)   OR LESS               ANIKINA    73 STRC                        3/78
R31  D         8.81  OR LESS  CL=.90       DONALDSON  76 SPEC                        6/77
R31  D  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.126 .                               6/77

R32      KOL INTO (PI0 PI+- E-+ NEU)/TOTAL (UNITS 10**-3) (P18)                     12/75
R32  D        (2.2)  OR LESS  CL=.90       DONALDS3   74 SPEC                        6/77
R32      16    0.062     0.020             CARROLL3   80 SPEC                        9/81*
R32  D  DONALDSON3 74 USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.126 .                 6/77

R33      KOL INTO (PI MU ATOM) NEU/TOTAL (UNITS 10**-7)  (P19)                        6/77
R33      18   SEEN                         COOMBES    76 WIRE                        6/77

R34      KOL INTO (E+ E- PI0)/TOTAL (UNITS 10**-6)             (P20)
R34  C    0    2.3   OR LESS  CL=.90       CARROLL1   80 SPEC                       12/80*
R34  C  USES KOL TO PI+PI-PI0/ALL KOL DECAYS = 0.1239 .                             12/80*
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                    13  KOL ENERGY DEPENDENCE OF DALITZ PLOT

         RELATED TEXT SECTION VI B.1 AND MINI-REVIEW ON SLOPE PARAMETERS
         IN THE CHARGEC K SECTION OF THE DATA CARD LISTINGS ABOVE

        MATRIX ELEMENT SQUARED = 1 + G*U + H*U**2 + J*V + K*V**2
        WHERE U=(S3-S0)/(MPI**2) AND V=(S1-S2)/(MPI+**2)

GTO     LINEAR COEFFICIENT G FOR KL --> PI+ PI- PIO MATRIX ELEMENT SQUARED
GTO Q   79   (0.55)   (0.23)            ADAIR     64 HBC  AV=-7.6 +- 1.7          3/71
GTO Q   77   (0.51)   (0.20)            LUERS     64 HBC  AV=-7.3 +- 1.6          3/71
GTO Q   66   (0.32)   (0.13)            ASTBURY1  65 CC   AV=-5.5 +- 1.5          3/71
GTO Q  310   (0.51)   (0.09)            ASTBURY2  65 CC   AV=-(7.3 +.6 -.8)       3/71
GTO Q  280   (0.64)   (0.17)            ANIKINA   66 CC   AV=-(8.2 +.9 -1.3)      3/71
GTO Q  126   (0.70)   (0.12)            HAWKINS   66 HBC  AV=-8.6 +- 0.7          3/71
GTO Q 1350   (0.649)  (0.044)           HOPKINS   67 HBC  AT=-0.294 +- .018      10/69
GTO Q 1198   (0.428)  (0.055)           NEFKENS   67 CSPK AU=-0.204 +- .025       3/71
GTO Q 2446   (0.400)  (0.045)           BASILE2   68 DSPK AT=-0.188 +- .020       3/71
GTO Q  29K   (0.650)  (0.012)           ALBROW    70 ASPK AY=-0.858+-.015         1/79
GTO QB 36K   (0.593)  (0.022)           BUCHANAN  70 SPEC AU=-0.278 +- .010       2/76
GTO Q 4400   (0.664)  (0.056)           SMITH     70 DSPK AT=-0.306 +-0.024       1/79
GTO Q  180   (0.50)   (0.11)            JAMES     72 HBC                          1/73
GTO Q 1486   (0.608)  (0.043)           KRENZ     72 HLBC AT=-0.277 +- .018      11/72
GTO Q  384   (0.688)  (0.074)           METCALF   72 ASPK AT=-0.31  +- .03       11/72
GTO Q        (0.612)  (0.032)           ALEXANDER 73 HBC                          2/76
GTO Q 3200   (0.73)   (0.04)            BRANDENBU 73 HBC                          1/74
GTO QC 20K   (0.619)  (0.027)           BISI      74 ASPK AT=-0.282 +- .011      10/74
GTO   509K    0.677    0.010            MESSNER   74 ASPK AY=-0.917+-.013         7/75
GTO Q  192   (0.69)   (0.07)            BALDOCECL 75 HLBC                        12/75
GTO Q  56K   (0.590)  (0.022)           BUCHANAN  75 SPEC AU=-0.277 +- .010       7/75
GTO  H6499    0.681    0.024            CHO       77 HBC                         11/77
GTO   4709    0.620    0.023            PEACH     77 HBC                         11/77
GTO Q   QUADRATIC DEPENDENCE REQUIRED BY SOME EXPERIMENTS (SEE SECTIONS
GTO Q   HTO AND KTO BELOW).  CORRELATIONS PREVENT US FROM AVERAGING RESULTS
GTO Q   OF FITS NOT INCLUDING G, H, AND K TERMS.
GTO  B  BUCHANAN 70 RESULT REVISED BY BUCHANAN 75 TO INCLUDE RADIATIVE COR.  2/76
GTO  B  AND TO USE MORE RELIABLE KL MOM.SPECT. OF 2ND EXPT.(HAD SAME BEAM).  2/76
GTO  C  BISI 74 VALUE COMES FROM QUADRATIC FIT WITH QUAD. TERM CONSISTENT   11/75
GTO  C  WITH ZERO.  GTO ERROR IS THUS LARGER THAN IF LINEAR FIT WERE USED.  11/75
GTO           . . . . . . . . .
GTO AVG       0.670    0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                               (SEE IDEOGRAM BELOW )
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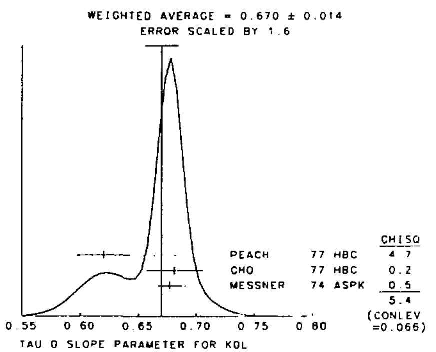


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HTO     QUADRATIC COEFF. H FOR KL --> PI+ PI- PIO MATRIX ELEMENT SQUARED
HTO Q  29K  (-0.011)  (0.018)           ALBROW    70 ASPK                         1/79
HTO Q 4400   (0.043)  (0.052)           SMITH     70 DSPK                         1/79
HTO   509K    0.079    0.007            MESSNER   74 ASPK                         3/78
HTO   6499    0.095    0.032            CHO       77 HBC                          3/78
HTO   4709    0.048    0.036            PEACH     77 HBC                          3/78
HTO     SEE NOTES IN SECTION GTO ABOVE.                                           1/79
HTO           . . . . . . . . .
HTO AVG       0.0786   0.0067  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

KTO     QUADRATIC COEFF. K FOR KL --> PI+ PI- PIO MATRIX ELEMENT SQUARED
KTO   509K    0.0097   0.0018           MESSNER   74 ASPK                         3/78
KTO   6499    0.024    0.010            CHO       77 HBC                          3/78
KTO   4709   -0.008    0.012            PEACH     77 HBC                          3/78
KTO           . . . . . . . . .
KTO AVG       0.0098   0.0018  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

JTO     LINEAR COEFF. J FOR KL --> PI+ PI- PIO IS LISTED UNDER CP VIOLATION  1/79
JTO     PARAMETERS IN KOL DECAYS.                                            1/79

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                    13  KOL FORM FACTORS

         RELATED TEXT SECTION VI B.2 AND MINI-REVIEW ON FORM FACTORS
         IN THE CHARGED K SECTION OF THE DATA CARD LISTINGS ABOVE.

         IN THE FORM FACTOR COMMENTS. THE FOLLOWING ABBREVIATIONS ARE USED.
         F+ AND F- ARE FORM FACTORS FOR THE VECTOR MATRIX ELEMENT.
         FS AND FT REFER TO THE SCALAR AND TENSOR TERM.
         FO = (F+) + (F-)*T/(MK**2-MPI**2)
         L+, L- AND LO ARE THE LINEAR EXPANSION COEFFS. OF F+, F- AND FO.
         L+ REFERS TO THE KMU3 VALUE EXCEPT IN THE KE3 SECTIONS.
         DXI/DL IS THE CORRELATION BETWEEN XI(O) AND L+ IN KMU3.
         DLO/DL+ IS THE CORRELATION BETWEEN LO AND L+ IN KMU3.
         T   = MOMENTUM TRANSFER TO THE PI IN UNITS OF MPI**2.
         DP  = DALITZ PLOT ANALYSIS
         PI  = PI SPECTRUM ANALYSIS
         MU  = MU SPECTRUM ANALYSIS
         POL = MU POLARIZATION ANALYSIS
         BR  = KMU3/KE3 BRANCHING RATIO ANALYSIS
         E   = POSITRON OR ELECTRON SPECTRUM ANALYSIS
         RC  = RADIATIVE CORRECTIONS
```

```
XIA     XIA = F-/F+ (DETERMINED FROM SPECTRA)   ---------------------------
XIA  A1341   +1.2     (0.8)             CARPENTER 66 OSPK    DP, DXI/DL=-18      1/74
XIA B 3140  (-3.9)    (0.4)             BASILE    70 DSPK    DP, INDEP OF L+     1/74
XIA C  16K  (-0.68)   (0.12)   (0.20)   CHIEN     70 ASPK    DP, DXI/DL=-26      1/74
XIA  09086   -1.5      0.7              ALBROW    72 ASPK    DP, DXI/DL=-28      1/74
XIA C  16K  (+0.50)   (0.61)            DALLY     72 ASPK    DP, DXI/DL UNKN.    1/74
XIA  E1385   -1.00    (0.45)            PEACH     73 HLBC    DP, DXI/DL=-20      1/74
XIA  F1.6M   -0.11     0.07             DONALDS2  74 SPEC    DP, DXI/DL=-17     11/75
XIA  G 32K   -0.25     0.22             BUCHANAN  75 SPEC    DP, DXI/DL=-5.9     2/76
XIA  H 16K   +0.13     0.23             HILL      79 STRC    DP, DXI/DL=-20      4/82*
XIA  H 14K   +0.26     0.16             CHO       80 HBC     DP, DXI/DL=-13      4/82*
XIA  I150K   -0.10     0.09             BIRULEV   81 SPEC    DP, DXI/DL=-12      4/82*
XIA           . . . . . . . . .
XIA AVG      -0.074    0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
XIA FIT      -0.11     0.09   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIA      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SEC. OF DATA CDS.
XIA  A  CARPENTER 66 XI(O) IS FOR L+=0.  DXI/DL IS FROM FIG. 9.              1/74
XIA B   BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST   1/74
XIA B   THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                      1/74
XIA C   CHIEN 70 ERRORS ARE STATISTICAL ONLY.  DXI/DL FROM FIG.4.            1/74
XIA  C  DALLY 72 IS A REANALYSIS OF CHIEN 70.  THE DALLY 72 RESULT IS        1/74
XIA  C  NOT COMPATIBLE WITH ASSUMPTION L-=0 SO NOT INCLUDED IN OUR FIT.      2/76
XIA  C  THE NON-ZERO L- VALUE AND THE RELATIVELY LARGE L+ VALUE FOUND BY     1/74
XIA  C  DALLY 72 COME MAINLY FROM A SINGLE LOW T BIN (FIGS.1,2).             1/74
XIA  C  THE (F+,XI) CORRELATION WAS IGNORED.                                 1/74
XIA  C  WE ESTIMATE FROM FIG. 2 THAT FIXING L-=0 WOULD GIVE XI(O)=-1.4+-0.3  1/74
XIA  C  AND WOULD ADD 10 TO CHI SQUARED.  DXI/DL IS NOT GIVEN.               1/74
XIA  D  ALBROW 72 FIT HAS L- FREE, GETS L-=-.030+-.060 OR LAM=+.15+.17-.11.  1/74
XIA  E  PEACH 73 GIVES XIO=-.95+-.45 FOR L+=L-=.025 .  THE ABOVE VALUE IS    1/74
XIA  E  FOR L-=0.  K.PEACH, PRIVATE COMMUNICATION(1974).                     1/74
XIA  F  DONALDSON2 74 GIVES XI=-.11+-.02 NOT INCLUDING SYSTEMATICS.  ABOVE  11/75
XIA  F  ERROR AND DXI/DL WERE CALCULATED BY US FROM LO AND L+ ERRORS (WHICH 11/75
XIA  F  INCLUDE SYSTEMATICS) AND DLO/DL+.                                   11/75
XIA  G  BUCHANAN 75 IS CALCULATED BY US FROM LO, L+ AND DLO/DL+ BECAUSE      2/76
XIA  G  THEIR APPENDIX A VALUE -.20+-22 ASSUMES XI(T) CONSTANT, I.E. L-=L+.  2/76
XIA  H  HILL 79 AND CHO 80 CALCULATED BY US FROM LO, L+, AND DLO/DL+.        4/82*
XIA  I  BIRULEV 81 ERROR, DXI/DL CALC. BY US FROM LO, L+.  DLO/DL+=0 USED.   4/82*

XIB     XIB = F-/F+ (DETERMINED FROM KMU3/KE3)  ---------------------------
XIB      THE KMU3/KE3 BRANCHING RATIO FIXES A RELATIONSHIP BETWEEN XI(O)     1/74
XIB      AND L+.  WE QUOTE THE AUTHORS XI(O) AND ASSOCIATED L+ BUT DO NOT    1/74
XIB      AVERAGE BECAUSE THE L+ VALUES DIFFER.  THE FIT RESULT AND SCALE     1/74
XIB      FACTOR GIVEN IN THE NOTE ON KL3 FORM FACTORS IN THE K+- SECTION OF  2/76
XIB      THE DATA CARDS ARE NOT OBTAINED FROM THESE XIB VALUES.  INSTEAD     2/76
XIB      THEY ARE OBTAINED DIRECTLY FROM THE AUTHORS KMU3/KE3 BRANCHING      2/76
XIB      RATIO VIA THE FITTED KMU3/KE3 RATIO (RIC).                          2/76
XIB    389  (+1.1)    (1.1)             ADAIR     64 HBC     BR, L+=0            1/74
XIB         (+0.66)   (0.9)    (1.3)    LUERS     64 HBC     BR, L+=0            1/74
XIB         (+0.2)    (0.8)    (1.2)    KULYUKINA 66 CC      BR, L+=0            1/74
XIB    569  (+0.45)   (0.28)            BEILLIERE 69 HLBC    BR, L+=0            1/74
XIB E 1309  (-0.22)   (0.30)            EVANS     69 HLBC                        1/74
XIB   3548  (-0.5)    (0.5)             BASILE    70 DSPK    BR, L+=.02          1/74
XIB   6700  (0.5)     (0.4)             BRANDENBU 73 HBC     BR,L+=.019+-.013    1/74
XIB  E1309  (-0.08)   (0.25)            EVANS     73 HLBC    BR, L+=.02          1/74
XIB           . . . . . . . . .
XIB FIT      -0.11     0.09   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIB      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SEC. OF DATA CDS.
XIB  E  EVANS 73 REPLACES EVANS 69.                                          1/74

XIC     XIC = F-/F+ (DETERMINED FROM MU POLARIZATION IN KMU3)  ------------
XIC     THE MU POLARIZATION IS A MEASURE OF XI(T). NO ASSUMPTIONS ON L+-
XIC     NECESSARY. T (WEIGHTED BY SENSITIVITY TO XIO) SHOULD BE SPECIFIED.
XIC     IN L+,XI(O) PARAMETERIZATION THIS IS XI(O) FOR L+=0.  DXI/DL=XI*T.
XIC      FOR RAD. CORR. TO MUON POLARIZATION IN KMU3. SEE GINSBERG 73.       2/72
XIC T 2608  (-1.2)    (0.5)             AUERBACH  66 OSPK    POLARIZATION        8/67
XIC T  638  (-1.6)    (0.5)             ABRAMS    68 OSPK    POLARIZATION        5/69
XIC  L       -1.81     0.50     0.26    LONGO     69 CNTR    POL. T=3.3          1/74
XIC  S2.2M   -0.385    0.105            SANDWEISS 73 CNTR    POL.DXI/DL=-6       1/74
XIC  H207K   +0.178    0.105            CLARK     77 SPEC    POL.DXI/DL=+.68    11/77
XIC           . . . . . . . . .
XIC AVG      -0.17     0.28    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.9)
XIC FIT      -0.11     0.09   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

XIC      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SEC. OF DATA CDS.
XIC T   T VALUE NOT GIVEN.                                                   1/74
XIC  L  LONGO 69 T=3.3 CALC. FROM DXI/DL=-6.0 (TABLE 1) DIVIDED BY XI=-1.81  1/74
XIC  S  SANDWEISS 73 IS FOR L+=0 AND T=0.                                    1/74
XIC  H  CLARK 77 T=+3.80, DXI/DL=XI(T)*T=.178*3.80=+.68 .                   11/77

IXI        IMAGINARY PART OF XI  (TEST OF T REVERSAL)  ------------------
IXI          -0.2      0.6              ABRAMS    68 OSPK    POLARIZATION       10/69
IXI          -0.02     0.08             LONGO     69 CNTR    POL. T=3.3         11/69
IXI   2.2M   -0.060    0.045            SANDWEISS 73 CNTR    POL. T=0            1/74
IXI  S2.2M   -0.085    0.064            SANDWEISS 73 CNTR    POL.T=0            12/79
IXI  C207K    0.35     0.30             CLARK     77 SPEC    POL. T=0           11/77
IXI          (0.012)  (0.026)           SCHMIDT   79 CNTR    REPL.BY MORSE 80   12/79
IXI    12M    0.009    0.030            MORSE     80 CNTR    POLARIZATION       10/81*
IXI  S  SANDWEISS 73 VALUE CORRECTED FROM VALUE QUOTED IN THEIR PAPER DUE   12/79
IXI  S  TO NEW VALUE OF RE(XI). SEE FTNOTE 4 OF SCHMIDT 79.                 12/79
IXI  C  CLARK 77 VALUE HAS ADDITIONAL XIO DEPENDENCE +0.21*RE(XIO).         11/77
IXI           . . . . . . . . .
IXI AVG      -0.020    0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

L+M     LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN KMU3 DECAY)  ---------
L+M      SEE ALSO THE CORRESPONDING ENTRIES AND NOTES IN SECTION XIA AND LO.
L+M      FOR RAD.COR. OF KMU3 DP SEE GINSBURG 70 AND BECHERRAWY 70.          3/74
L+M    16K  (0.07)    (0.02)            CHIEN     70 ASPK REPL. BY DALLY 72  1/74
L+M  A9086    0.085    0.015            ALBROW    72 ASPK    DP              1/74
L+M    16K  (0.11)    (0.04)            DALLY     72 ASPK    DP              1/74
L+M    82K  (0.046)   (0.008)           ALBRECHT  74 WIRE REPL. BY BIRULEV 81 11/75
L+M   1.6M    0.030    0.003            DONALDS2  74 SPEC    DP             10/74
L+M    32K    0.046    0.030            BUCHANAN  75 SPEC    DP              9/75
L+M   129K  (0.0337)  (0.0033)          DZHORDZHA 77 SPEC REPL. BY BIRULEV 81 12/79
L+M    16K    0.028    0.011            HILL      79 STRC    DP             12/79
L+M    14K    0.028    0.010            CHO       80 HBC     DP              2/82*
L+M   150K    0.0427   0.0044           BIRULEV   81 SPEC    DP              1/82*
L+M           . . . . . . . . .
L+M AVG       0.0347   0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
L+M FIT       0.034    0.005  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

L+M      FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SEC. OF DATA CDS.
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LO      LAMBDA 0 (LINEAR ENERGY DEPENDENCE OF F0 IN KMU3 DECAY)   ----------
LO       WHEREVER POSSIBLE, WE HAVE CONVERTED THE ABOVE VALUES OF XI(0) INTO
LO       VALUES OF LO USING THE ASSOCIATED L+M AND DXI/DL.
LO L  1371   +0.08    (0.07)            CARPENTER 66 OSPK   DP,DLO/DL+=-0.54  1/74
LO L         -0.140   (0.043)  (0.022)LONGO     69 CNTR   POL,DLO/DL+=+.49  1/74
LO  B 3140  (-0.333)  (0.034)           BASILE    70 OSPK   DP,DLO/DL+=+1.    1/74
LO A  9086   -0.043    0.052            ALBROW    72 ASPK   DP,DLO/DL+=-1.39  1/74
LO  C  16K  (-0.067)  (0.227)           DALLY     72 ASPK   DP,DLO/DL+ UNKN.  1/74
LO  R 6700  (+0.06)   (0.03)            BRANDENBU 73 HBC    BR,L+=.019+-.013  1/74
LO P  1385   -0.060   (0.038)           PEACH     73 HLBC   DP,DLO/DL+=-0.71  1/74
LO L  2.2M   -0.018   (0.009)           SANDWEISS 73 CNTR   POL,DLO/DL+=+.49  1/74
LO     82K  (+0.024)  (0.011)           ALBRECHT  74 WIRE REPL. BY BIRULEV 81 11/75
LO E  1.6M   +0.019    0.004            DONALDS2  74 SPEC   DP,DLO/DL+=-0.47 10/74
LO   F 32K   +0.025    0.019            BUCHANAN  75 SPEC   DP,DLO/DL+=+0.5   2/76
LO L  207K   +0.047   (0.009)           CLARK     77 SPEC   POL,DLO/DL+=1.06 11/77
LO     47K  (+0.0485) (0.0076)          DZHOROZHA 77 SPEC REPL. BY BIRULEV 81 12/79
LO     16K   +0.039    0.010            HILL      79 STRC   DP,DLO/DL+=-0.67 12/79
LO     14K   +0.050    0.008            CHO       80 HBC    DP,DLO/DL+=-0.11  2/82*
LO  G  14K  (0.041)   (0.008)           CHO       80 HBC    BR, L+=0.020      2/82*
LO H  150K   0.0341    0.0067           BIRULEV   81 SPEC   DP,DLO/DL+=?      4/82*
LO            . . . . . . . . . . .
LO  AVG      0.0279    0.0057  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
LO  FIT      0.025     0.006  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.3)  5/82*

LO       FIT DISCUSSED IN NOTE ON KL3 FORM FACTORS IN K+- SEC. OF DATA CDS.
LO L     LO VALUE IS FOR L+=0.03  CALCULATED BY US FROM XI0 AND DXI/DL.          1/74
LO  B    BASILE 70 LO IS FOR L+=0.  CALCULATED BY US FROM XIA WITH DXI/DL=0.     1/74
LO  B    BASILE 70 IS INCOMPATIBLE WITH ALL OTHER RESULTS.  AUTHORS SUGGEST      1/74
LO  B    THAT EFFICIENCY ESTIMATES MIGHT BE RESPONSIBLE.                         1/74
LO A     ALBROW 72 LO IS CALCULATED BY US FROM XIA,L+ AND DXI/DL.  THEY GIVE     1/74
LO A     LO=-.043+-.039 FOR L-=0.  WE USE OUR LARGER CALCULATED ERROR.           1/74
LO  C    DALLY 72 GIVES F0=1.20+-.35, LO=-.080+-.272, LOPRIME=-.006+-.045,       1/74
LO  C    BUT WITH A DIFFERENT DEFINITION OF LO.  OUR QUOTED LO IS HIS LO/F0.     1/74
LO  C    WE CANNOT CALCULATE TRUE LO ERROR WITHOUT HIS (LO,F0) CORRELATIONS.     1/74
LO  C    SEE ALSO NOTE C IN SECTION XIA.                                         1/74
LO P     PEACH 73 ASSUMES L+=0.025.  CALCULATED BY US FROM XI0 AND DXI0/DL+.     1/74
LO  R    FIT FOR LO DOES NOT INCLUDE THIS VALUE BUT INSTEAD INCLUDES THE         2/76
LO  R    KMU3/KE3 RESULT FROM THIS EXPERIMENT.                                   2/76
LO E     DONALDSON2 74 DLO/DL+ OBTAINED FROM FIG. 18.                           11/75
LO   F   BUCHANAN 75 VALUE IS FROM THEIR APPENDIX A AND USES ONLY KMU3 DATA.     2/76
LO   F   DLO/DL+ WAS OBTAINED BY PRIVATE COMMUNICATION, C.BUCHANAN, 1976.        2/76
LO   G   CHO 80 BR RESULT NOT INDEPENDENT OF THEIR DP RESULT.                    4/82*
LO   H   BIRULEV 81 GIVES DLO/DL+=-1.5, GIVING AN UNREASONABLY NARROW ERROR      4/82*
LO   H   ELLIPSE WHICH DOMINATES ALL OTHER RESULTS.  WE USE DLO/DL+=0.           4/82*

L+E      LAMBDA +  (LINEAR ENERGY DEPENDENCE OF F+ IN K0 E3 DECAY)   ------
L+E      FOR RAD.CCR. OF KE3 DP SEE GINSBURG 67 AND BECHERRAWY 70.               3/74
L+E    153   +0.07     0.06             LUERS     64 HBC    DP, NO RC
L+E    577   +0.15     0.08             FISHER    65 OSPK   DP, NO RC         8/67
L+E    762   -0.01     0.02             FIRESTONE 67 HBC    DP, NO RC         8/67
L+E    531   +0.01     0.015            KADYK     67 HBC    E,PI, NO RC       8/67
L+E    240   +0.08     0.10      0.08   LOWYS     67 FBC    PI                8/67
L+E   1000    0.02     0.013            ARONSON   68 OSPK   PI                5/69
L+E   4800   +0.023    0.012            BASILE    68 OSPK   DP, NO RC         3/68
L+E    42K    0.023    0.005            BISI      71 ASPK   DP               12/71
L+E    16K    0.05     0.01             CHIEN     71 ASPK   DP, NO RC         6/71
L+E   1910    0.022    0.014            NEUHOFER  72 ASPK   PI                1/73
L+E   5600    0.045    0.014            ALBROW    73 ASPK   DP                9/73
L+E   1871    0.019    0.013            BRANDENBU 73 HBC    PI TRANSV.        1/74
L+E   2171    0.040    0.012            WANG      74 OSPK   DP                7/74
L+E    25K    0.0270   0.0028           BLUMENTHA 75 SPEC   DP                7/75
L+E    24K    0.044    0.006            BUCHANAN  75 SPEC   DP                7/75
L+E    48K   (0.032)  (0.0042)          BIRULEV   76 SPEC REPL. BY BIRULEV 81 1/78
L+E   500K    0.0312   0.0025           GJESDAL   76 SPEC   DP                1/77
L+E  E 12K    0.025    0.005            ENGLER    78 HBC    DP                7/79
L+E    18K    0.0348   0.0044           HILL      78 STRC   DP                6/78
L+E    26K   (0.0286) (0.0049)          BIRULEV   79 SPEC REPL. BY BIRULEV 81 10/81*
L+E E  19K   (0.0291) (0.005)           CHO       80 HBC    DP                2/82*
L+E    74K    0.0306   0.0034           BIRULEV   81 SPEC   DP                1/82*
L+E E    ENGLER 78 USES UNIQUE KE3 SUBSET OF CHO 80 EVENTS AND IS LESS           2/82*
L+E E    SUBJECT TO SYSTEMATIC EFFECTS.                                          2/82*
L+E           . . . . . . . . . . .
L+E AVG      0.0300    0.0016  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                               (SEE IDEOGRAM BELOW )
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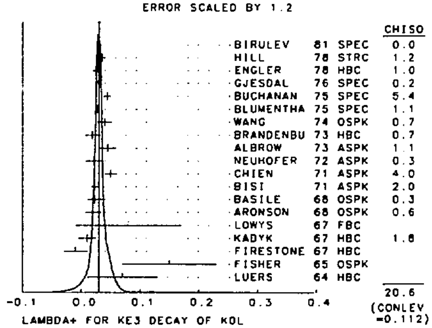
WEIGHTED AVERAGE = 0.0300 ± 0.0016
ERROR SCALED BY 1.2



LAMBDA+ FOR KE3 DECAY OF KOL

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FS      FS/F+  RATIO OF SCALAR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FS            (0.15) OR LESS  CL=.68   KULYUKINA 67 CC                          10/69
FS     5600   (0.19) OR LESS  CL=.95   ALBROW    73 ASPK                         9/73
FS      25K   (0.04) OR LESS  CL=.68   BLUMENTHA 75 SPEC                         7/75
FS      48K   (0.07) OR LESS  CL=.68   BIRULEV   76 SPEC SEE ALSO BIRULEV 81     1/78
FS      18K   (0.095)OR LESS  CL=.95   HILL      78 STRC                         6/78

FT      FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KE3 DECAY(ABS. VALUE)----
FT            (1.0)   OR LESS  CL=.68   KULYUKINA 67 CC                         10/69
FT     5600   (1.0)   OR LESS  CL=.95   ALBROW    73 ASPK                        9/73
FT      25K   (0.23) OR LESS  CL=.68   BLUMENTHA 75 SPEC                         7/75
FT      48K   (0.34) OR LESS  CL=.68   BIRULEV   76 SPEC SEE ALSO BIRULEV 81     1/78
FT      18K   (0.40) OR LESS  CL=.95   HILL      78 STRC                         6/78

FTM     FT/F+  RATIO OF TENSOR TO F+ COUPLINGS FOR KMU3 DECAY(ABS. VALUE)---
FTM           (0.12)   (0.12)          BIRULEV   81 SPEC                         2/82*

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                    13  CP VIOLATION PARAMETERS IN KOL DECAYS

        RELATED TEXT SECTION VI B.3 AND MINI-REVIEW BELOW

-----------------13 CHARGE ASYMMETRY IN TAU DECAYS-------------------

JTO     COEFF OF TERM (S1-S2)/(MPI2) IN MATRIX ELEMENT DEFINED AT BEGINNING
JTO     OF SECTION GTO ABOVE. SEE ALSO MINIREVIEW ON SLOPE PARAMETERS IN
JTO     CHGD K SECTION AND TEXT SEC. VI B.1.  THIS SECTION REPLACES CHARGE
JTO     ASYMMETRY PARAMETER SECTION(A) IN THE 1978 AND EARLIER EDITIONS.
JTO    238K    0.001     0.004            BLANPIED  68                        1/79
JTO      3M    0.0013    0.0009           SCRIBANO  70                        1/79
JTO    4400    0.0       0.017            SMITH     70 OSPK                   1/79
JTO    6499    0.001     0.011            CHO       77                        1/79
JTO    4709   -0.001     0.003            PEACH     77                        1/79
JTO           . . . . . . . . . . .
JTO AVG        0.00110   0.00084  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

-----------------13  CHARGE ASYMMETRY IN LEPTONIC DECAYS (PERCENT)------
TEXT SECTION VI B.3 C

      SUCH ASYMMETRY VIOLATES CP . IT IS RELATED TO REAL(EPSILON).

A1     KOL INTO (MU+PI-NU)-(MU-PI+NU)/(MU+PI-NU)+(MU-PI+NU)     (PERCENT)
A1  D    1M    (0.403)   (0.134)          DORFAN    67 OSPK   DERIVED FROM R16 11/67
A1 D     1M     0.57      0.17            PACIOTTI  69 OSPK                   1/73
A1     7.7M     0.278     0.051           PICCIONI  72 ASPK                   1/73
A1     4.1M     0.60      0.14            MCCARTHY  73 CNTR                   6/73
A1      15M     0.313     0.029           GEWENIG1  74 ASPK                   7/74
A1 D     PACIOTTI 69 IS A REANALYSIS OF DORFAN 67 AND IS CORRECTED FOR        1/73
A1 D     MU+ MU- RANGE DIFFERENCE IN MC CARTHY 72.                            1/73
A1            . . . . . . . . . . .
A1  AVG        0.319     0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                                 (SEE IDEOGRAM BELOW )
```
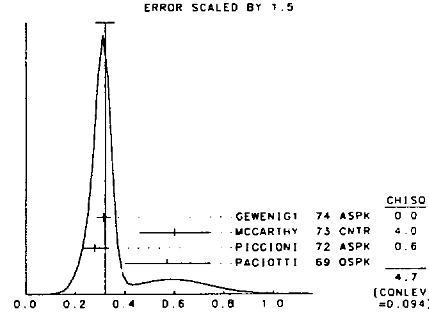

WEIGHTED AVERAGE = 0.319 ± 0.038
ERROR SCALED BY 1.5



CHARGE ASYMMETRY FOR KL --> MU PI NU

```
A2     KOL INTO (E+PI-NU)-(E-PI+NU)/(E+PI-NU)+(E-PI+NU)          (PERCENT)
A2  B   10M    (0.224)   (0.036)          BENNETT   67 CNTR                  11/67
A2 B    10M     0.246     0.059           SAAL      69 CNTR                  10/70
A2      10M     0.346     0.033           MARX      70 CNTR                  10/70
A2     600K     0.36      0.18            ASHFORD   72 ASPK                   2/72
A2      40M     0.318     0.038           FITCH     73 ASPK                  12/73
A2      34M     0.341     0.018           GEWENIG1  74 ASPK                   7/74
A2   B SAAL 69 IS A REANALYSIS OF BENNETT 67
A2            . . . . . . . . . . .
A2  AVG         0.333     0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AL      KOL INTO ((L+)-(L-))/((L+)+(L-))  (COMBINED A1 AND A2) (PERCENT)
AL B    10M     0.246     0.059           SAAL      69 CNTR    KE3            2/71
AL D     1M     0.57      0.17            PACIOTTI  69 OSPK    KMU3           1/73
AL      10M     0.346     0.033           MARX      70 CNTR    KE3            2/71
AL     600K     0.36      0.18            ASHFORD   72 ASPK    KE3            2/72
AL     7.7M     0.278     0.051           PICCIONI  72 ASPK    KMU3           1/73
AL      40M     0.318     0.038           FITCH     73 ASPK    KE3           12/73
AL     4.1M     0.60      0.14            MCCARTHY  73 CNTR    KMU3           6/73
AL      33M     0.333     0.050           WILLIAMS  73 ASPK    KMU3+KE3      12/73
AL      15M     0.313     0.029           GEWENIG1  74 ASPK    KMU3           7/74
AL      34M     0.341     0.018           GEWENIG1  74 ASPK    KE3            7/74
AL        SEE FOOTNOTES IN SECTIONS A1 AND A2 ABOVE.                          1/73
AL            . . . . . . . . . . .
AL  AVG         0.330     0.012   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

------ ------ -------13  PARAMETERS FOR KOL INTO 2PI DECAY-----------------
TEXT SECTION VI B.3 C

     ETA+- = A(KL TO PI+PI-)/A(KS TO PI+PI-)
     ETA00 = A(KL TO PI0PI0)/A(KS TO PI0PI0)

     THE FITTED VALUES OF ETA+- AND ETA00 GIVEN BELOW ARE THE RESULTS
     OF A FIT TO ETA+-, ETA00 AND ETA00/ETA+- RESULTS.  THE VALUES LISTED
     BELOW WHICH ARE NOT PARENTHESIZED ENTER THE FIT AS SHOWN.  THE
     VALUES WHICH ARE PARENTHESIZED AND BEAR THE FOOTNOTE X DO NOT ENTER
     THE FIT AS SHOWN.  THESE EXPERIMENTS GIVE BRANCHING RATIOS AND ENTER
     THE FIT VIA THE QUANTITY ACTUALLY MEASURED -- BRANCHING RATIOS
     R9, R20 AND R27 (ETA+-) AND R17 AND R19 (ETA00).  THESE BRANCHING
     RATIOS ARE COMBINED WITH CURRENT NORMALIZATIONS AND CURRENT KL AND KS
     MEAN LIVES TO OBTAIN PI PI RATES.  THE ETA+- AND ETA00 VALUES OBTAINED
     FROM THESE RATES ARE ENTERED BELOW WITH THE NAME 'GKL/GKS'.
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EOS       (ETA00)**2 = (A(KL TO 2PI0)/A(KS TO 2PI0))**2  (UNITS 10**-6)   ---
EOS X    0  (-2.)      (7.0)            BARTLETT  68 OSPK                     10/69
EOS X   57   (4.9)     (1.2)            BANNER    69 OSPK                      2/72
EOS XR 133  (14.1)     (3.4)            CENCE     69 OSPK                     10/69
EOS XF 180  (13.)      (4.)             GAILLARD  69 OSPK                     10/69
EOS X   29   (4.08)    (0.9)            BARMIN    70 HLBC                     12/70
EOS X   30   (3.61)    (1.9)            BUDAGOV   70 HLBC                     10/70
EOS  C        8.7       3.7             CHOLLET   70 OSPK    CU REG.,4 GAMMAS  2/72
EOS XF 172   (9.9)     (3.4)            FAISSNER  70 OSPK                     12/70
EOS  C  56    7.4       2.0             WOLFF     71 OSPK    CU REG.,4GAMMAS  12/71
EOS XR 150  (14.1)     (3.4)            REY       76 OSPK                      8/76
EOS           5.43      0.84            CHRISTE1  79 ASPK                     12/79
EOS  X        5.1       1.0             GKL/GKS   82 RVUE BR SCALE FACTOR=1.5  4/82*
EOS X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
EOS  R  CENCE 69 EVENTS ARE INCLUDED IN REY 76.                                1/77
EOS  F  FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69
EOS  C  CHOLLET 70 GIVES ETA00=(1.23+-0.24)*(REGEN AMPL,2GEV/C CU)/10000MB     2/72
EOS  C  WOLFF 71   GIVES ETA00=(1.13+-0.12)*(REGEN AMPL,2GEV/C CU)/10000MB     2/72
EOS  C  WE COMPUTE BOTH ETA00**2 VALUES FOR (REGEN AMPL,2GEV/C CU)=24+-2MB.    2/72
EOS  C  THIS REGEN AMPL RESULTS FROM AVERAGING OVER FAISSNER 69,               2/72
EOS  C  EXTRAPOLATED USING OPTICAL MODEL CALCULTIONS OF BOHM ET AL.            2/72
EOS  C  PL 27B 594 (1968) AND THE DATA OF BALATS 71. (FROM H. FAISSNER,        2/72
EOS  C  PRIVATE COMMUNICATION)                                                 2/72
EOS  F  FAISSNER 70 CONTAINS SAME 2PI0 EVENTS AS GAILLARD 69
EOS           . . . . . . . . . .
EOS AVG       5.58      0.60    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
EOS FIT       5.41      0.38  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)    4/82*
EOO THIS FIT VALUE CORRESPONDS TO ETA00=2.325+-0.082                           4/82*

E+-     ETA+-  = A(KL TO PI+PI-)/A(KS TO PI+PI-) UNITS 10**-3  ---- ---
E+- X   45   (1.95)    (0.20)           CHRISTENS 64 OSPK                      2/76
E+- X   54   (1.99)    (0.16)           GALBRAITH 65 OSPK                      2/76
E+- X        (1.92)    (0.13)           BASILE    66 OSPK                      2/76
E+- X        (1.95)    (0.04)           BOTT-BODE 66 OSPK                      2/76
E+- X        (2.00)    (0.09)           DEBOUARD  67 OSPK                      2/76
E+- X        (1.94)    (0.08)           FITCH     67 OSPK                      2/76
E+- AX       (1.95)    (0.03)           GKL/GKS   71 RVUE     EXPTS. BEFORE 71 2/76
E+- A   AVERAGE OF ABOVE EXPERIMENTS.  THESE ARE EXCLUDED FROM THE GKL/GKS,    1/80
E+- A   AVERAGE, AND FIT VALUES BELOW SINCE THEY DO NOT AGREE WITH MORE        1/80
E+- A   RECENT PRECISE AND IN PRINCIPLE SUPERIOR EXPERIMENTS.                  1/80
E+- X 4200   (2.23)    (0.05)           MESSNER   73 ASPK                     11/75
E+-           2.30      0.035           GEWENIG2  74 ASPK                      3/74
E+- X 2703   (2.25)    (0.05)           DEVOE     77 SPEC                     11/77
E+-           2.27      0.12            CHRISTE2  79 ASPK                     12/79
E+-  X        2.255     0.029           GKL/GKS   82 RVUE     BR EXP. AFTER 71 4/82*
E+- X   SEE NOTE ABOVE REGARDING FITTED VALUES OF ETA+- AND ETA00.
E+-           . . . . . . . . . .
E+- AVG       2.273     0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
E+- FIT       2.274     0.022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)    4/82*

ER      RATIO OF ETA00 OVER ETA+-
ER      124   1.03      0.07            BANNER1   72 OSPK                      8/72
ER      167   1.00      0.06            HOLDER    72 ASPK                      8/72
ER  C        (1.00)    (0.09)           CHRISTE1  79 ASPK                      2/80
ER  C   NOT INDEPENDENT OF E+- AND EOS VALUES WHICH ARE INCLUDED IN FIT.       2/80
ER            . . . . . . . . . .
ER  AVG       1.013     0.045   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
ER  FIT       1.023     0.036 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)    4/82*

F+-     PHASE OF ETA +-            (DEGREES)   --------------------------- - --
F+-      THE DEPENDENCE OF THE PHASE ON THE KOL-KOS MASS DIFFERENCE
F+-      IS GIVEN FOR EACH EXPERIMENT IN THE COMMENTS BELOW, WHERE DM IS
F+-      (MASS DIFF./HBAR) IN UNITS 10**10 SEC-1.  WE HAVE EVALUATED THESE
F+-      MASS DEPENDENCES USING OUR APRIL 1982 VALUE, DM=0.5349+-0.0022
F+-      TO OBTAIN THE VALUES AND AVERAGE QUOTED BELOW. WE ALSO GIVE THE
F+-      REGENERATOR PHASE FR IN THE COMMENTS BELOW.
F+- O        (45.0)    (50.0)           FITCH     65 OSPK    PE REGEN         11/76
F+- O        (30.0)    (45.0)           FIRESTONE 66 HBC                      11/67
F+- O        (70.0)    (21.0)           BOTT-BODE 67 OSPK    C REGEN          11/67
F+- O        (25.0)    (35.0)           MISCHKE   67 OSPK    CU REGEN          7/66
F+- O   OLD EXPERIMENTS WITH LARGE ERRORS NOT INCLUDED IN AVERAGE.             2/76
F+- N        (41.0)    (11.0)           BENNETT2  68 CNTR    CU REG. USES      8/68
F+-  C        34.2      10.0            BENNETT   69 CNTR    CU REGEN          2/71
F+-  B        45.3      12.0            BOHM      69 OSPK    VACUUM REGEN      2/71
F+-  F        45.2       7.4            FAISSNER  69 ASPK    CU REGEN          2/71
F+-  J        43.6       4.2            JENSEN    70 ASPK    VACUUM REGEN      2/71
F+-  D        37.2      12.0            BALATS    71 OSPK    CU REGEN          5/71
F+-  P        36.2       6.1            CARNEGIE  72 ASPK    CU REGEN          1/73
F+-  G        46.5       1.6            GEWENIG2  74 ASPK    VACUUM REGEN      3/74
F+-  H        45.5       2.8            CARITHERS 75 SPEC    C REGEN           7/75
F+-           41.7       3.5            CHRISTE2  79 ASPK                     12/79
F+-           . . . . . . . . . .
F+- AVG       44.6       1.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F+- FIT       44.6       1.2   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   4/82*
                          COMMENTS
F+-  N  BENNETT 69 IS A REEVALUATION OF BENNETT2 68.                          11/69
F+-  C  BENNETT 69 USES MEASUREMENT OF (F+-)-(PHIF) OF ALFF STEINBERGER 66.    2/71
F+-  C  BENNETT 69  F+-=(34.9+-10.0)+ 69*(DM-.545) DEG.  FR=-49.9+-5.4 DEG.    2/71
F+-  B  BOHM 69      F+-=(41.0+-12.0)+479*(DM-.526) DEG.                       2/71
F+-  F  FAISSNER 69 ERROR ENLARGED TO INCLUDE ERROR IN REGENERATOR PHASE.     11/69
F+-  F  FAISSNER 69 F+-=(49.3+-7.4)+205*(DM-.555) DEG.   FR=-42.7+-6.0 DEG.    2/71
F+-  J  JENSEN 70   F+-=(42.4+-4.0)+576*(DM-.538) DEG.                         2/71
F+-  D  BALATS 71   F+-=(39.0+-12.0)+198*(DM-.544) DEG.  FR=-43.9+-4.0 DEG.    5/71
F+-  P  CARNEGIE 72 F+- IS INSENSITIVE TO DM.             FR=-56.2+-5.2 DEG.   1/73
F+-  G  GEWENIG2 74 F+-=(49.4+-1.0)+565*(DM-.540) DEG.                         3/74
F+-  H  CARITHER 75 F+-=(45.5+-2.8)+224*(DM-.5349) DEG.  FR=-49.9+-7.6 DEG.   11/75

F00     PHASE OF ETA 00     (DEGREES)      --- ---------------------------- - -
F00         FIRST QUADRANT PREFERRED   GOBBI     69 OSPK                      11/69
F00  C        51.0      30.0            CHOLLET   70 OSPK    CU REG.,4 GAMMAS 10/70
F00  W  56    38.0      25.0            WOLFF     71 OSPK    CU REG.,4 GAMMAS 12/71
F00           . . . . . . . . . .
F00 AVG       43.3      19.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
F00           55.7       5.8            CHRISTE1  79 ASPK                     12/79
F00  C  CHOLLET 70 USES REGENERATOR PHASE FR=-46.5+-4.4 DEG.                   1/73
F00  W  WOLFF 71   USES REGENERATOR PHASE FR=-49.7+-3.5 DEG.                   1/73
F00           . . . . . . . . . .
F00 FIT       54.5       5.3   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   4/82*

DF      PHASE DIFFERENCE F00 - F+-     (DEGREES)--------------------------------
DF B           7.6      18.0            BARBIELLI 73 ASPK                      7/73
DF  C        (12.6)     (6.2)           CHRISTE1  79 ASPK                      2/80
DF B    INDEPENDENT OF REGENERATOR MECHANISM,DM,AND LIFETIMES.                 7/73
DF  C   NOT INDEPENDENT OF F+- AND F00 VALUES WHICH ARE INCLUDED IN FIT.       2/80
DF            . . . . . . . . . .
DF  FIT        9.8       5.4   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)   4/82*
```

Superweak Model Predictions for $|\eta_{00}/\eta_{+-}|$, ϕ_{+-}, and Reϵ

In terms of the parameters defined in the text, Sec. VI B(d), the superweak model[1] predicts that[2]

$$|\eta_{00}/\eta_{+-}| = 1 \quad ,$$

$$\phi_{+-} = \phi_{00} = \tan^{-1}\left(\frac{2\Delta m\tau_S}{\hbar}\right) \quad ,$$

and

$$\mathrm{Re}\,\epsilon = |\eta_{+-}| \left[1 + \left(\frac{2\Delta m\tau_S}{\hbar}\right)^2\right]^{-1/2} \quad .$$

The latter two expressions and the values of the $K_L^0 - K_S^0$ mass difference $\Delta m = (0.5349 \pm 0.0022) \times 10^{10}\hbar$ sec^{-1}, the K_S^0 mean life $\tau_S = (0.8923 \pm 0.0022) \times 10^{-10}$ sec, and the magnitude of the $K_L^0 \to \pi^+\pi^-/K_S^0 \to \pi^+\pi^-$ amplitude ratio $|\eta_{+-}| = (2.274 \pm 0.022) \times 10^{-3}$, all from the current edition, result in the predictions that

$$\phi_{+-} = \phi_{00} = (43.67 \pm 0.14)^\circ$$

and

$$\mathrm{Re}\,\epsilon = (1.645 \pm 0.016) \times 10^{-3} \quad .$$

The above predictions can be compared with the experimental values

$$|\eta_{00}/\eta_{+-}| = 1.023 \pm 0.036 \quad ,$$

$$\phi_{+-} = (44.6 \pm 1.2)^\circ \quad ,$$

$$\phi_{00} = (54.5 \pm 5.3)^\circ \quad ,$$

$$\mathrm{Re}\,\epsilon = (1.621 \pm 0.088) \times 10^{-3} \quad ,$$

where Reϵ has been computed using the relation

$$\mathrm{Re}\,\epsilon = \frac{\delta}{2}\left(\frac{|1 - x|^2}{1 - |x|^2}\right) \quad ,$$

and our current values of the charge asymmetry parameter for leptonic K_L^0 decay $\delta = (0.330 \pm 0.012)\%$ and the $\Delta S = -\Delta Q$ amplitude (Rex, Imx) = (0.009 ± 0.020, −0.004 ± 0.026).

The superweak predictions are in agreement with the data except for the measured value of ϕ_{00}, which is two standard deviations above the prediction. This results primarily from the CHRISTENSON1 79 measurement $\phi_{00} = (55.7 \pm 5.8)^\circ$.

References

1. L. Wolfenstein, Phys. Lett. 13, 562 (1964).
2. T. D. Lee and L. Wolfenstein, Phys. Rev. 138B, 1490 (1965).

```
13   X = (DS=-DQ AMPLITUDE)/(DS=+DQ AMPLITUDE)

RELATED TEXT SECTION VI B.4

REX        REAL PART OF X
REX  C 152    0.06      0.18      0.44  BALDO-CE   65 HLBC     K+ CHARGE EXCHNG 11/67
REX    196    0.035     0.11      0.13  AUBERT     65 HLBC     K+ CHARGE EXCHNG 11/67
REX  F 109   -0.08      0.16      0.28  FRANZINI   65 HBC      PBAR P           11/67
REX    116    0.17      0.16      0.35  FELDMAN    67 OSPK     PI-P TO KO LMBDA 11/67
REX N  335   (0.17)    (0.10)           HILL       67 DBC      K+D YIELDS KOPP  11/67
REX B        (0.03)    (0.03)           BENNETTI   68 CNTR                       7/68
REX    121    0.09      0.07      0.09  JAMES      68 HBC      PBAR P            5/69
REX  B       -0.020     0.025           BENNETT    69 CNTR     CHAR ASYM+ CU FE 10/69
REX    686    0.09      0.14      0.16  LITTENBER  69 OSPK     K+N TO KOP        4/69
REX  N 215    0.12      0.09            CHO        70 DBC      K+D TO KOPP      10/70
REX  U 222   (0.06)    (0.07)    (0.08) BURGUN     71 HBC      K+P TO KOPPI+     2/72
REX    252    0.25      0.07      0.09  WEBBER     71 HBC      K-P TO KBAR N    10/69
REX  U 410    0.03      0.06      0.06  BURGUN     72 HBC      K+P TO KOPPI+     1/73
REX    126    0.26      0.10      0.14  MANN       72 HBC      K-P TO KOBAR N    9/72
REX G  342   (-0.13)   (0.11)           MANTSCH    72 CSPK     KE3  FROM KO LMB  2/72
REX G  100   (0.04)    (0.10)    (0.13) GRAHAM     72 OSPK     KMU3 FROM KO LMB  2/72
REX  G 442   -0.05      0.09            GRAHAM     72 OSPK     PI-P TO KO LMBDA  2/72
REX   1757   -0.008     0.044           FACKLER    73 OSPK     KE3 FROM KO       9/73
REX   1367   -0.03      0.07            HART       73 OSPK     KE3 FROM K   LMB  2/74
REX   1079   -0.070     0.036           MALLARY    73 OSPK     KE3 FROM KO LM +  6/73
REX   4724    0.04      0.03            NIEBERGA   74 ASPK     K+P TO KOPPI+     7/74
REX     79    0.10      0.18      0.19  SMITH      75 WIRE     PI-P TO KO LMBDA  8/76
REX  C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.          11/67
REX  F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.          11/67
REX N   CHO TO IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.      10/70
REX  U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                  11/73
REX  B  BENNETT 69 IS A REANALYSIS OF BENNETTI 68.                             10/69
REX G   SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH          2/72
REX G   MANTSCH 72.                                                             2/72
REX             . . . . . . . . .
REX AVG       0.009     0.020      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                   (SEE IDEOGRAM BELOW )
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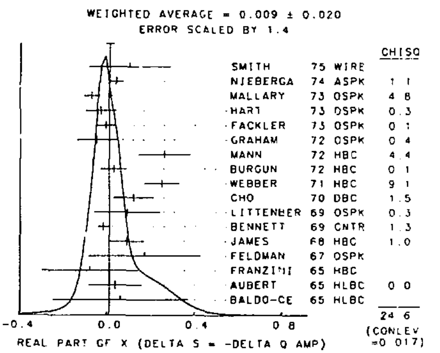


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IMX        IMAGINARY PART OF X (ASSUMES MIKLI-MIKS) POSITIVE -- SEE S130)
IMX  C 152   -0.44      0.32      0.19  BALDO-CE   65 HLBC     K+ CHARGE EXCHNG  3/68
IMX    196   -0.21      0.11      0.15  AUBERT     65 HLBC     K+ CHARGE EXCHNG  3/68
IMX  F 109   +0.24      0.40      0.30  FRANZINI   65 HBC      PBAR P            3/68
IMX    116    0.0       0.25            FELDMAN    67 OSPK     PI-P TO KO LMBDA 11/67
IMX N  335   (-0.20)   (0.10)           HILL       67 DBC      K+D YIELDS KOPP  11/67
IMX    121   +0.22      0.37      0.29  JAMES      68 HBC      PBAR P            5/69
IMX    686   -0.11      0.10      0.11  LITTENBER  69 OSPK     K+N TO KOP        4/69
IMX  N 215   -0.08      0.07            CHO        70 DBC      K+D TO KOPP      10/70
IMX U  222   (0.12)    (0.08)    (0.09) BURGUN     71 HBC      K+P TO KOPPI+     2/72
IMX    252    0.0       0.08      0.07  WEBBER     71 HBC      K-P TO KBAR N    10/69
IMX  U 410    0.07      0.06      0.07  BURGUN     72 HBC      K+P TO KOPPI+     1/73
IMX    126    0.21      0.15      0.12  MANN       72 HBC      K-P TO KOBAR N    9/72
IMX G  342   (-0.04)   (0.16)           MANTSCH    72 CSPK     KE3  FROM KO LMB  2/72
IMX G  100   (0.12)    (0.17)    (0.16) GRAHAM     72 OSPK     KMU3 FROM KO LMB  2/72
IMX  G 442    0.05      0.13            GRAHAM     72 OSPK     PI-P TO KO LMBDA  2/72
IMX   1757   -0.017     0.060           FACKLER    73 OSPK     KE3 FROM KO       9/73
IMX   1367    0.09      0.07            HART       73 OSPK     KE3 FROM KO LMB   2/74
IMX   1079    0.107     0.092     0.074 MALLARY    73 OSPK     KE3 FROM KO LM +  6/73
IMX   4724   -0.06      0.05            NIEBERGA   74 ASPK     K+P TO KOPPI+     7/74
IMX     79   -0.10      0.16      0.19  SMITH      75 WIRE     PI-P TO KO LMBDA  8/76
IMX  C  BALDO-CE 65 GIVES X AND THETA.CONVERTED BY US TO REX AND IMX.          11/67
IMX  F  FRANZINI 65 GIVES X AND THETA.FOR REX AND IMX SEE SCHMIDT 67.          11/67
IMX N   FNOTE 10 OF HILL 67 SHOULD READ +0.58, NOT -0.58 (PRIV.COMM.).          3/68
IMX N   CHO TO IS ANALYSIS OF UNAMBIGUOUS EVENTS IN NEW DATA AND HILL 67.      10/70
IMX  U  BURGUN 72 IS A FINAL RESULT WHICH INCLUDES BURGUN 71.                  11/73
IMX G   SECOND GRAHAM 72 VALUE IS FIRST GRAHAM 72 VALUE COMBINED WITH          2/72
IMX G   MANTSCH 72.                                                             2/72
IMX             . . . . . . . . .
IMX AVG      -0.004     0.026      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

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REFERENCES FOR KOL


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BARDON   58 ANP 5 156           M BARDON,K LANDE,L LEDERMAN  (COLUMBIA+BNL)
CRAWFORD 59 PRL 2 361           CRAWFORD,CRESTI,DOUGLASS,GOOD +        (LRL)
ASTIER   61 AIX CONF 1 227      ASTIER,BLASKOVIC,RIVET,SIAUD +        (EPOL)
FITCH    61 NC  22 1160         V FITCH,P PIROUE,R PERKINS       (PRINCETON)
GOOD     61 PR 124 1223         GOOD,MATSEN,MULLER,PICCIONI,POWELL +   (LRL)
NEAGU    61 PRL  6  552         NEAGU,OKONOV,PETROV,ROSANOVA,RUSAKOV (JINR)
    ALSO 61 JETP 13 1138        NYAGU,OKONOV,PETROV,ROZANOVA,RUSAKOV (JINR)

CAMERINI 62 PR 128 362          CAMERINI,FRY,GAIDOS,BIRGE,ELY +  (WISC+LRL)
DARMON   62 PL 3 57             J DARMON,A ROUSSET,J SIX              (EPOL)

ADAIR    64 PL 12 67            R K ADAIR,L B LEIPUNER            (YALE+BNL)
ALEKSANY 64 DUBNA 2 102         ALEKSANYAN,ALIKHANYAN,VARTAZARYAN+ (EREVAN)
    ALSO 64 JETP 19 1019        ALEKSANYAN+    (LEBEDEV+MOS ENG PHYS+EREVAN)
ANIKINA  64 JETP 19 42          ANIKINA,ZHURAVLEVA+ (GEORG ACAD SCI+ DUBNA)
CHRISTEN 64 PRL 13 138          CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FUJII    64 DUBNA 2 146         FUJII,JOVANOVICH,TURKOT+ (BNL,MARYLAND,MIT)
LUERS    64 PR 133 B 1276       LUERS,MITTRA,WILLIS,YAMAMOTO           (BNL)

ANIKINA  65 JINR P 2488         ANIKINA,VARDENGA,ZHURAVLEVA,KOTLYA+ (DUBNA)
ANDERSON 65 PRL 14 475          ANDERSON,CRAWFORD,GOLDEN,STERN + (LRL+WISC)
ASTBURY1 65 PL 16 80            ASTBURY,FINOCCHIARO,BEUSCH +   (CERN+ZURICH)
    ALSO 65 HELV.PH.AC.39 523   M PEPIN
ASTBURY2 65 PL 18 175           ASTBURY,MICHELINI,BEUSCH +     (CERN+ZURICH)
ASTBURY3 65 PL 18 178           ASTBURY,MICHELINI,BEUSCH +     (CERN+ZURICH)

AUBERT   65 PL 17 59            AUBERT,BEHR,CANAVAN,CHOUNET+    (EPOL+ORSAY)
    ALSO 67 LOWYS
BALDO-CE 65 NC 38 684           BALDO-CEOLIN,CALIMANI,CIAMPOLILLO +   (PADO)
CHRISTEN 65 PR 140 B 74         CHRISTENSON,CRONIN,FITCH,TURLAY (PRINCETON)
FISHER   65 ANL 7130 63         FISHER,ABASHIAN,ABRAMS,CARPENTER+      (ILL)
FITCH    65 PRL 15 73           FITCH,ROTH,RUSS,VERNON           (PRINCETON)

FRANZINI 65 PR 140 B 127        FRANZINI,KIRSCH,PLANO +  (COLUMBIA+RUTGERS)
GALBRAIT 65 PRL 14 383          GALBRAITH,MANNING,JONES +   (AERE+BRIS+RHEL)
GUIDONI  65 ARGONNE CONF 49     +BARNES,FOELSCHE,FERBEL,FIRESTO+ (BNL+YALE)
HOPKINS  65 ARGONNE CONF 67     H W K HOPKINS,BACON,EISLER    (VAND+RUTGERS)
VISHNEVS 65 PL  18   339        VISHNEVSKY,GALANINA,SEMENOV +         (ITEP)

ALFF-STE 66 PL 21 595           ALFF-STEINBERGER,HEUER,RUBBIA +       (CERN)
ANIKINA  66 SJNP 2 339          ANIKINA, VARDENGA, ZHURAVLEVA+        (JINR)
AUERBACH 66 PRL  17  980        AUERBACH,MANN,MCFARLANE,SCIULLI       (PENN)
AUERBACH 66 PR  149 1052        AUERBACH,DOBBS,LANDE,MANN,SCIULLI+    (PENN)
    ALSO 65 PRL  14  192        +LANDE,MANN,SCIULLI,UTO,WHITE,YOUNG   (PENN)
BALDO-CE 66 NC  45A  733        BALDO-CEOLIN,CALIMANI,CIAMPOLILLO+  (PADUA)
BASILE   66  BALATON CONF       BASILE,CRONIN,THEVENET +            (SACLAY)

BEHR     66 PL   22 540         +BRISSON,BALDO-CEOLIN,AUBERT+   (PADO,EPOL)
BELLOTTI 66 NC   45A  737       BELLOTTI,PULLIA,BALDO-CEOLIN+ (MILAN,PADUA)
BOTT-BOD 66 PL   23  277        BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
CAMERINI 66 PR   150 1148       CAMERINI,CLINE,ENGLISH,FISCHBEIN+WISCONSIN
CANTER   66 PRL 17 942          +CHO,ENGLER,FISK,HILL +       (CARNEGIE+BNL)
CARPENTE 66 PR   142  871       CARPENTER,ABASHIAN,ABRAMS,FISHER  (ILLINOIS)
CHANG    66 PL   23  702        CHANG,BASSANO,KIKUCHI,OCDD+   (SYRACUSE,BNL)

CRIEGEE  66 PRL 17 150          +FOX,FRAUENFELDER,HANSON,MOSCAT+ (ILLINOIS)
FIRESTON 66 PRL 16 556          FIRESTONE,KIM,LACH,SANDWEISS+     (YALE,BNL)
FIRESTON 66 PRL 17 116          FIRESTONE,KIM,LACH,SANDWEISS+     (YALE,BNL)
FUJII    66 PRL 13 253          FUJII,JOVANOVICH,TURKOT,ZORN (BNL+MARYLAND)
    FUJII 66 IS THE CORRECTED VALUE GIVEN BY JOVANOVICH+ 66
HAWKINS  66 PL 21 238           C J B HAWKINS                         (YALE)
    ALSO 67 PR   156  1444      C J B HAWKINS                         (YALE)

JOVANOVI 66 PRL 17 1075         JOVANOVICH,FUJII,TURKOT,ZORN +(BNL+UMD+MIT)
KULYUKIN 66  BERKELEY 28        KULYUKINA,MESTVIRISHVILI,NEAGU,PETR+ (JINR)
MEISNER1 66 PRL 16 278          G W MEISNER,B B CRAWFORD,F CRAWFORD    (LRL)
MEISNER2 66 PRL  17  492        G MEISNER,B CRAWFORD,F CRAWFORD        (LRL)
NEFKENS  66 PL 19 706           NEFKENS,ABASHIAN,ABRAMS,CARPENTER+     (ILL)
VERHEY   66 PRL 17 669          VERHEY,NEFKENS,ABASHIAN+               (ILL)

BENNETT  67 PRL   19   993      BENNETT,NYGREN,SAAL,STEINBERGER +(COLUMBIA)
BOTT-BOD 67 PL   24B   194      BOTT-BODENHAUSEN,DEBOUARD,CASSEL +    (CERN)
BOTT-BOD 67 PL   24B   438      BOTT-BODENHAUSEN,DEBOUARD,DEKKERS+    (CERN)
    ALSO 66 PL   20   212       BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
    ALSO 66 PL   23   277       BOTT-BODENHAUSEN,DEBOUARD,CASSEL+     (CERN)
CANTER   67 THESIS              J.M. CANTER                       (CARNEGIE)

CRONIN 1 67 PRL 18 25           +KUNZ,RISK,WHEELER               (PRINCETON)
CRONIN 2 67 PRINC CONF(11/67)   +KUNZ,RISK,WHEELER               (PRINCETON)
DEBOUARD 67 NC   52A   662      DEBOUARD,DEKKERS,JORDAN,MERMOD +      (CERN)
    ALSO 65 PL   15   58        DE BOUARD,DEKKERS,SCHARFF+ (CERN+ORSA+MPIM)
DEVLIN   67 PRL 18 54           DEVLIN,SOLOMON,SHEPARD,BEALL+     (PRIN+UMD)
    ALSO 68 PR 169 1045         SAYER,BEALL,DEVLIN,SHEPHARD+ (UMD+PPA+PRIN)

DORFAN   67 PRL   19   987      DORFAN,ENSTROM,RAYMOND,SCHWARTZ +(SLAC+LRL)
FELDMAN  67 PR   155   1611     FELDMAN,FRANKEL,HIGHLAND,SLOAN        (PENN)
FIRESTON 67 PRL  18   176       FIRESTONE,KIM,LACH,SANDWEISS +    (YALE,BNL)
FITCH    67 PR 164   1711       FITCH,ROTH,RUSS,VERNON           (PRINCETON)
HAWKINS  67 PR   156   1444     C J B HAWKINS                         (YALE)
HILL     67 PRL   19   668      HILL,LUERS,ROBINSON,CANTER+  (BNL,CARNEGIE)

HOPKINS  67 PRL  19   185       HOPKINS,BACON,EISLER                   (BNL)
KADYK    67 PRL  19   597       KADYK,CHAN,ORIJARD,OREN,SHELDON        (LRL)
KULYUKIN 67  PREPRINT           KULYUKINA+MESTVIRISHVILI+NEAGU +      (JINR)
LOWYS    67 PL   24B   75       LOWYS,AUBERT,CHOUNET,PASCAUD+   (EPOL,ORSA)
MISCHKE  67 PRL  18   138       MISCHKE,ABASHIAN,ABRAMS+          (ILLINOIS)
NEFKENS  67 PR   157   1233     +ABASHIAN,ABRAMS,CARPENTER,FISHER+     (ILL)
TODOROFF 67  THESIS             JOHN A TODOROFF                   (ILLINOIS)

ABRAMS   68 PR    176  1603     +ABASHIAN,MISCHKE,NEFKENS,SMITH+ (ILLINOIS)
ARNOLD   68 PL 28B 56           ARNOLD,BUDAGOV,CUNDY,AUBERT+    (CERN+ORSAY)
ARONSON  68 PRL 20 287          S.H.ARONSON, K.W.CHEN            (PRINCETON)
    ALSO 69 PR   175 1708       S H ARONSON, K W CHEN            (PRINCETON)
BALATZ   68 PL 26B  320         BALATZ,BEREZIN,VISHNEVSKY,GALANINA+  (ITEP)
BARTLETT 68 PRL 21 558          BARTLETT,CARNEGIE,FITCH+         (PRINCETON)

BASILE   68 PL 26B  542         BASILE,CRONIN,THEVENET,TURLAY+      (SACLAY)
BASILE2  68 PL 28B   58         +CRONIN,THEVENET,TURLAY,ZYLBERAJCH+(SACLAY)
BENNETT1 68 PL 27B 244          BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BENNETT2 68 PL 27B 248          BENNETT,NYGREN,STEINBERGER+ (COLUMBIA+CERN)
BLANPIED 68 PRL 21 1650         BLANPIED,LEVIT,ENGELS+       (CASE+HARV+MCGI)
BUDAGOV  68 NC 57A 162          BUDAGOV,BURMEISTER,CUNDY+   (CERN,ORSA,IPNP)
    ALSO 68 PL   28B 215        +CUNDY,MYATT,NEZRICK+       (CERN,ORSA,EPOL)

CARNEGIE 68 PRINC TR44 THESIS   R.K.CARNEGIE                     (PRINCETON)
JAMES    68 NP   8B 365         F JAMES, H BRIAND                (IPNP,CERN)
    ALSO 68 PRL  21 257         HELLAND,LONGO,YOUNG              (UCLA,MICH)
KULYUKIN 68 JETP 26 20          KULYUKINA,MESTVIRISHVILI,NEAGU+       (JINR)
KUNZ     68 THESIS (PU 46)      P F KUNZ                         (PRINCETON)
MELHOP   68 PR 172 1613         MELHOP MURTY BOWLES,BURKETT+      (LA JOLLA)
THATCHER 68 PR 174 1674         THATCHER,ABASHIAN,ABRAMS,CARPENTER +   (ILL)

BANNER   69 PR 188 2033         +CRONIN,LIU,PILCHER              (PRINCETON)
    ALSO 68 PRL  21 1103        BANNER,CRONIN,LIU,PILCHER        (PRINCETON)
    ALSO 68 PRL  21 1107        BANNER CRONIN,LIU,PILCHER        (PRINCETON)
BEILLIER 69 PL   30B 202        BEILLIERE,BOUTANG,LIMON               (EPOL)
BENNETT  69 PL   29B 317        +NYGREN,SAAL,STEINBERGER+         (COLU,BNL)
BOHM     69 NP   B9 605         +DARRIULAT,GROSSO,KAFTANOV+           (CERN)
    ALSO 68 PL 27B 321          BOHM,DARRIULAT,GROSSO,KAFTANOV        (CERN)

BOTT-BOD 69 CERN 69-7 329       BOTT-BODENHAUSEN,DE BOUARD,CASSEL+    (CERN)
CENCE    69 PRL 22 1210         CENCE,JONES,PETERSON,STENGER+   (HAWAII,LRL)
EVANS    69 PRL 23 427          EVANS,GOLDEN,MUIR,PEACH+    (EDINBURGH,CERN)
FAISSNER 69 PL   30B 204        +FOETH,STAUDE,TITTEL+       (AACH,CERN,TORI)
FOETH    69 PL 30B 282          +HOLDER,RADERMACHER +     (AACHEN,CERN,TORI)

GAILLARD 69 NC   59A 453        +GALBRAITH,HUSSRI,JANE+  (CERN,RHEL,AACHEN)
    ALSO 67 PRL 18 20           +KRIENEN,GALBRAITH,HUSSRI+ (CERN+RHEL+AACH)
GOBBI    69 PRL 22 685          +GREEN,HAKEL,MOFFETT,ROSEN,GOZ+ (ROCH+RUTG)
LITTENBE 69 PRL 22 654          LITTENBERG,FIELD,PICCIONI,MEHLHOP+    (UCSD)
LONGO    69 PR 181  1808        M J LONGO,K K YOUNG,J A HELLAND (MICH,UCLA)
PACIOTTI 69 THESIS,UCRL 19446   M A PACIOTTI                           (LRL)
SAAL     69 THESIS              H J SAAL                          (COLUMBIA)
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ALBROW    70 PL 33B 516        +ASTON,BARBER,BIRD,ELLISON +      (MCHS+DARE)
ARONSON   70 PRL 25 1057       +EHRLICH,HOFER,JENSEN+         (EFI,ILLC,SLAC)
BARMIN    70 PL 33B 377        +BARYLON,BORISOV,BYSHEVA+          (ITEP,JINR)
BASILE    70 PR D2 78          +CRONIN,THEVENT,TURLAY,ZYLBERAJCH +   (SACL)
BUCHANAN  70 PL 33B 623        +DRICKEY,RUDNICK,SHEPARD+     (SLAC,JHU,UCLA)
    ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71

BUDAGOV   70 PR D2 815         +CUNDY,MYATT,NEZRICK+        (CERN, ORSA,EPOL)
    ALSO 68 PL  28B 215        +CUNDY,MYATT,NEZRICK+         (CERN,ORSA,EPOL)
CHIEN     70 PL 33B 627        C-Y,CHIEN,COX,ETTLINGER +     (JHU+SLAC+UCLA)
    ALSO PRIVATE COMMUNICATION, B. COX, FEB. 71.
CHO       70 PR D1 3031        +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
    ALSO 67 PRL 19 668         HILL,LUERS,ROBINSON,SAKITT +        (BNL,CARN)

CHOLLET   70 PL 31B 658        +GAILLARD,JANE,RATCLIFFE,REPELLIN +    (CERN)
CULLEN    70 PL 32B 523        +DARRIULAT,DEUTSCH,FOETH + (AACH,CERN,TORI)
DARRIULA  70 PL 33B 249        +FERRERO,GROSSO,HOLDER +   (AACH,CERN,TORI)
FAISSNER  70 NC 70A 57         +REITHLER,THONE,GAILLARD+  (AACH,CERN,RHEL)
JENSEN    70 THESIS            D.A. JENSEN                             (EFI)
    ALSO 69 PRL 23 615         JENSEN,ARONSON,EHRLICH,FRYBERGER+ (EFI,ILL)

MARX      70 PL 32B 219        +NYGREN,PEOPLES,STEINBERGE+(COLU,HARV,CERN)
    ALSO 70 THESIS,NEVIS 179   JAY MARX                           (COLUMBIA)
SCRIBANO  70 PL 32B 22A        +MANNELLI,PIERAZZINI,MARX+ (PISA,COLU,HARV)
SMITH     70 PL 32B 133        +WANG,WHATLEY,ZORN,HORNBOSTEL        (UMD,BNL)
WEBBER    70 PR D1 1967        +SOLMITZ,CRAWFORD,ALSTON-GARNJOST      (LRL)
    ALSO 69 UCRL 19226 THESIS B R WEBBER                             (LRL)

BALATS    71 SJNP 13 53        +BEREZIN,VISHNEVSKII,GALANINA+        (ITEP)
BARMIN    71 PL 35B 604        +BARYLOV,VESELOVSKY,DAVIDENKO+        (ITEP)
BISI      71 PL 36B 533        +DARRIULAT,FERRERO,RUBBIA+ (AACH,CERN,TORI)
BURGUN    71 LNC 2 1169        +LESQUOY,MULLER,PAULI+      (SACL+CERN+OSLO)
CARNEGIE  71 PR D4 1           +CESTER,FITCH,STROVINK,SULAK          (PRIN)
CHAN      71 LBL-350  THESIS   J.HIONG-SING CHAN                      (LBL)

CHIEN     71 PL 35B 261        +COX,ETTLINGER,RESVANIS+      (JHU,SLAC,UCLA)
    ALSO 72 DALLY
CHO       71 PR D3 1557        +DRALLE,CANTER,ENGLER,FISK+ (CARN,BNL,CASE)
CLARK     71 PRL 26 1667       +ELIOFF,FIELD,FRISCH,JOHNSON,KERTH+    (LRL)
    ALSO 70 UCRL 19709-THESIS ROLLAND JOHNSON                        (LRL)
    ALSO 71 UCRL 20264-THESIS HENRY FRISCH                           (LRL)
    ALSO 74 SLAC-PUB-1498      R.C.FIELD                             (SLAC)

ENSTROM   71 PR D4 2629        +AKAVIA,COOMBES,DORFAN+          (SLAC,STAN)
    ALSO 70 THESIS (SLAC 125) J E ENSTROM                        (STANFORD)
HILL      71 PR D4 7           +SAKITT,SKJEGGESTAD,CANTER+ (BNL,CARN,CASE)
JAMES     71 PL 35B 265        +MONTANET,PAUL,PAULI+       (CERN+SACL+OSLO)
MEISNER   71 PR D3 59          +MANN,HERTZBACH,KOFLER +     (MASA+BNL+YALE)
PEACH     71 PL 35B 351        +EVANS,MUIR,BUDAGOV,HOPKINS+      (EDIN,CERN)

REPELLIN  71 PL 36B 603        +WOLFF,CHOLLET,GAILLARD,JANE+     (ORSA,CERN)
WEBBER    71 PR D3 64          +SOLMITZ,CRAWFORD,ALSTON-GARNJOST      (LRL)
    ALSO 68 PRL 21 498         WEBBER,SOLMITZ,CRAWFORD,ALSTONGARNJOST(LRL)
    ALSO 69 UCRL 19266-THESIS B R WEBBER                             (LRL)
WOLFF     71 PL 36B 517        +CHOLLET,REPELLIN,GAILLARD+       (ORSA,CERN)

ALBROW    72 NP B44 1          +ASTON,BARBER,BIRD,ELLISON+      (MCHS+DARE)
ASHFORD   72 PL 38B 47         +BROWN,MASEK,MAUNG,MILLER,RUDERMAN+   (UCSD)
BANNER1   72 PRL 28 1597       +CRONIN,HOFFMAN,KNAPP,SHOCHET    (PRINCETON)
BANNER2   72 PRL 29 237        +CRONIN,HOFFMAN,KNAPP,SHOCHET    (PRINCETON)
BARMIN1   72 SJNP 15 636       +DAVIDENKO,DEMIDOV,DOLGOLENKO+        (ITEP)
BARMIN2   72 SJNP 15 638       +BARYLOV,DAVIDENKO,DEMIDOV+           (ITEP)
BURGUN    72 NP B50 194        +LESQUOY,MULLER,PAULI,+     (SACL+CERN+OSLO)
CARNEGIE  72 PR D6 2335        +CESTER,FITCH,STROVINK,SULAK     (PRINCETON)

DALLY     72 PL 41B 647        +INNOCENTI,SEPPI,CHIEN,COX+ (SLAC+JHU+UCLA)
    ALSO 70 CHIEN
    ALSO 71 CHIEN
GRAHAM    72 NC 9A 166         +ABASHIAN,JONES,MANTSCH,ORR+      (ILL+NEAS)
HOLDER    72 PL 40B 141        +RADERMACHER,STAUDE+        (AACH+CERN+TORI)
JAMES     72 NP B49 1          +MONTANET,PAUL,SAETRE+      (CERN+SACL+OSLO)
KRENZ     72 LNC 4 213         +HOPKINS,EVANS,MUIR,PEACH   (AACH+CERN+EDIN)

MANN      72 PR D6 137         +KOFLER,MEISNER,HERTZBACH+   (MASA+BNL+YALE)
MANTSCH   72 NC 9A 160         +ABASHIAN,GRAHAM,JONES,ORR+       (ILL+NEAS)
METCALF   72 PL 40B 703        +NEUHOFER,NIEBERGALL+        (CERN+IPN+WIEN)
NEUHOFER  72 PL 41B 642        +NIEBERGALL,REGLER,STIER+   (CERN+ORSA+VIEN)
PICCIONI  72 PRL 29 1412       +COOMBES,DONALDSON,DORFAN,FRYBERGER+ (SLAC)
    ALSO 74 PR D9 2939         PICCIONI,DONALDSON +        (SLAC+UCSC+COLO)
VOSBURGH  72 PR D6 1834        +DEVLIN,ESTERLING,GOZ,BRYMAN +   (RUTG,MASA)
    ALSO 71 PRL 26 866         VOSBURGH,DEVLIN,ESTERLING,GOZ + (RUTG,MASA)

ALBROW    73 NP B58 22         +ASTON,BARBER,BIRD,ELLISON+      (MCHS+DARE)
ALEXANDE  73 NP B65 301        ALEXANDER,BENARY,BOROWITZ,LANDE+(TELA+HEID)
ANIKINA   73  P1-T539 COM,JINR +BALASHOV,BANNIK +                     (JINR)
BARBIELL  73 PL 43B 529        BARBIELLINI,DARRIULAT,FAINBERG+       (CERN)
BRANDENB  73 PR D8 1978        BRANDENBURG,JOHNSON,LEITH,LOOS+       (SLAC)
CARITHER  73 PRL 31 1025       CARITHERS,NYGREN,GORDON+     (COLU+BNL+CERN)
    ALSO 73 PRL 30 1336        CARITHERS,MODIS,NYGREN,PUN+ (COLU+CERN+NYU)
EVANS     73 PR D7 36          +MUIR,PEACH,BUDAGOV+        (EDINBURGH+CERN)
    ALSO 69 PRL 23 427         EVANS,GOLDEN,MUIR,PEACH+    (EDINBURGH+CERN)

FACKLER   73 PRL 31 847        +FRISCH,MARTIN,SMOOT,SOMPAYRAC         (MIT)
FITCH     73 PRL 31 1524       +HEPP,JENSEN,STROVINK,WEBB       (PRINCETON)
    ALSO 72 COO-3072-13        R.C.WEBB (THESIS)                (PRINCETON)
HART      73 NP B66 317        +HUTTON,FIELD,SHARP,BLACKMORE+   (CAVE+RHEL)
MALLARY   73 PR D7 1953        +BINNIE,GALLIVAN,GOMEZ,PECK,SCIULLI + (CIT)
    ALSO 70 ·    25 1214       SCIULLI,GALLIVAN,BINNIE,GOMEZ +        (CIT)

MCCARTHY  73 PR D7 687         +BREMER,BUDNITZ,ENTIS,GRAVEN,MILLER+   (LRL)
    ALSO 72 PL 42B 291         MCCARTHY,BREMER,BUDNITZ,ENTIS,GRAVEN+  (LBL)
    ALSO 71 THESIS LBL-550     R.L.MCCARTHY                           (LBL)
MESSNER   73 PRL 30 876        +MORSE,NAUENBERG,HITLIN +   (COLO+SLAC+UCSC)
PEACH     73 PL 43B 441        +EVANS,MUIR,HOPKINS,KRENZ   (EDIN+CERN+AACH)
SANDWEIS  73 PRL 30 1002       +SUNDERLAND,TURNER,WILLIS,KELLER (YALE+ANL)
WILLIAMS  73 PRL 31 1521       +LARSEN,LEIPUNER,SAPP,SESSOMS+    (BNL+YALE)

ALBRECHT  74 PL 48B 393        DUBNA+BERLIN+BUDAPEST+PRAGUE+SERPUKH+SOFIA
BISI      74 PL 50B 504        BISI,FERRERO                          (TORI)
BOBISUT   74 LNC 11 646        +HUZITA,MATTIOLI,PUGLIERIN            (PADO)
DONALDS1  74 PRL 33 554        DONALDSON,HITLIN,KENNELLY,KIRKBY +    (SLAC)
    ALSO 74 DONALDSON 3
    ALSO 76 DONALDSON
DONALDS2  74 PR D9 2960        DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
    ALSO 73 PRL 31 337         DONALDSON,FRYBERGER,HITLIN,LIU+ (SLAC+UCSC)
DONALDS3  74 SLAC 184-THESIS   GREGORY J. DONALDSON                  (SLAC)
    ALSO 76 DONALDSON

GEWENIG1  74 PL 48B 483        GEWENIGER,GJESDAL,KAMAE,PRESSER+(CERN+HEID)
    ALSO 74 CERN INT. REPT.    VERA LUTH (THESIS-INT. REPT. 74-4)  (HEID)
GEWENIG2  74 PL 52B 487        GEWENIGER,GJESDAL,PRESSER +      (CERN+HEID)
    ALSO 74 PL 52B 119         GJESDAL,PRESSER,STEFFEN +        (CERN+HEID)
GEWENIG3  74 PL 52B 108        GEWENIGER,GJESDAL,PRESSER +      (CERN+HEID)
GJESDAL   74 PL 52B 113        +PRESSER,KAMAE,STEFFEN+          (CERN+HEID)

MESSNER   74 PRL 33 1458       +FRANKLIN,MORSE,NAUENBERG+ (COLO+SLAC+UCSC)
NIEBERGA  74 PL 49B 103        NIEBERGALL,REGLER,STIER +   (CERN+ORSA+VIEN)
WANG      74 PR D9 540         +SMITH,WHATLEY,ZORN,HORNBOSTEL       (UMD+BNL)
WILLIAMS  74 PRL 33 240        +LARSEN,LEIPUNER,SAPP,SESSOMS +   (BNL+YALE)
WOO       74 LNC 10 38         +BUCHANAN,PEPPER                       (UCLA)

BALDOCEO  75 NC 25A 688        BALDO-CEOLIN,BOBISUT,CALIMANI+   (PADO+WISC)
BLUMENTH  75 PRL 34 164        BLUMENTHAL,FRANKEL,NAGY +   (PENN+CHIC+TEMP)
BUCHANAN  75 PR D11 457        +DRICKEY,PEPPER,RUDNICK +    (UCLA+SLAC+JHU)
CARITHER  75 PRL 34 1244       CARITHERS,MODIS,NYGREN,PUN +      (COLU+NYU)
SMITH     75 UCSD THESIS-UNPUB JAMES G. SMITH                        (UCSD)

BIRULEV   76 SJNP 24, 178      +VESTERGOMBI,VOVENKO,VOTRUBA,GENCHEV+(JINR)
COOMBES   76 PRL 37 249        +FLEXER,HALL,KENNELLY,KIRKBY +    (STAN+NYU)
DONALDSO  76 PR D14 2839       DONALDSON,HITLIN,KENNELLY,KIRKBY,LIU+(SLAC)
    ALSO 74 SLAC 184-THESIS    GREGORY J. DONALDSON                  (SLAC)
FUKUSHIM  76 PRL 36 348        FUKUSHIMA,JENSEN,SURKO,THALER+  (PRIN+MASA)
GJESDAL   76 NP B109 118       +KAMAE,PRESSER,STEFFEN +         (CERN+HEID)
REY       76 PR D13 1161       +CENCE,JONES,PARKER +        (NDAM+HAWA+LBL)
    ALSO 69 CENCE

CHO       77 PR D15 587        +DERRICK,LISSAUER,MILLER,ENGLER+ (ANL+CARN)
CLARK     77 PR D15 553        +FIELD,HOLLEY,JOHNSON,KERTH,SAH,SHEN   (LBL)
    ALSO 75 LBL-4275 THESIS    GILBERT SHEN                           (LBL)
DEVOE     77 PR D16 565        +CRONIN,FRISCH,GROSSO-PILCHER+     (EFI+ANL)
DZHORDZH  77 SJNP 26 478       DZHORDZHADZE,KEKELIDZE,KRIVOKHIZHIN+ (JINR)
PEACH     77 NP B127 399       +CAMERON +         (BGNA+EDIN+GLAS+PISA+RHEL)

ENGLER    78 PR D18 623        +KEYES,KRAEMER,TANAKA,CHO+        (CARN+ANL)
HILL      78 PL 73B 483        +SAKITT,SNAPE,STEVENS+       (BNL+SLAC+SBER)
BIRULEV   79 SJNP 29 778       +VESTERGOMBI,GVAKHARIYA,GENCHEV+      (JINR)
CHRISTE1  79 PRL 43 1209       CHRISTENSON,GOLDMAN,HUMMEL,ROTH+       (NYU)
CHRISTE2  79 PRL 43 1212       CHRISTENSON,GOLDMAN,HUMMEL,ROTH+       (NYU)
HILL      79 NP B153 39        +SAKITT,SNAPE,STEVENS+       (BNL+SLAC+SBER)
SCHMIDT   79 PRL 43 556        +BLATT,CAMPBELL,GRANNAN+          (YALE+BNL)
SHOCHET   79 PR D19 1965       +LINSAY,GROSSO-PILCHER,FRISCH+     (EFI+ANL)
    ALSO 77 PRL 39 59          SHOCHET,LINSAY,GROSSO-PILCHER,+    (EFI+ANL)

CARROLL1  80 PRL 44 525        +CHIANG,KYCIA,LI,LITTENBERG,MARX+(BNL+ROCH)
CARROLL2  80 PRL 44 529        +CHIANG,KYCIA,LI,LITTENBERG,MARX+(BNL+ROCH)
CARROLL3  80 PL 96B 407        +CHIANG,KYCIA,LI,LITTENBERG,MARX+(BNL+ROCH)
CHO       80 PR D22 2688       +DERRICK,MILLER,SCHLERETH,ENGLER+(ANL+CARN)
MORSE     80 PR D21 1750       +LEIPUNER,LARSEN,SCHMIDT,BLATT+   (BNL+YALE)
BIRULEV   81 NP B182 1         +DZHORDZHADZE,GENCHEV,GRIGALASHVILI+ (JINR)
    ALSO 80 SJNP 31 622        BIRULEV,VESTERGOMBI,GENCHEV +         (JINR)

                               PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE  62 PRL 9 69          G ALEXANDER,S ALMEIDA,F CRAWFORD       (LRL)
JOVANOVI  63 BNL CONF 42       JOVANOVIC,FISCHER,BURRIS +   (BNL+MARYLAND)
STERN     64 PRL 12 459        STERN,BINFORD,LIND,ANDERSON +     (WISC+LRL)
BEHR      65 ARGONNE CONF 59   BEHR,BRISSON,BELLOTTI+       (EPOL,MILA,PADO)
MESTVIRI  65 JINR P 2449       MESTVIRISHVILI,NYAGU,PETROV,PUSAKOV+ (JINR)
TRILLING  65 UCRL 16473        GEORGE H TRILLING                      (LRL)
    UPDATED FROM 1965 ARGONNE CONF., PAGE 115.

GINSBERG  67 PR 162  1570      EDWARD S GINSBERG              (U. MASS BOSTON)
RUBBIA    67 PL   24B  531     C.RUBBIA,J.STEINBERGER           (CERN+COLU)
  ALSO 1  66 PL   20   207     ALFF-STEINBERGER,HEUER,KLEINKNECHT+   (CERN)
  ALSO 2  66 PL   21   595     ALFF-STEINBERGER,HEUER,KLEINKNECHT+   (CERN)
  ALSO 3  66 PL   23   167     C.RUBBIA,J.STEINBERGER           (CERN+COLU)
SCHMIDT   67 NEVIS 160(THESIS) P. SCHMIDT                        (COLUMBIA)

CRONIN    68 VIENNA CONF P.281 CRONIN,RAPPORTEURS TALK          (PRINCETON)
BECHERRA  70 PR D1 1452        T BECHERRAWY                          (ROCH)
GINSBERG  70 PR D1 229         E S GINSBERG                      (IIT HAIFA)
HEUSSE    70 LNC  3 449        +AUBERT,PASCAUD,VIALLE               (ORSAY)
GINSBERG  73 PR D8 3887        E S GINSBERG, J SMITH             (MIT+STON)
KLEINKNE  76 ARNS 26 1         K. KLEINKNECHT                        (DORT)

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                  31  CHARGED D(1869,JP=0-)  I=1/2

     FOR A RECENT REVIEW SEE TRILLING 81

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                  31  CHARGED D MASS (MEV)

M         50(1876.)     (15.)               PERUZZI   76 SMAG +- K-+PI+-PI+-        1/77
M           (1874.)     (5.)                GOLDHABER 77 SMAG +- DD,D+ RECOIL SPC 12/77
M     P     (1868.3)    (0.9)               PERUZZI   77 SMAG +- E+E- 3.77GEV ECM 12/77
M           (1874.)     (11.)               PICCOLO   77 SMAG +- E+E-4.03,4.41ECM  1/78
M     P     (1868.4)    (0.5)               SCHINDLER 81 SMK2 +- E+E- 3.77GEV ECM  1/82*
M      P     1869.4      0.6                TRILLING  81 RVUE +- E+E- 3.77GEV ECM  1/82*
M      P  PERUZZI 77 AND SCHINDLER 81 ERRORS DO NOT INCLUDE THE 0.13 PERCENT       1/82*
M      P  UNCERTAINTY IN THE ABSOLUTE SPEAR ENERGY CALIBRATION.  TRILLING 81       1/82*
M      P  USES THE HIGH PRECISION PSI AND PSI-PRIME MEASUREMENTS OF                1/82*
M      P  ZHOLENTZ 80 TO DETERMINE THIS UNCERTAINTY AND COMBINES THE               1/82*
M      P  PERUZZI 77 AND SCHINDLER 81 RESULTS TO OBTAIN THE VALUE QUOTED.          1/82*

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                  31  CHARGED D MEAN LIFE   (UNITS 10**-13 SEC)

T              (9.)    OR LESS  CL=.90   ARHENISE  79 HYBR NEU P -->DIMUONS +   1/80
T          4   2.5      2.2       1.1    ALLASIA   80 EMUL NEU WIDEBAND        12/81*
T     A       (10.4)   (3.9)     (2.9)   BACINO    80 DLCO E+E- 3.77 GEV ECM    1/81*
T          5   10.3     10.5      4.1    USHIDA    80 EMUL NEU WIDEBAND        12/81*
T     B    8  (4.4)                      ADAMOVICH 81 EMUL GAM NUC-->           1/82*
T     C    1  (2.2)    (2.3)     (1.1)   BALLAGH   81 HYBR FNAL 15FT, NU HE-H2  1/82*
T      D   9   8.2      4.5       2.5    ABE       82 HYBR SLAC GAM P 19.5 GEV  2/82*
T      E  70   9.5      3.1       1.9    ALBINI    82 SILI CERN GAM SI          2/82*
T     F    7  (6.5)    (4.7)     (2.1)   REUCROFT  82 HYBR PI- P, P P           4/82*
T     A   USES THEORETICAL RATE D TO (K E NEU)=2.4*10**11 SEC**-1 .             1/81*
T     B   ADAMOVICH 81 VALUE ESTIMATED WITHOUT INFORMATION ON D MOMENTUM .      1/82*
T     C   BALLAGH 81 VALUE QUOTED HERE ASSUMES THAT ALL DILEPTON EVENTS         1/82*
T     C   CONTAIN DD OR D+, EACH WITH EQUAL NUMBERS OF SEMILEPTONIC DECAYS.     1/82*
T      D  ABE 82 CANNOT RULE OUT F+- INTERP., OR ON 2 EVTS. LAMBDA/C+ INTERP.   2/82*
T      E  ALBINI 82 ASSUMES D MOMENTUM IS 1/2 BEAM MOMENTUM.                    2/82*
T     F   CERN NA16 (LEBC-EHS) EXPT.  PRESENTED AT MORIOND CONF. 82.            4/82*
T            . . . . . . . . . .
T     AVG      9.1      2.2       1.5     AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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              31  CHARGED D PARTIAL DECAY MODES

                                                        DECAY MASSES
P1    D+ INTO K- PI+ PI+                                493+ 139+ 139
P2    D+ INTO KOBAR PI+                                 497+ 139
P3    D+ INTO PI+ PI+ PI-                               139+ 139+ 139
P4    D+ INTO PI+ K+ K-                                 139+ 493+ 493
P5    D+ INTO K+ PI+ PI-                                493+ 139+ 139
P6    D+ INTO E+ NUE                                     .5+   0
P7    D+ INTO E+ ANYTHING
P8    D+ INTO K- ANYTHING
P9    D+ INTO KOBAR ANYTHING + KO ANYTHING
P10   D+ INTO K+ ANYTHING
P11   D+ INTO K*(892)OBAR PI+                           891+ 139
P12   D+ INTO KOBAR PI+ PIO                             497+ 139+ 134
P13   D+ INTO KOBAR PI+ PI+ PI-                         497+ 139+ 139+ 139
P14   D+ INTO K- PI+ PI+ PI+ PI-                        493+ 139+ 139+ 139+
P15   D+ INTO PI+ PIO                                   139+ 134
P16   D+ INTO KOBAR K+                                  497+ 493
P18   D+ INTO KOBAR RHO+                                497+ 769
P19   D+ INTO ETA ANYTHING

      D- MODES ARE CHARGE CONJUGATES OF THE ABOVE MODES

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              31  CHARGED D BRANCHING RATIOS

R1    D+ INTO (K- PI+ PI+)/TOTAL                        (P1)
R1      85    0.039     0.010        PERUZZI    77 SMAG    E+E- 3.77GEV ECM 12/77
R1     239    0.063     0.015        SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM    1/82*
R1
R1  AVG       0.046     0.011   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R2    D+ INTO (KOBAR PI+)/TOTAL                         (P2)
R2      17    0.015     0.006        PERUZZI    77 SMAG    E+E- 3.77GEV ECM 12/77
R2      36    0.023     0.007        SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM    1/82*
R2
R2  AVG       0.0184    0.0046  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3    D+ INTO (KOBAR PI+)/(K- PI+ PI+)                  (P2)/(P1)
R3    P         0.45  OR LESS  CL=.90    PICCOLO    77 SMAG +- E+E- 4.03GEV ECM 12/77
R3    P  OBTAINED FROM SIGMA*BR VALUES OF TABLE I.                              12/77

R4    D+ INTO (PI+ PI+ PI-)/(K- PI+ PI+)                (P3)/(P1)
R4    P         0.08  OR LESS  CL=.90    PICCOLO    77 SMAG +- E+E- 4.03GEV ECM 12/77
R4           (0.084)OR LESS  CL=.90    SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM    1/82*
R4    P  OBTAINED FROM SIGMA*BR VALUES OF TABLE I.                              12/77

R5    D+ INTO (PI+ K+ K-)/(K- PI+ PI+)                  (P4)/(P1)
R5    P        (0.15) OR LESS  CL=.90    PICCOLO    77 SMAG +- E+E- 4.03GEV ECM 12/77
R5               0.14  OR LESS  CL=.90    SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM    1/82*
R5    P  OBTAINED FROM SIGMA*BR VALUES OF TABLE I.                              12/77

R6    D+ INTO (K+ PI+ PI-)/(K- PI+ PI+)                 (P5)/(P1)
R6    P         0.05  OR LESS  CL=.90    PICCOLO    77 SMAG +- E+E- 4.03GEV ECM 12/77
R6    P  OBTAINED FROM SIGMA*BR VALUES OF TABLE I.                              12/77

R7    (D+ INTO E+ NUE)/(D+ INTO E+ ANYTHING + DO INTO E+ ANYTHING)
R7         0.10  OR LESS  CL=.90    BRANDELIK 77 DASP E+E- 3.99-4.08 GEV   12/77

R8    D+ AND DO INTO (E+ ANYTHING)/(TOTAL D+ AND DO)
R8    MEASURED AT THE PSI(3772).  THIS GIVES A WEIGHTED AVERAGE OF              2/82*
R8    D+ (44 PCT.) AND DO (56 PCT.) BRANCHING FRACTIONS.                        2/82*
R8         0.072      0.028          FELLER     78 SMAG E+E- 3.772 GEV ECM      2/78
R8        (0.11)     (0.02)          BACINO     78 DLCO REPL. BY BACINO 79      3/78
R8    A   (0.08)     (0.015)         BACINO     79 DLCO E+E- 3.772 GEV ECM      4/82*
R8    A  NOT INDEPENDENT OF BACINO 80 R13(D+) AND R13(DO).                      4/82*

R9    D+ INTO (K- ANYTHING)                             (P8)                   1/79
R9      3     0.10      0.07         VUILLEMIN 78 SMAG E+E- 3.772 GEV ECM      1/79
R9     26     0.19      0.05         SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*
R9
R9  AVG       0.160     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10   D+ INTO (KOBAR ANYTHING + KO ANYTHING)/TOTAL     (P9)                   1/79
R10     3     0.39      0.29         VUILLEMIN 78 SMAG E+E- 3.772 GEV ECM      1/79
R10    15     0.52      0.18         SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*
R10
R10 AVG       0.48      0.15    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11   D+ INTO (K+ ANYTHING)/TOTAL                       (P10)
R11     2     0.06      0.06         VUILLEMIN 78 SMAG E+E- 3.772 GEV ECM      1/79
R11    12     0.06      0.04         SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*
R11
R11 AVG       0.060     0.033   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12   D+ INTO (K*(892)OBAR PI+)/TOTAL                   (P11)
R12    92 EVENTS SEEN                ORIJARD    79 SFM  +  P P,ECM=53 GEV      1/79
R12        0.037 OR LESS  CL=.90     SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R13   D+ INTO (E+ ANYTHING)/TOTAL                       (P7)
R13       (0.220)  (0.044)  (0.022)BACINO     80 DLCO E+E- 3.77 GEV ECM       4/82*
R13    23  (0.168)  (0.064)          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      4/82*
R13         0.17     0.04    0.03  TRILLING   81 RVUE BEST ESTIMATE            4/82*

R14   D+ INTO (KOBAR PI+ PIO)/TOTAL                     (P12)                  1/82*
R14    10     0.129     0.084        SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R15   D+ INTO (KOBAR PI+ PI+ PI-)/TOTAL                 (P13)                  1/82*
R15    21     0.084     0.035        SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R16   D+ INTO (K- PI+ PI+ PI+ PI-)/TOTAL                (P14)                  1/82*
R16         0.041 OR LESS  CL=.90    SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R17   D+ INTO (KOBAR RHO+)/TOTAL                        (P18)                  1/82*
R17 S       (0.016)OR MORE  CL=.90    SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*
R17 S  SCHINDLER 81 USE TRIANGLE RELATION FOR AMPLITUDES DO -->KOBAR RHOO,     1/82*
R17 S  DO -->K- RHO+ AND D+ -->KOBAR RHO+, AND THEIR D+/DO LIFETIME RATIO.     1/82*

R18   D+ INTO (PI+ PIO)/(KOBAR PI+)                     (P15)/(P2)             1/82*
R18         0.30  OR LESS  CL=.90    SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R19   D+ INTO (KOBAR K+)/(KOBAR PI+)                    (P16)/(P2)             1/82*
R19     6     0.25      0.15         SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM      1/82*

R21   D+ AND DO INTO (ETA ANYTHING)/(TOTAL D+ AND DO)
R21   B      (0.02) OR LESS           BRANDELIK 79 DASP    E+E- ECM=4.03GEV    1/82*
R21           0.13  OR LESS           PARTRIDGE 81 CBAL    E+E- ECM=3.77GEV    1/82*
R21   B BRANDELIK 79 RESULT BASED ON ABSENCE OF ETA SIGNAL AT 4.03 GEV.         1/82*
R21   B PARTRIDGE 81 OBSERVE SUBSTANTIALLY HIGHER ETA CROSS SECTION AT 4.03.    1/82*

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                              REFERENCES FOR CHARGED D

GOLDHABE 76 PRL 37 255          GOLDHABER,PIERRE,ABRAMS,ALAM+     (LBL+SLAC)
PERUZZI  76 PRL 37 569          +PICCOLO,FELDMAN,NGUYEN,WISS+     (SLAC+LBL)
WISS     76 PRL 37 1531         +GOLDHABER,ABRAMS,ALAM,BOYARSKI+  (LBL+SLAC)

BRANDELI 77 PL 70B 387          BRANDELIK +      (AACH+DESY+HAMB+MPIM+TOKY)
GOLDHABE 77 PL 69B 503          GOLDHABER,WISS,ABRAMS,ALAM +      (LBL+SLAC)
PERUZZI  77 PRL 39 1301         +PICCOLO,FELDMAN+       (SLAC+LBL+NWES+HAWA)
PICCOLO  77 PL 70B 260          +PERUZZI,LUTH,NGUYEN,WISS,ABRAMS+(SLAC+LBL)

BACINO   78 PRL 40 671          +BAUMGARTEN,BIRKWOOD +        (SLAC+UCLA+UCI)
FELLER   78 PRL 40 274          +LITKE,MADARAS,RONAN+   (LBL+SLAC+NWES+HAWA)
VUILLEMI 78 PRL 41 1149         VUILLEMIN,FELDMAN +     (LBL+SLAC+NWES+HAWA)

ARMENISE 79 PL 86B 115          +ERRIQUEZ+          (BARI+CERN+EPOL+MILA+ORSA)
BACINO   79 PRL 43 1073         +FERGUSON,NODULMAN+        (UCLA+SLAC+UCI+STON)
BRANDELI 79 PL 80B 412          BRANDELIK+          (AACH+DESY+HAMB+MPIM+TOKY)
ORIJARD  79 PL 81B 250          +FISCHER,GEIST+          (CERN+CDEF+HEID+KARL)

ALLASIA  80 NP B176 13           (ANKA+LIBH+CERN+DJUC+LOUC+KEYN+PISA+ROMA+)
BACINO   80 PRL 45 329          +FERGUSON+               (UCLA+SLAC+STAN+UCI+STON)
USHIDA   80 PRL 45 1053          (AICH+FNAL+KOBE+SEOU+MCGI+NAGO+OSU+OKAY+)
ZHOLENTZ 80 PL 96B 214          +KURDADZE,LELCHUK,MISHNEV,NIKITIN+    (NOVO)
    ALSO 81 YAD.PHYS.34 1471    ZHOLENTZ +                            (NOVO)

ADAMOVIC 81 PL 99B 271          ADAMOVICH+(PHOTON-EMUL,OMEGA-PHOTON COLL..)
BALLAGH  81 PR D24 7            +BINGHAM+      (LBL+UCB+FNAL+HAWA+WASH+WISC)
    ALSO 80 PL 89B 423          BALLAGH +      (LBL+UCB+FNAL+HAWA+WASH+WISC)
PARTRIDG 81 PRL 47 760          PARTRIDGE,PECK+     (CIT+HARV+PRIN+STAN+SLAC)
SCHINDLE 81 PR D24 78           SCHINDLER,ALAM,BOYARSKY +             (SLAC+LBL)
ABE      82  PRL (TO BE PUBL.)(SLAC HYBRID FACILITY PHOTON COLLABORATION)
ALBINI   82 PL 110B 339         ALBINI+        (FRAS+MILA+PISA+ROMA+TORI+TRST)
REUCROFT 82  CERN/EP/0903R/SR S.REUCROFT (MORIOND CONF) (LEBC-EHS COLLAB)

                                   REVIEWS

BARBAROG 78 LBL-8537            A.BARBARO-GALTIERI (ERICE 1978)           (LBL)
WOJCICKI 78 SLAC-PUB-2232       S.WOJCICKI (SLAC SUMMER INST.1978)       (SLAC)
KIRKBY   79 SLAC-PUB-2419       J.KIRKBY (LEPTON CONF. BATAVIA, 1979)(SLAC)
TRILLING 81 PRPL 75 57          G.H.TRILLING                          (LBL+UCB)

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              32  NEUTRAL D(1865,JP=0-)  I=1/2

     FOR A RECENT REVIEW SEE TRILLING 81

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              32  NEUTRAL D MASS (MEV)

M          234(1865.)     (15.)          GOLDHABER 76 SMAG    K PI AND K 3PI     1/77
M             (1863.)      (3.)          GOLDHABER 77 SMAG    DO,D+ RECOIL SPC  12/77
M      P      (1863.3)     (0.9)         PERUZZI   77 SMAG    E+E- 3.77GEV ECM  12/77
M             (1868.)     (11.)          PICCOLO   77 SMAG    E+E-4.03,4.41EC    1/78
M           64(1850.)     (15.)          BALTAY    78 HBC     NEU NUCL,KOPIPI    1/79
M      A    94(1854.)      (6.)          ATIYA     79 SPEC GAM NUC-->DO DOBAR  12/79
M            1(1866.)      (9.)          ADAMOVICH 80 EMUL GAMMA NUC-->DOBAR +  2/80
M          238(1863.0)     (2.5)         ASTON     80 OMEG GAMMA P-->DOBAR     12/81*
M      A   143(1860.)      (2.)          AVERY     80 SPEC    GAMMA NUC-->D*+  12/81*
M      A    35(1869.)      (4.)          AVERY     80 SPEC    GAMMA NUC-->D*+  12/81*
M            1(1847.)      (7.)          FIORINO   81 EMUL GAMMA NUC-->DOBAR +  1/82*
M      P      (1863.8)     (0.5)         SCHINDLER 81 SMK2    E+E- 3.77GEV ECM  1/82*
M       P      1864.7       0.6          TRILLING  81 RVUE +- E+E- 3.77GEV ECM  1/82*
M       P  PERUZZI 77 AND SCHINDLER 81 ERRORS DO NOT INCLUDE THE 0.13 PERCENT    1/82*
M       P  UNCERTAINTY IN THE ABSOLUTE SPEAR ENERGY CALIBRATION.  TRILLING 81    1/82*
M       P  USES THE HIGH PRECISION PSI AND PSI-PRIME MEASUREMENTS OF             1/82*
M       P  ZHOLENTZ 80 TO DETERMINE THIS UNCERTAINTY AND COMBINES THE            1/82*
M       P  PERUZZI 77 AND SCHINDLER 81 RESULTS TO OBTAIN THE VALUE QUOTED.       1/82*
M       A  ERROR DOES NOT INCLUDE POSSIBLE SYSTEMATIC MASS SCALE SHIFT.          1/81*
M       A  ESTIMATED TO BE LESS THAN 5 MEV.                                      1/81*

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              32  (D+-) - (DO) MASS DIFFERENCE (MEV)

DM    A         5.0        0.8            PERUZZI   77 SMAG +- E+E- 3.77GEV ECM  3/78
DM    A         4.7        0.3            SCHINDLER 81 SMK2 +- E+E- 3.77GEV ECM  1/82*
DM    A  NOT INDEPENDENT OF D+- AND DO MASS MEASUREMENTS.                        3/78
DM
DM  AVG         4.74       0.28     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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Note on the D^0 Lifetime

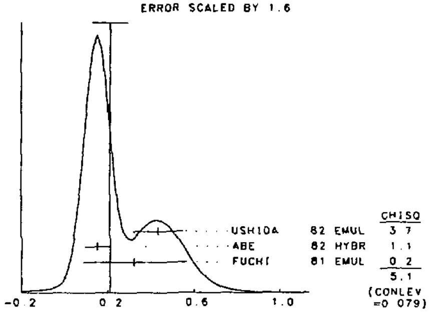
The D^0 lifetime is a subject of uncertainty, with the problems of inconsistent experimental results not yet resolved. Earlier results, primarily using emulsion targets, reported lifetimes of the order of 1×10^{-13} sec or less. The e^+e^- colliding-beams results indicate a charged/neutral D lifetime ratio of 3 or possibly much larger (subject to some theoretical uncertainties). Many of these results are characterized by relatively large quoted errors, and the most recent experiments suggest that the D^0 lifetime lies in the range $2\text{-}7\times10^{-13}$ sec. The observation of individual events with proper lifetimes of the order of

20×10^{-13} sec suggests that the mean life may indeed be longer than first thought, perhaps comparable to the $D^{\pm}$ lifetime. The possibility of there being 2 lifetimes in the manner of the K_S^0-K_L^0, or of there being more than one type of massive weakly-decaying neutral particle, has been discussed, but there is no solid evidence.

```
                32  NEUTRAL D MEAN LIFE   (UNITS 10**-13 SEC)

T             (8.0)   OR LESS  CL=.90   ARMENISE  79 HYBR NEU P -->DIMUONS +    1/80
T          1  (0.226)                   ADAMOVICH 80 EMUL INCL IN ADAMOVICH81   2/80
T    E     3  (0.53)   (0.57)   (0.25)  ALLASIA   80 EMUL NEU WIDEBAND         12/81*
T    C        (2.1)   OR LESS  CL=.95   BACINO    80 DLCO E+E- 3.77 GEV ECM     1/81*
T    G     7  (1.00)   (0.52)   (0.31)  USHIDA    80 EMUL INCL. IN USHIDA 82   12/81*
T    F     3  (0.58)   (0.8)    (0.2)   ADAMOVICH 81 EMUL CERN-SPS GAMMA NUCL   1/82*
T    H     1  (0.14)                    ADAMOVI2  81 EMUL CERN-SPS GAMMA NUCL   4/82*
T    H     1  (3.4)   OR  (7.5)         ADAMOVI2  81 EMUL CERN-SPS GAMMA NUCL   4/82*
T    B     2  (2.8)    (2.2)    (1.3)   BALLAGH   81 HYBR FNAL 15FT, NU NE-H2   1/82*
T    A     1  (2.1)                     ADEVA     81 HYBR LEBC CERN-SPS PI- P   1/82*
T    A     1  (5.9)                     ADEVA     81 HYBR LEBC CERN-SPS PI- P   1/82*
T          5   3.1      2.0      1.6    FUCHI     81 EMUL CERN-SPS PI- NUC      1/82*
T         11   6.7      3.5      2.0    ABE       82 HYBR SLAC GAM P 19.5 GEV   2/82*
T    O     8  (2.1)    (1.3)    (0.7)   REUCROFT  82 HYBR PI- P, P P            4/82*
T     G   16   2.3      0.8      0.5    USHIDA    82 EMUL FNAL NU,ANU WIDEBND   2/82*
T    E    ALLASIA 80 ASSUMES NO LONG-LENGTH LOSSES.  VISIBILITY PROBLEMS IN     4/82*
T    E    THE EMUL.                                                             4/82*
T    C    USES THEORETICAL RATE D TO (K E NEU)=1.4*10**11 SEC**-1 .             1/81*
T    F    ADAMOVICH 81 ASSUMES NO LONG-LENGTH LOSSES.                           4/82*
T    H    ADAMOVICH2 81 HAS NO CORRECTION FOR DETECTION EFFICIENCY.             4/82*
T    B    BALLAGH 81 VALUE QUOTED HERE ASSUMES THAT ALL DILEPTON EVENTS         1/82*
T    B    CONTAIN DO OR D+, EACH WITH EQUAL NUMBERS OF SEMILEPTONIC DECAYS.     1/82*
T    A    ADEVA 81 FIRST AND SECOND VALUES ARE PROPER LIFETIMES OF DO AND ADO   1/82*
T    A    FROM SINGLE EVENT.  DETECTION EFFICIENCY LOW FOR LIFETIMES 10**-13    1/82*
T    A    SEC OR LESS.                                                          1/82*
T    D    CERN NA16 (LEBC-EHS) EXPT.  PRESENTED AT MORIOND CONF. 82.            4/82*
T     G   USHIDA 82 HAVE 3 SEMI-LEPTONIC DECAYS NOT INCLUDED IN THIS NUMBER.    4/82*
T     G   BUT BELIEVED TO HAVE MUCH LONGER LIFETIMES.  SUPERCEDES USHIDA 80.    4/82*
T             . . . . . . . . . .
T    AVG       4.8      2.4      1.5    AVERAGE (ERROR INCL. SCALE FACTOR OF 1.6)
                        (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.210 ± 0.080
ERROR SCALED BY 1.6



NEUTRAL D DECAY RATE (UNITS 10**13SEC-1)

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                32  (CHARGED D)/(NEUTRAL D) MEAN LIFE RATIO

TR       FROM RATIO OF D+ TO DO SEMILEPTONIC BRANCHING FRACTIONS
TR          (4.3)   OR MORE  CL=.95   BACINO    80 DLCO E+E- 3.77 GEV ECM    1/82*
TR          (3.1)    (4.6)    (1.4)   SCHINDLER 81 SMK2 E+E- 3.77 GEV ECM    1/82*
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                32  NEUTRAL D PARTIAL DECAY MODES

                                                        DECAY MASSES
P1    DO INTO K- PI+                                    493+ 139
P2    DO INTO K- PI+ PI+ PI-                            493+ 139+ 139+ 139
P3    DO INTO KOBAR PI+ PI-                             497+ 139+ 139
P4    DO INTO KOBAR PI+ PI- PI+ PI-                     497+ 139+ 139+ 139+
P5    DO INTO PI+ PI-                                   139+ 139
P6    DO INTO K+ PI- (VIA DOBAR)                        493+ 139
P7    DO INTO K+ K-                                     493+ 493
P8    DO INTO K- PI+ PIO                                493+ 139+ 134
P9    DO INTO KOBAR PIO                                 497+ 134
P10   DO INTO E+ ANYTHING
P11   DO INTO K- ANYTHING
P12   DO INTO K+ ANYTHING
P13   DO INTO KOBAR ANYTHING + KO ANYTHING
P14   DO INTO K*(892)- PI+                              891+ 139
P15   DO INTO K*(892)O PIO                              891+ 134
P16   DO INTO K- RHO+                                   493+ 769
P17   DO INTO KOBAR RHOO                                497+ 769
P18   DO INTO PI- PI- PI+ PI+                           139+ 139+ 139+ 139
P19   DO INTO UNFITTED MODES (KEEPS FIT PGM. HAPPY)
P20   DO INTO K- PI+ PIO PIO                            493+ 139+ 134+ 134
P21   DO INTO ETA ANYTHING (SEE CHARGED D SECTION R21)

      DOBAR MODES ARE CHARGE CONJUGATES OF ABOVE MODES
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1        P 2        P 3        P 5        P 7       P19
P 1  .0240+-.0039
P 2   .2151   .0453+-.0126
P 3   .1745     .0375   .0421+-.0077
P 5   .3354     .0721     .0585   .0008+-.0004
P 7   .5204     .1120     .0908     .1745   .0027+-.0008
P19  -.5078    -.8234    -.5344    -.1906    -.3011   .8850+-.0168
```

```
                32  NEUTRAL D BRANCHING RATIOS

R1      DO INTO (K- PI+)/TOTAL                           (P1)
R1      130    0.022     0.006          PERUZZI   77 SMAG   E+E- 3.77GEV ECM 12/77
R1      263    0.030     0.006          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*
R1            . . . . . . . . . .
R1  AVG        0.0260    0.0042  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT        0.0240    0.0039 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      DO INTO (K- PI+ PI+ PI-)/TOTAL                   (P2)
R2       44    0.032     0.011          PERUZZI   77 SMAG   E+E- 3.77GEV ECM 12/77
R2      185    0.085     0.021          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*
R2            . . . . . . . . . .
R2  AVG        0.043     0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)
R2  FIT        0.045     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R3      DO INTO (KOBAR PI+ PI-)/TOTAL                    (P3)
R3       28    0.040     0.013          PERUZZI   77 SMAG   E+E- 3.77GEV ECM 12/77
R3       32    0.038     0.012          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*
R3            . . . . . . . . . .
R3  AVG        0.0389    0.0088  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT        0.0421    0.0077 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      DO INTO (K- PI+ PI+ PI-)/(K- PI+)                (P2)/(P1)
R4    P 214    2.2       0.8            PICCOLO   77 SMAG   E+E-4.03,4.41ECM 12/77
R4    P THIS CHANNEL DOMINATED BY K- PI+ RHOO (85+-15 PERCENT).                12/77
R4    P K* PI+ PI- AND K- A2+ CONSISTENT WITH 0, K* RHOO FRAC IS 0.1+-0.1 .    12/77
R4            . . . . . . . . . .
R4  FIT        1.89      0.55   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R5      DO INTO (KOBAR PI+ PI-)/(K- PI+)                 (P3)/(P1)
R5      116    2.8       1.0            PICCOLO   77 SMAG   E+E-4.03,4.41ECM 12/77
R5       35    1.7       0.8            AVERY     80 SPEC   GAMMA NUC-->D*+  12/81*
R5            . . . . . . . . . .
R5  AVG        2.13      0.62    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT        1.75      0.39   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      DO INTO (PI+ PI-)/(K- PI+)                       (P5)/(P1)
R6             0.07   OR LESS  CL=.90   PICCOLO   77 SMAG   E+E- 4.03 GEVECM 12/77
R6             0.033     0.015          ABRAMS    79 SMK2   E+E- 3.77GEV ECM 12/79
R6            . . . . . . . . . .
R6  FIT        0.033     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      DO INTO (K+ K-)/(K- PI+)                         (P7)/(P1)
R7             0.07   OR LESS  CL=.90   PICCOLO   77 SMAG   E+E- 4.03GEV ECM 12/77
R7             0.113     0.030          ABRAMS    79 SMK2   E+E- 3.77GEV ECM 12/79
R7            . . . . . . . . . .
R7  FIT        0.113     0.030  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      DO INTO (K+ PI- VIA DOBAR)/(K- PI+ + K+ PI-)     (P6)/(P1+P6)
R8       THIS IS THE DO-DOBAR MIXING LIMIT
R8             0.16   OR LESS  CL=.90   FELDMAN   77 SMAG    D*+ TO DO PI+     3/77
R8            (0.18)  OR LESS  CL=.90   GOLDHABER 77 SMAG                     12/77

R9      DO INTO (K- PI+ PIO)/TOTAL                       (P8)
R9        7    0.12      0.06           SCHARRE   78 SMAG    E+E- 3.77 GEV     1/78
R9       37    0.085     0.032          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM   1/82*
R9            . . . . . . . . . .
R9  AVG        0.093     0.027   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     DO INTO (KOBAR PIO)/TOTAL                        (P9)
R10           (0.06)  OR LESS  CL=.90   SCHARRE   78 SMAG    E+E- 3.77 GEV     1/78
R10       8    0.022     0.011          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM   1/82*

R12     DO INTO (KOBAR ANYTHING + KO ANYTHING)/TOTAL     (P13)
R12       6    0.57      0.26           VUILLEMIN 78 SMAG E+E- 3.772 GEV ECM   1/79
R12      13    0.29      0.11           SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM   1/82*
R12           . . . . . . . . . .
R12 AVG        0.33      0.10    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R13     DO INTO (E+ ANYTHING)/TOTAL                      (P10)
R13       0    0.04   OR LESS  CL=.95   BACINO    80 DLCO E+E- 3.77 GEV ECM    4/82*
R13      12    0.055     0.037          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM   4/82*
R13           . . . . . . . . . .
R13 EST        0.06   OR LESS  CL=.90   OUR ESTIMATE                          4/82*

R14     DO INTO (K*(892)- PI+)/TOTAL                     (P14)                1/82*
R14      25    0.034     0.014          SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R15     DO INTO (K*(892)O PIO)/TOTAL                     (P15)                1/82*
R15       4    0.014     0.023    0.014 SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R16     DO INTO (K- RHO+)/TOTAL                          (P16)                1/82*
R16      31    0.072     0.030    0.031 SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R17     DO INTO (KOBAR RHOO)/TOTAL                       (P17)                1/82*
R17       1    0.001     0.006    0.001 SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R18     DO INTO (PI- PI- PI+ PI+)/(K- PI+ PI+ PI-)       (P18)/(P2)           1/82*
R18            0.21   OR LESS  CL=.90   SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R19     DO INTO (K- ANYTHING)/TOTAL                      (P11)                1/82*
R19      19    0.35      0.10           VUILLEMIN 78 SMAG E+E- 3.772 GEV ECM  1/79
R19     121    0.55      0.11           SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*
R19           . . . . . . . . . .
R19 AVG        0.440     0.100   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R20     DO INTO (K+ ANYTHING)/TOTAL                      (P12)                1/82*
R20      25    0.08      0.03           SCHINDLER 81 SMK2 E+E- 3.771 GEV ECM  1/82*

R21     DO INTO (K- PI+ PIO PIO)/TOTAL                   (P20)                1/82*
R21       1 SEEN                        ADEVA     81 HYBR   PI- P-->DO DOBAR  1/82*

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                                  REFERENCES FOR NEUTRAL D

GOLDHABE 76 PRL 37 255          GOLDHABER,PIERRE,ABRAMS,ALAM+     (LBL+SLAC)
FELDMAN  77 PRL 38 1313         +PERUZZI,PICCOLO,ABRAMS,ALAM +    (SLAC+LBL)
GOLDHABE 77 PL 69B 503          GOLDHABER,WISS,ABRAMS,ALAM +      (LBL+SLAC)
PERUZZI  77 PRL 39 1301         +PICCOLO,FELDMAN+        (SLAC+LBL+NWES+HAWA)
PICCOLO  77 PL 70B 260          +PERUZZI,LUTH,NGUYEN,WISS,ABRAMS+(SLAC+LBL)

BALTAY   78 PRL 41 73           +CAROUMBALIS,FRENCH,HIBBS,HYLTON+(COLU+BNL)
SCHARRE  78 PRL 40 74           +BARBARO-GALTIERI +      (SLAC+LBL+NWES+HAWA)
VUILLEMI 78 PRL 41 1149         VUILLEMIN,FELDMAN +      (LBL+SLAC+NWES+HAWA)
ABRAMS   79 PRL 43 481          +ALAM,BLOCKER,BOYARSKI+            (SLAC+LBL)
ARMENISE 79 PL 86B 115          +ERRIQUEZ+          (BARI+CERN+EPOL+MILA+ORSA)
ATIYA    79 PRL 43 414          +HOLMES,KNAPP,LEE+              (COLU+ILL+FNAL)

ADAMOVIC 80 PL 89B 427          ADAMOVICH+(PHOTON-EMUL.OMEGA-PHOTON COLLS.)
ALLASIA  80 NP B176 13           (ANKA+LIBH+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
ASTON    80 PL 94B 113          +(BONN+CERN+EPOL+GLAS+LANC+MCHS+LALO+LPNP+)
AVERY    80 PRL 44 1309         +WISS,BUTLER,GLADDING+         (ILL+FNAL+COLU)
BACINO   80 PRL 45 329          +FERGUSON+          (UCLA+SLAC+STAN+UCI+STON)
USHIDA   80 PRL 45 1049           (AICH+FNAL+KOBE+SEOU+MCGI+NAGO+OSU+OKAY+)
ZHOLENTZ 80 PL 96B 214          +KURDADZE,LELCHUK,MISHNEV,NIKITIN+     (NOVO)
    ALSO 81 YAD.PHYS.34 1471    ZHOLENTZ +                             (NOVO)

ADAMOVIC 81 PL 99B 271          ADAMOVICH+(PHOTON-EMUL.OMEGA-PHOTON COLLS.)
ADAMOVI2 81  DESY-L-TRANS-260 (PISMA JETF 34 477)(PHOT.EMUL..OMEGA-PHOT.)
    ALSO 90 ADAMOVICH
    ALSO 81 FIORINO
ADEVA    81 PL 102B 285         +AGUILAR-BENITEZ + (LEBC-EHS COLLABORATION)
BALLAGH  81 PR D24 7            +BINGHAM+      (LBL+UCB+FNAL+HAWA+WASH+WISC)
    ALSO 80 PL 89B 423          BALLAGH +      (LBL+UCB+FNAL+HAWA+WASH+WISC)
FIORINO  81 LNC 30 166          FIORINO+ (PHOTON-EMUL, OMEGA-PHOTON COLLS.)
FUCHI    81 LNC 31 199          +HOSHINO,MIYANISHI+   (NAGO+AICH+TOKY+YOKO)
SCHINDLE 81 PRD 24 78           SCHINDLER,ALAM,BOYARSKY +          (SLAC+LBL)
ABE      82  PRL (TO BE PUBL.)(SLAC HYBRID FACILITY PHOTON COLLABORATION)
REUCROFT 82  CERN/EP/0903R/SR S.REUCROFT (MORIOND CONF) (LEBC-EHS COLLAB)
USHIDA   82  PRL 48 844           (AICH+FNAL+KOBE+SEOU+MCGI+NAGO+OSU+OKAY+)

      QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

NGUYEN   77 PRL 39 262          +WISS,ABRAMS,ALAM,BOYARSKI+       (LBL+SLAC)

                                REVIEWS

BARBAROG 78 LBL-8537            A.BARBARO-GALTIERI (ERICE 1978)        (LBL)
WOJCICKI 78 SLAC-PUB-2232       S.WOJCICKI (SLAC SUMMER INST.1978)    (SLAC)
KIRKBY   79 SLAC-PUB-2419       J.KIRKBY (LEPTON CONF. BATAVIA, 1979)(SLAC)
TRILLING 81 PRPL 75 57          G.H.TRILLING                       (LBL+UCB)

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                 34  F+-(2020,JP= )

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                 34  F+-(2020) MASS (MEV)

M   B    4(2030.)    (60.)       BRANDELIK 77 DASP +- E+E- ECM=4GEV      12/77
M    B   6 2030.      60.        BRANDELIK 79 DASP    E+E- ECM=4.42GEV    1/80
M        1 2017.      25.        AMMAR     80 HYBR +  NEU WIDEBAND        9/81*
M        1 2026.      56.        USHIDA    80 EMUL -  FNAL NU WIDEBAND    4/82*
M        1 2089.     121.        USHIDA    80 EMUL +  FNAL NU WIDEBAND    2/82*
M   A  400 2020.      22.        ASTON     81 OMEG +- GAMMA P-->F +       1/82*
M    B  BRANDELIK 77 EVENTS INCLUDED IN BRANDELIK 79 VALUE.               1/80
M   A  ERROR QUOTED BY ASTON 81 IS 10 MEV STAT AND <20 MEV SYST.          1/82*
M              . . . . . . . . .
M   AVG      2021.1      15.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 34  F+-(2020) MEAN LIFE     (UNITS 10**-13 SEC)

T        2   2.24     2.78    1.05  USHIDA   80 EMUL    NEU WIDEBAND     12/81*
T        1  (1.4)                   AMMAR    80 HYBR +  NEU WIDEBAND      1/82*

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                 34  F+-(2020) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      F+- INTO ETA PI+-                                  548+ 139
P2      F+- INTO ETA ANYTHING                              548+   0
P3      F+- INTO ETA PI+- PI+ PI-                          548+ 139+ 139+ 139
P4      F+- INTO ETA PRIME PI+- PI+ PI-                    957+ 139+ 139+ 139
P5      F+- INTO RHO+- PHI                                 769+1019

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                 34  F+-(2020) BRANCHING RATIOS

R1      F+- INTO (ETA PI+-)/(ETA ANYTHING)            (P1)/(P2)
R1  A     6  (0.09)   (0.06)        BRANDELIK 79 DASP   E+E- ECM=4.42GEV 4/82*
R1  A   DENOMINATOR INCONSISTENT WITH PARTRIDGE 81 (CRYSTAL BALL)        4/82*

R2      F+- INTO ETA PI+- PI+ PI-                     (P3)               1/82*
R2      300 SEEN                ASTON     81 OMEG    GAMMA P-->F +       1/82*

R3      F+- INTO ETA PRIME PI+- PI+ PI-               (P4)               1/82*
R3       50 SEEN                ASTON     81 OMEG    GAMMA P-->F +       1/82*

R4      F+- INTO RHO+- PHI                            (P5)               1/82*
R4       30 SEEN                ASTON2    81 OMEG    GAMMA P-->F +       1/82*

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                                REFERENCES FOR F+-(2020)

BRANDELI 77 PL 70B 132          BRANDELIK +        (AACH+DESY+HAMB+MPIM+TOKY)
BRANDELI 79 PL 80B 412          BRANDELIK+         (AACH+DESY+HAMB+MPIM+TOKY)
AMMAR    80 PL 94B 118          +      (KANS+FNAL+SERP+ITEP+CRAC+JINR+WASH+)
USHIDA   80 PRL 45 1053           (AICH+FNAL+KOBE+SEOU+MCGI+NAGO+OSU+OKAY+)
ASTON    81 PL 100B 91           (BONN+CERN+EPOL+GLAS+LANC+MCHS+LALO+LPNP+)
ASTON2   81 NP B189 205          (BONN+CERN+EPOL+GLAS+LANC+MCHS+LALO+LPNP+)
PARTRIDG 81 PRL 47 760          PARTRIDGE,PECK+   (CIT+HARV+PRIN+STAN+SLAC+)

                                REVIEWS

TRILLING 81 PRPL 75 57          G.H.TRILLING                       (LBL+UCB)

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                 39  BOTTOM MESON B(5200, JP=  )

                 SEE ALSO THE LISTING FOR BOTTOM HADRON SEARCHES.
                 NEEDS CONFIRMATION, NOT ENTERED INTO TABLE.

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                 39  B MASS  (MEV)

M               5140 TO 5290            ANDREWS   80 CLEO UPSIL(4S) THRESHOLD  4/82*
M               5275  OR LESS           FINNOCCHI 80 CUSB UPSIL(4S) THRESHOLD  4/82*

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                 39  B PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      B INTO ELECTRON ANYTHING
P2      B INTO MUON ANYTHING
P3      B INTO E+ E- ANYTHING
P4      B INTO MU+ MU- ANYTHING
P5      B INTO KAON ANYTHING

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                 39  B BRANCHING FRACTIONS

R1      B INTO (ELECTRON ANYTHING)/TOTAL                  (P1)
R1  A         0.13     0.042          BEBEK     81 CLEO DIRECT E AT UPS(4S)  4/82*
R1  A   THE STATISTICAL AND SYSTEMATIC ERRORS ARE EACH +-0.03.               4/82*
R1  B         0.136    0.039          SPENCER   81 CUSB DIRECT E AT UPS(4S)  4/82*
R1  B   THE STATISTICAL AND SYSTEMATIC ERRORS ARE +-0.025 AND +-0.03.        4/82*
R1  AB  THE ELECTRON ENERGY SPECTRA IN BOTH BEBEK 81 AND SPENCER 81 FAVOR    4/82*
R1  AB  B-TO-C OVER B-TO-U QUARK TRANSITIONS.                                4/82*
R1            . . . . . . . . .
R1  AVG       0.133    0.029   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      B INTO (MUON ANYTHING)/TOTAL                      (P2)
R2            0.094    0.036          CHADWICK  81 CLEO DIRECT MU AT UP(4S)  4/82*

R3      B INTO (E+ E- ANYTHING)/TOTAL                     (P3)
R3            0.05  OR LESS  CL=0.90  BEBEK     81 CLEO E+ E- AT UPSIL(4S)   4/82*

R4      B INTO (MU+ MU- ANYTHING)/TOTAL                   (P4)
R4            0.017 OR LESS  CL=0.90  CHADWICK  81 CLEO E+ E- AT UPSIL(4S)   4/82*

R5      B INTO (KAON ANYTHING)/TOTAL                      (P5)
R5  C          SEEN                   BRODY     82 CLEO KAONS AT UPSIL(4S)   4/82*
R5  C   ASSUMING UPSILON(4S) --> B BBAR, A TOTAL OF 3.38+-0.34+-0.68 KAONS   4/82*
R5  C   PER UPSILON(4S) DECAY IS FOUND (THE SECOND ERROR IS SYSTEMATIC). IN  4/82*
R5  C   THE CONTEXT OF THE STANDARD B-DECAY MODEL, THIS LEADS TO A VALUE     4/82*
R5  C   FOR (B-QUARK --> C-QUARK)/(B-QUARK --> ALL) OF 1.09+-0.33+-0.13.     4/82*

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                        REFERENCES FOR BOTTOM MESON B(5200)

ANDREWS  80 PRL 45 219          +       (CORN+HARV+ITHA+SYRA+ROCH+RUTG+VAND)
FINOCCHI 80 PRL 45 222          FINOCCHIARO,GIANNINI,+      (STON+COLU+LSU)
BEBEK    81 PRL 46 84           +       (HARV+ITHA+SYRA+ROCH+RUTG+VAND+CORN)
CHADWICK 81 PRL 46 88           +GANCI+(ROCH+RUTG+SYRA+VAND+CORN+HARV+ITHA)
SPENCER  81 PRL 47 771          +FINOCCHIARO,+          (STON+COLU+LSU+MPIM)
BRODY    82 PRL 48 1070         +CHEN,+(SYRA+VAND+CORN+ITHA+HARV+ROCH+RUTG)

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                 16  PROTON(938,J=1/2) I=1/2

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                 16  PROTON MASS (MEV)

M          (938.256)  (0.005)        COHEN     65 RVUE                       7/66
M          (938.2592) (0.00052)      TAYLOR    69 RVUE    USING NEW E/M      7/70
M           938.2796   0.0027        COHEN     73 RVUE                       3/74

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                 16  ANTIPROTON MASS  (MEV)

M1          938.3      0.5           BAMBERGER 70 CNTR                      12/79
M1          938.179    0.058         HU        75 CNTR    EXOTIC ATOMS      12/79
M1          938.229    0.049         ROBERSON  77 CNTR                      12/79
M1          938.30     0.13          ROBERTS   78 CNTR                       6/78
M1          . . . . . . . . .
M1  AVG     938.216    0.036   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  16  PROTON MEAN LIFE / BRANCHING FRACTION (UNITS YEARS)

      BARYON CONSERVATION WOULD BE VIOLATED BY A FINITE PROTON MEAN LIFE.
      (SEE ALSO NEUTRON-ANTINEUTRON OSCILLATIONS IN NEUTRON SECTION BELOW
      FOR ANOTHER TEST OF BARYON CONSERVATION.)
      LIMITS QUOTED ARE PARTIAL MEAN LIFE FOR PROTON OR BOUND NUCLEON
      DECAY MODE SHOWN AT RIGHT.
      SEE ALSO THE REVIEWS BY REINES AND SCHULTZ, SURVEYS IN HIGH ENERGY
      PHYSICS 1, 89 (1980); GOLDHABER, LANGACKER, SLANSKY, SCIENCE 210,
      851 (1980); GOLDHABER AND SULAK, COMMENTS NUCL. PART. PHYS. 10,
      215 (1981).

T  H       (1.4E20) CR MORE            GOLDHABER 54 TH232  NUC-->ANYTHING
T  H       (1.4E22) CR MORE            REINES    54 CNTR   NUC-->CHGD ANY     9/81*
T  H       (6. E23) CR MORE            REINES    57 CNTR   P --> CHGD ANY     9/81*
T  H       (3. E23) CR MORE            FLEROV    58 TH232  NUC-->ANYTHING
T  H M     (4. E26) CR MORE            BACKENSTO 60 CNTR   NUC-->MU ANY
T  H M     (9. E27) CR MORE            GIAMATI   62 CNTR   P --> MU GAMMA     9/81*
T  H M     (6. E28) OR MORE            KROPP     65 CNTR   P --> MU GAMMA
T  H M     (1.2E30) CR MORE            GURR      67 CNTR   P --> MU GAMMA
T          (3. E23) CR MORE            DIX       70 DEUT   P --> ANYTHING     9/81*
T          (1.3E29) CR MORE            BERGAMASC 74 CNTR   P --> CHGD ANY    12/75
T   L      (2. E30) CR MORE            REINES    74 CNTR   NUC-->MU ANY      12/75
T          (1.6E25) CR MORE            EVANS     77 TE130  NUC-->ANYTHING     9/81*
T  L M     (6. E30) CR MORE            LEARNED   79 CNTR   NUC-->MU ANY       9/81*
T  L       (1. E30) CR MORE            LEARNED   79 CNTR   NUC-->ANYTHING    12/79
T          (1.8E30) CR MORE  CL=.90    COWSIK    80 CNTR   NUC-->MU ANY       4/82*
T        0 (1.25E30)CR MORE            ALEKSEEV  81 CNTR   NUC-->ANYTHING     2/82*
T  C     2 (3. E31) CR MORE            CHERRY    81 CNTR   NUC-->MU ANY       1/82*
T  C       (1.5E30) CR MORE            CHERRY    81 CNTR   NUC-->ANYTHING     1/82*
T  K     2  8. E30  CR MORE            KRISHNASW 81 CNTR   NUC-->ANYTHING     1/82*
T  H    CONVERTED TO MEAN LIFE BY DIVIDING HALF-LIFE BY LN(2)=.693 .
T    M  REFERENCE ALSO GIVES LIMITS FOR OTHER MODES. WE GIVE HIGHEST LIMIT.
T  L    FIRST LEARNED 79 VALUE SUPERCEDES REINES 74.  SECOND LEARNED 79
T  L    VALUE IS FIRST TIMES B.F.=.15, A GRAND UNIF. GAUGE THEORY ESTIMATE.
T  C    CHERRY 81 SEE (2+-2) EVENTS ABOVE BACKGROUND. SECOND CHERRY 81     1/82*
T  C    VALUE IS FIRST TIMES B.F.=.05, A GRAND UNIF. GAUGE THEORY ESTIMATE. 1/82*
T  K    KRISHNASWAMY 81 SEE 2 EVENTS IN FIDUCIAL VOLUME OF DETECTOR.       1/82*
T  K    TENTATIVE MEAN LIFE ASSUMES B.F. * EFF. =0.5 (FROM GUT) .          1/82*
T  K    WE QUOTE THEIR TENTATIVE MEAN LIFE AS A LOWER LIMIT.               1/82*

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                  16  ANTIPROTON MEAN LIFE / BR. FRACTION  (UNITS HOURS)

      LIMITS SHOWN ARE PARTIAL MEAN LIFE FOR MODE SHOWN AT RIGHT.

TI       (3.3E-8)  CR MORE  CL=.95   GANGULI   78 HBC    PBAR-->ANYTHING   6/78
TI  B    (32.)     CR MORE           BREGMAN   78 ICE    PBAR-->ANYTHING   7/79
TI  E    (1700.)   OR MORE  CL=.90   BELL      79 ICE    PBAR-->E- PI0     1/80
TI  G    (1. E11)  CR MORE           GOLDEN    79 SPEC   PBAR-->ANYTHING  12/79
TI  B  BREGMAN 78 STORED ANTIPROTONS IN ICE STORAGE RING AT CERN 85 HOURS. 7/79
TI  E  BELL 79 STORED ANTIPROTONS IN ICE STORAGE RING FOR 10 DAYS.         1/80
TI  G  GOLDEN 79 VALUE INFERRED FROM PBAR/P RATIO IN COSMIC RAYS.         12/79

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                  16  PROTON MAGNET. MOMENT(E/2MP)

MM       (2.79276)(0.00002)          COHEN     65 RVUE
MM       (2.792787 0.000017)         TAYLOR    69 RVUE   USING NEW E/H     7/70
MM        2.7928456 .0000011         COHEN     73 RVUE                     3/74

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                  16  ANTIPROTON MAGNETIC MOMENT (E/2MP)

MMI O     (-1.8)    (1.2)            BUTTON    62 CNTR
MMI R     (-2.83)   (0.10)           FOX       72 CNTR                    11/75
MMI P     (-2.819)  (0.056)          ROBERTS   74 CNTR                     7/75
MMI        -2.791    0.021           HU        75 CNTR   EXOTIC ATOMS     12/79
MMI  R     -2.817    0.048           ROBERTS   78 CNTR                     6/78
MMI O  OLD EXPERIMENT WITH LARGE ERROR.  NOT AVERAGED.
MMI  R ROBERTS 74 IS REANALYSIS OF FOX 72 DATA.  REPLACES OLD FOX VALUE.   7/75
MMI  P ROBERTS 78 IS A REANALYSIS OF ROBERTS 74.                           6/78
MMI         . . . . . . . . .
MMI AVG    -2.795    0.019    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  16  PROTON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)

            FORBIDDEN BY BOTH T INVARIANCE AND P INVARIANCE

EDM     1G  (700.)   (900.)          HARRISON  69 MBP                     10/69
EDM         (55000.) CR LESS         KHRIPLOVI 76                          1/78

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                  16  PROTON ELECTRON CHARGE DIFFERENCE (UNITS E)

DQ   D     1.0E-21 OR LESS           DYLLA     73      NEUTRALITY OF SF6   2/80
DQ   D  ASSUMES THAT Q(NEUTRON)=Q(PROTON)-Q(E-).  SEE DYLLA 73 FOR A       2/80
DQ   D  SUMMARY OF EXPERIMENTS ON THE NEUTRALITY OF MATTER.                2/80

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REFERENCES FOR PROTON


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GOLDHABE 54 PR 96 1157 FNOTE2 GOLDHABER,REINES,COWAN            (LASL+BNL)
REINES   54 PR 96 1157        REINES,COWAN,GOLDHABER            (LASL+BNL)
FLEROV   58 SOV PHYS DOK 3 79 FLEROV,KLOCHKOV,SKOBKIN,TERENTEV      (USSR)
REINES   57 PR 109 609        REINES,COWAN,KRUSE                     (LASL)
BACKENST 60 NC 16 749         BACKENSTOSS,FRAUENFELDER,HYAMS +       (CERN)

BUTTON   62 PR 127 1297       J BUTTON,B MAGLIC                       (LBL)
GIAMATI  62 PR 126 2178       GIAMATI,REINES                         (CASE)
COHEN    65 RMP 37 537        +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
KROPP    65 PR 137B 740       W R KROPP,F REINES                     (CASE)
GURR     67 PR 158 1321       GURR,KROPP,REINES,MEYER (CASE,JOHANNESBURG)

HARRISON 69 PRL 22 1263       HARRISON,SANDARS,WRIGHT  (CLARENDON OXFORD)
TAYLOR   69 RMP 41 375        +PARKER,LANGENBERG           (PRIN+UCI+PENN)
BAMBERGE 70 PL 33B 233        BAMBERGER,LYNEN,PIEKARZ+   (MPIN+CERN+KARL)
DIX      70 THESIS CASE       F E DIX                                (CASE)
FOX      72 PRL 29 193        +BARNES,EISENSTEIN+(BNL+CARN+VPI+WILL+WYOM)
COHEN    73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DYLLA    73 PR A7 1224        H.F.DYLLA, J.G.KING                     (MIT)

BERGAMAS 74 LNC 11 636        BERGAMASCO,PICCHI                 (TORI+FRAS)
REINES   74 PRL 32 493        +CROUCH                           (UCI+CASE)
ROBERTS  74 PRL 33 1181       +COX,ECKHAUSE+ (WILL+VPI+CARN+WYOM+CIT+BNL)
    ALSO 75 PR D12 1232       ROBERTS,COX +  (WILL+VPI+CARN+WYOM+CIT+BNL)
HU       75 NP A254 403       +ASANO,CHEN,CHENG,DUGAN+          (COLU+YALE)

KHRIPLOV 76 JETP 44 25        I.B.KHRIPLOVICH   (NUC.PHYS.INST.,SIBERIA)
EVANS    77 SCIENCE 197 989   +STEINBERG                         (BNL+PENN)
ROBERSON 77 PR C16 1945       +KING,KUNSELMAN+    (WYOM+CIT+CARN+VPI+WILL)
BREGMAN  78 PL 78B 174        +CALVETTI,CARRON,CITTOLIN,HAUER,HERR+(CERN)
GANGULI  78 PL 74B 130        +MALHOTRA,RAGHAVAN,SUBRAMANIAN +     (TIFR)
ROBERTS  78 PR D17 358        B. L. ROBERTS                     (WILL+RHEL)

BELL     79 PL 86B 215        +CALVETTI,CARRON,CHANEY,CITTOLIN+    (CERN)
GOLDEN   79 PRL 43 1196       +HORAN,MAUGER,BADHWAR,LACY+     (NASA+PSLL)
LEARNED  79 PRL 43 907        +REINES,SONI                          (UCI)
COWSIK   80 PR D22 2204       R.COWSIK,V.S.NARASIMHAN              (TIFR)
ALEKSEEV 81 JETPL 33 651      +BAKATANOV,BUTKEVICH,VOEVODSKII +    (LENI)
CHERRY   81 PRL 47 1507       +DEAKYNE,LANDE,LEE,STEINBERG +   (PENN+BNL)
KRISHNAS 81 PL 106B 339       KRISHNASWAMY,MENON,MONDAL+ (TIFR+OSKC+TOKY)
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QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

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KALOGERO 76 PRL 37 1037       KALOGEROPOULOS,CHIU,SUDARSHAN   (SYRA+TEXA),
FRANKLIN 77 PR D16 910        JERROLD FRANKLIN                    (HAIF)P
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                  17  NEUTRON(939,J=1/2) I=1/2

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                  17  NEUTRON MASS (MEV)

M  T     (939.5527) (0.0052)         TAYLOR    69 RVUE   USING NEW E/H     7/70
M  T      939.5731   0.0027          COHEN     73 RVUE                     3/74
M  T  THESE DETERMINATIONS OF NEUTRON MASS NOT INDEPENDENT OF              7/70
M  T  NEUTRON-PROTON MASS DIFFERENCE MEASUREMENTS BELOW.                   7/70

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                  17  (NEUTRON) - (PROTON) MASS DIFFERENCE (MEV)

D  M    (1.29344)(0.00007)           MATTAUCH  65 RVUE                     3/71
D        1.293429 0.000036           COHEN     73 RVUE                     3/74
D  M  WE HAVE CONVERTED MATTAUCH NEUTRON-HYDROGEN MASS DIFFERENCE TO       3/71
D  M  NEUTRON-PROTON MASS DIFFERENCE USING CURRENT VALUE OF ELECTRON MASS  3/71
D  M  AND A HYDROGEN BINDING ENERGY OF 13.6 EV.                            3/71

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                  17  NEUTRON MEAN LIFE (UNITS 10**3 SEC)

      THE MEASUREMENT OF THE NEUTRON MEAN LIFE BY SOSNOVSKII 59 HAS
      BEEN DISCARDED SINCE 1.  IT DISAGREES WITH THE BETTER AND MORE
      RECENT RESULT OF CHRISTENSEN 67.  2.  THE VALUE OF GA/GV DE-
      RIVED FROM THE NEW VALUE OF THE MEAN LIFE AGREES WELL WITH THE
      GA/GV VALUE OBTAINED FROM THE FREE NEUTRON DATA.

T  A      (1.013)  (0.026)           SOSNOVSKI 59 PILE                     7/68
T         (0.935)  (0.014)           CHRISTENS 67 PILE REPL BY CHRISTENS72 3/68
T          0.918    0.014            CHRISTENS 72 PILE                     6/72
T  A      (0.877)  (0.008)           BONDARENK 78 PILE                     8/81*
T          0.937    0.018            BYRNE     80 PILE                     2/82*
T          0.875    0.095            KOSVINTSE 80 PILE                    10/81*
T  B      (0.903)  (0.010)           WILKINSON 80 RVUE    INFERRED VALUE   5/82*
T  A  THE RESULTS OF BONDARENKO 78 AND SOSNOVSKI 59 ARE IN SIGNIFICANT    5/82*
T  A  DISAGREEMENT WITH THE TWO OTHER PRECISE DIRECT MEAN LIFE MEASURE-   5/82*
T  A  MENTS AND THE INFERRED VALUE GIVEN BY WILKINSON 80.  WE EXCLUDE     5/82*
T  A  THESE TWO RESULTS FROM THE AVERAGE, AS IS RECOMMENDED BY            5/82*
T  A  WILKINSON 80.                                                       5/82*
T  B  WILKINSON 80 VALUE INFERRED FROM N DECAY ANGULAR CORRELATIONS.      5/82*
T         . . . . . . . . .
T  AVG     0.925    0.011     0.011  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                  17  NEUTRON MAGNETIC MOMENT (MAGNETONS,938.2 MEV)

MM      (-1.913148   0.000066)       COHEN     56 RVUE                     7/66
MM      (-1.91304211 0.00000088)     GREENE    77 MRS  REPL. BY GREENE 79  3/78
MM       -1.91304184 0.00000088      GREENE    79 MRS                     12/79

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                  17  NEUTRON ELECTRIC DIPOLE MOMENT (UNITS 10**-23 E CM)

            FORBIDDEN BY BOTH T INVARIANCE AND P INVARIANCE

EDM M     (-20.)    (30.)            MILLER    67 MRS                      1/78
EDM        +24.      39.             SHULL     67 CNTR                     1/78
EDM  M    (30.)    CR LESS           DRESS     68 MRS  ABSOLUTE VALUE      1/78
EDM        (5.)    CR LESS           BAIRD     69 MRS  INCLUDED IN DRESS73 10/69
EDM       - 2.       39.             APOSTOLES 70 MRS                      1/78
EDM         0.32     0.75            DRESS     73 MRS  < 10**-23 (CL=.80)  6/73
EDM         0.04     0.15            DRESS     77 MRS  < 3  E-24 (CL=.90)  6/77
EDM  A      0.040    0.075           ALTAREV   79 MRS  < 1.6E-24 (CL=.90) 10/81*
EDM  A      0.021    0.024           ALTAREV   81 MRS  < 6  E-25 (CL=.90)  2/82*
EDM  M DRESS 68 INCLUDES DATA OF MILLER 67.                                1/78
EDM  A ALTAREV 79 AND 81 USE ULTRACOLD NEUTRONS.                           4/82*
EDM          . . . . . . . . .
EDM AVG     0.023    0.023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  17  NEUTRON CHARGE

      SEE SECTION DC IN THE PROTON DATA CARD LISTINGS ABOVE

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                  17  NEUTRON PARTIAL DECAY MODES

                                                              DECAY MASSES
                                                              DECAY MASSES
P1     NEUTRON INTO PROTON E- ANTI(NUE)                       938+ .5+  0
P2     NEUTRON INTO PROTON NUE ANTI(NUE)                      938+  0+  0

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                  17  NEUTRON BRANCHING RATIOS

R1     NEUTRON INTO (PROTON NUE ANTI(NUE))/(PROTON E- ANTI(NUE))  (P2)/(P1)
R1      FORBIDDEN BY CHARGE CONSERVATION
R1  S     (3. E-17)OR LESS           SUNYAR    50 CNTR RB87-->SR87M+NEUTRL 2/80
R1        (3. E-19)OR LESS           NORMAN    79 CNTR RB87-->SR87M+NEUTRL 2/80
R1         9. E-24 OR LESS           BARABANOV 80 CNTR GA71-->GE71 + ANY   2/82*
R1  S  WE HAVE CONVERTED SUNYAR 60 MEAN LIFE LIMIT FOR (N --> P + NEUTRLS) 2/80
R1  S  AS DESCRIBED IN NORMAN 79.                                          2/80

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                 17  LIMIT ON NEUTRON-ANTINEUTRON OSCILLATIONS

NAN      MEAN TIME FOR N-ANTIN TRANSITION IN VACUUM  (UNITS SEC.)
NAN A         (1.E8) OR MORE           CHETYRKIN 81                      1/82*
NAN A   ESTIMATE BASED ON DATA FROM NUCLEON STABILITY EXPERIMENTS. CONTAINS  1/82*
NAN A   REFERENCES TO EARLIER ESTIMATES AND DISCUSSIONS.  SEE ALSO       1/82*
NAN A   MOHAPATRA 82.                                                    1/82*
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                 17  NEUTRON BETA DECAY PARAMETERS

        RELATED TEXT SECTION VI D.1

AV       GA/GV  (SEE TEXT FOR SIGN CONVENTION)
AV  C      (-1.250)  (0.044)         CONFORTO  67 RVUE   SEE NOTE C BELOW
AV EP      (-1.23)   (0.01)          CHRISTENS 67 CNTR   N DECAY FT VALUE   11/68
AV  P      (-1.22)   (0.08)          GRIGOREV  68 CNTR  E-NEU ANG CORREL    10/71
AV  P      (-1.26)   (0.02)          CHRISTENS 70 CNTR  PE.NEUT SPIN CORREL 10/71
AV EP      (-1.27)   (0.025)         EROZOLIMS 71 CNTR  REPL.BY EROZOLIMS79 10/71
AV EP      (-1.239)  (0.011)         CHRISTENS 72 CNTR    N DEC.+ FT VALUE   1/73
AV  P      (-1.263)  (0.016)         KROPF     73 RVUE    N DECAY ALONE      1/73
AV    P     -1.250    0.009          KROPF     73 RVUE    N DEC.+ FT VALUE   1/73
AV E       (-1.250)  (0.036)         DOBROZEMS 75 CNTR  REPL.BY STRATOWA 78 12/75
AV    K     -1.253    0.021          KROHN     75 CNTR  PE.NEUT SPIN CORREL  1/77
AV         (-1.263)  (0.015)         EROZOLIMS 77 CNTR  REPL.BY EROZOLIMS79  1/78
AV E        -1.259    0.017          STRATOWA  78 CNTR  PROTON RECOIL SPECT  2/82*
AV E        -1.261    0.012          EROZOLIMS 79 CNTR  PE.NEUT SPIN CORREL 10/81*
AV  C   CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967.  REPL. BY KROPF 73.  1/73
AV E    THESE EXPERIMENTS MEASURE THE ABSOLUTE VALUE OF GA/GV ONLY          10/71
AV   P  KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.            1/73
AV   K  KROHN 75 PAPER GIVES -1.258+-.015 INCLUDING EVENTS OF CHRISTENS 70.  1/78
AV   K  THE VALUE QUOTED ABOVE IS DERIVED FROM HIS A.BASED ON NEW EXPT ONLY  1/77
AV            . . . . . . . . . .
AV  AVG     -1.2546   0.0063   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F        PHASE ANGLE OF GA RELATIVE TO GV  (DEGREES)
F   P      (175.)     (10.)          BURGY     60 CNTR     POLAR. NEUTRONS   6/77
F   P      (198.)     (27.)          CLARK     60 CNTR     POLAR. NEUTRONS   6/77
F   C      (176.1)    (6.4)          CONFORTO  67 RVUE                      11/68
F   P      (181.3)    (1.3)          EROZOLIMS 70 CNTR   POLAR. NEUTRON     10/69
F     P     181.1      1.3           KROPF     73 RVUE    N DECAY            1/73
F           180.35     0.43          EROZOLIMS 74 CNTR     POLAR. NEUTRONS   6/77
F           180.14     0.22          STEINBERG 74 CNTR     POLAR. NEUTRONS   6/77
F           179.71     0.39          EROZOLIMS 78 CNTR     POLAR. NEUTRONS   7/79
F   C   CONFORTO 67 COMBINES FREE NEUTRON DATA TO 1967.  REPL. BY KROPF 73.  1/73
F     P KROPF 73 VALUE OBTAINED BY FITTING ALL DATA THROUGH 1972.            1/73
F             . . . . . . . . . .
F   AVG     180.11     0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DI      THREE-VECTOR CORRELATION COEFFICIENT                                 7/76
DI      DI MEASURES COMPONENT OF NEUTRON SPIN PERPENDICULAR TO THE DECAY     7/76
DI      PLANE IN BETA DECAY. SHOULD BE ZERO IF T-INVARIANCE NOT              7/76
DI      VIOLATED.  SEE TEXT SEC VI D.                                        7/76
DI          -0.01      0.01          EROZOLIMS 70 CNTR     POLAR. NEUTRONS   7/76
DI    E     -0.0027    0.0050        EROZOLIMS 74 CNTR     POLAR. NEUTRONS  12/81*
DI    E     -0.0011    0.0017        STEINBERG 74 CNTR     POLAR. NEUTRONS  12/81*
DI          +0.0022    0.0030        EROZOLIMS 78 CNTR     POLAR. NEUTRONS   7/79
DI    E  EROZOLIMSKII 78 SAYS ASYMMETRIC PROTON LOSSES AND NON-UNIFORM BEAM  12/81*
DI    E  POLARIZATION MAY GIVE SYSTEMATIC ERROR UP TO 0.003, THUS INCREASING 12/81*
DI    E  THE EROZOLIMSKII 74 ERROR TO 0.005 .  STEINBERG 74. 76 ESTIMATES    12/81*
DI    E  THESE SYSTEMATIC ERRORS TO BE INSIGNIFICANT IN THEIR EXPERIMENT.    12/81*
DI            . . . . . . . . . .
DI  AVG     -0.0007   0.0014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR NEUTRON


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CDHEN     56 PR 104 283          V W COHEN, CORNGOLD, RAMSEY    (BNL+HARVARD)
SOSNOVSK 59 JETP  9  717         SOSNOVSKII,SPIVAK,PROKOFEV +   (IAE MOSCOW)
BURGY     60 PR 120 1829         +KROHN,NOVEY,RINGO                (ANL+CHIC)
CLARK     60 CJP 38 693          +ROBSON
SUNYAR    60 PR 120 871          A.W.SUNYAR, M.GOLDHABER                (BNL)

MATTAUCH 65 NP 67 1              +THIELE,WAPSTRA      (MAX PLANCK INST.CHEM.)
CHRISTEN 67 PL 26B 11            CHRISTENSEN,NIELSON,BAHNSEN,BROWN+    (RISO)
CONFORTO 67 APAH 22 15           G. CONFORTO                           (CERN)
MILLER    67 PRL 19 381          +DRESS,BAIRD,RAMSEY              (ORNL+HARV)
SHULL     67 PRL 19 384          C.G.SHULL, R.NATHANS              (MIT+BNL)
DRESS     68 PR 170 1200         +BAIRD,MILLER,RAMSEY             (ORNL+HARV)
GRIGOREV 68 SJNP 6 239           +GRISHIN,VLADIMIRSKII,NIKOLAEVSKII + (ITEP)

BAIRD     69 PR  179  1285       +MILLER,DRESS,RAMSEY             (ORNL,HARV)
TAYLOR    69 RMP 41 375          +PARKER,LANGENBERG          (PRIN+UCI+PENN)
APOSTOLE 70 RRP 15 343           APOSTOLESCU,IONESCU,IONESCU-BUJOR +  (BUCH)
CHRISTEN 70 PR C1 1693           CHRISTENSEN,KROHN,RINGO                (ANL)
EROZOLIM 70 SJNP 11 583          EROZOLIMSKI,BONDARENKO,  +            (KIAE)
    ALSO    PL 27B 557           EROZOLIMSKY,BONDARENKO  +             (KIAE)

EROZOLIM 71 JETPL 13 252         EROZOLIMSKII,BONDARENKO +             (KIAE)
CHRISTEN 72 PR D5 1628           CHRISTENSEN,NIELSON,BAHNSEN,BROWN+    (RISO)
COHEN     73 J.PHYS.CHEM.REF.DATA 2, P.663, E.R.COHEN,B.N.TAYLOR
DRESS     73 PR D7 3147          DRESS,MILLER,RAMSEY              (ORNL+HARV)
KROPF     73 ZPHY TO BE PUBL.    A KROPF,H PAUL                        (LINZ)
    ALSO 70 NP A154 160          H PAUL                                (VIEN)

EROZOLIM 74 JETPL 20 345         EROZOLIMSKII,MOSTOVOI,FEDUNIN,FRANK+
STEINBER 74 PRL 33 41            STEINBERG,LIAUD,VIGNON,HUGHES   (YALE+GREN)
    ALSO 76 PR D13 2469          STEINBERG,LIAUD,VIGNON,HUGHES   (YALE+GREN)
DOBROZEM 75 PR D11 510           DOBROZEMSKY,KERSCHBAUM,MORAW,PAUL +  (SEIB)
KROHN     75 PL 55B 175          KROHN,RINGO                            (ANL)

DRESS     77 PR D15 9            +MILLER,PENDLEBURY,PERRIN+ (ORNL+GREN+HARV)
EROZOLIM 77 JETPL 23 663         EROZOLIMSKII,FRANK,MOSTOVOI+          (KIAE)
GREENE    77 PL 71B 297          +RAMSEY,MAMPE+    (HARV+ILLG+SUSS+ORNL+CENG)
EROZOLIM 78 SJNP 28 48           EROZOLIMSKII,MOSTOVOI,FEDUNIN,FRANK+ (KIAE)
STRATOWA 78 PR D18 3970          +DOBROZEMSKY,WEINZIERL                (SEIB)
BONDAREN 78 JETPL 28 303         BONDARENKO,KURGUZOV,PROKOFEV+         (KIAE)

ALTAREV   79 JETPL 29 730        +BORISOV,BRANDIN,EGOROV,EZHOV,IVANOV+(LENI)
EROZOLIM 79 SJNP 30 356          EROZOLIMSKII,FRANK,MOSTOVOI+          (KIAE)
GREENE    79 PR D20 2139         +RAMSEY,MAMPE+    (HARV+ILLG+SUSS+ORNL+CENG)
NORMAN    79 PRL 43 1226         E.B.NORMAN, A.G.SEAMSTER              (WASH)

BARABANO 80 JETPL 32 359         BARABANOV,VERETENKIN,GAVRIN +         (LENI)
BYRNE     80 PL 92B 274          +MORSE,SMITH,SHAIKH,GREEN,GREENE  (SUSS+RL)
KOSVINTS 80 JETPL 31 236         KOSVINTSEV,KUSHNIR,MOROZOV,TEREKHOV  (JINR)
WILKINSO 80 ERICE SCH.NUC.PH.    D.H.WILKINSON:PROG.PART.NUC.PHY.6,325(SUSS)
ALTAREV   81 PL 102B 13          +BORISOV,BOROVIKOVA,BRANDIN,EGOROV + (LENI)
CHETYRKI 81 PL 99B 358           CHETYRKIN,KAZARNOVSKY,KUZMIN+         (INRM)
MOHAPATR 82 ICOBAN CONF 82       R.N.MOHAPATRA                         (TTFR)
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PAPERS NOT REFERRED TO IN DATA CARDS

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JACKSON   57 PR 106 517          JACKSON,TREIMAN,WYLD            (PRINCETON)
COHEN     65 RMP 37 537          +DUMOND (N.AMER.AVIATION SCIENCE CENT.,CIT)
BHALLA    66 PL 19  691          C P BHALLA                        (ALABAMA)
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                 18  LAMBDA(1116,JP=1/2+) I=0
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                 18  LAMBDA MASS (MEV)

M    N    SINCE OUR FINAL VALUES FOR THE SIGMA AND LAMBDA MASSES COME FROM
M    N    DOING AN OVERALL FIT TO ALL MEASURED MASSES AND MASS DIFFERENCES,
M    N    WE HAVE USED THE UNCORRELATED MEASUREMENTS FROM SCHMIDT 65 RATHER
M    N    THAN THE ONES COMING FROM THE OVERALL FIT REPORTED IN THAT PAPER.
M    N    SINCE THERE SEEMS TO BE NO CONVINCING ARGUMENT AS TO WHY ONE SHOULD
M    N    IGNORE DATA USING RANGE MEASUREMENTS. WE HAVE INCLUDED HERE VALUES
M    N    DEPENDING ON PROTON AND PION RANGES.  THE SCHMIDT 65 MASSES HAVE
M    N    BEEN REEVALUATED USING OUR APRIL 1973 PROTON AND CHARGED K AND PI
M    N    MASSES.  P. SCHMIDT, PRIVATE COMMUNICATION. (1974).

M           1115.44      0.12            BHOWMIK   63 RVUE +  SEE NOTE L BELOW
M    L    ABOVE LAMBDA MASS HAS BEEN RAISED 35 KEV TO ACCOUNT FOR 46 KEV
M    L    INCREASE IN PROTON MASS AND 11 KEV DECREASE IN CHARGED PION MASS.
M    S  635(1115.65)    (0.09)           BALTAY    65 HBC    ERROR IS STATIS.    6/66
M       488 1115.65      0.07            SCHMIDT   65 HBC  SEE NOTE N            3/74
M    S 1147(1115.74)    (0.04)           CHIEN     66 HBC     6.9 PBAR P         9/67
M    S  972(1115.69)    (0.  )           CHIEN     66 HBC     6.9 PBAR PANTIL    9/67
M           1115.6       0.4             LONDON    66 HBC                        6/66
M          (1116.01     (0.21)           BADIER    67 HBC     2.4 PBAR P.LLBAR   8/67
M       195 1115.35      0.12            MAYEUR    67 EMUL                      11/67
M    B 1524(1115.52)    (0.03)           BOHM      70 EMUL                       3/72
M       935 1115.59      0.08            HYMAN     72 HEBC                      11/71
M    B    AVERAGE OF VERY INCONSISTENT DATA. ERROR STATISTICAL ONLY. AUTHORS     3/72
M    B    DETECT SYSTEMATIC EFFECT OF ABOUT .15 MEV, WHICH THEY ATTRIBUTE        3/72
M    B    TO ERROR IN RANGE-ENERGY RELATIONS, IN REGION BETA=0.6-0.7.           3/72
M    B    THIS EFFECT, IF CONFIRMED, WOULD AFFECT VERY LITTLE THE VALUES OF      3/72
M    B    BHOWMICK 63 AND MAYEUR 67.
M    S    ERROR PURELY STATISTICAL.
M              . . . . . . . . .
M    AVG    1115.566     0.056     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
M    FIT    1115.596     0.046   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)   3/82*
                                  (SEE IDEOGRAM BELOW )
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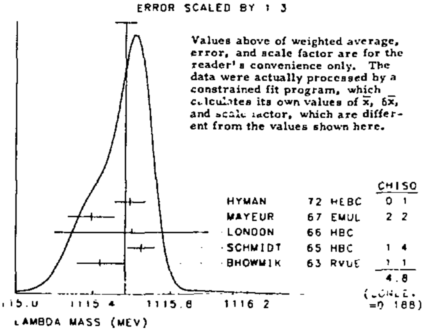
WEIGHTED AVERAGE = 1115.566 ± 0.056
ERROR SCALED BY 1.3



Values above of weighted average, error, and scale factor are for the reader's convenience only. The data were actually processed by a constrained fit program, which calculates its own values of $\bar{x}$, $\delta\bar{x}$, and scale factor, which are different from the values shown here.

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                 18  LAMDA - ANTILAMBDA MASS DIFFERENCE (MEV)
DM               0.05       0.06            CHIEN     66 HBC     6.9 PBAR P        9/67
DM               0.29       0.15            BADIER    67 HBC     2.4 PBAR P        8/67
DM            . . . . . . . . . .
DM   AVG         0.083      0.083   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

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                 18  LAMBDA MEAN LIFE (UNITS 10**-10 SEC)

T   O  188   (2.63)   (0.21)   (0.21) BOLOT      58 CC
T   O  825   (2.72)   (0.16)   (0.16) CRAWFORD   59 HBC
T   O  140   (2.72)   (0.29)   (0.27) BOWEN      60 CC
T   O  186   (2.60)   (0.28)   (0.20) CHANG      62 HBC
T   O  799   (2.69)   (0.11)   (0.11) HUMPHREY   62 HBC
T   O 2239   (2.36)   (0.06)   (0.06) BLOCK      63 HEBC
T   O  706   (2.76)   (0.20)          CHRETIEN   63 HLBC
T   O  794   (2.55)   (0.09)          HUBBARD    64 HBC
T   O 2260   (2.31)   (0.10)          KREISLER   64 OSPK
T   O 1378   (2.59)   (0.07)          SCHWARTZ   64 HBC
T   O  635   (2.51)   (0.16)          BALTAY     65 HBC                          6/66
T   O 2534   (2.6)    (0.1)           HILL       65 OSPK
T   O  916   (2.35)   (0.09)          BURAN      66 HLBC                         6/66
T   S 1147   (2.50)   (0.14)          CHIEN      66 HBC       6.9 PBAR P         9/67
T   S  972   (2.70)   (0.20)          CHIEN      66 HBC       6.9 PBAR P.ANTI    9/67
T   O 2213   (2.452)  (0.056) (0.054)ENGELMANN   66 HBC                          9/66
T   O  585   (2.68)   (0.13)  (0.11) AUERBACH    67 OSPK                         8/67
T   O        (2.44)   (0.15)          BADIER     67 HBC      2.4 PBAR P          6/68
T   O        (2.55)   (0.15)          BADIER     67 HBC      2.4 PBAR P.ANTIL    6/68
T   O 8342   (2.535)  (0.035)         GRIMM      68 HBC                          6/68
T   O 2600   (2.47)   (0.08)          HEPP       68 HBC                          6/68
T   O 1059   (2.39)   (0.10)          DEMIDOV    70 HLBC PI-P, 3.86 GEV/C       12/70
T   O 4572   (2.54)   (0.04)          BALTAY     71 HBC      K-P AT REST         6/71
T   O 6582   (2.69)   (0.05)          ALTHOFF    73 OSPK     PI+N TO K+LAMBDA    2/74
T      36K    2.626    0.020          POULARD    73 HBC      K-P,KMOM .4TO2.3    9/73
T      34K    2.611    0.020          CLAYTON    75 HBC      K-P,KMOM .96-1.4    1/77
T      53K    2.69     0.03           ZECH       77 SPEC NEUTRAL HYP. BEAM      12/77
T   O   OLD LOWER STATISTICS EXPERIMENTS NOT INCLUDED IN AVERAGE.                1/78
T   S   ERROR PURELY STATISTICAL.
T           . . . . . . . . . .
T   AVG      2.632    0.020    0.020  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.6)
                                (SEE IDEOGRAM BELOW )
```
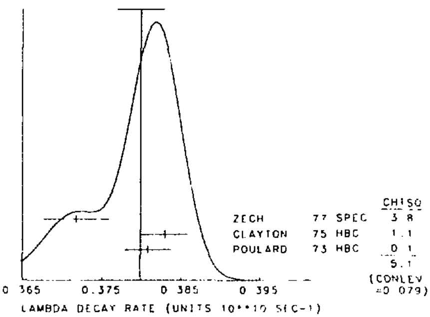

WEIGHTED AVERAGE = 0.3799 ± 0.0029
ERROR SCALED BY 1.6

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18  (LAMBDA - ANTILAMBDA)/AVG., MEAN LIFE DIFFERENCE

DT            0.044     0.085            BADIER    67 HBC     2.4 PBAR P          8/67
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18  LAMBDA MAGNETIC MOMENT (MAGNETONS,938.28 MEV)

MM           -1.5       0.5              COOL       62 DSPK
MM            0.0       0.6              KERNAN     63 CC
MM     8553  -1.39      0.72             ANDERSON   64 HBC
MM      151  -0.5       0.28             CHARRIERE  65 EMUL
MM       49  (-0.67)    (0.31)   (0.37)  BARKOV     71 EMUL   PRELIM. RESULT     2/72
MM     1300  -0.66      0.07             DAHLJENSE  71 EMUL   MAG FIELD=200KG    6/71
MM     3668  -0.73      0.18             HILL       71 DSPK                     10/71
MM       57  -0.65      0.28             BARKOV     72 EMUL INCLUDES BARKOV 71   3/78
MM     1.2M  -0.57      0.05             BUNCE      76 SPEC                      1/78
MM     350K  -0.59      0.07             HELLER     77 SPEC                      1/78
MM       3M  -0.6138    0.0047           SCHACHING  78 SPEC                      1/79
MM     200K  -0.606     0.015            COX        81 SPEC                     12/81*
MM                  . . . . . . . . . . .
MM  AVG      -0.6130    0.0044  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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18  LAMBDA ELECTRIC DIPOLE MOMENT (UNITS 10**-14 E CM)
    NONZERO VALUE IMPLIES VIOLATION OF T AND P

EDM        (5.0)  OR LESS  CL=.95   GIBSON     66 EMUL                      2/72
EDM  B     (1.0)  OR LESS  CL=.95   BARONI     71 EMUL                      2/72
EDM  P     (0.015)OR LESS  CL=.95   PONDROM    81 SPEC                      1/82*
EDM  B  BARONI MEASURES (-5.9+-2.9)*10**-15 E CM                            2/72
EDM  P  PONDROM 81 MEASURE (-3.0+-7.4)*10**-17 E CM .                       1/82*
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18  LAMBDA PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     LAMBDA INTO PROTON PI-                        938+ 139
P2     LAMBDA INTO NEUTRON PI0                       939+ 134
P3     LAMBDA INTO PROTON MU- NEUTRINO               938+ 105+   0
P4     LAMBDA INTO PROTON E- NEUTRINO                938+  .5+   0
P5     LAMBDA INTO PROTON PI- GAMMA                  938+ 139+   0
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18  LAMBDA BRANCHING RATIOS

R1     LAMBDA INTO (P PI-)/((P PI-)+(N PI0))                 (P1)/(P1+P2)
R1            0.627     0.031            CRAWFORD  59 HBC
R1            0.65      0.05             COLOMBIA  60 HBC
R1  U        (0.685)   (0.017)           ANDERSON  62 HBC
R1     903    0.643     0.016            HUMPHREY  62 HBC
R1  U 6736    0.635     0.007            DOYLE     69 HBC     PI-P TO LAM. K0   2/71
R1    4572    0.646     0.008            BALTAY    71 HBC     K-P AT REST       6/71
R1  U   ANDERSON RESULT NOT PUBLISHED. EVENTS ADDED TO DOYLE SAMPLE.            2/71
R1               . . . . . . . . . . .
R1  AVG       0.6399    0.0049  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT       0.6419    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     LAMBDA INTO (N PI0)/((P PI-)+(N PI0))                 (P2)/(P1+P2)
R2            0.23      0.09             FISLER    57 HLBC
R2            0.43      0.14             CRAWFORD  59 HBC
R2            0.28      0.08             BAGLIN    60 HLBC
R2            0.35      0.05             BROWN     63 HLBC
R2      75    0.291     0.034            CHRETIEN  63 HLBC
R2               . . . . . . . . . . .
R2  AVG       0.304     0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       0.3581    0.0049 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     LAMBDA INTO (P E- NEU)/TOTAL (UNITS 10**-3)       (P4)/(P1+P2)
R3  O   15   (2.0)     (0.5)             HUMPHREY  61 RVUE
R3  O    8   (2.9)     (1.5)     (1.2)   AUBERT    62 FBC
R3  N  150   (0.82)    (0.12)            ELY       63 FBC     K- AT REST
R3  N  102   (0.78)    (0.12)    (0.13)  BAGLIN    64 FBC     K- AT 1.45 GEV/C
R3  O   20   (1.55)    (0.34)            LIND      64 HBC
R3  N  143   (0.80)    (0.08)            MALONEY   69 HBC                      10/69
R3  N   86   (0.78)    (0.09)            CANTER    71 HBC     K-P AT REST       4/71
R3  N  218   (0.88)    (0.10)            LINDQUIST 71 DSPK    PI- P TO K0 LAM   2/72
R3  N   THESE VALUES HAVE BEEN CHANGED BY US INTO RATIOS TO PROTON PI-,         3/72
R3  N   BECAUSE THAT IS THE DIRECTLY MEASURED QUANTITY. SEE R5 BELOW            3/72
R3  O   LOW STATISTICS EXPERIMENTS.  NOT AVERAGED                               7/70

R4     LAMBDA INTO (P MU- NEU)/TOTAL (UNITS 10**-4)      (P3)/(P1+P2)
R4       1   ....  ... MORE              ....      62 HBC
R4       1   (1.0)  OR LESS              ALSTON    63 HBC
R4       2   (1.0)  OR LESS              KERNAN    64 FBC
R4     BETWEEN 1.3 AND 6.0               LIND      64 HBC
R4       3    1.3       0.7              LIND      64 RVUE                      7/66
R4       2    1.5       1.2              RONNE     64 FBC
R4       9    2.4       0.8              CANTER1   71 HBC     STOPPED K-P       7/71
R4      14    1.4       0.5              BAGGETT2  72 HBC     STOP K-           8/72
R4               . . . . . . . . . . .
R4  AVG       1.57      0.35    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5     LAMBDA INTO (P E- NEU)/(P PI-) (UNITS 10**-3)     (P4)/(P1)
R5     150    1.  .     0.20             ELY       63 FBC                       2/72
R5     120    1.17      0.18             BAGLIN    64 FBC                       2/72
R5     143    1.20      0.12             MALONEY   69 HBC                       2/72
R5    1078    1.31      0.06             ALTHOFF1  71 DSPK                      2/72
R5  C   86    1.17      0.13             CANTER    71 HBC     K-P AT REST       3/72
R5  LC 218   (1.32)    (0.15)            LINDQUIST 71 DSPK    PI-P TO K0 LAM    3/72
R5  L  544    1.23      0.11             LINDQUIST 77 SPEC    PI-P TO K0 LAM   12/77
R5     10K    1.313     0.024            WISE      80 SPEC                      8/81*
R5  C  CALCULATED BY US FROM R3 ASSUMING THE AUTHORS USED (P PI-)/TOT=2/3    3/72
R5  L  LINDQUIST 77 INCLUDES DATA OF LINDQUIST 71.                           12/77
R5               . . . . . . . . . . .
R5  AVG       1.300     0.021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6     LAMBDA INTO (P PI- GAMMA)/(P PI-) (UNITS 10**-3) (P5)/(P1)              1/73
R6      72    1.32      0.22             BAGGETT3  72 HBC  PI- MOM LT 95 MEV/C  1/73
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18  LAMBDA DECAY PARAMETERS

    RELATED TEXT SECTION VI D AND APPENDIX I

A-     ALPHA LAMBDA- (LAMBDA INTO PI- PROTON)
A-    1156    0.62      0.07             CRONIN    63 CNTR    LAMBDA FROM PI-P  6/67
A-           (0.663)   (0.022)           BERGE     66 RVUE  INCLUDES ABOVE      5/56
A-   10130    0.645     0.017            OVERSETH  67 OSPK    LAMBDA FROM PI-P  8/67
A-  M 2529   (0.747)   (0.086)           MERRILL   68 HBC  REPL BY DAUBER 69    6/66
A-    3520    0.67      0.06             DAUBER    69 HBC  FROM XI DECAY        6/69
A-   10325    0.649     0.023            CLELAND   72 OSPK    LAMBDA FROM PI-P  5/72
A-    8500    0.584     0.046            ASTBURY   75 SPEC    LAMBDA FROM PI-P  2/76
A-               . . . . . . . . . . .
A-  AVG       0.642     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

A0     ALPHA0 /ALPHA- FOR LAMBDA (L INTO PI0 N/L INTO PI- P)
A0            1.10      0.27             CORK      60 CNTR
A0 D  4760    1.000     0.068            OLSEN     70 OSPK PI+N TO K+ LAMBDA   5/70
A0               . . . . . . . . . . .
A0  AVG       1.006     0.066   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A0 D   DONE BY COMPARING PROTON DISTR.WITH N DISTR. FROM LAMBDA DECAY.

F-     PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)   (DEGREES)
F-    1156   13.0      17.0              CRONIN    63 OSPK    LAMBDA FROM PI-P 11/67
F-   10130   -8.0       6.0              OVERSETH  67 OSPK    LAMBDA FROM PI-P 11/67
F-    7377  (-9.2)     (5.2)             CLELAND   67 OSPK REPL BY CLELAND 72   5/72
F-   10325   -7.0       4.5              CLELAND   72 OSPK    LAMBDA FROM PI-P  5/72
F-               . . . . . . . . . . .
F-  AVG      -6.5       3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV      GA/GV FOR LAMBDA BETA DECAY (SEE TEXT SEC. VI D.1 FOR SIGN CONV.)
AV  C   22  (-1.03)                      LIND      64 HBC                       6/67
AV  C  102   (0.6)   OR MORE             BAGLIN    65 HLBC    NO SIGN GIVEN     1/71
AV  C      BETW 0. AND -1.1              BARLOW    65 DSPK                      6/68
AV  C  102   (0.7)   OR MORE  CL=.95     ELY       65 HLBC     ABS. VALUE       1/71
AV  C   EXPERIMENTS INCLUDED IN CONFORTO 65. RVUE                               6/56
AV           -1.19      0.23      0.33   CONFORTO  65 RVUE                     11/67
AV M   148   -0.72      0.14      0.19   MALONEY   69 HBC                      10/69
AV  A 1078  (-0.62)    (0.08)    (0.09)  ALTHOFF2  71 OSPK    POLARIZED LAMBDA  7/73
AV M   141   -0.75      0.15      0.18   CANTER    71 HBC                       4/71
AV  L  173  (-0.40)    (0.13)    (0.17)  LINDQUIST 71 OSPK  E-NEU AND UP-DOWN   9/71
AV M   352   -0.74      0.09      0.12   BAGGETT1  72 HBC     STOP.K-           2/72
AV A   817   -0.63      0.06             ALTHOFF1  73 OSPK  POLARIZED LAMBDA    7/73
AV     405   -0.47      0.09             BURNETT   76 SPEC  E-NEU AND SPIN      2/78
AV   L 441   -0.53      0.09      0.11   LINDQUIST 77 SPEC POL LAMBDA, 3 ASYMM 12/77
AV M   10K   -0.734     0.031            WISE      81 SPEC E-NEU ANG. CORREL.   1/82*
AV  A   ALTHOFF1 73 INCLUDES DATA OF ALTHOFF2 71.  USES PROT SPECTRUM AND       7/73
AV  A   THREE SPIN ASYMMETRIES.                                                 7/73
AV M    EXPT MEASURES ONLY THE ABSOLUTE VALUE OF A/V                            7/73
AV   L  LINDQUIST 77 INCLUDES DATA OF LINDQUIST 71.                            12/77
AV               . . . . . . . . . . .
AV  AVG      -0.690     0.034   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                (SEE IDEOGRAM BELOW )
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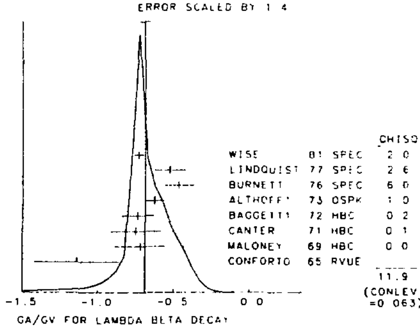
WEIGHTED AVERAGE = -0.690 ± 0.034
ERROR SCALED BY 1.4



REFERENCES FOR LAMBDA

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EISLER    57 NC      5 1700        EISLER,PLANO,SAMIOS,SCHWARTZ +    (COLU+BNL)
BOLDT     58 PRL     1  148        E BOLDT,D O CALDWELL,Y PAL              (MIT)
CRAWFORD  59 PRL     2  266        CRAWFORD,CRESTI,DOUGLASS,GOOD +         (LRL)

BAGLIN    60 NC     18 1043        BAGLIN,BLOCH,BRISSON,HENNESSY +        (EPOL)
BOWEN     60 PR    119 2030        BOWEN,HARDY,REYNOLDS,SUN +        (PRINCETON)
CORK      60 PR    120 1000        CORK,KERTH,WENZEL,CRONIN+     (LRL+PRIN+BNL)
COLUMBIA  60 ROCH CONF 726         M SCHWARTZ +                       (COLUMBIA)
HUMPHREY  61 PRL     6  479        HUMPHREY,KIRZ,ROSENFELD,RHEE +     (LRL+SYRA)

ANDERSON  62 CERN CONF 832         ANDERSON,CRAWFORD,GOLDEN,LLOYD +        (LRL)
AUBERT    62 NC     25  479        AUBERT,BRISSON,HENNESSY,STY +          (EPOL)
CHANG     62 THESIS DUKE           CHUEN CHUEN CHANG                      (DUKE)
COOL      62 PR    127 2223        COOL,HILL,MARSHALL +         (BNL+MIT+NYU+ANL)
GOOD      62 PRL     9  518        M L GOOD,V G LIND                 (WISCONSIN)
HUMPHREY  62 PR    127 1305        W E HUMPHREY,R R ROSS                   (LRL)

ALSTON    63 UCRL 10926            ALSTON,KIRZ,NEUFELD,SOLMITZ,WOHLHUT     (LRL)
BHOWMIK   63 NC     28 1494        B BHOWMIK,D P GOYAL                   (DELHI)
BLOCK     63 PR    130  766        BLOCK,GESSAROLI,RATTI+(NWES+BGNA+SYRA+ORNL)
BROWN     63 PR    130  769        BROWN,KADYK,TRILLING,ROE +         (LRL+MICH)
CHRETIEN  63 PR    131 2208        CHRETIEN,CROUCH+    (BRAN+BROWN+HARVARD+MIT)
CRONIN    63 PR    129 1795        J W CRONIN,O E OVERSETH           (PRINCETON)
ELY       63 PR    131  868        ELY,GIDAL,KALMUS,OSWALD,POWELL +        (LRL)
KERNAN    63 PR    129  870        KERNAN,NOVEY,WARSHAW,WATTENBERG    (ANL+ILL)

ANDERSON  64 PRL    13  167        J A ANDERSON,F S CRAWFORD               (LRL)
BAGLIN    64 NC     35  977        BAGLIN,BINGHAM+  (EPOL+CERN+LOUC+RHEL+BERG)
HUBBARD   64 PR    135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +      (LRL)
KERNAN    64 PR    133 B 1271      KERNAN,POWELL,SANDLER +            (LRL+LOUC)
KREISLER  64 PR 136 B 1074         M N KREISLER,O OVERSETH,J CRONIN       (PRIN)
LIND      64 PR    135 B 1483      LIND,BINFORD,GOOD,STERN           (WISCONSIN)
RONNE     64 PL     11  357        RONNE+          (CERN+EPOL+LOUC++UNIV.BERGEN)
SCHWARTZ  64 UCRL 11360 THESIS     JOSEPH ADAM SCHWARTZ                    (LRL)

BAGLIN    65 NC 35 977             BAGLIN +          (EPOL,CERN,LOUC,RHEL,BERGEN)
BALTAY    65 PR 140 B 1027         BALTAY,SANDWEISS,CULWICK,KOPP +    (YALE+BNL)
BARLOW    65 PL   18  64           J BARLOW,BLAIR,CONFORTO+     (CERN+RHEL+PENN)
CHARRIER  65 PL    15     66       CHARRIERE,GIBSON+       (EPOL+BRIS+CERN+MPIM)
    ALSO  66 NC   46A  205         CHARRIERE,GIBSON +      (EPOL,BRIS,CERN,MPIM)
CONFORTO  65 EC INT HERZEGNOVI     G CONFORTO                             (CERN)
ELY       65 PR 137 B1302          ELY,GIDAL,KALMUS,POWELL +          (LRL,LOUC)
HILL      65 PRL 15 85             HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
SCHMIDT   65 PR 140 B 1328         P SCHMIDT                          (COLUMBIA)

BERGE     66  BERKELEY 46          BERGE,CABIBBO              ((RVUE) LRL,CERN)
BURAN     66 PL 20 318             BURAN,EIVINDSON,SKJEGGESTAD,TOFTE +    (OSLO)
CHIEN     66 PR   152  1171        +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)
ENGELMAN  66 NC 45B  1038          ENGELMANN,FILTHUTH,ALEXANDER+     (HEID,REHO)
GIBSON    66 NC 45B 882            W M GIBSON,K GREEN                     (BRIS)
LONDON    66 PR 143 1034           LONDON,RAU,GOLDBERG,LICHTMAN+     (BNL,SYRA)

AUERBACH  67 NC   47A  19          AUERBACH,BOWEN,DOBBS,LANDE,MANN+       (PENN)
BADIER    67 PL 253 152            +BONNET,BRIANDET,SADOULET              (EPOL)
CLELAND   67 PL 24B 45             CLELAND,BIENLEIN,CONFORTO+ (CERN+GEVA+LUND)
MAYEUR    67 U.LIBR.BRUX.BUL32     C.MAYEUR,E.TOMPA,J.WICKENS        (BELG,LOUC)
OVERSETH  67 PRL   19  391         O E OVERSETH, R F ROTH            (MICH+PRIN)
GRIMM     68 NC 54A 187            H.-J.GRIMM                       (HEIDELBERG)
HEPP      68 ZPHYS 214 71          V.HEPP,H. SCHLEICH               (HEIDELBERG)
MERRILL   68 PR 167 1202           MERRILL,SHAFER                          (LRL)

DAUBER    69 PR   179 1262         +BERGE,HUBBARD,MERRILL,MILLER           (LRL)
DOYLE     69 UCRL 18139-THESIS     J.C. DOYLE                              (LRL)
MALONEY   69 PRL 23 425            MALONEY SECHI-ZORN           (UNIV MARYLAND)
BOHM      70 NC 70A 394            + KRECKER + (BEPL+BRUX+DUUC+LOUC+LOWC+WARS)
DEMIDOV   70 SJNP 10 691           +KIRILLOV-UGRYUMOV,PONOSOV,PROTASOV+ (ITEP)
OLSEN     70 PRL 24 843            +PONDROM,HANDLER,LIMON,SMITH +   (WISC,MICH)

ALTHOFF1  71 PL 37B 531            +BROWN,FREYTAG,HEARD,HEINTZE +   (CERN,HEID)
ALTHOFF2  71 PL 37B 535            +BROWN,FREYTAG,HEARD,HEINTZE +   (CERN,HEID)
BALTAY    71 PR 04 670             +BRIDGEWATER,COOPER,HABIBI+       (COLU+BING)
BARKOV    71 JETPL 14 60           +GUREVICH,MAKARINA,MARTEMYANCV+        (ITEP)
BARONI    71 LNC 2 1256            G BARONI,S PETRERA,G ROMANO            (ROMA)
CANTER    71 PRL 26 868            +COLE,LEE-FRANZINI,LOVELESS +     (STON+COLU)

CANTER1   71 PRL 27 59             +COLE,LEE-FRANZINI,LOVELESS+      (STON+COLU)
DAHLJENS  71 NC 3A 1               DAHL-JENSEN +     (CERN+ANKA+LAUS+MPIM+ROMA)
HILL      71 PR D4 1979            +LI,JENKINS,KYCIA,RUDERMAN          (MIT,BNL)
    ALSO  65 PRL 15 85             HILL,LI,JENKINS,KYCIA,RUDERMAN      (MIT,BNL)
LINDQUIS  71 PRL 27 612            LINDQUIST,SUMNER+          (EFI,WUSL,OSU,ANL)

BAGGETT1  72 ZPHY 249 279          +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT2  72 ZPHY 252 362          +BAGGETT,EISELE,FILTHUTH,FREHSE+       (HEID)
BAGGETT3  72 PL 42B 379            +BAGGETT,EISELE,FILTHUTH,FREHSE,HEPP+(HEID)
BARKOV    72 JETPL 16 104          +GUREVICH,MAKARINA,MARTEMYANCV +       (ITEP)
CLELAND   72 NP B40 221            +CONFORTO,EATON,GERBER+     (CERN+GEVA+LUND)
HYMAN     72 PR D5 1063            +BUNNELL,DERRICK,FIELDS,KATZ+      (ANL+CARN)

ALTHOFF1  73 PL 43B 237            +BROWN,FREYTAG,HEARD,HEINTZE+     (CERN+HEID)
ALTHOFF2  73 NP B66 29             +BROWN,FREYTAG,HEARD,HEINTZE+     (CERN+HEID)
COULARD   73 PL 46B 135            +GIVERNAUD,BORG                        (SACL)

ASTBURY   75 NP B99 30             +GALLIVAN,JAFAR +         (LOIC+CERN+ETH+SACL)
CLAYTON   75 NP B95 130            +BACON,BUTTERWORTH,WATERS +       (LOIC+RHEL)
BUNCE     76 PRL 36 1113           +HANDLER,MARCH,MARTIN +      (WISC+MICH+RUTG)
BURNETT   76 NC 34A 14             +INNES,MASEK,MAUNG,MILLER,RUDERMAN+    (UCSC)

HELLER    77 PL 68B 480            +OVERSETH,PONDROM,DYDAK +    (MICH+WISC+HEID)
LINDQUIS  77 PR D16 2104           LINDQUIST,SWALLOW,SUMNER +      (EFI+OSU+ANL)
    ALSC  76 JPG 2 L211            LINDQUIST,SWALLOW,SUMNER+(EFI+WUSL+OSU+ANL)
TECH      77 NP B124 413           +DYDAK,NAVARRIA+        (SIEG+CERN+DORT+HEID)
SCHACHIN  78 PRL 41 1348           SCHACHINGER,BUNCE,COX +      (MICH+RUTG+WISC)

WISE      80 PL 91B 165            +JENSEN,KREISLER,LOMANNO,POSTER+ (MASA+BNL)
COX       81 PRL 46 877            +DWORKIN +            (MICH+WISC+RUTG+MINN+BNL)
PONDROM   81 PRD 23 814            +HANDLER,SHEAFF,COX + (WISC+MICH+RUTG+MINN)
WISE      81 PL 98B 123            +JENSEN,KREISLER,LOMANNO,POSTER, (MASA+BNL)

                                   PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER  62 CERN CONF 236         ARMENTEROS+ (CERN+EPOL+LOIC+BIRM+CEN-SACLAY)
BALTAY    62 CERN CONF 233         BALTAY,FOWLER,SANDWEISS,CULWICK+ (YALE+BNL)
BERGE     63 THESIS (BERKELEY)     J PETER BERGE                           (LRL)
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                  19  SIGMA+(1189,JP=1/2+) I=1

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                  19  SIGMA+ MASS (MEV)

M    N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M       144 1189.38     0.15             BARKAS    63 EMUL +  SEE NOTE S BELOW
M        58 1189.48     0.22             BHOWMIK   64 EMUL +  SEE NOTE S BELOW
M    S  ABOVE SIGMA+ MASSES HAVE BEEN RAISED 30  KEV TO ACCOUNT FOR 46 KEV
M    S  INCREASE IN PROTON MASS AND 21 KEV DECREASE IN PION MASS
M      4205 1189.61     0.08             SCHMIDT   65 HBC  SEE NOTE N        3/74
M           1189.16     0.12             HYMAN     67 HEBC                   6/68
M     B 607 1189.33     0.04             BOHM      72 EMUL                  12/73
M     B  BOHM 72 UPDATED WITH PDG APR. 73 K-, PI- AND PIO MASSES.           12/73
M
M               . . . . . . . . . .
M    AVG    1189.371    0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
M    FIT    1189.365    0.058  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)  3/82*
                                (SEE IDEOGRAM BELOW )
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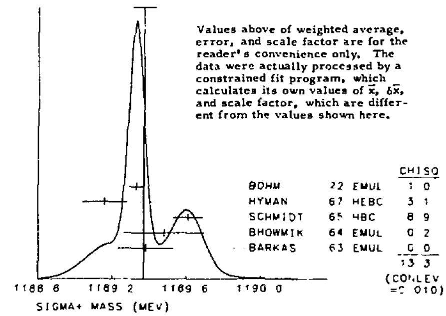
WEIGHTED AVERAGE = 1189.371 ± 0.060
ERROR SCALED BY 1 8

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                  19  SIGMA+ MEAN LIFE (UNITS 10**-10 SEC)

T                                         GLASER    56 RVUE
T         127     0.98      0.16   0.12   PUSCHEL   60 EMUL
T          41     0.82      0.34   0.20   EVANS     60 EMUL
T         117     0.85      0.14   0.11   FREDEN    60 EMUL
T          54     0.80      0.10   0.067  KAPLON    60 EMUL
T          23     0.76      0.22   0.14   CHIESA    61 EMUL
T          49     0.75      0.13   0.09   BERTHELOT 61 HLBC
T         140     0.87      0.10   0.08   BARKAS    61 EMUL
T         192     0.749     0.056  0.052  GRARD     62 HBC
T         456     0.765     0.04          HUMPHREY  62 HBC
T         203     0.84      0.12   0.08   BHOWMIK   64 EMUL
T         181     0.84      0.09          BALTAY    65 HBC                    6/66
T         900     0.76      0.03          CARAYAN   65 HBC                    6/66
T   C    1300     0.83      0.032         CHANG     66 HBC                    6/66
T    S    125    (0.86)    (0.15)         CHIEN     66 HBC  +   6.9 PBAR P    9/67
T    S    117    (1.10)    (0.24)         CHIEN     66 HBC  -   6.9 PBAR P,ANTI 9/67
T         381     0.80      0.07          COOK      66 OSPK                   7/66
T       10664     0.803     0.008         BARLOUTAU 69 HBC   K-P .4-1.2 GEV/C 11/69
T         20K     0.795     0.010         EISELE    70 HBC   K-P AT REST      2/71
T         526     0.83      0.04          BAKKER    71 DBC   K-N TO SIG+ 2PI- 10/71
T        5719     0.807     0.013         CONFORTO  76 HBC   K-P 1-1.4 GEV/C  11/77
T         30K     0.798     0.005         MARRAFFIN 80 HBC   K- P TO SIG+ PI-  2/80
T   C    CHANG ERROR 0.018 RAISED BY US.  SEE 1970 EDITION. RMP 42.123(1970)  1/73
T    S   ERROR PURELY STATISTICAL
T              . . . . . . . . . .
T    AVG          0.7997    0.0036   0.0036 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                  19  SIGMA+ MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM        381     1.5       1.1           COOK       66 OSPK                  7/66
MM         57     3.5       1.5           KOTELCHUC  67 EMUL  K-P AT 1.15BEV/C 8/67
MM         51     3.0       1.2           SULLIVAN   67 EMUL  PHOTOPRODUCTION  6/57
MM         69     3.5       1.2           COMBE      68 EMUL                  10/68
MM      29333     2.1       1.0           MAST       68 HBC   K-P AT .4 GEV/C  6/68
MM        955     2.67      0.97          ALLEY      71 OSPK  1.28 GEV/C PI+P 10/70
MM       2651     2.7       0.9           SAHA       73 HLBC  K-P.25TO.55GEV/C 6/73
MM     S 8503    (2.95)    (0.31)         DOBLE      77 HBC   K-P .46 GEV/C   12/77
MM     S  14K     2.30      0.14          SETTLES    79 HBC   K-P.42TO.50GEV/C 12/79
MM     S  SETTLES 79 INCLUDES DOBLE 77 DATA.                                  12/79
MM             . . . . . . . . . .
MM   AVG          2.33      0.13    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  19  SIGMA+ PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      SIGMA+ INTO PROTON PI0                               938+ 134
P2      SIGMA+ INTO NEUTRON PI+                              939+ 139
P3      SIGMA+ INTO NEUTRON PI+ GAMMA                        939+ 139+   0
P4      SIGMA+ INTO LAMBDA E+ NEU                           1115+  .5+   0
P5      SIGMA+ INTO PROTON GAMMA                             938+   0
P6      SIGMA+ INTO NEUTRON MU+ NEUTRINO                     939+ 105+   0
P7      SIGMA+ INTO NEUTRON E+ NEUTRINO                      939+  .5+   0
P8      SIGMA+ INTO PROTON E+ E-                             938+  .5+  .5

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                19  SIGMA+ BRANCHING RATIOS

R1      SIGMA+ INTO (NEUTRON PI+)/(NUCLEON PI)              (P2)/(P1+P2)
R1      308    0.490    0.024         HUMPHREY  62 HBC
R1      534    0.46     0.02          CHANG     66 HBC                        6/66
R1     1331    0.488    0.010         BARLOUTAU 69 HBC     K-P .4-1.2 GEV/C 11/69
R1      537    0.484    0.015         TOVEE     71 EMUL                      12/71
R1     1861    0.488    0.008         NOWAK     78 HBC   BRITISH 1.5M (TST)  7/79
R1    M 10K    0.4828   0.0036        MARRAFFIN 80 HBC     K-P 420-500MEV/C  2/80
R1   M  MARRAFFINO 80 GIVES BR TO (P PI0)/ALL.  WE QUOTE 1-BR.               2/80
R1           . . . . . . . . . .
R1   AVG       0.4836   0.0030  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      SIGMA+ INTO (NEUT PI+ GAM)/(PI+N) (UNITS 10**-3) (P3)/(P2)
R2           (1.8)      ABOUT         BAZIN2    65 HBC     PI+ LT 116 MEV/C  8/67
R2      29   (0.27)     (0.05)        ANG       69 HBC     PI+ LT 110 MEV/C 11/68
R2     180    0.93       0.10         EBENHOH   73 HBC     PI+ LT 150 MEV/C  3/74
R2      PI+ MOMENTUM CUTS DIFFER, NOT AVERAGED. LATEST VALUE USED IN TABLE.  4/82*

R3      SIGMA+ INTO (LAMBDA E+ NEU)/TOTAL (UNITS 10**-5) (P4)
R3  M     4   (3.3)      (1.7)         WILLIS    64 HBC     STOP. K-          9/66
R3  M                    EVENTS FROM THIS EXPERIMENT.INCLUDED IN EISELE1 69  11/69
R3        6    2.0        0.8          BARASH    67 HBC     STOP K-           8/67
R3        5    1.6        0.7          BALTAY    69 HBC     STOP K-          11/69.
R3       10    2.9        1.0          EISELE1   69 HBC     STOP K-          10/69
R3           . . . . . . . . . .
R3  AVG        2.02       0.47    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      SIGMA+ INTO (P GAMMA)/(P PI0) (UNITS 10**-2)      (P5)/(P1)
R4        1  (0.068)OR LESS            CARRARA   64 HBC
R4       24    0.37       0.08         BAZIN     65 HBC
R4        4  (0.17)                    QUARENI   65 EMUL                       6/66
R4       45    0.21       0.03         ANG       69 HBC     STOP K-          10/69
R4       31    0.276      0.051        GERSHWIN  69 HBC                      10/69
R4       46    0.211      0.038        MANZ      80 HBC  K- P-->SIGMA+ PI-    9/81*
R4           . . . . . . . . . .
R4  AVG        0.232      0.025   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                  (SEE IDEOGRAM BELOW )
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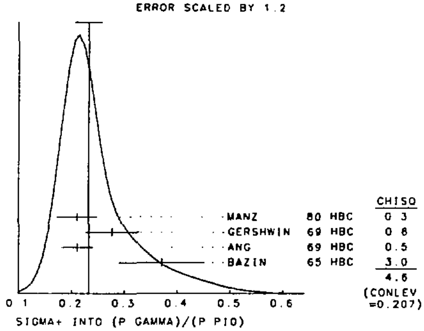
WEIGHTED AVERAGE = 0.232 ± 0.025
ERROR SCALED BY 1.2

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R5      SIGMA+ INTO (N E+ NEU)/(N PI+) (UNITS 10**-5)     (P7)/(P2)
R5 ED     0   (16220)EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E       11/67
R5 ED     0    (2720)EFFECTIVE DENOM.  MURPHY    64 HBC     SEE NOTE E       11/67
R5 ED     1    (9690)EFFECTIVE DENOM.  NAUENBERG 64 HBC     SEE NOTE E        6/68
R5  D     0   (32406)EFFECTIVE DENOM.  BIERMAN   68 HBC                       6/68
R5 UA     0   (80400)EFFECTIVE DENOM.  EISELE2   69 HBC     STOP K-           6/68
R5 UD     1   (30000)EFFECTIVE DENOM.  NORTON    69 HBC                      11/69
R5  D   OLDER LOWER STATISTICS EXPTS. NOT INCLUDED IN AVERAGE.                2/76
R5 U      0   105000 EFFECTIVE DENOM.  SECHIZORN 73 HBC     STOP K-           2/76
R5 U A    0   111000 EFFECTIVE DENOM.  EBENHOH   74 HBC     STOP K-           1/76
R5 U                 EFFECTIVE DENOM.  CALCULATED BY US
R5 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                  11/67
R5    A  EISELE2 69 REPLACED BY BY EBENHOH 74.                                1/76
R5           . . . . . . . . . .
R5            1.1   OR LESS  CL=.90   OUR AVERAGE (2.3 EVTS)/(EFF.DNOM.SUM)  2/76
R5      NUMBER OF EVENTS INCREASED TO 2.3 FOR 90PC CONFIDENCE LEVEL           2/76

R6      SIGMA+ INTO (N MU+ NEU)/(PI+N) (UNITS 10**-5)     (P6)/(P2)
R6        1    (120)ANALYSED EVENTS    GALTIERI  62 EMUL    NO RATIO QUOTED  11/67
R6 E      0    10150 EFFECTIVE DENOM.  COURANT   64 HBC     SEE NOTE E       11/67
R6 E      0     1710 EFFECTIVE DENOM.  NAUENBERG 64 HBC     SEE NOTE E       11/67
R6 U      2    62000 EFFECTIVE DENOM.  EISELE2   69 HBC                       6/68
R6        0    33800 EFFECTIVE DENOM.  BAGGETT   69 HBC                      11/68
R6 E                 EFFECTIVE DENOM.  TAKEN FROM EISELE 67                  11/67
R6 U                 EFFECTIVE DENOM.  CALCULATED BY US
R6           . . . . . . . . . .
R6            6.2   OR LESS  CL=.90   OUR AVERAGE (6.7 EVTS)/(EFF.DNOM.SUM)  2/76
R6      NUMBER OF EVENTS INCREASED TO 6.7 FOR 90PC CONFIDENCE LEVEL           2/76

R7      (SIGMA+ INTO LEPTONS)/(SIGMA- INTO LEPTONS)
R7        0   (0.034)OR LESS           BAGGETT   67 HBC                       6/68
R7        1   (0.08) OR LESS           NORTON    69 HBC                      10/69
R7           . . . . . . . . . .
R7            0.043 OR LESS  CL=.90   OUR AVERAGE  USING R5 AND R6            2/76

R8      SIGMA+ INTO (PROTON E+ E-)/TOTAL (UNITS 10**-6)  (P8)
R8            7.0   OR LESS            ANG       69 HBC     STOP K-          10/69
R8    A   ANG 69 FOUND 3 E+E- EVENTS IN AGREEMENT WITH GAMMA CONVERSION OF
R8    A   PROTON GAMMA DECAY -LIMIT GIVEN HERE IS FOR NEUTRAL CURRENT

R9      (SIGMA+ INTO N MU+ NEU)/(SIGMA- INTO N MU- NEU)
R9      2  0.06        0.045    0.03   EISELE2   69 HBC  +- STOP K-          10/69
R9           . . . . . . . . . .
R9            0.12  OR LESS  CL=.90   OUR AVERAGE  USING R6                   2/71

R10     (SIGMA+ INTO N E+ NEU)/(SIGMA- INTO N E- NEU)
R10 E     0   (0.03) OR LESS  CL=.90   EISELE2   69 HBC  +- STOP K-          10/69
R10 D     0   (0.12) OR LESS  CL=.95   COLE      71 HBC  +- STOP K-          10/71
R10 D   LOWER STATISTICS EXPERIMENT NOT INCLUDED IN AVERAGE                   2/76
R10       0   (0.018)OR LESS  CL=.90   SECHIZORN 73 HBC  +- STOP K-,POISSON   8/73
R10  E    0   (0.019)OR LESS  CL=.90   EBENHOH   74 HBC  +- STOP K-          12/75
R10  E  EISELE2 69 REPLACED BY EBENHOH 74.                                   12/75
R10          . . . . . . . . . .
R10           0.009 OR LESS  CL=.90   OUR AVERAGE  USING R5                   2/76
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                19  SIGMA+ DECAY PARAMETERS

        RELATED TEXT SECTION VI D AND APPENDIX I

A+0     ALPHA+/ALPHA0 FOR SIGMA+ (SIG+ TO PI+ N)/(SIG+ TO PI0 P)
A+0          (+0.04)    (0.11)        CORK      60 CNTR    SIG+ FROM PI+P
A+0          (+0.20)    (0.24)        TRIPP     62 HBC     REPLAC.BY BANGER
A+0 D 3500   (-.014)    (0.052)       BANGERTER 66 HBC     SIG+ FROM K-P     9/66
A+0 D 2600   (-.047)    (0.07)        BERLEY    66 HBC     SIG+ FROM K-P     9/66
A+0     20K  (-0.104)   (0.028)       REUCROFT  77 HBC REPL.BY MARRAFFINO80  6/77
A+0     23K   -0.073     0.021        MARRAFFIN 80 HBC     K- P TO SIG+ PI-  2/80
A+0 D        OLD RESULTS, HAVE BEEN REPLACED. SEE BELOW.
A+0          . . . . . . . . . .
A+0 FIT       -0.069     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  4/82*

A+      ALPHA+ FOR SIGMA+ (SIG+ TO PI+ N)
A+    35000    0.069     0.017        BANGERTER 69 HBC     K-P AT 400 MEV/C 11/69
A+     4101    0.037     0.049        BERLEY    70 HBC                      12/70
A+           . . . . . . . . . .
A+  AVG        0.066     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A+  FIT        0.068     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  4/82*

A0      ALPHA0 FOR SIGMA+ (SIG+ INTO PI0 PROTON)
A0            -0.80      0.16             BEALL     62 CNTR
A0           (-0.90)    (0.25)            TRIPP     62 HBC     REPLAC. BY BANGE
A0  D 5200   (-0.986)   (0.072)           BANGERTER 66 HBC     K-P TO SIG+ PI-   7/66
A0    32000   -0.999     0.022            BANGERTER 69 HBC                     10/69
A0 H  1335    -0.98      0.05      0.02   HARRIS    70 OSPK    PI+P TO SIG+ K+   5/70
A0      16K   -0.940     0.045            BELLAMY   72 ASPK    PI+P TO SIG+ K+  11/72
A0 L  1259    -0.945     0.055     0.042  LIPMAN    73 OSPK    PI+P TO SIG +     7/73
A0 L     DECAY PROTONS SCATTERED OFF ALUMINUM.                                  7/73
A0 H     DECAY PROTONS SCATTERED OFF CARBON.
A0           . . . . . . . . . .
A0  AVG       -0.979     0.016   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
A0  FIT       -0.979     0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  4/82*

F+      PHI+ ANGLE (SIG+ INTO N PI)  SIN(PHI)/COS(PHI)=BETA/GAMMA  (DEGREE)
F+  D  370 (180.)     (30.)           BERLEY    66 HBC     NEUTRON RESCATT.  9/66
F+     560  143.       29.            BANGERT1  69 HBC                      10/69
F+   C1054  184.       24.            BERLEY    70 HBC     K-P AT 400 MEV/C 11/69
F+   C  CHANGED FROM 176 TO 184 TO AGREE WITH SIGN CONVENTION.
F+           . . . . . . . . . .
F+  AVG      167.3      20.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

AG      ALPHAG FOR SIGMA+ (SIG+ INTO PROTON GAMMA)
AG       61   -1.03      0.52      0.42  GERSHWIN  69 HBC     K-P TO SIG PI    11/69
AG       46   -0.53      0.38      0.36  MANZ      80 HBC  K- P-->SIGMA+ PI-    9/81*
AG           . . . . . . . . . .
AG  AVG       -0.72      0.29    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

F0      PHI0 ANGLE (SIG+ INTO PI0 PROTON) SIN(PHI)/COS(PHI)=BETA/GAMMA (DEG)
F0 H          22.0      90.0             HARRIS    70 OSPK PI+P TO SIG+ K+    5/70
F0 L  1259    38.1      35.7      37.1   LIPMAN    73 OSPK    PI+P TO SIG+K+    7/73
F0 L     DECAY PROTON SCATTERED OFF ALUMINUM.                                   7/73
F0 H     DECAY PROTONS SCATTERED OFF CARBON.
F0           . . . . . . . . . .
F0  AVG       35.8      33.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR SIGMA+


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CORK     60 PR 120 1000         CORK,KERTH,WENZEL,CRONIN,COOL(LRL+PRIN+BNL)
EVANS    60 NC 15 873           BRIST+BRUSS+IAS-U.COL-DUBLIN+LON+MILAN+PAD
FREDEN   60 NC 16 611           S FREDEN,H KORNBLUM,P WHITE              (LRL)
KAPLON   60 ANP 9 139           M KAPLON,A MELISSINOS,YAMANOUCHI        (ROCH)
PUSCHEL  60 NP 20 254           W PUSCHEL                     (MAX PLANCK INST)

BARKAS   61 PR 124 1209         BARKAS,DYER,MASON,NICHOLS,SMITH          (LRL)
BERTHELO 61 NC 21 693           BERTHELOT,DAUDIN,GOUSSU +      (SACLAY+ORSAY)
CHIESA   61 NC 19 1171          CHIESA,QUASSIATI,RINAUDO          (INFN-TURIN)

BEALL    62 PRL 8 75            BEALL,CORK,KEEFE,MURPHY,WENZEL           (LRL)
GRARD    62 PR 127 607          F GRARD,G A SMITH                        (LRL)
GALTIERI 62 PRL 9 26            GALTIERI,BARKAS,HECKMAN,PATRICK,SMITH (LRL)
HUMPHREY 62 PR 127 1305         W E HUMPHREY,R R ROSS                    (LRL)
TRIPP    62 PRL 9 66            R D TRIPP,M B WATSON,M FERRO-LUZZI       (LRL)

BARKAS   63 PRL 11 26           W H BARKAS,J N DYER,H H HECKMANN         (LRL)
    ALSO 61 UCRL 9450           JOHN DYER (THESIS, BERKELEY)             (LRL)

BHOWMIK  64 NP 53 22            B BHOWMIK,P JAIN,P MATHUR,LAKSHMI     (DELHI)
CARRARA  64 PL 12 72            CARRARA,CRESTI,GRIGOLETTO,PERUZZO+ (PADOVA)
COURANT  64 PR 136 B 1791       COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MURPHY   64 PR 134 B 188        C THORNTON MURPHY                  (WISCONSIN)
NAUENBER 64 PRL 12 679          NAUENBERG,MARATECK,+         (COLU+RUTG+PRIN)
WILLIS   64 PRL 13 291          WILLIS,COURANT,ENGELMAN+(BNL,CERN,HEID,UMD)

BALTAY   65 PR 140 B 1027       BALTAY,SANDWEISS,CULWICK,KOPP +  (YALE+BNL)
BAZIN    65 PRL 14 154          BAZIN,BLUMENFELD,NAUENBERG +     (PRIN+COLU)
BAZIN2   65 PR 140  B1358       BAZIN,PLAND,SCHMIDT+             (PRIN,RUTG,COLU)
CARAYAN  65 PR 138 B 433        CARAYANNOPOULOS,TAUTFEST,WILLMANN  (PURDUE)
QUARENI  65 NC 40 A 928         QUARENI,CARTACCI +     (BGNA,FIRZ,GENO,PARMA)
SCHMIDT  65 PR 140 B 1328       P SCHMIDT                           (COLUMBIA)

BANGERTE 66 PRL  17  495        BANGERTER,GALTIERI,BERGE,MURRAY+         (LRL)
BERLEY   66 PRL 17 1071         +HERZBACH,KOFLER,YAMAMOTO + (BNL+MASA+YALE)
CHANG    66 PR   151  1081      CHUNG YUN CHANG                     (COLUMBIA)
    ALSO 65 NEVIS 145  THESIS   CHUNG YUN CHANG                     (COLUMBIA)
CHIEN    66 PR   152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
COOK     66 PRL   17   223      V COOK,EWART,MASEK,ORR,PLATNER (WASHINGTON)

BAGGETT  67 PRL 19 1458         BAGGETT,DAY,GLASSER,KEHOE,KNOP+   (MARYLAND)
    ALSO 68 VIENNA ABS. 374     BAGGETT,KEHOE                       (MARYLAND)
    ALSO 68 PRIVATE COMM.       N. BAGGETT                          (MARYLAND)

BARASH   67 PRL 19  181         BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
EISELE   67 ZPHYS 205 409       +ENGELMANN,FILTHUTH,FOLISH,HEPP+       (HEID)
HYMAN    67 PL 25 B 376         +LOKEN,PEWITT,MCKENZIE,+      (ANL+CARN+NWES)
KOTELCHU 67 PRL 18 1166         KOTELCHUCK,GOZA,SULLIVAN,ROSS  (VANDERBILT)
SULLIVAN 67 PRL 18 1163         SULLIVAN,MCINTURFF,KOTELCHUCH  (VANDERBILT)
    ALSO 64 PRL 13 246          A D MCINTURFF,C E ROOS         (VANDERBILT)
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BIERMAN 68 PRL 20 1459 BIERMAN,KOUNOSU,NAUENBERG + (PRINCETON)
COMBE 68 NC 57A 54 CERN-BRISTOL-LAUSANNE-MUNICH-ROME-COLLABOR
MAST 68 PRL 20 1312 MAST,GERSHWIN,ALSTON-GARNJOST + (LRL)

ANG 69 ZPHYS 228 151 +EBENHOH,EISELE,ENGELMANN,FILTHUTH+ (HEID)
BAGGETT 69 MDDP-TR-973 N V BAGGETT (THESIS) (UMD)
BALTAY 69 PRL 22 615 BALTAY,FRANZINI,NEWMAN,NORTON+ (COLU,STON)
BANGERTE 69 UCRL-19244 ROGER ODELL BANGERTER (THESIS) (LRL)
BANGERTI 69 PR 187 1821 BANGERTER,GARNJOST,GALTIERI,GERSHWIN+ (LRL)

BARLOUTA 69 NP B14 153 BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
EISELE1 69 ZPHYS 221 1 +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+ (HEID)
EISELE2 69 ZPHYS 221 401 +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+ (HEID)
GERSHWIN 69 PR 188 2077 +ALSTON-GARNJOST,BANGERTER + (LRL)
ALSO UCRL 19246 THESIS LAWRENCE K GERSHWIN (LRL)
NORTON 69 NEVIS 175 (THESIS) HERBERT NORTON (COLUMBIA)

BERLEY 70 PR D1 2015 +YAMIN,HERTZBACH,KOFLER + (BNL,MASA,YALE)
EISELE 70 ZPHY 238 372 +FILTHUTH,HEPP,PRESSER,ZECH (HEIDELBERG)
HARRIS 70 PRL 24 165 +OVERSETH,PONDROM,DETTMANN (MICH,WISC)

ALLEY 71 PR D3 75 +BENBROOK,COOK,GLASS,GREEN,HAGUE + (WASH)
BAKKER 71 LNC 1 37 +,SABRE COLLAB. (ZEEM+SACL+BGNA+REHO+EPOL)
COLE 71 PR D4 631 +LEE-FRANZINI,LOVELESS,BALTAY+ (STON,COLU)
TOVEE 71 NP B33 493 LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
BELLAMY 72 PL 39B 299 +ANDERSON,CRAWFORD,OSMON+ (LOUC+RHEL+SUSS)
BOHM 72 NP B48 1 BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
ALSO 73 TIME-73.2 NOV BRUSSELS BULLETIN, SAME COLLABORATION

EBENHOH 73 ZPHY 264 413 +EISELE,FILTHUTH,HEPP,LEITNER,THOUW+ (HEID)
LIPMAN 73 PL 43B 89 +UTO,WALKER,MONTGOMERY+ (RHEL+SUSS+LOWC)
SAHA 73 PR D7 3295 +FETKOVICH,HEINTZELMAN,MELTZER + (CARN)
SECHIZOR 73 PR D8 12 B.SECHI-ZORN,G.SNOW (UMD)

EBENHOH 74 ZPHY 266 367 +EISELE,ENGELMANN,FILTHUTH,HEPP + (HEID)
CONFORTO 76 NP B105 189 +GOPAL,KALMUS,LITCHFIELD,ROSS + (RHEL+LOIC)
DOBLE 77 PL 67B 483 +GOTTSTEIN,HANSL,HERYNEK+ (MPIM+BOHR+VAND)
REUCROFT 77 PR D15 5 +ROOS,WATERS,WEBSTER,HANSL + (VAND+MPIM)
NOWAK 78 NP B139 61 +ARMSTRONG,DAVIS+ (LOUC+BELG+DURH+WARS)

SETTLES 79 PR D20 2154 +MANZ,MATT,HANSL,HERYNEK,DOBLE+ (MPIM+VAND)
MANZ 80 PL 96B 217 +REUCROFT,SETTLES,WOLF + (MPIM+VAND)
MARRAFFI 80 PR D21 2501 MARRAFFINO,REUCROFT,ROOS,WATERS+(VAND+MPIM)

PAPERS NOT REFERRED TO IN DATA CARDS

GLASER 58 CERN CONF 270 GLASER,GOOD,MORRISON (MICH+LRL)

QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

TRIPP 62 PRL 8 175 R TRIPP,M WATSON,M FERRO-LUZZI (LRL) P
ALFF 63 SIENA CONF 1 205 ALFF,NAUENBERG,KIPSCH,+ (COLU+RUTG+BNL)
ALSO 65 PR 137 B 1105 ALFF,GELFAND,BRUGGER,BERLEY+(COLU+RUTG+BNL)
COURANT 63 SIENA CONF 1 73 COURANT,FILTHUTH,BURNSTEIN,DAY+ (CERN+UMD)

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20 SIGMA-(1197,JP=1/2+) I=1

20 SIGMA- MASS (MEV)

M N SEE NOTE PRECEDING LAMBDA MASS LISTINGS

M	3000	1197.43	0.08	SCHMIDT	65 HBC	SEE NOTE N		3/74
M		1197.24	0.15	DUGAN	75 CNTR	EXOTIC ATOMS		12/79
M		. . . .						
M	AVG	1197.388	0.079	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)				
M	FIT	1197.34	0.05	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)				3/82*

20 (SIGMA-) - (SIGMA+) MASS DIFFERENCE (MEV)

D	87	8.25	0.40	BARKAS	63 EMUL	
D	2500	8.25	0.25	DOSCH	65 HBC	
D	86	7.91	0.23	BOHM	72 EMUL	1/73
D		. . . .				
D	AVG	8.09	0.16	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)		
D	FIT	7.97	0.07	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)		3/82*

20 (SIGMA-) - (LAMBDA) MASS DIFFERENCE (MEV)

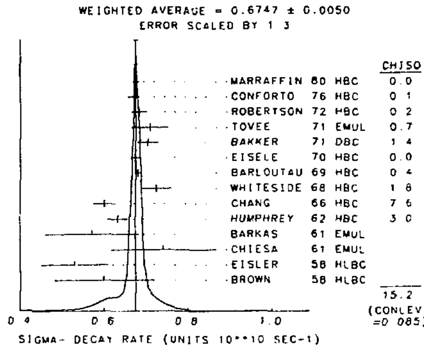
DL N SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL		81.70	0.19	BURNSTEIN	64 HBC		9/66
DL	85	81.80	0.13	SCHMIDT	65 HBC	SEE NOTE N	3/74
DL	2279	81.64	0.09	HEPP	68 HBC		8/68
DL		. . . .					
DL	AVG	81.693	0.069	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)			
DL	FIT	81.740	0.052	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)			3/82*

20 SIGMA- MEAN LIFE (UNITS 10**-10 SEC)

T			1.67	0.40	0.28	BROWN	58 HLBC		
T			1.89	0.33	0.25	EISLER	58 HLBC		
T		45	1.39	0.32	0.17	CHIESA	61 EMUL		
T		41	1.75	0.39	0.30	BARKAS	61 EMUL		
T		1208	1.58	0.06	0.06	HUMPHREY	62 HBC	STOP. K-	
T	C	3267	1.666	0.075		CHANG	66 HBC	STOP. K-	6/66
T	S	61	(2.09)	(0.22)		CHIEN	66 HBC	- 6.9 PBAR P	9/67
T	S	64	(1.46)	(0.31)		CHIEN	66 HBC	+ 6.9 PBAR P,ANTI	9/67
T		506	1.38	0.07		WHITESIDE	68 HBC	STOP. K-	6/68
T		10253	1.472	0.016		BARLOUTAU	69 HBC	K-P .4-1.2 GEV/C	11/69
T		0.1M	1.485	0.022		EISELE	70 HBC	K-P AT REST	2/71
T		1383	1.42	0.05		BAKKER	71 DBC	K-N TO SIG- 2PI	10/71
T			1.41	0.09	0.08	TOVEE	71 EMUL		12/71
T		2400	1.463	0.039		ROBERTSON	72 HBC	K-P .25 GEV/C	3/74
T		8437	1.49	0.03		CONFORTO	76 HBC	K-P 1-1.4 GEV/C	11/77
T		16K	1.480	0.014		MARRAFFIN	80 HBC	K- P TO SIG- PI+	2/80

T C CHANG ERROR 0.018 RAISED BY US. SEE 1970 EDITION, RMP 42,123(1970) 1/73
T S ERROR PURELY STATISTICAL.
T . . . .
T AVG 1.482 0.011 0.011 AVERAGE (ERROR INCL. SCALE FACTOR OF 1.3)
(SEE IDEOGRAM BELOW)



20 SIGMA- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM	R	BTWN -1.6 AND +0.8			FOX	73 CNTR	SIG-ATOM FINE ST	3/74
MM	R	-1.48	0.37		ROBERTS	74 CNTR	SIG-ATOM FINE ST	12/75
MM	D	-1.40	0.41	0.28	DUGAN	75 CNTR	SIG-ATOM FINE ST	12/79
MM	D	(0.65)	(0.28)	(0.40)	DUGAN	75 CNTR	SIG-ATOM FINE ST	12/79
MM	28K	-0.71	1.25		HANSL	78 HBC	K-P-->SIG- PI+	7/79

MM R ROBERTS 74 INCLUDES DATA FROM FOX 73. 12/75
MM D DUGAN 75 NEGATIVE VALUE AVERAGED SINCE IT AGREES WITH ROBERTS 74. 12/79
MM . . . .
MM AVG -1.41 0.25 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

20 SIGMA- PARTIAL DECAY MODES

		DECAY MASSES
P1	SIGMA- INTO NEUTRON PI-	939+ 139
P2	SIGMA- INTO NEUTRON PI- GAMMA	939+ 139+ 0
P3	SIGMA- INTO NEUTRON MU- NEUTRINO	939+ 105+ 0
P4	SIGMA- INTO NEUTRON E- NEUTRINO	939+ .5+ 0
P5	SIGMA- INTO LAMBDA E- NEUTRINO	1115+ .5+ 0

20 SIGMA- BRANCHING RATIOS

R1 SIGMA- INTO (N MU- NEU)/(N PI-) (UNITS 10**-3) (P3)/(P1)

R1	22	0.66	0.15	COURANT	64 HBC		
R1	11	0.56	0.20	BAZIN	65 HBC	FROM STOP. K-	6/66
R1	56	0.43	0.09	BAGGETT	69 HBC	STOP. K-	10/69
R1	72	0.43	0.06	ANG 1	69 HBC	STOP K-	10/69
R1	13	0.38	0.11	COLE	71 HBC	STOP K-	10/71

R1 . . . .
R1 AVG 0.447 0.043 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2 SIGMA- INTO (N E- NEU)/(N PI-) (UNITS 10**-3) (P4)/(P1)

R2	9	1.0	0.4	0.3	MURPHY	64 HLBC		
R2	16	1.37	0.34		NAUENBERG	64 HBC		
R2	16	1.15	0.4		MILLER	64 FBC		
R2	31	1.4	0.3		COURANT	64 HBC		
R2	180	1.11	0.09		BIERMAN	68 HBC		6/68
R2	A 331	(1.02)	(0.08)		ANG 1	69 HBC	STOP K-	10/69
R2	57	0.97	0.15		COLE	71 HBC	STOP K-	10/71
R2	455	1.05	0.07		SECHIZORN	73 HBC	STOP K-	8/73
R2	A 601	1.05	0.06		EBENHOH	74 HBC	STOP K-	1/76

R2 A ANG 1 69 REPLACED BY EBENHOH 74. 1/76
R2 . . . .
R2 AVG 1.082 0.038 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3 SIGMA- INTO (LAMBDA E- NEU)/(N PI-) (UNITS 10**-4)
R3 (P5)/(P1)

R3	11	0.75	0.28	COURANT	64 HBC	STOP. K-	
R3	35	0.64	0.12	BARASH	67 HBC	STOP K-	8/67
R3	31	0.69	0.12	EISELE1	69 HBC	STOP K-	10/69
R3	31	0.52	0.09	BALTAY	69 HBC	STOP K-	4/69
R3	H 122	(0.60)	(0.11)	HERBERT	78 ASPK	HYPERON BEAM	6/78
R3	H 114	0.63	0.11	THOMPSON	80 ASPK	HYPERON BEAM	9/81*

R3 H HERBERT 78 REPLACED BY THOMPSON 80.
R3 . . . .
R3 AVG 0.610 0.053 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4 SIGMA- INTO (N PI- GAMMA)/(N PI-) (UNITS 10**-3) (P2)/(P1)

R4		(1.1)APPROXIM.		BAZIN	65 HBC	PI- LT 166 MEV/C	8/67
R4	23	(0.10)	(0.02)	ANG 2	69 HBC	PI- LT 110 MEV/C	10/69
R4	292	0.46	0.06	EBENHOH	73 HBC	PI+ LT 150 MEV/C	3/74

R4 PI+ MOMENTUM CUTS DIFFER, NOT AVERAGED. LATEST VALUE USED IN TABLE. 4/82*

20 SIGMA- DECAY PARAMETERS

RELATED TEXT SECTION VI D AND APPENDIX I

A- ALPHA SIGMA-

A-		(-0.16)	(0.21)	TRIPP	62 HBC	REPL.BY BANGERTE	
A-	O 6500	(-0.010)	(0.043)	BANGERTER	66 HBC	K-P TO SIG- PI+	7/66
A-	O 6068	(-0.104)	(0.04)	BERLEY	67 HBC	K-P TO SIG- PI+	11/67
A-	51000	-0.071	0.012	BANGERTER	69 HBC		10/69
A-	B 5978	(-0.134)	(0.034)	BERLEY	70 HBC	K-P AT 400 MEV/C	2/71
A-	60000	-0.067	0.011	BOGERT	70 HBC	K-P AT 400 MEV/C	12/70
A-	28K	-0.062	0.024	HANSL	78 HBC	K-P-->SIG- PI+	7/79

A- O OLD RESULTS. HAVE BEEN REPLACED.
A- B BERLEY 70 REPLACED BY BOGERT 70 2/71
A- . . . .
A- AVG -0.0681 0.0077 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

```
F-      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F-  D 1006 (+22.)     (30.)            BERLEY    67 HBC     K-P TO SIG- PI+  11/67
F-    1385  14.        19.             BANGERT1  69 HBC                      10/69
F-   CL092  + 5.       23.             BERLEY    70 HBC     NEUTRON RESCATT. 11/69
F-  C   CHANGED FROM -5 TO +5 TO AGREE WITH SIGN CONVENTION
F-          . . . . . . . . . .
F-  AVG       10.3       14.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
```

Note on $\Sigma^- \to \Lambda e^- \nu$

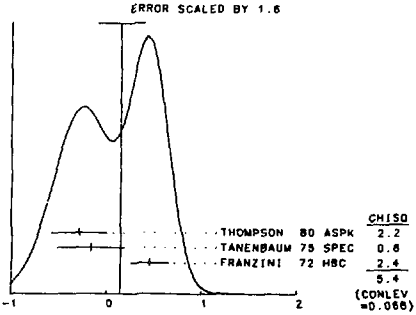
(by J. A. Thompson, University of Pittsburgh)

The decay $\Sigma^- \to \Lambda e^- \nu$ is of special interest because its form is predicted by the strong form of CVC and is not sensitive to the current octet assumptions or SU_3 structure constants which enter into Cabibbo's predictions for the other hyperon decays. For $\Delta S = 0$ transitions, the weak interaction vector current is related to the electromagnetic current through a multiplicative constant, set by neutron beta decay, and an isospin rotation.

The decay $\Sigma^0 \to \Lambda\gamma$ (the isospin-rotation analogue of $\Sigma^- \to \Lambda e^- \nu$) is mediated predominantly through the magnetic interaction, assuming there are no inhomogeneities in the Σ^0, Λ charge distributions. Thus we expect the g_{WM} term $[g_{WM} \sim \frac{\mu_{\Sigma\Lambda}}{\sqrt{2}} \sim -\frac{\sqrt{3}}{2}\mu_n$ (by SU_3)] to dominate the vector part of the weak current. The strong CVC predictions are thus: $g_V/g_A = 0$ and $g_{WM} \sim 1.6$.

```
AV      GV/GA FOR SIGMA TO LAMBDA BETA DECAY (TEXT SEC VI D.1 FOR SIGN CONV)
AV       PREDICTED TO BE ZERO BY CONSERVED VECTOR CURRENT THEORY.
AV       VALUES AVERAGED ASSUME CVC-SU3 WEAK MAGNETISM TERM.
AV  FB  45  (0.31)   (0.30)          BARASH    67 HBC                        11/67
AV  FS  51  (0.7)    (0.4)           BALTAY    69 HBC      USING SIG+-        4/69
AV  FS  81 (+0.22)   (0.28)          EISELE1   69 HBC                        10/68
AV F S 186   0.45     0.20           FRANZINI  72 HBC      USING SIG+-        1/73
AV       55  -0.17    0.35           TANENBAUM 75 SPEC     BNL HYPERON BEAM 12/75
AV      114  -0.29    0.29           THOMPSON  80 ASPK     BNL HYPERON BEAM  1/82*
AV   B  BARASH 67 MEASURED ABSOLUTE VALUE.
AV   S  SIGN CHANGED TO AGREE WITH OUR CONVENTION.
AV F    FRANZINI 72 INCLUDES EVENTS OF BARASH 67, EISELE1 69, BALTAY 69.     1/73
AV        . . . . . . . . . .
AV  AVG      0.14     0.24    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                              (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.14 ± 0.24
ERROR SCALED BY 1.6

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WM      GWM/GA FOR SIGMA TO LAMBDA BETA DECAY
WM       VALUES QUOTED ASSUME THE CVC PREDICTION GV=0.
WM      186    2.4      2.1            FRANZINI  72 HBC     USING SIG+-        1/82*
WM       55    3.5      4.5            TANENBAUM 75 SPEC    BNL HYPERON BEAM   1/82*
WM      114    1.75     3.5            THOMPSON  80 ASPK    BNL HYPERON BEAM   1/82*
WM           . . . . . . . . . .
WM  AVG        2.4      1.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV1     GA/GV FOR SIGMA TO NEUTRON BETA DECAY(TEXT SEC VI D.1 FOR SIGN CONV)
AV1      57  (0.05)   (0.23)   (0.32) GERSHWIN  68 HBC  REPLACED BY GER.69    6/68
AV1      61  +0.19     0.20     0.17  GERSHWIN  69 HBC  POLARIZED SIGMAS     10/69
AV1      63  -0.33     0.30     0.85  BOGERT    70 HBC  K-P AT 400 MEV/C     10/70
AV1      43  -0.4      0.52     1.5   ELLIS     72 ASPK    POLARIZED SIGMAS  10/71
AV1 E       (+0.10)   (0.11)          ELLIS     72 RVUE    SUM LIKEL.(+SOL)  10/71
AV1 E       (-0.27)   (0.13)   (0.17) ELLIS     72 RVUE    SUM LIKEL.(-SOL)  10/71
AV1 E   ELLIS 72 HAS COMBINED THE MAXIMUM LIKELIHOODS OF COLLERAINE 69,       3/72
AV1 E   EISELE2 69, GERSHWIN 69, ELLIS 72, AND GETS TWO POSSIBLE VALUES.      3/72
AV1          . . . . . . . . .
AV1 AVG        0.13     0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

AV2     ABSOLUTE VALUE OF GA/GV FOR SIGMA TO NEUTRON BETA DECAY
AV2      49    0.23     0.16          COLLERAIN 69 HBC     NEUTRON SCATTER   10/69
AV2      33    0.37     0.26     0.19 EISELE2   69 HBC     NEUTRON SCATTER   10/69
AV2      36    0.29     0.28     0.29 BALTAY    72 HBC     NEUTRON SCATTER    6/72
AV2    3507    0.435    0.035         TANENBAU  74 ASPK                      10/74
AV2     519    0.17     0.07     0.09 DECAMP    77 ELEC    H.E.HYPERON BEAM  11/77
AV2          . . . . . . . . . .
AV2 AVG        0.385    0.070   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
                        (SEE IDEOGRAM BELOW )
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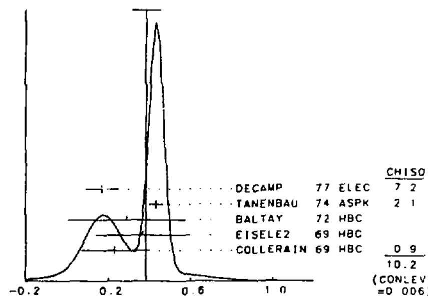
WEIGHTED AVERAGE = 0.385 ± 0.070
ERROR SCALED BY 2.3



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REFERENCES FOR SIGMA-

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BROWN    58 CERN CONF 270       BROWN,GLASER,GRAVES,PERL,CRONIN +      (MICH)
EISLER   58 NC SERIO 10 150     EISLER,BASSI,CONVERSI+ (COLU,BNL,BGNA,PISA)

BARKAS   61 PR 124 12..         BARKAS,DYER,MASON,NICHOLS,SMITH        (LRL)
CHIESA   61 NC 19 1171          A M CHIESA,B QUASSIATI,G RINAUDO     (TURIN)
HUMPHREY 62 PR 127 1305         W E HUMPHREY,R R ROSS                  (LRL)
TRIPP    62 PRL 9 66            R D TRIPP,M WATSON,M FERRO-LUZZI       (LRL)

BARKAS   63 PRL 11 26           W H BARKAS,J N DYER,H H HECKMAN        (LRL)
BURNSTEI 64 PRL 13 66           BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW    (UMD)
COURANT  64 PR 136 B 1791       COURANT,FILTHUTH+    (CERN+HEID+UMD+NRL+BNL)
MILLER   64 PL 11 262           MILLER,STANNARD,BEZAGUET+  (LOUC,EPOL+BERG)
MURPHY   64 PR 134 B 188        C THORNTON MURPHY                (WISCONSIN)
NAUENBER 64 PRL 12 679          NAUENBERG,SCHMIDT,MARATECK+(COLU+RUTG+PRIN)

BAZIN    65 PR 140 B 1358       BAZIN,PLAND,SCHMIDT +       (PRIN+RUTG+COLU)
DOSCH    65 PL 14 239           DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
   ALSO  66 PR  151  1081       CHUNG YUN CHANG                   (COLUMBIA)
SCHMIDT  65 PR 140 B 1328       P SCHMIDT                         (COLUMBIA)
BANGERTE 66 PRL  17  495        BANGERTER,GALTIERI,BERGE,MURRAY+       (LRL)
CHANG    66 PR  151 1081        CHUNG YUN CHANG                   (COLUMBIA)
CHIEN    66 PR  152  1171       +LACH,SANDWEISS,TAFT,YEH,OREN +    (YALE+BNL)

BARASH   67 PRL 19  181         BARASH,DAY,GLASSER,KEHOE,KNOP +   (MARYLAND)
BERLEY   67 PRL  19  979        BERLEY,HERTZBACH,KOFLER +   (BNL,MASA,YALE)
BIERMAN  68 PRL 20 1459         BIERMAN,KOUNOSU,NAUENBERG +      (PRINCETON)
GERSHWIN 68 PRL 20 1270         GERSHWIN,ALSTON-GARNJOST,BANGERTER+    (LRL)


HEPP     68 ZPHY 214 71         V.HEPP,H. SCHLEICH              (HEIDELBERG)
WHITESID 68 NC  54A  537        H. WHITESIDE,J. GOLLUB             (OBERLIN)

ANG 1    69 ZPHY 223 103        ANG,EISELE,ENGELMANN,FILTHUTH +       (HEID)
ANG 2    69 ZPHY 228 151        +EBENHOR,EISELE,ENGELMANN,FILTHUTH+   (HEID)
BAGGETT  69 PRL 23 249          BAGGETT,KEHOE,SNOW         (UNIV MARYLAND)
BALTAY   69 PRL 22 615          BALTAY,FRANZINI,NEWMAN,NORTON+  (COLU,STON)
BANGERTE 69 UCRL-19244          ROGER ODELL BANGERTER (THESIS)         (LRL)
BANGERT1 69 PR 187 1821         BANGERTER,GARNJOST,GALTIERI,GERSHWIN+  (LRL)

BARLOUTA 69 NP B14 153          BARLOUTAUD,BELLEFON,GRANET+(SACL+CERN+HEID)
COLLERAI 69 PRL 23 198          COLLERAINE,DAY,GLASSER,KNOP+(UNIV MARYLAND)
EISELE1  69 ZPHY 221 1          +ENGELMANN,FILTHUTH,FOHLISCH,HEPP+    (HEID)
EISELE2  69 ZPHY 223 487        EISELE,ENGELMANN,FILTHUTH,FOHLISCH+   (HEID)
GERSHWIN 69 UCRL-19246          LAWRENCE KENNETH GERSHWIN (THESIS)     (LRL)

BERLEY   70 PR D1 2015          +YAMIN,HERTZBACH,KOFLER +   (BNL,MASA,YALE)
BOGERT   70 PR D2 6             +LUCAS,TAFT,WILLIS,BERLEY + (BNL,MASA,YALE)
EISELE   70 ZPHY 238 372        +FILTHUTH,HEPP,PRESSER,ZECH     (HEIDELBERG)

BAKKER   71 LNC 1 37            +,SABRE COLLAB.  (ZEEM+SACL+BGNA+REHO+EPOL)
COLE     71 PR D4 631           +LEE-FRANZINI,LOVELESS,BALTAY+  (STON,COLU)
   ALSO  69 NEVIS-175 THESIS    HERBERT NORTON                    (COLUMBIA)
TOVEE    71 NP B33 493          LOUC,BELGRADE,BERL,BRUX,DUBLIN,WARS COLLAB
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BALTAY   72 PR D5 1569       +FEINMAN,FRANZINI,NEWMAN,YEH+   (COLU+STON)
BOHM     72 NP B48 1         BERLIN+BELGRADE+BRUX+DUBLIN+LOUC+WARSAW
ELLIS    72 NP B39 77        OXF+AERE+RHEL+LOQM+LYON+NMES+ITEP COLLABOR
FRANZINI 72 PR D6 2417       COLUMBIA+HEIDELBERG+MARYLAND+STONY BROOK
ROBERTSO 72 THESIS           R.M.ROBERTSON                         (IIT)

EBENHOH  73 ZPHY 264 413     +EISELE,FILTHUTH,HEPP,LEITNER,THOUN+ (HEID)
FOX      73 PRL 31 1084      +LAM,BARNES,EISENSTEIN+ (BNL+VPI+WILL+WYOM)
SECHIZOR 73 PR D8 12         B.SECHI-ZORN,G.SNOW                   (UMD)

EBENHOH  74 ZPHY 266 367     +EISELE,ENGELMANN,FILTHUTH,HEPP +    (HEID)
ROBERTS  74 PRL 32 1265      WILL+VPI+CARN+WYOM+CIT COLLABORATION
    ALSO 74 PRL 33 122       ERRATUM TO ROBERTS 74
    ALSO 75 PR D12 1232      ROBERTS,COX +  (WILL+VPI+CARN+WYOM+CIT+BNL)
TANENBAU 74 PRL 33 175       TANENBAUM,HUNGERBUEHLER +    (YALE+FNAL+BNL)
    ALSO 75 TANENBAUM

DUGAN    75 NP A254 396      +ASANO,CHEN,CHENG,WU,LIDOFSKY+  (COLU+YALE)
TANENBAU 75 PR D12 1871      TANENBAUM,HUNGERBUEHLER +    (YALE+FNAL+BNL)
CONFORTO 76 NP B105 189      +GOPAL,KALMUS,LITCHFIELD,ROSS + (RHEL+LOIC)
DECAMP   77 PL 66B 255       +BADIER,BLAND,CHOLLET,GAILLARD+ (LALO+EPOL)
HANSL    78 NP B132 45       +MANZ,MATT,REUCROFT,SETTLES +   (MPIM+VAND)
HERBERT  78 PRL 40 1230      +CLELAND,COOPER,DRIS,ENGELS +     (PITT+BNL)
MARRAFFI 80 PR D21 2501      MARRAFFINO,REUCROFT,ROOS,WATERS+(VAND+MPIM)
THOMPSON 80 PR D21 25        +CLELAND,COOPER,DRIS,ENGELS+      (PITT+BNL)

                             PAPERS NOT REFERRED TO IN DATA CARDS

BROWN    57 PR 108 1036      J BROWN, D GLASER, M PERL        (MICH+BNL)
NIETO    68 RMP 40 140       M NIETO                              (STON)
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                  21  SIGMA0(1193,JP=1/2 -) I=1
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                  21  (SIGMA-) - (SIGMA0) MASS DIFFERENCE (MEV)
D1  N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

D1       18    4.75      0.1            BURNSTEIN 64 HBC
D1       27    4.87      0.12           DOSCH     65 HBC
D1       12    5.01      0.12           SCHMIDT   65 HBC  SEE NOTE N       3/74
D1              . . . . . . . . . .
D1  AVG         4.860     0.076   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
D1  FIT         4.881     0.063  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

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                  21  (SIGMA0) - (LAMBDA) MASS DIFFERENCE (MEV)

DL  N   SEE NOTE PRECEDING LAMBDA MASS LISTINGS.

DL      208    76.63     0.28           SCHMIDT   65 HBC  SEE NOTE N       6/68
DL      109    76.23     0.55           COLAS     75 HLBC   LAMBDA-GAMMA DEC 12/75
DL              . . . . . . . . . .
DL  AVG        76.55     0.25     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DL  FIT        76.86     0.08    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

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                  21  SIGMA0 MEAN LIFE (UNITS 10**-19 SEC)

T              (E-14 CR LESS)           DAVIS     62 EMUL                      6/77
T              0.58      0.13           DYDAK     77 SPEC PRIMAKOFF EFFECT     6/77

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                  21  SIGMA0 PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      SIGMA0 INTO LAMBDA GAMMA                          1115+   0
P2      SIGMA0 INTO LAMBDA E+ E-                          1115+  .5+  .5
P3      SIGMA0 INTO LAMBDA GAMMA GAMMA                    1115+   0+   0

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                  21  SIGMA0 BRANCHING RATIOS

R1      SIGMA0 INTO(LAMBDA E+ E-)/TOTAL                 (P2)/(P1+P2)
R1            0.00545    THEORET. CAL. FEINBERG  58       QUANTUM ELECT.     9/66

R2      SIGMA0 INTO (LAMBDA GAMMA GAMMA)/(LAMBDA GAMMA)  (P3)/(P1)          12/75
R2             0.03  CR LESS  CL=.90   COLAS     75 HLBC                   12/75

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                             REFERENCES FOR SIGMA0

FEINBERG 58 PR 109 1019      G.FEINBERG                            (BNL)
DAVIS    62 PR 127 605       O DAVIS,R SETTI,M RAYMOND,G TOMASIN   (EFI)
BURNSTEI 64 PRL 13 66        BURNSTEIN,DAY,KEHOE,SECHI ZORN,SNOW   (UMD)
DOSCH    65 PL 14 239        DOSCH,ENGELMANN,FILTHUTH,HEPP,KLUGE+ (HEID)
SCHMIDT  65 PR 140 B 1328    P SCHMIDT                        (COLUMBIA)

COLAS    75 NP B91 253       +FARWELL,FERRER,SIX                  (ORSA)
DYDAK    77 NP B118 1        +NAVARRIA,OVERSETH,STEFFEN+(CERN+DORT+HEID)

                             PAPERS NOT REFERRED TO IN DATA CARDS

COURANT  63 PRL 10 409       COURANT,FILTHUTH,FRANZINI+   (CERN+UMD+NRL)

        QUANTUM NUMBER DETERMINATIONS NOT REFERRED TO IN THE DATA CARDS

ALFF     65 PR 137 B1105     ALFF,GELFAND,NAUENBERG+ (COLUMBIA+RUTG+BNL)P
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                  22  XI-(1321,JP=1/2 ) I=1/2
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                  22  XI- MASS (MEV)

M   H   11(1317.0)    (2.2)            WANG      61 HLBC
M   H   18(1317.9)    (1.9)            FOWLER    61 HLBC
M   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J P HUBBARD)
M      517 1321.4      0.4             JAUNEAU   63 FBC
M       62 1321.1      0.65            SCHNEIDER 63 HBC
M      241 1321.1      0.3             BADIER1   64 HBC
M       ALL MASSES ABOVE WERE RAISED 0.09 MEV BECAUSE LAMBDA MASS RAISED
M      149 1321.3      0.4             PJERROU   65 HBC                     11/67
M        6 1321.67     0.52            CHIEN     66 HBC   -  6.9 PBAR P      9/67
M      299 1321.4      1.1             LONDON    66 HBC                      6/66
M  G   195 1321.87     0.51            GOLDWASSE 70 HBC      5.5 K-P         8/70
M   G   USES LAMBDA MASS OF 1115.58-M(XI) IS 1322.18 IF M(LAMBDA)=1115.84    8/70
M      268 1321.12     0.41            WILQUET   72 HLBC                     1/73
M      632 1321.46     0.34            DIBIANCA  75 DBC      4.9 GEV/C K-D   1/77
M              . . . . . . . . . .
M   AVG       1321.34     0.14     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT       1321.32     0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                  22  ANTI-XI+ MASS (MEV)

MI        1(1322.0)    (1.3)           BROWN     62 HBC     ANTI-XI-         7/66
MI        5 1320.69     0.93           CHIEN     66 HBC  +   6.9 PBAR P,ANTI  9/67
MI  S    12(1321.7)    (0.6)           SHEN      67 HBC     ANTI-XI-        10/67
MI       34 1321.2      0.4            STONE     70 HBC                     10/70
MI       35 1321.6      0.3            VOTRUBA   72 HBC     10 GEV/C K+ P   11/72
MI  S   THE ERROR IS STATISTICAL ONLY
MI             . . . . . . . . . .
MI  AVG       1321.20     0.23     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
MI  FIT       1321.32     0.13   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*
        THE FIT ASSUMES XI AND ANTI-XI MASSES EQUAL.

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                  22  (XI-) - (ANTI-XI+) MASS DIFFERENCE (MEV)

DM          1.0       1.1              CHIEN     66 HBC      6.9 PBAR P      9/67

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                  22  XI- MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM    2724   -0.1      2.1             BINGHAM   70 OSPK  - 1.8 GEV/C K-P    2/71
MM    2436   -2.1      0.8             COOL      74 OSPK -  1.8 GEV/C K-P   10/74
MM             . . . . . . . . . .
MM  AVG       -1.85     0.75    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  22  XI- MEAN LIFE (UNITS 10**-10 SEC)

T   H   11   (3.5)    (3.4)    (1.23) WANG      61 HLBC
T   H   18   (1.28)   (0.41)   (0.25) FOWLER    61 HLBC
T   H   (OLD DATA AND LOW STATISTICS DROPPED ON SUGGESTION OF J P HUBBARD)
T      517    1.86     0.15     0.14  JAUNEAU   63 FBC
T       62    1.55     0.31     0.31  SCHNEIDER 63 HBC
T      356   (1.77)   (0.12)          CARMONY   64 HBC    REP BY PJERROU 65
T      794    1.69     0.07           HUBBARD   64 HBC
T      246    1.70     0.12           PJERROU   65 HBC                       11/67
T   S    6   (1.37)   (0.31)          CHIEN     66 HBC   -  6.9 PBAR P       9/67
T      299    1.80     0.16           LONDON    66 HBC                        6/66
T   S        (1.67)   (0.07)          BURGUN    68 HBC    K-P AT 1.3-1.8      2/71
T     2610    1.61     0.04           DAUBER    69 HBC                        6/68
T      680    1.73     0.08     0.07  MAYEUR    72 HLBC   2.1 GEV/C K-        1/73
T     4303    1.63     0.03           BALTAY    74 HBC    1.75 GEV/C K-       3/74
T   S 2436   (1.637)  (0.050)         COOL      74 CSPK - 1.8 GEV/C K-P      10/74
T             1.67     0.08           DIBIANCA  75 DBC    4.9 GEV/C K-D       1/77
T     4286    1.609    0.028          HEMINGWAY 78 HBC    4.2 GEV/C K- P      7/79
T      41K    1.665    0.065          BOURQUIN  79 SPEC   HYPERON BEAM       12/79
T   S   THE ERROR IS STATISTICAL ONLY
T            . . . . . . . . . .
T   AVG       1.641    0.016    0.016  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                  22  ANTI-XI+ MEAN LIFE (UNITS 10**-10 SEC)

TI  S    5   (1.51)   (0.55)          CHIEN     66 HBC  +  6.9 PBAR P,ANTI  9/67
TI  S   12   (1.9)    (0.7)    (0.5)  SHEN      67 HBC     ANTI-XI-        10/67
TI      34    1.6      0.3            STONE     70 HBC                     10/70
TI  S   35   (1.55)   (0.35)   (0.20) VOTRUBA   72 HBC     10 GEV/C K+ P   11/72
TI  S   THE ERROR IS STATISTICAL ONLY

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                  22  XI- PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      XI- INTO LAMBDA PI-                              1115+ 139
P2      XI- INTO LAMBDA E- NEUTRINO                      1115+  .5+   0
P3      XI- INTO NEUTRON PI-                              939+ 139
P4      XI- INTO LAMBDA MU- NEUTRINO                     1115+ 105+   0
P5      XI- INTO SIGMA0 E- NEUTRINO                      1192+  .5+   0
P6      XI- INTO SIGMA0 MU- NEUTRINO                     1192+ 105+   0
P7      XI- INTO NEUTRON E- NEUTRINO                      939+  .5+   0
P8      XI- INTO NEUTRON MU- NEUTRINO                     939+ 105+   0
P9      XI- INTO SIGMA- GAMMA                            1197+   0
P10     XI- INTO PROTON PI- PI-                           938+ 139+ 139
P11     XI- INTO PROTON PI- E- NEUTRINO                   938+ 139+  .5+   0
P12     XI- INTO PROTON PI- MU- NEUTRINO                  938+ 139+ 105+   0
P13     XI- INTO XI0 E- NEUTRINO                         1314+  .5+   0

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                22  XI- BRANCHING RATIOS

R1     XI- INTO (LAMBDA E- NEU)/(LAMBDA PI-) (UNITS 10**-3)
R1                                                   (P2)/(P1)
R1       1      155 EFFECTIVE DENOM.  CARMONY   63 HBC                  11/67
R1       0      260 EFFECTIVE DENOM.  JAUNEAU   63 HBC                  11/67
R1       0      220 EFFECTIVE DENOM.  BERGE     66 HBC                  11/67
R1       1      155 EFFECTIVE DENOM.  LONDON    66 HBC                  11/67
R1       0      717 EFFECTIVE DENOM.  TRIPPE    67 HBC                  11/67
R1       2     1976 EFFECTIVE DENOM.  HUBBARD   68 HBC                   6/68
R1  H    4   (1.15)    (0.90)    (0.55) HUBBARD   68 RVUE              6/68
R1  H   HUBBARD 68 (RVUE) INCLUDES ALL ABOVE EVENTS                      6/68
R1       1    0.24      0.24          YEH       74 HBC                   7/75
R1      11   (0.31)    (0.11)         HERBERT   78 ASPK REPL.BY THOMPSON 80  9/81*
R1      11    0.30      0.13          THOMPSON  80 ASPK    HYPERON BEAM  9/81*
R1          . . . . . . . . . .
R1  AVG       0.29      0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2     XI- INTO (NEUTRON PI-)/(LAMBDA PI-) (UNITS 10**-3)
R2                                                   (P3)/(P1)
R2           (5.0)  OR LESS           FERRO-LUZ 63 HBC                   6/68
R2            1.1   OR LESS           DAUBER    69 HBC                   6/68
R2       0   (3.0)  OR LESS  CL=.90   YEH       74 HBC      760 EFF.DENOM.  7/75

R3     XI- INTO (LAMBDA MU- NEUTRINO)/TOTAL (UNITS 10**-3)
R3                                                   (P4)
R3          (12.0)  OR LESS           BERGE     66 HBC                   6/68
R3           (1.3)  OR LESS           DAUBER    69 HBC                   6/68
R3       1    0.35      0.35          YEH       74 HBC     2859 EFF.DENOM.  7/75
R3       0   (2.3)  OR LESS  CL=.90   THOMPSON  80 ASPK    1017 EFF.DENOM.  9/81*

R4     XI- INTO (SIGMA0 E- NEUTRINO)/TOTAL (UNITS 10**-3)
R4                                                   (P5)
R4           (3.0)  OR LESS           BERGE     66 HBC                   6/68
R4           (0.5)  OR LESS           DAUBER    69 HBC                   6/68
R4       0   (0.53) OR LESS  CL=.90   YEH       74 HBC     4363 EFF.DENOM.  7/75
R4       0    0.14  OR LESS  CL=.90   THOMPSON  80 ASPK   16000 EFF.DENOM.  9/81*

R5     XI- INTO (SIG0 MU- NEU)/(LAM PI-) (UNITS 10**-3) (P6)/(P1)
R5           (5.0)  OR LESS           BERGE     66 HBC                   7/66
R5       0    0.76  OR LESS  CL=.90   YEH       74 HBC     3026 EFF.DENOM.  7/75

R6     XI- INTO (N E- NEU)/(LAMBDA PI-) (UNITS 10**-3)  (P7)/(P1)
R6          (10.0)  OR LESS  CL=.90   BINGHAM   65 RVUE                  9/66
R6       0    3.2   OR LESS  CL=.90   YEH       74 HBC      715 EFF.DENOM.  7/75

R7     XI- INTO (SIGMA0 E- NEU + LAMBDA E- NEU)/TOTAL (10**-3)
R7                                                   (P2+P5)
R7  D   17   (0.68)    (0.22)         DUCLOS    71 OSPK    SEE NOTE D    10/71
R7  D   THIS EXPERIMENT CANNOT DISTINGUISH SIGMA0 FROM LAMBDA. THE CABIBBO
R7  D   THEORY PREDICTS SIGMA0 RATE ABOUT A FACTOR 6 SMALLER THAN THE
R7  D   LAMBDA.

R8     XI- INTO (N MU- NEU)/(LAMBDA PI-) (UNITS 10**-3) (P8)/(P1)
R8       0   15.3   OR LESS  CL=.90   YEH       74 HBC      150 EFF.DENOM. 11/75

R9     XI- INTO (SIGMA- GAMMA)/(LAM PI-) (UNITS 10**-4) (P9)/(P1)
R9       0   11.5   OR LESS  CL=.90   YEH       74 HBC     2000 EFF.DENOM. 11/75

R10    XI- INTO (P PI- PI-)/(LAMBDA PI-) (UNITS 10**-4) (P10)/(P1)
R10      0    3.7   OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENOM. 11/75

R11    XI- INTO (P PI- E- NEU)/(LAM PI-) (UNITS 10**-4) (P11)/(P1)
R11      0    3.7   OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENOM. 11/75

R12    XI- INTO (P PI- MU- NEU)/(LAM PI-) (UNITS 10**-4) (P12)/(P1)
R12      0    3.7   OR LESS  CL=.90   YEH       74 HBC     6200 EFF.DENOM. 11/75

R13    XI- INTO (XI0 E- NEU)/(LAM PI-) (UNITS 10**-3)   (P13)/(P1)
R13      0    2.3   OR LESS  CL=.90   YEH       74 HBC     1000 EFF.DENOM. 11/75
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                22  XI- DECAY PARAMETERS

     RELATED TEXT SECTION VI D AND APPENDIX I

A      ALPHA XI-
A   D        (-0.44)   (0.12)         JAUNEAU   63 FBC     SEE NOTE D BELOW  6/68
A   D   62   (-0.73)   (0.23)         SCHNEIDER 63 HBC     SEE NOTE D BELOW  6/68
A      240    -0.5      0.38          BADIERI   64 HBC     SEE NOTE D BELOW  6/68
A      356    -0.62     0.13          CARMONY   64 HBC     SEE NOTE D BELOW  6/68
A     1004    -0.365    0.068         BERGE     66 HBC     SEE NOTE D BELOW  6/68
A   L  364    -0.47     0.13          LONDON    66 HBC     SEE NOTE D BELOW  6/68
A            (-0.391)  (0.032)        BERGE 2   66 RVUE  INCLUDES ALL ABOVE  9/66
A     2529   (-0.375)  (0.051)        MERRILL   68 HBC   REPL. BY DAUBER 69  6/68
A     2781    -0.391    0.045         DAUBER    69 HBC     SEE NOTE A BELOW
A     2724    -0.383    0.065         BINGHAM   70 OSPK                     10/70
A      820    -0.42     0.11          MAYEUR    72 HLBC    2.1 GEV/C K-      1/73
A     4303    -0.376    0.038         BALTAY    74 HBC     1.75 GEV/C K-     3/74
A     2436    -0.39     0.05          COOL      74 OSPK -  1.8 GEV/C K-P    10/74
A    B 414    -0.40     0.19          DIBIANCA  75 DBC     4.9 GEV/C K-D     1/77
A     6599    -0.370    0.032         HEMINGWAY 78 HBC     4.2 GEV/C K- P    1/79
A     9046    -0.49     0.04          CLELAND   80 ASPK    BNL HYPERON BEAM  9/81*
A   C 150K    -0.462    0.015         BIAGI     82 SPEC CERN-SPS HYPERON BM  4/82*
A   D   OLD DATA NOT INCLUDED IN AVERAGE.
A   D   ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A   D   POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)            6/68
A   L   LONDON 66 USES ALPHA-LAMBDA = 0.62
A    A  USED ALPHA LAMBDA = 0.647 +- 0.020.
A     B DIBIANCA 75 USES ALPHA LAMBDA = 0.647.                            1/77
A   C   BIAGI 82 USES ALPHA LAMBDA = -0.647+-0.014                        4/82*
A          . . . . . . . . . .
A   AVG       -0.434    0.015   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                        (SEE IDEOGRAM BELOW )

F      PHI ANGLE (SIN(PHI)/COS(PHI)=BETA/GAMMA) (DEGREES)
F   D        (-16.0)   (45.0)         JAUNEAU   63 FBC     SEE NOTE D BELOW  6/68
F   D   62   (45.0)    (36.0)         SCHNEIDER 63 HBC     SEE NOTE D BELOW  6/68
F      356    54.0      30.0          CARMONY   64 HBC     SEE NOTE D BELOW  6/68
F     1004    0.        12.           BERGE     66 HBC     SEE NOTE D BELOW  6/68
F   L  364    0.0       20.4          LONDON    66 HBC     SEE NOTE D BELOW  6/68
F     2529    (9.8)    (11.6)         MERRILL   68 HBC   REPL. BY DAUBER 69  6/68
F     2781   -14.       11.           DAUBER    69 HBC     SEE NOTE A BELOW
F     2724   -26.0      30.0          BINGHAM   70 OSPK                     10/70
F     4303    11.0       9.0          BALTAY    74 HBC     1.75 GEV/C K-     3/74
F     2436     5.0      16.0          COOL      74 OSPK -  1.8 GEV/C K-P    10/74
F   D   OLD DATA NOT INCLUDED IN AVERAGE.
F   D   ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F   D   POLARIZATION. (SEE DAUBER 68 FOR DETAILED DISCUSSION)
F   L   LONDON 66 USES ALPHA-LAMBDA = 0.62
F    A  USED ALPHA LAMBDA = 0.647 +- 0.020.
F          . . . . . . . . . .
F   AVG        2.0       5.7      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)
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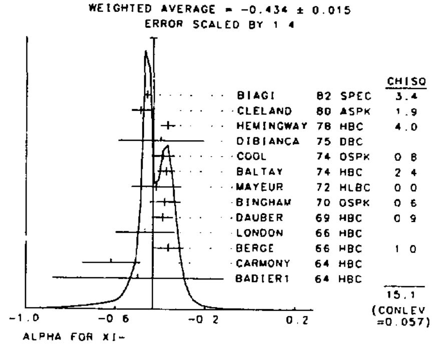


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                    REFERENCES FOR XI-

FOWLER    61 PRL 6 134          FOWLER,BIRGE,EBERHARD,ELY,GOOD,POWELL+(LRL)
WANG      61 JETP 13 512        K WANG,T WANG,VIRYASOV,TING,SOLOVEV+ (JINR)
BROWN     62 PRL 8 255          BROWN,CULWICK,FOWLER,GAILLOUD +   (BNL+YALE)

CARMONY   63 PRL  10  381       CARMONY,PJERROU                       (UCLA)
FERRO-LU  63 PR 130 1568        FERRO-LUZZI,ALSTON,ROSENFELD,WOJCICKI (LRL)
JAUNEAU   63 SIENA CONF 4       JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
   ALSO   63 PL  5  261         JAUNEAU,+        (EPOL,CERN,LOUC,RHEL,BERGEN)
SCHNEIDE  63 PL 4 360           H SCHNEIDER                           (CERN)

CARMONY   64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA) J
BADIERI   64 DUBNA CONF I 593   BADIER,DEMOULIN,BARLOUTAUD+(EPOL,SACL,ZEEM)
HUBBARD   64 PR 135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +     (LRL)
BINGHAM   65 PRSL  285  202     H H BINGHAM                           (CERN)
PJERROU   65 PRL 14 275         + SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)
PJERROU   65 THESIS             G M PJERROU                           (UCLA)

BERGE     66 PR  147  945       BERGE,EBERHARD,HUBBARD,PERRILL +       (LRL)
BERGE 2   66 BERKELEY CONF 46   BERGE,CABIBBO               (LRL,CERN(RVUE))
LONDON    66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)
CHIEN     66 PR  152  1171      +LACH,SANDWEISS,TAFT,YEH,OREN +   (YALE+BNL)
SHEN      67 PL 25 B 443        B.C.SHEN,A.FIRESTONE,G.GOLDHABER  (UCR+LRL)
TRIPPE    67 PRIV. COMM.        T. TRIPPE                             (UCLA)

BURGUN    68 NP B8 447          +MEYER,PAULI,TALLINI, +     (SACL+CDEF+RHEL)
HUBBARD   68 PRL 20 465         HUBBARD,BERGE,DAUBER                   (LRL)
MERRILL   68 PR 167 1202        MERRILL,SHAFER                         (LRL)J

DAUBER    69 PR  179 1262       +BERGE,HUBBARD,MERRILL,MILLER          (LRL)J
BINGHAM   70 PR D1 3010         +COOK,HUMPHREY,SANDER,WILLIAMS+ (UCSD,WASH)
GOLDWASS  70 PR D1 1960         GOLDWASSER, SCHULTZ                    (ILL)
STONE     70 PL 32B 515         +BERLINGHIERI,BROMBERG,COHEN,FERBEL +(ROCH)

DUCLOS    71 NP B32 493         +FREYTAG,HEINTZE,HEINZELMAN,JONES+    (CERN)
MAYEUR    72 NP B47 333         +VAN BINST,WILQUET+   (BRUX+CERN+TUFT+LOUC)
VOTRUBA   72 NP B45 77          VOTRUBA,SAFDER,RATCLIFFE         (BIRM+EDIN)
WILQUET   72 PL 42B 372         +FLAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)

BALTAY    74 PR D9 49           +BRIDGEWATER,COOPER,GERSHWIN+   (COLU+BING)J
COOL      74 PR D10 792         +GIACOMELLI,JENKINS,KYCIA,LEONTIC,LI+ (BNL)
   ALSO   72 PRL 29 1630        COOL,GIACOMELLI,JENKINS,KYCIA,LEONTIC+(BNL)
YEH       74 PR D10 3545        +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
DIBIANCA  75 NP B98 137         F.A.DIBIANCA, R.J.ENDORF              (CARN)

HEMINGWA  78 NP B142 205        HEMINGWAY,ARMENTEROS+  (CERN+ZEEM+NIJM+OXF)
HERBERT   78 PRL 40 1230        +CLELAND,COOPER,DRIS,ENGELS +     (PITT+BNL)
BOURQUIN  79 PL 87B 297           (BRIS+GEVA+HEID+ORSA+RHEL+STRB+CERN+MELB)
CLELAND   80 PR D21 12          +COOPER,DRIS,ENGELS,HERBERT+      (PITT+BNL)
THOMPSON  80 PR D21 25          +CLELAND,COOPER,DRIS,ENGELS+      (PITT+BNL)
BIAGI     82 PL (SUBMITTED)     +        (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RL)
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                23  XI0(1315,JP=1/2 ) I=1/2

                23  XI0 MASS (MEV)

M         1 1313.4       1.8          PALMER    68 HBC                    3/68
M        49 1315.2       0.92         WILQUET   72 HLBC                   1/73
M           . . . . . . . . . .
M    AVG    1314.83      0.82    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT    1314.91      0.55  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*

                23  (XI-) - (XI0) MASS DIFFERENCE (MEV)

D        23    6.8       1.6          JAUNEAU   63 FBC
D        45   (6.1)     (1.6)         CARMONY   64 HBC    REP BY PJERROU 65
D        88    6.1       0.9          PJERROU   65 HBC                    11/67
D        29    6.9       2.2          LONDON    66 HBC                     6/66
D           . . . . . . . . . .
D    AVG       6.34      0.74    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D    FIT       6.41      0.55  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*
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                  23  XIO MEAN LIFE (UNITS 10**-10 SEC)

T        24    3.9      1.4      0.80  JAUNEAU    63 FBC
T        45   (3.5)    (1.0)    (0.8)  CARMONY    64 HBC     REP BY PJERROU 65
T       101    2.5      0.4      0.3   HUBBARD    64 HBC
T        80    3.0      0.5            PJERROU    65 HBC                         11/67
T       340    3.07     0.22     0.20  DAUBER     69 HBC                          6/68
T   M   157    2.90     0.32     0.27  MAYEUR     72 HLBC    2.1 GEV/C K-         1/74
T       452    2.88     0.21     0.19  BALTAY     74 HBC     1.75 GEV/C K-        3/74
T   Z  6300    2.77     0.16           ZECH       77 SPEC NEUTRAL HYP. BEAM      12/77
T   M    MAYEUR 72 VALUE MODIFIED BY ERRATUM.                                     1/74
T   Z    ZECH 77 VALUE IS FOR LAMBDA LIFETIME=2.59E-10. FOR LAM LIFETIME         12/77
T   Z    DIFFERENT FROM THIS, TAUXIO=(2.77-(TAULAMBDA-2.69))E-10.                12/77
T             . . . . . . . . . .
T    AVG       2.903    0.099    0.093  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)
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                  23  XIO MAGNETIC MOMENT (MAGNETONS,938.26 MEV)

MM      42K   -1.20     0.06           BUNCE      79 SPEC                         1/80
MM     270K   -1.253    0.014          COX        81 SPEC                        12/81*
MM            . . . . . . . . . .
MM   AVG      -1.250    0.014   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                  23  XIO PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     XIO INTO LAMBDA PIO                                  1115+ 134
P2     XIO INTO PROTON PI-                                   938+ 139
P3     XIO INTO PROTON E- NEU                                938+  .5+   0
P4     XIO INTO SIGMA+ E- NEU                               1189+  .5+   0
P5     XIO INTO SIGMA- E+ NEU                               1197+  .5+   0
P6     XIO INTO SIGMA+ MU- NEUTRINO                         1189+ 105+   0
P7     XIO INTO SIGMA- MU+ NEUTRINO                         1197+ 105+   0
P8     XIO INTO PROTON MU- NEUTRINO                          938+ 105+   0
P9     XIO INTO LAMBCA GAMMA                                1115+   0
P10    XIO INTO SIGMAO GAMMA                                1192+   0
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                  23  XIO BRANCHING RATIOS

R1     XIO INTO (PROTON PI-)/(LAMBDA PIO)  (UNITS 10**-5) (P2)/(P1)
R1        (2700.)   OR LESS             TICHO      63 HBC                      6/68
R1        (500.)    OR LESS             HUBBARD    66 HBC                      6/68
R1         (90.)    OR LESS             DAUBER     69 HBC                      6/68
R1      0 (180.)    OR LESS   CL=.90    YEH        74 HBC     1300 EFF.DENOM. 11/75
R1           3.6    OR LESS   CL=.90    GEWENIGER  75 SPEC                    11/75

R2     XIO INTO (PROTON E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R2                                                          (P3)/(P1)
R2         (27.0)   OR LESS             TICHO      63 HBC                      6/68
R2         (6.0)    OR LESS             HUBBARD    66 HBC                      6/68
R2          1.3     OR LESS             DAUBER     69 HBC                      6/68
R2      0  (3.4)    OR LESS   CL=.90    YEH        74 HBC      670 EFF.DENOM. 11/75

R3     XIO INTO (SIGMA+ E- NEU)/(LAMBDA PIO) (UNITS 10**-3)
R3                                                          (P4)/(P1)
R3         (13.0)   OR LESS             TICHO      63 HBC                      6/68
R3         (7.0)    OR LESS             HUBBARD    66 HBC                      6/68
R3         (1.5)    OR LESS             DAUBER     69 HBC                      6/68
R3      0   1.1     OR LESS   CL=.90    YEH        74 HBC     2100 EFF.DENOM. 11/75

R4     XIO INTO (SIGMA- E+ NEU)/(LAMBDA PIO) (UNITS 10**-3)
R4                                                          (P5)/(P1)
R4         (6.0)    OR LESS             HUBBARD    66 HBC                      6/68
R4         (1.5)    OR LESS             DAUBER     69 HBC                      6/68
R4      0   0.9     OR LESS   CL=.90    YEH        74 HBC     2500 EFF.DENOM. 11/75

R5     XIO INTO (SIGMA+ MU- NEU)/TOTAL (UNITS 10**-3)   (P6)
R5         (7.0)    OR LESS             HUBBARD    66 HBC                      6/68
R5         (1.5)    OR LESS             DAUBER     69 HBC                      6/68
R5      0   1.1     OR LESS   CL=.90    YEH        74 HBC     2100 EFF.DENOM. 11/75

R6     XIO INTO (SIGMA- MU+ NEU)/TOTAL (UNITS 10**-3)   (P7)
R6         (6.0)    OR LESS             HUBBARD    66 HBC                      6/68
R6         (1.5)    OR LESS             DAUBER     69 HBC                      6/68
R6      0   0.9     OR LESS   CL=.90    YEH        74 HBC     2500 EFF.DENOM. 11/75

R7     XIO INTO (PROTON MU- NEU)/TOTAL (UNITS 10**-3)   (P8)
R7         (6.0)    OR LESS             HUBBARD    66 HBC                      6/68
R7          1.3     OR LESS             DAUBER     69 HBC                      6/68
R7      0  (3.5)    OR LESS   CL=.90    YEH        74 HBC      664 EFF.DENOM. 11/75

R8     XIO INTO (LAMBCA GAMMA)/(LAM PIO) (UNITS 10**-3) (P9)/(P1)
R8      1     5.        5.              YEH        74 HBC      200 EFF.DENOM. 11/75

R9     XIO INTO (SIGMAO GAMMA)/(LAM PIO) (UNITS 10**-2) (P10)/(P1)
R9     0-1    6.5   OR LESS   CL=.90    YEH        74 HBC       60 EFF.DENOM. 11/75
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                  23  XIO DECAY PARAMETER

       RELATED TEXT SECTION VI D AND APPENDIX I

A        ALPHA XI 0
A    X       (-0.09)   (0.46)          PJERROU    65 HBC      SEE NOTE D BELOW  6/68
A    X  146  (-0.13)   (0.17)          BERGE      66 HBC      SEE NOTE D BELOW  6/68
A    X   46  (-0.21    (0.4)           LONDON     66 HBC      SEE NOTE D BELOW  6/68
A   A   739   -0.43     0.09           DAUBER     69 HBC      1.7-2.6 GEV/C K-
A    X  130  (-0.34)   (0.27)          MAYEUR     72 HLBC     2.1 GEV/C K-      1/73
A   B   652   -0.54     0.10           BALTAY     74 HBC      1.75 GEV/C K-     3/74
A   U  6075   -0.490    0.042          BUNCE      78 SPEC FNAL HYPERON BEAM     7/79
A   H  300K   -0.465    0.012          HANDLER    82 SPEC FNAL HYPERON BEAM     1/82*
A    X   LOW STATISTICS EXPERIMENTS EXCLUDED FROM AVERAGE.                      1/82*
A    D   ERRORS MULTIPLIED BY 1.1 DUE TO APPROXIMATIONS USED FOR XI
A    D   POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
A   A    DAUBER 69 USES ALPHA LAMBDA = 0.650 +- 0.019.
A   B    BALTAY 74 USES ALPHA-LAMBDA = 0.645
A   U    BUNCE 78 USES ALPHA-LAMBDA = 0.647                                     7/79
A   H    HANDLER 82 USES ALPHA-LAMBDA=0.642+-0.013                              1/82*
A             . . . . . . . . . .
A    AVG      -0.413    0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)
                                (SEE IDEOGRAM BELOW )
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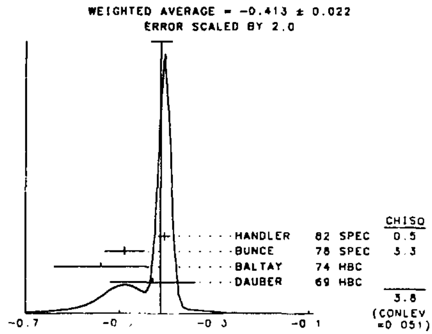

ALPHA FOR XIO

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F       PHI ANGLE  (SIN(PHI)/COS(PHI)=BETA/GAMMA)  (DEGREES)
F       146   -8.      30.             BERGE      66 HBC      SEE NOTE D BELOW  6/68
F   A   739   38.      19.             DAUBER     69 HBC      SEE NOTE A BELOW
F       652   16.0     17.0            BALTAY     74 HBC      1.75 GEV/C K-     3/74
F    A   USED ALPHA LAMBDA = 0.647 +- 0.020.
F    D   ERRORS MULTIPLIED BY 1.2 DUE TO APPROXIMATIONS USED FOR XI
F    D   POLARIZATION. (SEE DAUBER 69 FOR DETAILED DISCUSSION)
F            . . . . . . . . . .
F    AVG      20.7     11.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                            REFERENCES FOR XIO

ALVAREZ  59 PRL 2 215          ALVAREZ,EBERHARD,GOOD,GRAZIANO,TICHO+ (LRL)
JAUNEAU  63 SIENA CONF 1 1     JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
    ALSO 63 PL 4 49            JAUNEAU+         (EPOL+CERN+LOUC+RHEL+BERGEN)
TICHO    63 BNL CONF 410       HAROLD K TICHO                         (UCLA)

CARMONY  64 PRL 12 482         CARMONY,PJERROU,SCHLEIN,SLATER,STORK+(UCLA)
HUBBARD  64 PR 135 B 183       HUBBARD,BERGE,KALBFLEISCH,SHAFER +      (LRL)
PJERROU  65 PRL 14 275         + SCHLEIN,SLATER,SMITH,STORK,TICHO     (UCLA)
PJERROU  65 THESIS             G M PJERROU                            (UCLA)

BERGE    66 PR  147  945       BERGE,EBERHARD,HUBBARD,MERRILL +        (LRL)
HUBBARD  66 UCRL 11510         J RICHARD HUBBARD (THESIS,BERKELEY)     (LRL)
LONDON   66 PR 143 1034        LONDON,RAU,GOLDBERG,LICHTMAN+(BNL+SYRACUSE)

PALMER   68 PL 26B  323        PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
DAUBER   69 PR  179 1262       +BERGE,HUBBARD,MERRILL,MILLER           (LRL)

MAYEUR   72 NP B47 333         +VAN BINST,WILQUET+     (BRUX+CERN+TUFT+LOUC)
    ALSO 73 NP B53 268         ERRATUM TO MAYEUR 72
WILQUET  72 PL 42B 372         +FLAGINE,GUY,KNIGHT+ (BRUX+CERN+TUFT+LOUC)

BALTAY   74 PR D9 49           +BRIDGEWATER,COOPER,GERSHWIN+    (COLU+BING)J
YEH      74 PR D10 3545        +GAIGALAS,SMITH,ZENDLE,BALTAY + (BING+COLU)
GEWENIGE 75 PL 57B 193         GEWENIGER,GJESDAL,PRESSER +       (CERN+HEID)
ZECH     77 NP B124 413        +DYDAK,NAVARRIA+        (SIEG+CERN+DORT+HEID)

BUNCE    78 PR D18 633         +HANDLER,MARCH,MARTIN+       (WISC+MICH+RUTG)
BUNCE    79 PL 86B 386         +OVERSETH,COX,DWORKIN+ (BNL+MICH+RUTG+WISC)
COX      81 PRL 46 877         +DWORKIN +         (MICH+WISC+RUTG+MINN+BNL)
HANDLER  82 PR D25 639         +GROBEL,PONDROM+        (WISC+MICH+MINN+RUTG)

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                24  OMEGA-(1672,JP=3/2+) I=0

              QUANTUM NUMBERS ASSIGNED FROM SU3
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                24  OMEGA- MASS (MEV)

M    E    1(1615.)                     EISENBERG 54 EMUL                       9/73
M     F   1 1672.1       1.            FRY1      55 EMUL                       9/73
M     F   1 1670.6      (1.)           FRY2      55 EMUL                       9/73
M         1 1673.0       8.0           ABRAMS    64 HBC    INTO XI- PIO
M         3 1673.3       1.0           PALMER    68 HBC    K-P 4.6,5. GEV/C  11/69
M         3 1671.8       0.8           SCHULTZ   68 HBC    K-P 5.5 GEV/C     11/69
M         5 1674.2       1.6           SCOTTER   68 HBC    K-P 6.  GEV/C     11/69
M    B    6(1671.9)     (1.2)          SPETH     69 HBC    K-P 10. GEV/C     11/69
M    B   13(1671.43)    (0.78)         ABCLV     73 HBC    K-P 10. GEV/C     12/73
M     D   4 1673.4       1.7           DIBIANCA  75 DBC    4.9 GEV/C K-D      1/77
M        41 1673.0       0.8           BAUBILLIE 78 HBC    8.25 GEV/C K-P     2/79
M        27 1671.7       0.6           HEMINGWAY 78 HBC    4.2 GEV/C K-P      2/79
M            . . . . . . . . . .
M    AVG     1672.37     0.34   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M    FIT     1672.45     0.32  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*
        THE FIT COMBINES OMEGA- AND ANTI-OMEGA- VALUES
M
M    E   EISENBERG 54 MASS CALCULATED FOR DECAY IN FLIGHT. ALVAREZ 73 HAS      9/73
M    E   SHOWN THAT THE OMEGA INTERACTED WITH AG NUCLEUS TO GIVE K- XI AG.     9/73
M     F  BOTH FRY EVENTS IDENTIFIED AS OMEGA- BY ALVAREZ 73.                   9/73
M     F  FRY MASSES ASSUME DECAY TO LAMBDA K- AT REST.  DECAY FROM ATOMIC      3/74
M     F  ORBIT COULD DOPPLER SHIFT THE K- ENERGY AND RESULTING OMEGA- MASS     3/74
M     F  BY SEVERAL MEV FOR FRY 2.  THIS SHIFT IS NEGLIGIBLE FOR FRY 1         3/74
M     F  BECAUSE THE OMEGA DECAY IS APPROXIMATELY PERPENDICULAR TO ITS         3/74
M     F  ORBITAL VELOCITY, AS IS KNOWN BECAUSE THE LAMBDA STRIKES THE          3/74
M     F  NUCLEUS (L.ALVAREZ, PRIVATE COMM. 1973).  WE HAVE CALCULATED THE      3/74
M     F  ERROR ASSUMING THAT ORBITAL N IS 4 OR LARGER.                         3/74
M    B   ABCLV VALUE INCLUDES THE SPETH 69 EVENTS. EXCLUDED FROM AVERAGE.     12/73
M    B   SEE NOTE O IN THE OMEGA- MEAN LIFE SECTION BELOW.                     2/82*
M     D  DIBIANCA 75 GIVES MASS FOR EACH EVENT.  WE QUOTE AVERAGE.             1/77
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                   24  ANTI-OMEGA+ MASS (MEV)

MB        1 1673.1       1.0              FIRESTONE 71 HBC     12 GEV/C K+D      3/71
MB            . . . . . . . . . .
MB  FIT    1672.45      0.32   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  3/82*
       THE FIT COMBINES OMEGA- AND ANTI-OMEGA- VALUES

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                   24  OMEGA- MEAN LIFE (UNITS 10**-10 SEC)

T         1   (1.63)                     ABRAMS    64 HBC                       7/66
T         1   (0.7)                      BARNES 1  64 HBC                       7/66
T         1   (1.4)                      BARNES 2  64 HBC                       7/66
T         1   (1.85)                     COLLEY    65 HBC                       7/66
T         1   (1.5)                      RICHARDSO 65 HBC                       7/66
T         1   (1.20)                     SCHULTZ   68 HBC                      11/67
T         1   (0.06)                     SCHULTZ   68 HBC                      11/67
T         1   (0.63)                     SCHULTZ   68 HBC                      11/67
T         1   (0.25)                     SCOTTER   68 HBC                       6/68
T         1   (0.30)                     SCOTTER   68 HBC                       6/68
T         1   (3.71)                     SCOTTER   68 HBC                       6/68
T         1   (0.08)                     SCOTTER   68 HBC                       6/68
T         1   (1.04)                     SCOTTER   68 HBC                       6/68
T         1   (2.38)                     SCOTTER   68 HBC                       6/68
T    0   16   (1.39)    (0.45)    (0.31) ABCLV     73 HBC     K-P 10. GEV/C    12/73
T         1   (0.135)                    DIBIANCA  75 DBC     4.9 GEV/C K-D     1/77
T         1   (0.482)                    DIBIANCA  75 DBC     4.9 GEV/C K-D     1/77
T         1   (0.702)                    DIBIANCA  75 DBC     4.9 GEV/C K-D     1/77
T         1   (0.228)                    DIBIANCA  75 DBC     4.9 GEV/C K-D     1/77
T        40    0.80      0.16      0.12  BAUBILLIE 78 HBC     8.25 GEV/C K-P    2/79
T    D  101   (1.41)    (0.15)    (0.24) DEUTSCHMA 78 HBC     10,16 GEV/C K- P  6/78
T        39    0.75      0.14      0.11  HEMINGWAY 78 HBC     4.2 GEV/C K-P     2/79
T      2437    0.922     0.028           BOURQUIN  79 SPEC CERN SPS HYPERON BM 12/79
T    D   DEUTSCHMANN 78 INCLUDES EVENTS OF ABCLV 73. EXCLUDED FROM AVERAGE      2/80
T    D   BECAUSE OF SIGNIFICANT DISAGREEMENT WITH OTHER RECENT EXPERIMENTS.    2/80
T    D   POSSIBLY DUE TO XI- CONTAMINATION.                                    2/82*
T             . . . . . . . . . .
T    AVG       0.819     0.028     0.026  AVERAGE (ERROR INCL. SCALE FACTOR OF 1.0)

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                   24  OMEGA- PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      OMEGA- INTO LAMBDA K-                              1115+ 493
P2      OMEGA- INTO XI0 PI-                                1314+ 139
P3      OMEGA- INTO XI- PI0                                1321+ 134
P4      OMEGA- INTO LAMBDA PI-                             1115+ 139
P5      OMEGA- INTO XI- GAMMA                              1321+   0
P6      OMEGA- INTO XI*(1530)0 PI-                         1533+ 139
P7      OMEGA- INTO XI0 E- NEU                             1314+  .5+   0

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                   24  OMEGA- BRANCHING RATIOS

R1      OMEGA- INTO LAMBDA K-                                  (P1)
R1   F   1   EVENT                  FRY1      55 EMUL                      11/73
R1   F   1   EVENT                  FRY2      55 EMUL                      11/73
R1   F  BOTH FRY EVENTS IDENTIFIED BY ALVAREZ 73.                          11/73
R1       2   EVENTS                 PALMER    68 HBC                       11/69
R1       3   EVENTS                 SCHULTZ   68 HBC                       11/69
R1       5   EVENTS 1 XI PI DECAY AMB.SCOTTER 68 HBC                       11/69
R1      13   EVENTS +2 AMBIG. WITH XI-ABCLV   73 HBC     K-P 10. GEV/C     12/73
R1       2   EVENTS                 DIBIANCA  75 DBC     4.9 GEV/C K-D      1/77
R1    1920    0.686     0.013       BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R2      OMEGA- INTO XI0 PI-                                    (P2)
R2       5   EVENTS                 PALMER    68 HBC                       11/69
R2       3   EVENTS                 SCOTTER   68 HBC                       11/69
R2       3   EVENTS +1 AMBIG.WITH SIG-ABCLV   73 HBC     K-P 10. GEV/C     12/73
R2       2   EVENTS                 DIBIANCA  75 DBC     4.9 GEV/C K-D      1/77
R2     317    0.234     0.013       BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R3      OMEGA- INTO XI- PI0                                    (P3)
R3       1   EVENT                  ABRAMS    64 HBC                       11/69
R3       1   EVENT                  PALMER    68 HBC                       11/69
R3       1   EVENT                  SCOTTER   68 HBC                       11/69
R3       1   EVENT                  ABCLV     73 HBC     K-P 10. GEV/C     12/73
R3     145    0.080     0.008       BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R4      OMEGA- INTO (LAMBDA PI-)/TOTAL    (UNITS 10**-3)  (P4)
R4       0    1.3   OR LESS  CL=.90  BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R5      OMEGA- INTO (XI- GAMMA)/TOTAL     (UNITS 10**-3)  (P5)
R5       0    3.1   OR LESS  CL=.90  BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R6      OMEGA- INTO (XI*(1530)0 PI-)/TOTAL (UNITS 10**-3)(P6)
R6       1    2.     APPROX             BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

R7      OMEGA- INTO (XI0 E- NEU)/TOTAL    (UNITS 10**-2)  (P7)
R7       3    1.     APPROX             BOURQUI2  79 SPEC CERN SPS HYPERON BM   1/80

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                   24  OMEGA- DECAY PARAMETERS

        RELATED SECTION VI D IN TEXT

AL      ALPHA FOR OMEGA- TO K- LAMBDA
AL   K   15  (-0.66)   (0.36)   (0.30) KOCHER    74 HBC     10 GEV/C K-P      10/74
AL       40    0.58      0.50          BAUBILLIE 78 HBC     8.25 GEV/C K-P     2/79
AL       40   -0.2       0.4           HEMINGWAY 78 HBC     4.2 GEV/C K-P      2/79
AL   S 1400   (0.06)    (0.14)         SAUVAGE   78 SPEC CERN SPS HYPERON BM  4/82*
AL   K   SEE NOTE D IN THE OMEGA- MEAN LIFE SECTION ABOVE.                     2/82*
AL   S   SAUVAGE 78 IS PRELIMINARY.                                           4/82*
AL            . . . . . . . . . .
AL   AVG        0.10      0.3L    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

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REFERENCES FOR OMEGA-


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EISENBER 54 PR 96 541          Y EISENBERG                          (CORNELL)
FRY1     55 PR 97 1189         FRY,SCHNEPS,SWAMI                       (WISC)
FRY2     55 NC 2 346           FRY,SCHNEPS,SWAMI                       (WISC)

ABRAMS   64 PRL 13 670         + BURNSTEIN,GLASSER +                (UMD+NRL)
BARNES 1 64 PRL  12  204       V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
BARNES 2 64 PL 12 134          V E BARNES,CONNOLLY,CRENNELL,CULWICK+ (BNL)
COLLEY   65 PL 19 152          COLLEY,DODD +(BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
RICHARDS 65 BAPS 10 115        RICHARDSON,BARNES,CRENNEL+    (BNL+SYRACUSE)
SAMIOS   65 ARGONNE CONF 189   N P SAMIOS                         ((RVUE) BNL)
PALMER   68 PL 26B 323         PALMER,RADOJICIC,RAU,RICHARDSON+ (BNL,SYRA)
SCHULTZ  68 PR  168  1509      SCHULTZ+      (ILL,ARGONNE,NORTHWESTERN,WISC)
SCOTTER  68 PL 26B 474         SCOTTER+        (BIRM,GLASGOW,LOIC,MUNICH,OXF)
SPETH    69 PL  29B 252        SPETH+          (AACHEN,BERLIN,CERN,LOIC,VIEN)

FIRESTON 71 PRL 26 410         +GOLDHABER,LISSAUER,SHELDON,TRILLING  (LRL)
ABCLV    73 NP B61 132         AACHEN+BERLIN+CERN+LONDON+VIENNA COLLABOR.
ALVAREZ  73 PR D8 702          LUIS W. ALVAREZ                          (LBL)
KOCHER   74 PL 51B 153         KOCHER,WERNHARD                    (INN,+VIEN)
DIBIANCA 75 NP B98 137         F.A.DIBIANCA, R.J.ENDORF                (CARN)

BAUBILLI 78 PL 78B 342         BAUBILLIER +        (BIRM+CERN+GLAS+MSU+LPNP)
DEUTSCHM 78 PL 73B 96          DEUTSCHMANN+(AACH+BERL+CERN+INNS+LOIC+VIEN)
HEMINGWA 78 NP B142 205        HEMINGWAY,ARMENTEROS+   (CERN+ZEEM+NIJM+OXF)
SAUVAGE  78  TOKYO CONF P 427  G.SAUVAGE, PROC. 19TH INTL. HEP CONF (ORSA)
BOURQUIN 79 PL 87B 297            (BRIS+GEVA+HEID+ORSA+RHEL+STRB+CERN+MELB)
BOURQUI2 79 PL 88B 192            (BRIS+GEVA+HEID+ORSA+RHEL+STRB+CERN+MELB)

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                   33  LAMBDA/C+(2282,JP= )

                   FOR THE (SIGMA/C)-(LAMBDA/C) MASS DIFFERENCE SEE THE
                   SIGMA/C SECTION OF THE BARYON DATA CARD LISTINGS.

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                   33  LAMBDA/C+ MASS (MEV)

M       1  2260.       20.            CAZZOLI    75 HBC  +  LAMBDA 2PI+ PI-    3/77
M      60  2260.       10.            KNAPP      76 SPEC -  ANTILAM 2PI- PI+   3/77
M       1 (2248.)    (8 MORE          BARISH     77 DBC     MODE P15 BELOW     3/77
M       1 (2295.)    (15.)            ANGELINI   79 HYBR REPL. BY ALLASIA 80 12/79
M       6  2257.       10.            BALTAY     79 HLBC +  LAMBDA PI+         7/79
M       1  2254.       12.            CNOPS      79 DBC     P K*(892)- PI+    12/79
M    A 30  2262.       10.            GIBONI     79 SPEC    K- P PI+           2/80
M    A   GIBONI 79 RESULT CHANGED FROM 2255+-4 BY AUTHORS.  SEE KERNAN 79.     2/80
M      39  2285.        6.            ABRAMS     80 SMK2 +- K- P PI+ + C.C.    1/80
M       1  2260.       20.            ALLASIA    80 EMUL    P K- PI+          12/81*
M       1  2290.        3.            CALICCHIO  80 HYBR    P K- PI+          12/81*
M      19  2275.       10.            KITAGAKI   80 DBC     LAM PI+, KOBAR P 12/81*
M       1 (2330.)     (50.)           ADAMOVICH  81 EMUL +  LAMBDA PI+         1/82*
M    B  1 (2285.)     (5.)            GRAESSLER  81 HBC  +  P K- PI+           1/82*
M    B  1 (2280.)     (3.)            GRAESSLER  81 HBC  +  P K- PI+           1/82*
M      55  2284.0       5.0           RUSSELL    81 SPEC +- KOBAR P + C.C.    12/81*
M    B  3  2283.0       3.0           BOSETTI    82 HBC  +  P K- PI+           3/82*
M    B   BOSETTI 82 COMBINE ONE NEW EVENT AT 2288+-5 MEV WITH THEIR EARLIER    3/82*
M    B   TWO (GRAESSLER 81 ABOVE).                                             3/82*
M       3  2270.0      15.0           KITAGAKI   82 DBC     SIGMA0 PI+         2/82*
M            . . . . . . . . . .
M    AVG   2282.2       3.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
                                (SEE IDEOGRAM BELOW )
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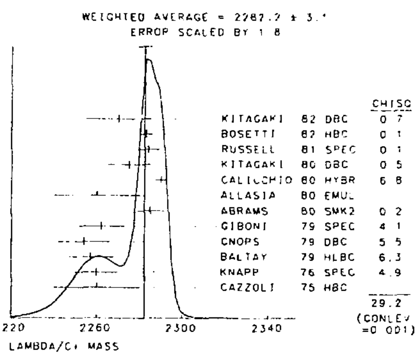


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                   33  LAMBDA/C+ MEAN LIFE (UNITS 10** 13 SEC)

T         1   (7.3)                      ANGELINI  79 HYBR P K- PI+             12/79
T         4    1.14      0.90      0.44  USHIDA    80 EMUL LAM 3PI, P KBAR 2PI 12/81*
T         1   (0.57)                     ADAMOVICH 81 EMUL LAMBDA PI+            2/82*

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                   33  LAMBDA/C+ PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      LAMBDA/C+ INTO LAMBDA PI+ PI+ PI-                  1115+ 139+ 139+ 139
P2      LAMBDA/C+ INTO LAMBDA PI+                          1115+ 139
P3      LAMBDA/C+ INTO P KOBAR                              938+ 497
P4      LAMBDA/C+ INTO P K- PI+                             938+ 493+ 139
P5      LAMBDA/C+ INTO K*(892)0 P                           891+ 938
P6      LAMBDA/C+ INTO DEL(1232)++ K-                      1232+ 493
P7      LAMBDA/C+ INTO P KOBAR PI- PI+                      938+ 497+ 139+ 139
P8      LAMBDA/C+ INTO P K*(892)- PI+                       938+ 891+ 139
P9      LAMBDA/C+ INTO SIGMA+ PI0                          1189+ 134
P10     LAMBDA/C+ INTO SIGMA0 PI+                          1192+ 139
P11     LAMBDA/C+ INTO SIGMA+ ETA                          1189+ 548
P12     LAMBDA/C+ INTO E+ ANYTHING
P13     LAMBDA/C+ INTO P E+ ANYTHING
P14     LAMBDA/C+ INTO LAMBDA E+ ANYTHING
P15     LAMBDA/C+ INTO P PI- PI0 K0 E+ NEU                  938+ 139+ 134+ 497+

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                    33  LAMBDA/C+ BRANCHING RATIOS

R1     LAMBDA/C+ INTO (P K- PI+)/TOTAL                          (P4)
R1      90   (SEEN)                     DRIJARD    79 SFM  P P AT 62.8 GEV ECM 12/79
R1      98   (SEEN)                     GIBONI     79 SPEC P P AT 63 GEV ECM   12/79
R1      18   (SEEN)                     LOCKMAN    79 SPEC P P 53, 62 GEV ECM  12/79
R1      39    0.022      0.010          ABRAMS     80 SMK2 E+E- 5.2 GEV ECM     1/80
R1       1   (SEEN)                     CALICCHIO  80 HBC  NU P IN BEBC-TST    12/81*
R1      74   (SEEN)                     IRION      81 SPEC P P AT 63 GEV ECM    2/82*

R2     LAMBDA/C+ INTO (P K*(892)0)/(P K- PI+)                   (P5)/(P4)
R2       1   (SEEN)                     ANGELINI   79 HYBR NU EMUL WITH BEBC   12/79
R2      47   (SEEN)                     DRIJARD    79 SFM  P P AT 52.5 GEV ECM 12/79
R2            0.18       0.10           WEISS      80 SMK2 E+ E- 5.2 GEV ECM    4/82*
R2      12    0.42       0.24           BASILE     81 CNTR P P -> LAM/C+ E- X   2/82*
R2      THE ABOVE RATIOS INCLUDE THE KOBAR PIO MODE OF THE K*0.                 4/82*
R2           . . . . . . . . . .
R2  AVG       0.216      0.092      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3     LAMBDA/C+ INTO (DEL(1232)++ K-)/(P K- PI+)               (P6)/(P4)        1/82*
R3      40   (SEEN)                     DRIJARD    79 SFM  P P AT 52.5 GEV ECM 12/79
R3            0.17       0.07           WEISS      80 SMK2 E+ E- 5.2 GEV ECM    4/82*
R3      17    0.40       0.17           BASILE     81 CNTR P P -> LAM/C+ E- X   1/82*
R3           . . . . . . . . . .
R3  AVG       0.203      0.081      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R4     LAMBDA/C+ INTO P KOBAR                                   (P3)
R4       5   (SEEN)                     BALTAY     79 HLBC NU NE-H2 IN 15-FT    2/80
R4      10   (SEEN)                     KITAGAKI   80 DBC  NU D IN FNAL 15-FT  12/81*
R4      55   (SEEN)              55/75  RUSSELL    81 SPEC PHOTOPRODUCTION      2/82*

R5     LAMBDA/C+ INTO (P KOBAR)/(P K- PI+)                      (P3)/(P4)
R5      12    0.5        0.25           WEISS      80 SMK2 E+ E- 5.2 GEV ECM    4/82*

R6     LAMBDA/C+ INTO (P K- PI+)/(P KOBAR)                      (P4)/(P3)       12/81*
R6      50    1.5   OR LESS  CL=.90     RUSSELL    81 SPEC PHOTOPRODUCTION     12/81*

R7     LAMBDA/C+ INTO LAMBDA PI+                                (P2)
R7       6   (SEEN)                     BALTAY     79 HLBC NU NE-H2 IN 15-FT    2/80
R7       9   (SEEN)                     KITAGAKI   80 DBC  NU D IN FNAL 15-FT  12/81*

R8     LAMBDA/C+ INTO (LAMBDA PI+)/(P K- PI+)                   (P2)/(P4)
R8           (0.8)  OR LESS  CL=0.9     WEISS      80 SMK2 E+ E- 5.2 GEV ECM    4/82*

R9     LAMBDA/C+ INTO (LAMBDA PI+)/(P KOBAR)                    (P2)/(P3)
R9   K   5    0.67       0.78     0.35  BALTAY     79 HLBC NU NE-H2 IN 15-FT   12/81*
R9       9    0.51       0.62     0.27  KITAGAKI   80 DBC  NU D IN FNAL 15-FT  12/81*
R9      40   (0.4)  OR LESS  CL=.90     RUSSELL    81 SPEC PHOTOPRODUCTION     12/81*
R9   K  CALCULATED BY KITAGAKI 80 FROM BALTAY 79 RESULTS.                      12/81*
R9           . . . . . . . . . .
R9  AVG       0.57       0.35       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10    LAMBDA/C+ INTO LAMBDA PI+ PI+ PI-                        (P1)
R10      1    SEEN                      CAZZOLI    75 HBC  NU P IN BNL 7-FT     2/80
R10     60    SEEN                      KNAPP      76 SPEC GAMMA BE             2/80
R10      2    SEEN                      BALTAY     79 HLBC NU NE-H2 IN 15-FT    2/80
R10     12    SEEN                      GIBONI     79 SPEC P P AT 63 GEV ECM   12/79
R10     18    SEEN                      LOCKMAN    79 SPEC P P 53, 62 GEV ECM  12/79

R11    LAMBDA/C+ INTO (LAMBDA PI+ PI+ PI-)/(P K- PI+)   (P1)/(P4)
R11           1.4   OR LESS  CL=0.9     WEISS      80 SMK2 E+ E- 5.2 GEV ECM    4/82*

R12    LAMBDA/C+ INTO (LAMBDA PI+ PI+ PI-)/ (P KOBAR)   (P1)/(P3)               12/81*
R12    220   (3.1)  OR LESS  CL=.90     RUSSELL    81 SPEC PHOTOPRODUCTION     12/81*

R13    LAMBDA/C+ INTO (P KOBAR PI- PI+)/(P KOBAR)               (P7)/(P3)       12/81*
R13     45    3.3   OR LESS  CL=.90     RUSSELL    81 SPEC PHOTOPRODUCTION     12/81*

R14    LAMBDA/C+ INTO SIGMA0 PI+                                (P10)
R14      3    SEEN                      KITAGAKI   82 DBC  NU D IN FNAL 15-FT   2/82*

R15    LAMBDA/C+ INTO P K*(892)- PI+                            (P8)
R15      1    SEEN                      CNOPS      79 DBC  NU N IN BNL 7-FT     2/80

R16    LAMBDA/C+ INTO (E+ ANYTHING)/TOTAL                       (P12)            3/82*
R16           0.045      0.017          VELLA      82 SMK2 E+ E- 4.5-6.8 GEV    3/82*

R17    LAMBDA/C+ INTO (P E+ ANYTHING)/TOTAL                     (P13)            3/82*
R17  M        0.018      0.009          VELLA      82 SMK2 E+ E- 4.5-6.8 GEV    3/82*
R17  M  THIS INCLUDES PROTONS FROM LAMBDA DECAY.                                3/82*

R18    LAMBDA/C+ INTO (LAMBDA E+ ANYTHING)/TOTAL                (P14)            2/82*
R18      1   (0.022)OR LESS  CL=.90     BALLAGH    81 HYPR NU NE-H2 IN 15-FT    2/82*
R18  N        0.011      0.008          VELLA      82 SMK2 E+ E- 4.5-6.8 GEV    3/82*
R18  N  THIS INCLUDES LAMBDAS FROM SIGMA0 DECAY.                                3/82*

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REFERENCES FOR LAMBDA/C+


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CAZZOLI   75 PRL 34 1125           +CNOPS,CONNOLY,LOUTTIT,MURTAGH, +       (BNL)
KNAPP     76 PRL 37 882            +LEE,LEUNG,SMITH +       (COLU+HAWA+ILL+FNAL)
BARISH    77 PR D15 1              +DERRICK,DOMBECK,MUSGRAVE +        (ANL+PURD)

ANGELINI  79 PL 84B 150            (ANKA+LIBH+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
BALTAY    79 PRL 42 1721           +CARDUMBALIS,FRENCH,HIBBS, +       (COLU+BNL)
CNOPS     79 PRL 42 197            +CONNOLLY,KAHN,KIRK,MURTAGH,PALMER+    (BNL)
DRIJARD   79 PL 85B 452            +FISCHER+    (CERN+CDEF+DORT+HEID+LAPP+WARS)
GIBONI    79 PL 85B 437            +DIBITONTO+  (AACH+CERN+HARV+MUNI+NWES+UCR)
KERNAN    79  LEPTCN CONF.FNAL A. KERNAN                                  (UCR)
LOCKMAN   79 PL 85B 443            +MEYER,RANDER,SCHLEIN,WEBB+      (UCLA+SACL)

ABRAMS    80 PRL 44 10             +ALAM,BLOCKER,BOYARSKI, +         (SLAC+LBL)
ALLASI    80 NP B176 13            (ANKA+LIBH+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
CALICCHI  80 PL 93B 521            + (BARI+BIRM+BRUX+CERN+EPOL+RHEL+SACL+LOUC)
KITAGAKI  80 PRL 45 955            +TANAKA,YUTA,ABE, +(TOHO+IIT+UMD+STON+TUFT)
USHIDA    80 PRL 45 1053            (FNAL+MCGI+NAGO+DSU+OSKC+OTTA+TOKY+TNTO+)
WEISS     80 TORONTO CONF 319  J M WEISS                                 (SLAC)

ADAMOVIC  81 PL 99B 271            ADAMOVICH+(PHOTON-EMUL,OMEGA-PHOTON COLLS.)
BALLAGH   81 PR D24 7              +BINGHAM +    (LBL+UCB+FNAL+HAWA+WASH+WISC)
BASILE    81 NC 62A 14             +CARA ROMEO +            (CERN+BGNA+PGIA+FRAS)
FIORINO   81 LNC 30 166            (PHOTON-EMUL COLLAB.+OMEGA-PHOTON COLLAB.)
   -- THE EVENT IN FIORINO 81 IS ALSO IN ADAMOVICH 81.

GRAESSLE  81 PL 99B 159            GRAESSLER,LANSKE+ (AACH+BONN+CERN+MPIM+OXF)
IRION     81 PL 99B 495            +SEEBRUNNER, +    (AACH+CERN+HARV+MUNI+NWES)
RUSSELL   81 PRL 46 799            +AVERY,BUTLER,GLADDING +     (ILL+FNAL+COLU)
BOSETTI   82 PL 109B 234           +GRAESSLER, +     (AACH+BONN+CERN+MPIM+OXF)
KITAGAKI  82 PRL 48 299            +TANAKA,YUTA,ABE,+ (TOHO+IIT+UMD+STON+TUFT)
VELLA     82 PRL (SUBMITTED)       +TRILLING,ABRAMS,ALAM,+        (SLAC+LBL+UCB)
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THEORY AND REVIEW


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DERUJULA  75 PR D12 147         +GEORGI,GLASHOW                          (HARV)
GAISSER   76 PR D14 3153        T.K.GAISSER,F.HALZEN                (BART+WISC)
LEE       77 PR D15 157         +QUIGG,ROSNER                            (FNAL)
MULLER    79 CERN/EP 79-148     F.MULLER (CARGESE LEC.1979)              (CERN)
DIBITONT  81 MADISON CONF.      D.DIBITONTO                              (CERN)
TRILLING  81 PRPL 75 57         G H TRILLING                              (LBL)
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             40  LAMBDA/B0(5500, JP=  )

             THE CLAIM BY BASILE 81 IS HOTLY DISPUTED BY DRIJARD 82.
             SEE THE LISTING FOR BOTTOM HADRON SEARCHES.

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             40  LAMBDA/B0 MASS  (MEV)

M          5425.0    175.0     75.0   BASILE     81 SFM  D  P P 62 GEV ECM    4/82*

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             40  LAMBDA/B0 PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      LAMBDA/B0 INTO P D0 PI-                                938+1864+ 139

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             40  LAMBDA/B0 BRANCHING FRACTIONS

R1      LAMBDA/B0 INTO (P D0 PI-)/TOTAL                       (P1)
R1              SEEN                   BASILE     81 SFM  D0 TO K- PI+          4/82*

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REFERENCES FOR LAMBDA/B0


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BASILE    81 LNC 31 97          +BONVICINI,CARA ROMEO+(CERN+BGNA+FRAS+PGIA)
DRIJARD   82 PL 108B 361        +FISCHER,+   (CERN+CDEF+DORT+HEID+LAPP+WARS)
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SEARCHES FOR MASSIVE NEUTRINOS AND LEPTON MIXING

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       SEE THE NOTE ON NEUTRINOS BY R.E. SHROCK IN THE ELECTRON NEUTRINO
       SECTION NEAR THE BEGINNING OF THESE DATA CARD LISTINGS.

       SEARCHES FOR INDIRECT EFFECTS OF NEUTRINO MASSES AND LEPTON MIXING
       ARE LISTED HERE.  DIRECT SEARCHES FOR MASSES OF DOMINANTLY COUPLED
       NEUTRINOS ARE LISTED IN THE APPROPRIATE SECTION ON NU-MU, NU-E,
       OR NU-TAU.  RESULTS OF THESE INDIRECT SEARCHES ARE CORRELATED
       UPPER BOUNDS ON MIXING MATRIX COEFFICIENTS U(A,J) VERSUS
       NEUTRINO MASS.  THESE RESULTS ARE DIVIDED INTO THREE SECTIONS--
           (A) BOUNDS FROM PARTICLE AND NUCLEAR DECAYS
           (B) BOUNDS FROM NEUTRINO REACTIONS
           (C) SEARCHES FOR NEUTRINOLESS DOUBLE BETA DECAY

       FOR A COMPREHENSIVE REVIEW OF THESE LIMITS, SEE BALTAY 81.

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                   5  (A).  BOUND  FROM PARTICLE AND NUCLEAR DECAYS

U1J     LIMITS ON CABS(U(1,J))**2 AS FUNCTION OF MASS(NU-J) IN MEV REGION
U1J  A       0.1      OR LESS  CL=.68   SHROCK     80      M(NU-J) 0.1-3 MEV    1/82*
U1J  B       1. E-4   OR LESS  CL=.68   SHROCK1    81      M(NU-J) 10 MEV       1/82*
U1J  B       5. E-6   OR LESS  CL=.68   SHROCK1    81          TO 60 MEV        1/82*
U1J  C       1. E-5   OR LESS  CL=.68   SHROCK     80      M(NU-J) 80 MEV       1/82*
U1J  C       3. E-6   OR LESS  CL=.68   SHROCK     80          TO 160 MEV       1/82*
U1J  A  APPLICATION OF TEST TO SEARCH FOR KINKS IN BETA DECAY KURIE PLOTS.      1/82*
U1J  B  ANALYSIS OF (PI+ --> E+ NU-E)/(PI+ --> MU+ NUMU) AND                    1/82*
U1J  B  (K+ --> E+ NUE)/(K+ --> MU+ NUMU) DECAY RATIOS.                         1/82*
U1J  C  ANALYSIS OF (K+ --> E+ NUE) SPECTRUM.                                   1/82*
U1J
U1J     LIMITS ON CABS(U(1,J))**2 AS FUNCTION OF MASS(NU-J) IN KEV REGION
U1J  D       1.       OR LESS  CL=.95   SIMPSON    81      M(NU-J) 0.1 KEV      1/82*
U1J  D       4. E-3   OR LESS  CL=.95   SIMPSON    81          TO 10 KEV        1/82*
U1J  D  APPLICATION OF KINK SEARCH TEST TO TRITIUM BETA DECAY KURIE PLOT.       1/82*


U2J     LIMITS ON CABS(U(2,J))**2 AS FUNCTION OF MASS(NU-J) IN MEV REGION
U2J
U2J     APPLICATION OF PEAK SEARCH TEST TO EXISTING DATA.
U2J  A       5. E-2   OR LESS  CL=.95   SHROCK     80      M(NU-J) 4-6 MEV      1/82*
U2J  A       3. E-2   OR LESS  CL=.95   SHROCK1    81      M(NU-J) 7 MEV        1/82*
U2J  A       1. E-2   OR LESS  CL=.95   SHROCK1    81          TO  13 MEV       1/82*
U2J  A       1. E-4   OR LESS  CL=.68   SHROCK1    81      M(NU-J) 13 MEV       1/82*
U2J  A       3. E-5   OR LESS  CL=.68   SHROCK1    81          TO  33 MEV       1/82*
U2J  B       6. E-3   OR LESS  CL=.68   SHROCK1    81      M(NU-J) 80 MEV       1/82*
U2J  B       5. E-3   OR LESS  CL=.68   SHROCK1    81          TO  120 MEV      1/82*
U2J  C       6. E-6   OR LESS  CL=.95   ASANO      81      M(NU-J) 230 MEV      1/82*
U2J  C       4. E-7   OR LESS  CL=.95   ASANO      81          TO  280 MEV      1/82*
U2J  C       6. E-6   OR LESS  CL=.95   ASANO      81          TO  300 MEV      1/82*
U2J
U2J      NEW EXPERIMENTS TO APPLY PEAK SEARCH TEST.
U2J  D       1. E-1   OR LESS  CL=.90   ABELA      81      M(NU-J) 4 MEV        1/82*
U2J  D       7. E-5   OR LESS  CL=.90   ABELA      81          TO  11 MEV       1/82*
U2J  D       2. E-4   OR LESS  CL=.90   ABELA      81      M(NU-J) 11 MEV       1/82*
U2J  D       2. E-5   OR LESS  CL=.90   ABELA      81          TO  16 MEV       1/82*
U2J  D       2. E-5   OR LESS  CL=.90   ABELA      81      M(NU-J) 16-30 MEV    1/82*
U2J  D       1. E-2   OR LESS  CL=.95   CALAPRICE  81      M(NU-J) 7 MEV        1/82*
U2J  D       3. E-3   OR LESS  CL=.95   CALAPRICE  81          TO  33 MEV       1/82*
U2J  E       2. E-5   OR LESS  CL=.95   ASANO      81      M(NU-J) 160 MEV      1/82*
U2J  E       3. E-6   OR LESS  CL=.95   ASANO      81          TO  230 MEV      1/82*
U2J  A  ANALYSIS OF MAG. SPEC. EXP., BC EXP. AND EMUL. EXP. ON PI+ --> MU+      1/82*
U2J  A  NU-MU DECAY.                                                            1/82*
U2J  B  ANALYSIS OF MAG. SPEC. EXP. ON K-->MU,NUMU DECAY.                       1/82*
U2J  C  ANALYSIS OF EXP. ON K+ --> MU+ NU-MU NU-X ANU-X DECAY.                  1/82*
U2J  D  PI+ --> MU+ NU-MU  PEAK SEARCH EXP.                                     1/82*
U2J  E  K+ --> MU+ NU-MU  PEAK SEARCH EXP.                                      1/82*
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Data Card Listings

For notation, see key at front of Listings.

Stable Particles

MASSIVE ν'S AND LEPTON MIXING

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UAJ     LIMITS ON CABS(U(A,J))**2, WHERE A=1 OR 2, FROM ANALYSIS OF RHO
UAJ     PARAMETER IN MU DECAY.
UAJ         1. E-2  OR LESS  CL=.68   SHROCK2   81      M(NU-J) 10 MEV    1/82*
UAJ         2. E-3  OR LESS  CL=.68   SHROCK2   81           TO  40 MEV    1/82*
UAJ         4. E-2  OR LESS  CL=.68   SHROCK2   81           TO  70 MEV    1/82*

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                  5 (B).  BOUNDS FROM NEUTRINO REACTIONS

------ --------- --  5  SOLAR NEUTRINO EXPERIMENTS ---- --------- --------

S       SOLAR NU FLUX (UNITS, SNU)
S       (1 SOLAR NEUTRINO UNIT, SNU, =1.E-36 CAPTURES/SEC/TARGET ATOM)
S           (7.3)     (1.5)           BAHCALL   80          THEOR.CALC.FLUX   1/82*
S            2.1       0.3            DAVIS     81          MEAS. FLUX        1/82*
S           (7.0)     (3.0)           FILIPPONE 82          THEOR.CALC.FLUX   1/82*
S        SEE ALSO THE REVIEW OF J.N.BAHCALL, PROC. 1981 INTL. CONF. ON          4/82*
S        NEUTRINO PHYSICS AND ASTROPHYS. (MAUI. HAWAII) V.2. P. 253.            4/82*

------ --------- --  5  DEEP MINE EXPERIMENTS --------- --------- --------

DM      R= (MEASURED FLUX OF NU-MU)/(EXPECTED FLUX OF NU-MU)
DM           0.62      0.17           CROUCH    78          CASE WEST/UCI     1/82*
DM           1.        0.26           ZATSEPIN  81          BAKSAN            4/82*
DM          . . . . . . . . . .
DM   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

------ --------- --  5  REACTOR ANTINEUTRINO EXPERIMENTS --------- --------

RD      (EVENTS OBSERVED)/(EVENTS EXPECTED) FROM REACTOR ANU-E EXPTS.
RD  B       (0.89)    (0.15)          BOEHM     80       ANU-E P --> E+ N     1/82*
RD A R       0.38      0.21           REINES    80       SEE NOTE A           1/82*
RD A R       0.40      0.22           REINES    80       SEE NOTE A           1/82*
RD  B        0.955     0.12           KWON      81       ANU-E P --> E+ N     1/82*
RD   B  KWON 81 REPRESENTS AN ANALYSIS OF A LARGER SET OF DATA FROM THE      1/82*
RD   B  SAME EXPERIMENT AS BOEHM 80. SYST.+STAT. ERRORS COMBINED IN          1/82*
RD   B  QUADRATURE.                                                          1/82*
RD   A  REINES 80 INVOLVES COMPARISON OF NEUTRAL- AND CHARGED-CURRENT        1/82*
RD   A  REACTIONS ANU-E D --> N P ANU-E AND ANU-E D --> N N E+ RSPECTIVELY.  1/82*
RD   A  COMBINDED ANALYSIS OF REACTOR ANU-E EXPTS. WAS PERFORMED BY          1/82*
RD   A  SILVERMAN 81.                                                        1/82*
RD   R  THE TWO REINES 80 VALUES CORRESPOND TO THE CALCULATED ANU-E FLUXES   1/82*
RD   R  OF AVIGNONE-GREENWOOD AND DAVIS ET AL RESPECTIVELY.                  1/82*

------ --------- --  5  ACCELERATOR EXPERIMENTS -------- --------- --------

        BOUNDS ON DELTA(M**2) VS. SIN(2*THETA)**2
        WHERE DELTA(M**2) IS MAGNITUDE OF ( MASS(NU-I)**2 - MASS(NU-J)**2)
        AND THETA IS THE MIXING ANGLE FOR THE SIMPLIFYING ASSUMPTION OF
        MIXING BETWEEN TWO NEUTRINO FAMILIES ONLY.

        EACH EXPERIMENTAL RESULT IS A PLOT GIVING ALLOWED AND EXCLUDED
        REGIONS AS FUNCTIONS OF DELTA(M**2) AND SIN(2*THETA)**2.  WE QUOTE
        TWO REPRESENTATIVE LIMITS FROM EACH PLOT --
           1)  DELTA(M**2) FOR SIN(2*THETA)**2=1.
           2)  SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2), I.E. SUFFICIENTLY
               LARGE DELTA(M**2) THAT THE DETECTOR WOULD MEASURE ONLY AN
               EFFECT AVERAGED OVER MANY OSCILLATIONS.
        EXPERIMENTS ARE OF TWO GENERAL TYPES --
           (A) THOSE WHICH SEARCH FOR NU(A)-->NU(B) (B NOT EQUAL A), I.E.
               THE APPEARANCE OF L(B) FROM CHARGED CURRENT REACTION OF A
               NU(A) BEAM.
           (B) THOSE WHICH SEARCH FOR THE 'DISAPPEARANCE' OF PART OF THE
               INITITAL NU(A) BEAM BY COMPARING THE NUMBER OF OBSERVED L(A)
               EVENTS WITH THE NUMBER EXPECTED FROM FLUX CALCULATIONS.
               THESE EXPERIMENTS DO NOT TRY TO OBSERVE THE ANOMALOUS
               L(B)'S.  WE LABEL SUCH EXPERIMENTS AS NU-A -/-> NU-A


NU-MU --> NU-E

D1      DELTA(M**2) FOR SIN(2*THETA)**2=1    (UNITS EV**2)    NU-MU --> NU-E
D1          1.2       OR LESS  CL=.95   BELLOTTI  76 HLBC GGM CERN PS          1/82*
D1          1.2       OR LESS  CL=.95   BLIETSCHA 78 HLBC GGM CERN PS          1/82*
D1          1.7       OR LESS  CL=.90   ARMENISE  81 HLBC GGM CERN SPS         1/82*
D1          0.6       OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
D1          1.7       OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*

S1      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)            NU-MU --> NU-E
S1          1. E-2  OR LESS  CL=.95   BELLOTTI  76 HLBC GGM CERN PS          1/82*
S1          6. E-2  OR LESS  CL=.95   BLIETSCHA 78 HLBC GGM CERN PS          1/82*
S1          1. E-2  OR LESS  CL=.90   ARMENISE  81 HLBC GGM CERN SPS         1/82*
S1          6. E-3  OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
S1          1. E-2  OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*


ANU-MU --> ANU-E

D2      DELTA(M**2) FOR SIN(2*THETA)**2=1    (UNITS EV**2)    ANU-MU --> ANU-E
D2          1.        OR LESS  CL=.95   BLIETSCHA 78 HLBC GGM CERN PS          1/82*
D2          0.91      OR LESS  CL=.90   NEMETHY   81 CNTR LAMPF                1/82*

S2      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)            ANU-MU --> ANU-E
S2          6. E-2  OR LESS  CL=.95   BLIETSCHA 78 HLBC GGM CERN PS          1/82*
S2          0.2       OR LESS  CL=.90   NEMETHY   81 CNTR LAMPF                1/82*


NU-MU --> NU-TAU

D3      DELTA(M**2) FOR SIN(2*THETA)**2=1    (UNITS EV**2)    NU-MU --> NU-TAU
D3          4.6       OR LESS  CL=.90   ARMENISE  81 HLBC GGM CERN SPS         1/82*
D3          3.        OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
D3          6.        OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*
D3          3.        OR LESS  CL=.90   USHIDA    81 EMUL FNAL                 1/82*

S3      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)            NU-MU --> NU-TAU
S3          1.7E-2  OR LESS  CL=.90   ARMENISE  81 HLBC GGM CERN SPS         1/82*
S3          6. E-2  OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
S3          5. E-2  OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*
S3          1.3E-2  OR LESS  CL=.90   USHIDA    81 EMUL FNAL                 1/82*
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ANU-MU --> ANU-TAU

D4      DELTA(M**2) FOR SIN(2*THETA)**2=1   (UNITS EV**2)  ANU-MU --> ANU-TAU
D4          2.2       OR LESS  CL=.90   ASRATYAN  81 HLBC FNAL                 1/82*

S4      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)          ANU-MU --> ANU-TAU
S4          4.4E-2  OR LESS  CL=.90   ASRATYAN  81 HLBC FNAL                 1/82*


NU-E -/-> NU-E

D6      DELTA(M**2) FOR SIN(2*THETA)**2=1    (UNITS EV**2)    NU-E -/-> NU-E
D6          8.        OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
D6         56.        OR LESS  CL=.90   DEDEN     81 HLBC BEBC CERN SPS        1/82*
D6         10.        OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*
D6          2.3 TO 8 EXCLUDED CL=.90   NEMETHY   81 CNTR LAMPF                1/82*

S6      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)            NU-E -/-> NU-E
S6          0.6       OR LESS  CL=.90   BAKER     81 HLBC 15FT FNAL            1/82*
S6          0.3       OR LESS  CL=.90   DEDEN     81 HLBC BEBC CERN SPS        1/82*
S6          7.E-2     OR LESS  CL=.90   ERRIQUEZ  81 HLBC BEBC CERN SPS        1/82*


ANU-E --> ANU-TAU

S7      SIN(2*THETA)**2 FOR ''LARGE'' DELTA(M**2)            ANU-E --> ANU-TAU
S7   F      0.7       OR LESS  CL=.90   FRITZE    80 HYBR BEBC CERN SPS        1/82*
S7   F   AUTHORS GIVE P(NUE-->NUTAU)< .35, EQUIVALENT TO ABOVE LIMIT.         1/82*

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             5 (C).  SEARCHES FOR NEUTRINOLESS DOUBLE BETA DECAY

        THE DECAY (Z,A) --> (Z+2,A) + E- + E-, I.E. NEUTRINOLESS DOUBLE
        BETA DECAY, VIOLATES TOTAL LEPTON NUMBER BY TWO UNITS.  IT IS
        FORBIDDEN IF NEUTRINOS ARE DIRAC PARTICLES BUT CAN OCCUR IF
        NEUTRINOS ARE MAJORANA PARTICLES AND (A) THEY ARE MASSIVE OR
        (B) THEY HAVE NON (V-A) COUPLINGS.

MW      MNUW, THE WEIGHTED SUM OF NEUTRINO MASSES CONTRIBUTING TO
MW      NEUTRINOLESS DOUBLE BETA DECAY   (UNITS EV)
MW        MNUW= SUM FROM 1 TO N OF U(1,J)**2*M(NU-J), WHERE N= NUMBER OF
MW        NEUTRINO GENERATIONS, AND NU-J IS A MAJORANA NEUTRINO.
MW
MW   D       (30.)   APPROX.            DOI        81
MW   H       (12.)   OR LESS            HAXTON     81                          1/82*
MW   D  DOI 80 IS THEORETICAL ANALYSIS OF LIFETIME RATIO FOR                   1/82*
MW   D  TELLURIUM-128/TELLURIUM-130 AND USES NUCLEAR MATRIX ELEMENTS           1/82*
MW   D  CALCULATED BY VERGADOS.                                                1/82*
MW   H  HAXTON 81 IS THEORETICAL ANALYSIS OF LIFETIMES OF GERMANIUM-76 AND     1/82*
MW   H  SELENIUM-82, THE FORMER OF WHICH YIELDS MNUW.LT.12 EV AND THE          1/82*
MW   H  LATER OF WHICH YIELDS MNUW.LT.15 EV.  WE LIST THE MORE RESTRICTIVE     1/82*
MW   H  UPPER LIMIT ABOVE. THE DOI 81 VALUE OF MNUW AND THE HAXTON 81 LIMIT    1/82*
MW   H  ON MNUW BOTH ASSUME V-A COUPLINGS.  ROSEN 81 AND ROSEN2 81 DISCUSS     1/82*
MW   H  CORRELATED BOUNDS ON MNUW AND RIGHT-HANDED COUPLINGS.                  1/82*

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                           REFERENCES FOR COR. BOUNDS ON NU MASS, MIXING.

BELLOTTI 76 LNC 17 553          +CAVALLI,FIORINI,ROLLIER                  (MILA)
BLIETSCH 78 NP B133 205         BLIETSCHAU+(AACH+LIBH+CERN+EPOL+MILA+ORSA+)
CROUCH   78 PR D18 2239         +LANDECKER,LATHROP,REINES+   (CASE+UCI+WITW)

BAHCALL  80 PRL 45 945          +LUBOW,HUEBNER+     (IAS+LASL+YALE+LLL+UCLA)
    ALSO 76 SCIENCE 191 264     J.N.BAHCALL,R.DAVIS                  (IAS+BNL)
BOEHM    80 PL 97B 310          +CAVAIGNAC,FEILITZSCH+ (ILLG+CIT+GREN+MUNI)
FRITZE   80 PL 96B 427          +GRASSLER+    (AACH+BONN+CERN+LOIC+OXF+SACL)

REINES   80 PRL 45 1307         F.REINES,H.W.SOBEL,E.PASIERB               (UCI)
    ALSO 59 PR 113 273          F.REINES,C.L.COWAN                        (LASL)
    ALSO 66 PR 142 852          F.A.NEZRICK,F.REINES                      (CASE)
    ALSO 76 PRL 37 315          F.REINES,H.S.GURR,H.W.SOBEL                (UCI)
SHROCK   80 PL 96B 159          R.E.SHROCK                                (STON)

ABELA    81 PL 105B 263         +DAUM,EATON,FROSCH,JOST,KETTLE,STEINER(SIN)
ARMENISE 81 PL 100B 182         +FOGLI-MUCIACCIA+      (BARI+CERN+MILA+LALO)
ASANO    81 PL 104B 84          +HAYANO,KIKUTANI,KUROKAWA+   (KEK+TOKY+OSAK)
    ALSO 81 SHROCK1
ASRATYAN 81 PL 105B 301         +EFREMENKO,FEDOTOV +  (ITEP+FNAL+SERP+MICH)
BAKER    81 PRL 47 1576         +CONNOLLY,KAHN,KIRK,MURTAGH+        (BNL+COLU)
    ALSO 78 PRL 40 144          CNOPS,CONNOLLY,KAHN,KIRK+           (BNL+COLU)

BALTAY   81 NU 81 CONF HAWAII C.BALTAY                                  (COLU)
CALAPRIC 81 PL 106B 175         CALAPRICE,SCHREIBER,SCHNEIDER +   (PRIN+IND)
DAVIS    81  BNL NU WKSHP       B.T.CLEVELAND,R.DAVIS JR., J.K.ROWLEY (BNL)
DEDEN    81 PL 98B 310          +          (AACH+BONN+CERN+ATEN+LOIC+OXF+SACL)
DOI      81 PL 103B 219         +KOTANI,NISHIURA,OKUDA,TAKASUGI           (OSAK)
    ALSO 81 PTP 66 1739         DOI,KOTANI,NISHIURA,OKUDA,TAKASUGI        (OSAK)
    ALSO 81 PTP 66 1765         DOI,KOTANI,NISHIURA,OKUDA,TAKASUGI        (OSAK)

ERRIQUEZ 81 PL 102B 73          +NATALI+     (BARI+BIRM+LIBH+EPOL+RHEL+SACL+)
HAXTON   81 PRL 47 153          +G.J.STEPHENSON,D.STROTTMAN       (PURD,LASL)
KWON     81 PR D24 1097         +BOEHM,HAHN,HENRIKSON+          (CIT+GREN+MUNI)
NEMETHY  81 PR D23 262          +     (YALE+LBL+LASL+MIT+SACL+SIN+CNRC+BERN)

ROSEN    81 ARNS 31 145         S.P.ROSEN                                 (PURD)
ROSEN2   81 NU 81 CONF HAWAII S.P.ROSEN                                  (PURD)
    ALSO 78 RMP 50 11           D.BRYMAN,C.PICCIOTTO                  (TRIU,VICT)
SHROCK1  81 PR D24 1232         R.E.SHROCK                                (STON)
SHROCK2  81 PR D24 1275         R.E.SHROCK                                (STON)

SILVERMA 81 PRL 46 467          D.SILVERMAN,A.SONI                   (UCI+UCLA)
SIMPSON  81 PR D24 2971         J.SIMPSON                                 (GUEL)
USHIDA   81 PRL 47 1694           (AICH+FNAL+KOBE+SEOU+MCGI+NAGO+OSU+OKAY+)
ZATSEPIN 81 NU 81 CONF HAWAII BOLIEV,BUTKEVICH,CHUDAKOV,MAKOEV+        (MINR)
FILIPPON 82 APJ 253 393         B.W.FILIPPONE,D.N.SCHRAMM               (ANL+EFI)

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NEUTRINO BOUNDS FROM ASTROPHYSICS AND COSMOLOGY

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SEE THE NOTE ON NEUTRINOS BY R.E. SHROCK IN THE ELECTRON NEUTRINO
SECTION NEAR THE BEGINNING OF THESE DATA CARD LISTINGS.
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Note on ν Mass Limits

These limits apply to m_{tot} given by

$$m_{tot} = \sum_{j=1,n} \left(\frac{g_{\nu_j}}{2}\right) m_{\nu_j}$$

where n is the number of neutrino species and g_{ν_j} is the number of independent components in the neutrino field; $g_{\nu_j} = 4$ for Dirac neutrinos; $g_{\nu_j} = 2$ for chiral Majorana neutrinos.

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                          ν  NU MASS (EV)

M       LIMIT ON TOTAL MASS, SUMMED OVER ALL SPIN COMPONENTS, OF EFFECTIVELY
M       STABLE NEUTRINOS (I.E. THOSE WITH MEAN LIVES ROUGHLY EQUAL TO OR
M       GREATER THAN THE AGE OF THE UNIVERSE)  (UNITS EV)
M    A      (132.)   OR LESS              COWSIK    72 COSM
M    A      (80.)    OR LESS              LEE       77 COSM                5/81*
M           (100.)   OR LESS              OLIVE     81 COSM                1/82*
M    A  COWSIK 72 AND LEE 77 HAVE BEEN GENERALIZED TO APPLY TO M(TOT) AS   4/82*
M    A  DEFINED ABOVE, WHERE ONE ALLOWS EITHER DIRAC OR MAJORANA NEUTRINOS. 4/82*
M    A  THESE PAPERS ASSUMED DIRAC NEUTRINOS.                              4/82*
M       FOR OTHER LIMITS, SEE SATO 77, VYSOTSKY 77, DICUS 78, HUT 79,      2/82*
M       AND ZELDOVICH 80.                                                  2/82*

ML      ANALYSES OF M/L LIGHT RATIOS AND DYNAMICS OF GALAXIES AND
ML      CLUSTERS, ARE CONSISTENT WITH PRESENCE OF DARK MATTER WHICH,
ML      IF ASCRIBED TO NEUTRINOS, WOULD IMPLY A NON-ZERO VALUE OF THE SUM
ML      OF THE MASSES OF NEUTRINOS WITH LIFETIMES SUFFICIENTLY LONG TO
ML      AFFECT THESE GALAXIES AND CLUSTERS.  DIFFERENT ANALYSES FAVOR
ML      SOMEWHAT DIFFERENT VALUES OF THE SUM OF MASSES.  THIS IS ALSO
ML      CONSISTENT WITH MODELS OF GALAXY FORMATION.  ACCORDING TO D.SCHRAMM
ML      (PRIV. COMM.) IF ONE ALLOWS EITHER ADIABATIC OR ISOTHERMAL GALAXY
ML      FORMATION, THE RANGE OF MASSES IS PROBABLY FROM 4 TO 100 EV.
ML      HOWEVER ADIABATIC NOW FAVORED FOR MASSIVE NEUTRINOS.  (UNITS EV)
ML   A                                    TREMAINE  79 COSM  ISOTHERMAL     1/82*
ML       ORDER 30                         BOND      81 COSM  ADIABATIC      2/82*
ML         50-100                         DAVIS     81 COSM  ADIA.+DECAYING NUS 1/82*
ML          4-20                          SCHRAMM   81 COSM  ISOTHERMAL     1/82*
ML   A  TREMAINE 79 STATES THAT THE DARK MATTER CANNOT BE MUON OR ELECTRON 1/82*
ML   A  NEUTRINOS OF NONZERO REST MASS OR ANY NEUTRAL LEPTON LESS MASSIVE  1/82*
ML   A  THAN 1 MEV.                                                        1/82*

                ν  NU RADIATIVE MEAN LIFE / MASS  (UNITS SEC/EV)

T                                         COWSIK    77 COSM                1/82*
T                                         DICUS     77 COSM                1/82*
T                                         GOLDMAN   77 COSM                4/82*
T                                         FALK      78 COSM                1/82*
T               STRONGLY CORRELATED       COWSIK    79 COSM                1/82*
T               LIMITS: SEE REFERENCES    GOLDMAN   79 COSM                1/82*
T                                         DERUJULA  80 COSM                1/82*
T                                         STECKER   80 COSM                1/82*
T                                         HENRY     81 COSM                1/82*
T                                         KIMBLE    81 COSM                1/82*
T                                         TURNER    81 COSM                1/82*

                ν  POSSIBLE LIMITS ON NUMBER OF LIGHT (< ABOUT 1 MEV)
                   TWO-COMPONENT NU TYPES

N       NUMBER COUPLING WITH FULL WEAK STRENGTH
N                                         SHVARTSMA 69 COSM                1/82*
N             (7)    OR LESS              STEIGMAN  77 COSM                1/82*
N             (4)    OR LESS              YANG      79 COSM                1/82*
N    S     CRITICISM OF BOUND             STECKER2  80 COSM                1/82*
N          MAYBE NO FIRM BOUND            OLIVE     81 COSM                1/82*
N             (4)    OR LESS              TURNER    81 COSM                1/82*
N          CRITICISM OF BOUND             RANA      82 COSM                1/82*
N             (4)    OR LESS              YANG      82 COSM                4/82*
N    S  SEE, HOWEVER OLIVE2 81 CRITIQUE AND STECKER 81 REPLY.              1/82*
N       UNCERTAINTIES AND CRITICISMS COME FROM DIFFERING ESTIMATES OF LOWER 4/82*
N       LIMIT ON BARYON DENSITY OF THE UNIVERSE AND UPPER LIMIT ON THE     4/82*
N       PRIMORDIAL HELIUM-4 ABUNDANCE.                                     4/82*

NSW     NUMBER COUPLING WITH LESS THAN FULL WEAK STRENGTH
NSW  A        (20)   OR LESS              STEIGMAN  79 COSM                1/82*
NSW  A  LIMIT VARIES WITH STRENGTH OF COUPLING.                            4/82*

                ν  MAGNETIC MOMENT OF SUFFICIENTLY LIGHT NU
                                                  (UNITS EV/GAUSS)

MM   S     (4.9E-19)OR LESS               SUTHERLAN 76 COSM FOR M(NU)<10 KEV.  1/82*
MM   S  USES SUTHERLAND 76 EQ.3 WITH F<1/3 FROM THEIR TABLE AS MODIFIED TO 1/82*
MM   S  APPLY AS A LIMIT ON ANY ONE NEUTRINO SPECIES INDIVIDUALLY.         1/82*

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                               REFERENCES FOR NU BOUNDS FROM ASTRO. AND COSM.

SHVARTSM 69 JETPL 9 184          V. F. SHVARTSMAN                      (MOSU)
COWSIK   72 PRL 29 669           R.COWSIK,J.MC CLELLAND                 (UCB)
SUTHERLA 76 PR D13 2700          SUTHERLAND,NG,FLOWERS,+       (PENN+COLU+NYU)

COWSIK   77 PRL 39 784           R. COWSIK .                       (MPIM+TIFR)
    ALSO 79 COWSIK
DICUS    77 PRL 39 168           D.A.DICUS,F.W.KOLB,V.L.TEPLITZ    (TEXA+VPI)
GOLDMAN  77 PR D16 2256          T.GOLDMAN, G.J.STEPHENSON             (LASL)
LEE      77 PRL 39 165           B. W. LEE, S. WEINBERG           (FNAL+STAN)
SATO     77 PTP 58 1775          K.SATO,M.KOBAYASHI                    (KYOT)
STEIGMAN 77 PL 66B 202           G.STEIGMAN,D.SCHRAMM,J.GUNN (YALE+CHIC+CIT)
VYSOTSKY 77 JETPL 26 188         VYSOTSKY,DOLGOV,ZELDOVICH             (ITEP)

DICUS    78 PR D17 1529          +KOLB,TEPLITZ,WAGONER        (TEXA+VPI+STAN)
FALK     78 PL 79B 511           S. FALK, D. SCHRAMM                   (CHIC)
    ALSO 78 APJ 223 1015         GUNN,LEE+         (CIT+CAMB+FNAL+CHIC+YALE)

COWSIK   79 PR D19 2219          R. COWSIK                             (TIFR)
GOLDMAN  79 PR D19 2215          T.GOLDMAN,G.J.STEPHENSON              (LASL)
HUT      79 PL 87B 144           P.HUT,K.A.OLIVE                (AMSTERDAM+EFI)
STEIGMAN 79 PRL 43 239           G.STEIGMAN,K.OLIVE,D.SCHRAMM     (BART+EFI)
TREMAINE 79 PRL 42 407           S. TREMAINE, J. E. GUNN      (CIT+CAMB+CAIW)
YANG     79 APJ 227 697          YANG,SCHRAMM,STEIGMAN,RCOD (CHIC+YALE+VIRG)
    ALSO 79 STEIGMAN             FOOTNOTE 4

DERUJULA 80 PRL 45 942           A.DE RUJULA,S.L.GLASHOW          (MIT+HARV)
STECKER  80 PRL 45 1460          F.W.STECKER                           (NASA)
    ALSO 81 NU 81 CONF HAWAII    F.W.STECKER (PROC. V.1, P. 124)       (NASA)
STECKER2 80 PRL 44 1237          F.W.STECKER                           (NASA)
ZELDOVIC 80 SJNP 31 664          ZELDOVICH,KLYPIN,KHLOPOV,CHECHETKIN

BOND     81 NU 81 CONF HAWAII    J.R.BOND, A.S.SZALAY              (UCB+CHIC)
DAVIS    81 APJ 250 423          M.DAVIS,M.LECAR,C.PRYOR,E.WITTEN(HARV+PRIN)
HENRY    81 PRL 47 618           R.C.HENRY, P.D.FELDMAN                 (JHU)
KIMBLE   81 PRL 46 80            R.KIMBLE,S.BOWYER,P.JAKOBSEN           (UCB)

OLIVE    81 APJ 246 557          +SCHRAMM,STEIGMAN,TURNER,YANG+  (CHIC+BART)
OLIVE2   81 PRL 46 516           K.A.OLIVE,M.S.TURNER                   (EFI)
SCHRAMM  81 APJ 243 1            D. N. SCHRAMM, G. STEIGMAN      (CHIC+BART)
STECKER  81 PRL 46 517           F.W.STECKER                           (NASA)
TURNER   81 NU 81 CONF HAWAII    M.S.TURNER                       (UCSB+CHIC)

RANA     82 PRL 48 209           N.C.RANA                              (TIFR)
YANG     82 EFI PREPRINT         +TURNER,STEIGMAN,SCHRAMM,OLIVE  (CHIC+BART)

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HEAVY LEPTON SEARCHES

Data on the $\tau^{\pm}$(1785) heavy lepton are listed in a separate section above, following the e and μ listings.

The following section contains information on searches for heavy leptons of other types and searches for the $\tau^{\pm}$ in collisions other than e^+e^-.

Several types of heavy leptons (that is, non-strongly-interacting fermions other than e and μ) have been proposed. In the Data Card Listings we distinguish four types.[1,2] Each has a corresponding antiparticle with opposite charge and lepton number. For convenience we omit writing the antiparticles in the following descriptions. The four types are:

Sequential Leptons (L^-, ν_L). Such a pair is assumed to have its own separately strictly conserved lepton number $n_L = +1$. This means that the radiative decays

$$\left.\begin{array}{l} L^- \to e^-\gamma \\ L^- \to \mu^-\gamma \end{array}\right\} \text{ are forbidden },$$

while the weak decays (assuming m_{L^-} sufficiently massive)

$$\left.\begin{array}{l} L^- \to \nu_L\, e^- \bar{\nu}_e \\ L^- \to \nu_L\, \mu^- \bar{\nu}_\mu \\ L^- \to \nu_L \text{ hadrons} \end{array}\right\} \text{ are allowed .}$$

There could be an increasing mass sequence of such pairs. It is frequently assumed that the neutrinos are massless.

Decay rates are assumed calculable from conventional weak interactions theory. For L^- mass between 1 and 3 GeV, the branching fraction to each of the two leptonic modes should be roughly 10% to 20%. For L^- mass above 1 GeV, the mean life should be $\lesssim 10^{-12}$ sec, too short to be observed in a track chamber.[1]

Paraleptons (E^+,E^0) and (M^+,M^0). These pairs have the same lepton numbers as the opposite-charge ordinary leptons, i.e., e^- and μ^-, respectively. Radiative decays are again forbidden and decays similar to those allowed for L^- are allowed here, e.g.,

$$M^+ \to \nu_\mu\, e^+ \nu_e$$

or $$M^+ \to \nu_\mu\, \mu^+ \nu_\mu \quad .$$

However, the lightest member is not stable as is the case for sequential leptons, so that bizarre decay schemes such as (assuming $m_{E^0} < m_{E^+}$)

$$E^+ \to E^0\, \mu^+ \nu_\mu$$
$$\quad\;\; \hookrightarrow e^- e^+ \nu_e$$

are allowed.

Heavy leptons of this type (and/or a neutral intermediate boson Z^0) are desired in unified gauge theories of weak and electromagnetic interactions to cancel unphysical high energy behavior in such processes as $e^+e^- \to W^+W^-$.[3]

Ortholeptons (F^- and N^-). These have the same lepton numbers as e^- and μ^-, respectively. They may or may not have associated neutral leptons. Radiative decays are allowed in addition to weak modes similar to those of sequential leptons. The radiative mode can dominate or can be relatively unimportant depending on the model.[4] Decays such as

$$F^- \to e^- + \text{hadrons}$$

are also allowed.

Long-Lived Penetrating Particles. Heavy leptons could have long mean lives under certain circumstances. For example, if $m_{\nu_L} > m_{L^-}$, then L^-, the sequential lepton, is completely stable since its lepton number is conserved.

Experimental results. The results are summarized in the Data Card Listings below. Mass limits for sequential leptons are listed in subsection MS, while all other types are listed together in subsection M.

The Listings also contain cross-section upper limits reported as results of unsuccessful searches. We no longer list cross sections for anomalous $e\mu$ events in e^+e^- collisions. These cross sections are consistent with coming from $e^+e^- \to \tau^+\tau^-$ where the $\tau^\pm(1785)$ is assumed to be a spin-1/2 Dirac point particle with a mass about 1785 MeV.

References

1. M. L. Perl and P. Rapidis, SLAC-PUB-1496 (October 1974).
2. C. H. Llewellyn Smith, Invited paper presented at the Royal Society Meeting on New Particles and New Quantum Numbers, 11 March 1976, Oxford Ref. 33/76.
3. J. D. Bjorken and C. H. Llewellyn Smith, Phys. Rev. D7, 887 (1973).
4. F. Wilczek and A. Zee, Nucl. Phys. B106, 461 (1976).

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SEE PERL 81 FOR A REVIEW

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PROPERTIES OF THE TAU+-(1785) HEAVY LEPTON AND ITS ASSOCIATED
NEUTRINO ARE LISTED SEPARATELY ABOVE FOLLOWING THE E AND MU
LISTINGS.  THE FOLLOWING SECTION CONTAINS INFORMATION ON SEARCHES
FOR HEAVY LEPTONS OF OTHER TYPES AND SEARCHES FOR TAU+- IN
COLLISIONS OTHER THAN E+E-.  WE LIST MASS LIMITS AND CROSS SECTION
UPPER LIMITS REPORTED AS NEGATIVE SEARCH RESULTS.  WE NO LONGER
LIST CROSS SECTIONS FOR THE ESTABLISHED PROCESS E+ E- --> TAU+ TAU-
AS WAS DONE IN OUR 1977 SUPPLEMENT.

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            75  HEAVY LEPTON MASS LIMITS

   LIMITS APPLY ONLY TO HEAVY LEPTON TYPE GIVEN IN COMMENT AT RIGHT ON  3/77
   DATA CARD.  SEE REVIEW ABOVE FOR DESCRIPTION OF TYPES.               3/77
   IN COMMENTS BELOW: ALL BEAMS ARE MU TYPE NEUTRINO OR ANTINEUTRINO.   3/77
   L,E,M,F,N STAND FOR SEQUENTIAL LEPTON,PARA-ELECTRON,PARA-MUON,       3/77
   ORTHO-ELECTRON,ORTHO-MUON RESPECTIVLY.                               3/77

MS     SEQUENTIAL HEAVY LEPTON MASS LIMITS (GEV)
MS  A      (13.)   OR MORE           AZIMOV    80      +- SEQUENTIAL (L)   2/82*
MS  B       16.    OR MORE  CL=.95   BARBER    80 CNTR +- SEQUENTIAL (L)   9/81*
MS  C  NONE 4GEV TO 14.5GEV CL=.95   BERGER    81 PLUT +- SEQUENTIAL (L)   1/82*
MS  D  NONE BELOW 15.5 GEV  CL=.95   BRANDELIK 81 TASS +- SEQUENTIAL (L)   1/82*
MS
MS  A  AZIMOV 80 ESTIMATED PROBABILITIES FOR M+N TYPE EVENTS IN E+ E- -->  7/82*
MS  A  L+ L- DEDUCING SEMI-HADRONIC DECAY MULTIPLICITIES OF L FROM E+ E-   2/82*
MS  A  ANNIHILATION DATA AT WCM=(2/3)*ML. OBTAINED ABOVE LIMIT COMPARING   2/82*
MS  A  THESE WITH E+E- DATA (BRANDELIK 80,PL 92B 199).                     2/82*
MS
MS  B  BARBER 80 LOOKED FOR E+ E- --> L+ L-, L-->NEU(L)+X WITH MARK-J AT   9/81*
MS  B  DESY-PETRA.                                                         9/81*
MS
MS  C  BERGER 81 IS DESY DORIS AND PETRA EXPT. LOOKING FOR E+E- --> L+L-.  1/82*
MS
MS  D  BRANDELIK 81 IS DESY PETRA EXPT. LOOKING FOR E+E- --> L+L-.         1/82*
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Stable Particles

HEAVY LEPTON SEARCHES


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M      HEAVY LEPTON MASS LIMITS (GEV)
M   A   0    1.0   OR MORE                BEHREND    65 SPEC -  ORTHOELECTRON(F)  6/77
M   B  NONE BETWEEN 0.12 AND 0.57         BETOURNE   65 SPEC -  ORTHOELECTRON(F)  6/77
M   C  NONE BETWEEN 0.3  AND 0.7          BUDNITZ    66 SPEC -  ORTHOELECTRON(F)  6/77
M   D  NONE BETWEEN 0.2  AND 0.92         BARNA      68 CNTR -  LONG-LIVED        6/77
M   D  NONE BETWEEN 0.97 AND 1.03         BARNA      68 CNTR -  LONG-LIVED        6/77
M   E  NONE BETWEEN 0.1  AND 1.3          BOLEY      68 SPEC -  ORTHOELECTRON(F)  6/77
M   F  NONE BETWEEN 0.2  AND 0.6          LIBERMAN   69 DSPK -  ORTHOMUON(N)      6/77
M   G        0.490 OR MORE                ROTHE      69 RVUE                      6/77
M   H  NONE BETWEEN 0.26 AND 1.32         LICHTENST  70 SPEC -  ORTHOELECTRON(F)  6/77
M   I  20    (0.424)  (0.013)  (0.002)RAMM       70 HLBC 0                    6/77
M   I  22    (0.431)  (0.004)             RAMM       71 HLBC -  ORTHOMUON(N)      6/77
M   J   0    0.1   OR MORE                ANSORGE    73 HBC  -  LONG-LIVED        6/77
M   K   0    0.6   OR MORE                BACCI      73 ELEC +- ORTHOELECTRON(F)  1/76
M   K   0    2.2   OR MORE                BACCI      73 ELEC +- ORTHOELECTRON(F)  1/76
M   L   0    2.0   OR MORE  CL=.90        BARISH     73 ASPK +  PARAMUON (M)      2/74
M   M   0    1.4   OR MORE  CL=.95        BERNARDIN  73 ASPK +- ANY NON-RAD TYPE  2/74
M   M   0    1.0   OR MORE  CL=.95        BERNARDIN  73 ASPK +- ANY NON-RAD TYPE  2/74
M   N  NONE BETWEEN 0.55 AND 4.5          BUSHNIN    73 CNTR    LONG-LIVED        2/74
M   O   0    2.4   OR MORE  CL=.90        EICHTEN    73 HLBC +  PARAMUON (M)      3/74
M   P        7.8   OR MORE  CL=.95        HANSON     73 WIRE    ORTHOELECTRON(F)  6/77
M   Q        1.8   OR MORE  CL=.90        ASRATYAN   74 HLBC +- ORTHOMUON (N)    11/75
M   R        8.4   OR MORE  CL=.90        BARISH     74 SPEC +  PARAMUON (M)      7/74
M   S   NONE BETWEEN 0 AND 2.0            GITTLESON  74 SPEC    ORTHOMUON (N)    12/77
M   T   0    1.15  OR MORE  CL=.95        ORITO      74 ASPK +- ANY NON-RAD TYPE 11/75
M   U   NONE BETWEEN 0.25 AND 2.3         BACCI      77 SPEC +- ORTHOELECTRON(F) 12/77
M   V        1.2   OR MORE                MEYER      77 SMAG 0  NEUTRAL          12/77
M   W       10.3   OR MORE  CL=.98        ASRATYAN   78      -  ORTHOMUON (N)     1/79
M   X   0    7.5   OR MORE                CNOPS      78 HLBC -  ORTHOMUON (N)     8/78
M   X   0    9.0   OR MORE                CNOPS      78 HLBC +  PARAMUON (M)      8/78
M   Y       10.0   OR MORE                ERRIQUEZ   78 BEBC                      1/79
M   Z       12.    OR MORE  CL=.90        HOLDER     78 CNTR +  PARAMUON (M)      6/78
M   1  NONE 1 GEV TO 9 GEV  CL=.90        CLARK      81 SPEC 0  PARAMUON(MOBAR)   1/82*
M   1  NONE 1 GEV TO 9 GEV  CL=.90        CLARK      81 SPEC ++                   1/82*
M   2  NONE BETWEEN 0.6 AND 3.3           HAYES      82 SMK2 +- ORTHOMUON (N)     4/82*
M   2  NONE BETWEEN 0.5 AND 3.3           HAYES      82 SMK2 +- ORTHOELECTRON(F)  4/82*
M
M   A  BEHREND 65 IS DESY EXPT. LOOKS FOR E P-->F P, F--> E GAMMA.               6/77
M   A  THIS MASS LIMIT CORRESPONDS TO A LIMIT ON LAMBDA**2 OF 6.25*10**-4.       6/77
M
M   B  BETOURNE 65 IS ORSAY EXPT. LOOKS FOR E P -->F P. MASS OF .12              6/77
M   B  CORRESPONDS TO COUPLING CONSTANT LAMBDA**2 GT .0016, MASS OF .57          6/77
M   B  TO LAMBDA**2 GT .22.                                                      6/77
M
M   C  BUDNITZ 66 IS CEA EXPT. LOOKS FOR E P-->F P.                              6/77
M
M   D  BARNA 68 IS SLAC PHOTOPRODUCTION EXPT.                                    6/77
M
M   E  BOLEY 68 IS CEA EXPT. LOOKS FOR E P-->F P. MASS OF .1 CORRESPONDS         6/77
M   E  TO COUPLING CONSTANT LAMBDA**2 GT 3*10**-4. MASS LIMIT OF 1.3 TO          6/77
M   E  LAMBDA**2 GT .01.                                                         6/77
M
M   F  LIBERMAN 69 IS A BNL EXPT MEASURING MUON BREMSSTRAHLUNG.                  6/77
M
M   G  ROTHE 69 EXAMINES PREVIOUS DATA ON MU PAIR PROD AND PI AND K DECAYS       6/77
M
M   H  LICHTENSTEIN 70 IS CORNELL EXPT MEASURING E BREMSSTRAHLUNG.               6/77
M   H  MASS LIMIT DEPENDS ON COUPLING CONSTANT. FIRST VALUE ABOVE IS FOR         6/77
M   H  LAMBDA**2 GT .17, SECOND IS FOR LAMBDA**2 GT .42.                         6/77
M
M   I  RAMM 70 FINDS PEAK IN MU PI COMBINED MASS PRODUCED BY NEUTRINO            6/77
M   I  INTERACTIONS. HE ALSO CLAIMS EVIDENCE FOR THIS IN KOMU3 DECAYS IN         6/77
M   I  HBC WHERE PI MU COMBINED MASS PEAKS IN SAME REGION. CLARK 72 FINDS        6/77
M   I  NO EVIDENCE FOR PI MU PEAK IN HIGH STATISTICS KOL3 EXPT.                  6/77
M   I  RAMM 71 SEES PEAK IN MU GAMMA COMBINED MASS PRODUCED BY NEUTRINOS.        6/77
M
M   J  ANSORGE 73 LOOKS FOR ELECTRON PAIR PROD AND ELECTRON-LIKE BREMSS.         6/77
M
M   K  BACCI 73 IS FRASCATI E+E- EXPT. LOOKS FOR F --> E GAMMA.                  1/76
M   K  MASS LIMIT DEPENDS ON COUPLING CONSTANT LAMBDA FOR THIS DECAY.            1/76
M   K  FIRST VALUE ABOVE IS FOR LAMBDA**2 GT 9*10**-5, 2ND IS FOR                1/76
M   K  LAMBDA**2 GT 10**-3.                                                      1/76
M
M   L  BARISH 73 IS FNAL 50,145 GEV NEU EXPT.  LOOKS FOR (NEU NUCLEON -->        3/77
M   L  M+ ANYTHING). ASSUMES (M+ --> MU+ NEU NEU) WITH BR=.3.                    3/77
M
M   M  BERNARDINI 73 IS FRASCATI E+E- EXPT. FIRST VALUE ASSUMES UNIVERSAL        2/74
M   M  COUPLING TO ORDINARY LEPTONS.  SECOND VALUE ALSO ASSUMES COUPLING         2/74
M   M  TO HADRONS.                                                               2/74
M
M   N  BUSHNIN 73 IS SERPUKOV 70 GEV P EXPT. MASSES ASSUME MEAN LIFE ABOVE       2/74
M   N  7E-10 AND 3E-8 RESPECTIVELY. CALCULATED FROM CROSS SEC(DC BELOW)          2/74
M   N  AND 30 GEV MUON PAIR PRODUCTION DATA.                                     2/74
M
M   O  EICHTEN 73 IS CERN 1-10GEV NEU EXPT. LOOKS FOR M+ PRODUCED IN             2/76
M   O  NEU NUCL --> M+ HADRONS ASSUMING 15 PERCENT DECAY TO E+ NEU NEU.          2/76
M
M   P  HANSON 73 LOOK FOR DEVIATIONS FROM QED IN E+ E- -->2 GAMMA. THEY          6/77
M   P  MEASURE THE PRODUCT OF THE F MASS * THE COUPLING CONSTANT LAMBDA,         6/77
M   P  WHICH IS THE VALUE QUOTED ABOVE.                                          6/77
M
M   Q  ASRATYAN 74 USES EICHTEN 73 DATA ON NEU NUCL --> E- HADRONS AND           2/76
M   Q  ANTINEU NUCL --> E+ HADRONS TO SET LIMITS ON ORTHOMUON PRODUCTION.        2/76
M
M   R  BARISH 74 IS FNAL 50,135 GEV NEU EXPT.  LOOKS FOR (NEU NUCLEON -->        7/74
M   R  M+ ANYTHING).  ASSUMES (M+ -->MU+ NEU NEU) WITH BR=.3.                    7/74
M
M   S  GITTLESON 74 IS MU P --> P ORTHOMUON SEARCH. COUPLING CONSTANT           12/77
M   S  LAMBDA**2 IS <.01 FOR MASS UP TO .7 GEV, LIMIT ON LAMBDA**2 RISES        12/77
M   S  TO <.1 FOR MASS OF 2.0 GEV.                                              12/77
M
M   T  ORITO 74 LOOKED FOR M+M- PAIRS GIVING MU-E PAIRS. MASS LIMIT REFERS       3/74
M   T  TO ANY NON-RADIATIVE TYPE HEAVY LEPTON: L, E, M, F, N.                    3/74
M   T  COUPLING TO HADRON ASSUMED FROM THEORETICAL MODELS.                       3/74
M
M   U  BACCI 77 IS SAME TYPE AS BACCI 73. LOWER MASS LIMIT CORRESPONDS TO       12/77
M   U  LAMBDA**2 LIMIT OF 4*10**-5, UPPER VALUE IS FOR LAMBDA**2 LIMIT OF       12/77
M   U  1.5*10**-3.                                                              12/77
M
M   V  MEYER 77 LOOKS FOR NARROW NEUTRAL RESONANCE IN(E PI)AND(MU PI)           12/77
M   V  CHANNELS PRODUCED BY E+E- AT 6.8 GEV (ECM). ASSUMED TO BE DECAY          12/77
M   V  PRODUCT OF THE TAU. SEE SECTION NE BELOW.
M
M   W  ASRATYAN 78 ANALYZES DEPENDENCE OF N.C./C.C. ON ENERGY OF ASSOC.          1/79
M   W  HADRONS. USES DATA OF HOLDER 77 (PL 72B, 254)--NUMU INTERACTIONS          1/79
M   W  AT CERN-SPS.                                                              1/79
M
M   X  CNOPS 78 IS FNAL EXPT LOOKING FOR NEUMU NE --> L+(-), FOLLOWD BY          8/78
M   X  L+(-) --> E+(-) NEU NEU.                                                  8/78
M
M   Y  ERRIQUEZ 78 IS CERN SPS EXPT. LOOKS FOR NUMU NUCLEON-->MU- E+ X.          1/79
M   Y  FINDS CS FOR PRODUCING HVY LEPT--> E+ <.7*10**-3 *C.C. CS.                1/79
M
M   Z  HOLDER 78 IS A CERN NEU EXPT LOOKING FOR NEUMU NUCLEON --> MU+ ANY        6/78
M   Z  THING. ASSUMES M+ --> MU+ 2NEUMU WITH BR=0.2 .                            6/78
M
M   1  CLARK 81 IS FNAL EXP WITH 209 GEV MUONS. BOUNDS APPLY TO M0 WHICH         1/82*
M   1  COUPLES WITH FULL WEAK STRENGTH TO MUON. SEE ALSO SECTION MU.             1/82*
M
M   2  HAYES 82 IS SLAC SPEAR EXPT.  THEIR TBL.5,6 GIVES CROSS SEC. LIMITS      4/82*
M   2  FOR ORTHOMUON AND ORTHOELECTRON FOR MASSES IN ABOVE RANGE.                4/82*

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NEU    HEAVY LEPTON LIMITS (NEUTRINO NUCLEON)
NEU    SEE ALSO SECTION *Y* IN 'CHARMED HADRON SEARCHES' AND
NEU    SECTION *T* IN 'OTHER NEW PARTICLE SEARCHES'.
NEU  A   6 TRIMUON EVENTS                 BENVENU1  77 NEUL    5/6NEU.1/6NEUBAR  1/78
NEU  A  10 MU+ MU-, 3 MU- MU- EVENTS      BENVENU2  77 NEUL                      1/78
NEU  B                                    BOSETTI   78 HYBR                      6/78
NEU
NEU  A  BENVENUTI 77 IS FNAL EXPT.AND CLAIMS TRIMUON EVTS. INDICATE BY PROD     7/77
NEU  A  OF A NEW HEAVY LEPTON -->MU- NEUBAR NEW LIGHTER LEPTON --> MU+ MU-      7/77
NEU  A  NEUTRINO. SEE ALSO BENVENUT2 77, ALBRIGHT 77 AND BARGER 77 FOR         7/77
NEU  A  FURTHER ANALYSIS.  THIS CLAIM WAS REFUTED BY LATER EXPS. AT CERN        7/77
NEU  A  (HOLDER 78)  AND FNAL (CNOPS 78), AND BY THEORETICAL ANALYSIS OF        7/77
NEU  A  OF COMBINED DATA - SEE SMITH 78.                                        7/77
NEU
NEU  B  BOSETTI 78 ANALYSES MOMENTA OF MUONS FROM DIMUON EVENTS USING           6/78
NEU  B  200 GEV NARROW BAND NEU BEAM AT CERN. FINDS (NEUMU P --> HVY-LEPT)/     6/78
NEU  B  (NEUMU P --> MU) < 0.06 (90 PCNT CL) WHERE HVY-LEPT --> E- NU(E)        6/78
NEU  B  MU(HVY-LEPT) 15 PCNT OF THE TIME.                                       6/78

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MU     HEAVY LEPTON PRODUCTION CROSS SECTION (MU NUCLEON) (CM**2)              10/81*
MU     SEE ALSO SECT *MU* IN CHARM SEARCHES AND OTHER NEW PARTICLE SEARCHES    10/81*
MU   A      1.22E-34 OR LESS              LEBRITTON 80 SPEC     M0-->MU+ MU- NU 12/81*
MU   B   0  4. E-38 OR LESS               CLARK     81 SPEC 0  PARAMUON(MOBAR)  1/82*
MU   B   0  6. E-38 OR LESS               CLARK     81 SPEC ++                  1/82*
MU
MU   A  LEBRITTON 80 IS BNL EXP WITH 10.5GEV MUONS. TRIMUONS ARE CONSISTENT    12/81*
MU   A  WITH QED TRIDENT AND DIFFRACTIVELY PRODUCED RHO DECAY.                 12/81*
MU
MU   B  CLARK 81 IS FNAL EXP WITH 209 GEV MUON. LOOKED FOR MU+ N-->MOBAR X,     1/82*
MU   B  MOBAR-->MU+ MU- ANTINEU(MU) AND MU+ N-->M++ X,M++-->2MU+ NEU(MU).       1/82*
MU   B  ABOVE LIMITS ARE FOR CS*BR TAKEN FROM THEIR MASS-DEP PLOT FIG.2.        1/82*

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DC     HEAVY LEPTON PRODUCTION DIFF. CROSS SEC. (P NUCLEON) (CM**2/SR-GEV)
DC   A   0  1.6E-37 OR LESS  CL=.90   GOLOVKIN  72 CNTR- 70GEV P, SERPUKHOV  1/76
DC   B   0  4. E-38 OR LESS  CL=.90   BUSHNIN   73 CNTR- 70GEV P, SERPUKHOV  2/74
DC
DC   A  MASS RANGE 1 TO 4.5 GEV,THETA=0,P=25 GEV/C.                              1/76
DC
DC   B  BUSHNIN 73 HEAVY LEPTON PATH TRAVERSES 6800 GM/CM**2 ABSORBER.           2/74
DC   B  DIFFERENTIAL CROSS-SECTION MEASURED AT P=30 GEV/C THETA= 2 MRAD.         3/74

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TBD    TAU LEPTON PRODUCTION CROSS SECTIONS IN HADRONIC COLLISIONS (CM**2)     2/82*
TBD  A      1.8E-30 OR LESS  CL=.90   AGAKISHIE 80 SPRK 70GEV P FE BM DUMP     2/82*
TBD
TBD  A  AGAKISHIEV 80 REANALYZED BEAM DUMP DATA (ASRATYAN 78 PL 79B 497).      2/82*
TBD  A  FOUND NO EXCESS OF MUONLESS EVENT IN NEUTRINO DETECTOR. ABOVE LIMIT    2/82*
TBD  A  IS FOR CS(P NUC-->F X)*BR(F-->TAU NUTAU X) ASSUMING LINEAR A DEP       2/82*
TBD  A  AND THAT SOLE SOURCE OF TAU LEPTON IS DECAY OF F-MESON.                2/82*

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IC     INVARIANT HEAVY LEPTON PROD. CROSS SEC. (P NUCLEON) (CM**2/GEV**2)
IC   A   0  5.4E-39 OR LESS  CL=.90   CRONIN    74 SPEC -  M=1-6.8 GEV      1/76
IC   B   0  6.4E-35 OR LESS  CL=.90   BINTINGER 75 SPEC +- M=1-5 GEV        2/76
IC   C   0  1.8E-33 OR LESS  CL=.90   ARMITAGE  79 SPEC    M=1.87 GEV       7/79
IC
IC   A  CRONIN 74 IS AN FNAL 300 GEV P CU EXPT.  LOOKED FOR LONG LIVED          2/76
IC   A  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY     2/76
IC   A  EXP(1.22E-8*M/TAU) FOR MASS M(GEV) AND LIFETIME TAU(SEC). LIMIT         2/76
IC   A  OBTAINED AT THETA(LAB) = 77 MRAD, PT = 2.38 GEV/C.                      4/77
IC
IC   B  BINTINGER 75 IS A 30-300 GEV P C EXPT.  LOOKED FOR LONG LIVED           2/76
IC   B  PENETRATING PARTICLES.  ABOVE LIMIT ASSUMES STABLE.  MULTIPLY IT BY     2/76
IC   B  EXP(3.5E-8*M/TAU/P) FOR MASS M(GEV), LIFETIME TAU(SEC), MOM.P(GEV).     2/76
IC   B  OBTAINED AT THETA(LAB) = 91 MRAD, PT = 1-2.25 GEV/C.                    4/77
IC
IC   C  ARMITAGE 79 IS CERN-ISR EXPT AT ECM=53 GEV.  VALUE IS FOR X=0.1 AND     7/79
IC   C  PT=.15.                                                                 7/79

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RPI    HEAVY LEPTON PROD. CROSS SECTION ( CS(HVY LEP) / CS(PION) )             12/81*
RPI  A   0  7. E-12 OR LESS  CL=.95   BUSSIERE  80 CNTR Q= -1   M=4-4.5 GEV 12/81*
RPI  A   0  2.5E-12 OR LESS  CL=.95   BUSSIERE  80 CNTR Q= -2   M=5-7.5 GEV 12/81*
RPI
RPI  A  BUSSIERE 80 IS CERN-SPS EXPT WITH 200-240 GEV PROTONS ON BE AND AL     12/81*
RPI  A  TARGET SEARCHING FOR LONG-LIVED PARTICLES.  FOR LIMITS AT OTHER        12/81*
RPI  A  MASS RANGES SEE THEIR FIG. 7.                                          12/81*

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CN     NEUTRAL HEAVY LEPTON PRODUCTION CROSS SECTION  (CM**2)
CN   A   5 (1. E-37 OR MORE)              KRISHNASW 75 CNTR +0-  M=2-5 GEV       2/76
CN   B   0                                BENVENUTI 75 SPEC  0                   2/76
CN
CN   A  KRISHNASWAMY 75 IS KOLAR GOLD MINE COSMIC RAY EXPT.  TYPICAL EVENT       2/76
CN   A  HAS VERTEX IN AIR 70 CM FROM WALL WITH THREE OBSERVED CHARGED            2/76
CN   A  TRACKS.  AUTHORS SUGGEST NEU+ROCK GIVES NEW PARTICLE WITH MEAN LIFE      2/76
CN   A  10E-9 SEC OR LONGER.  DE RUJULA 75 GIVES ANOTHER INTERPRETATION.         2/76
CN   A  SEE ALSO RAJASEKARAN 75.                                                 6/76
CN
CN   B  BENVENUTI 75 IS AN FNAL EXPERIMENT WHICH ROUGHLY SIMULATES THE           2/76
CN   B  KRISHNASWAMY 75 EXPT. BUT APPARENTLY CONTRADICTS IT, FINDING NO          2/76
CN   B  EVENTS. SENSITIVE TO DECAYS OF NEUTRAL PENETRATING PARTICLES             3/77
CN   B  PRODUCED BY THE PRIMARY PROTONS OR BY SECONDARY NEUTRINO                 3/77
CN   B  INTERACTIONS IN THE 1 KM. NEUTRINO BEAM EARTH SHIELD.                    3/77

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N      NEUTRAL HEAVY LEPTON PRODUCED IN NEUTRINO INTERACTIONS
N    A   1      POSSIBLY SEEN             BARANOV   77 HLBC  0 SERPUKHOV          12/77
N    A   2      POSSIBLY SEEN             BARANOV   79 HLBC  0 SERPUKHOV           1/82*
N
N    A  BARANOV HEAVY LEPTON CLAIM REFUTED BY BALTAY 78.                           1/82*

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NM     UNEXPLAINED MISSING NEUTRAL (HEAVY LEPTON?) MOMENTUM /TOTAL MOMENTUM
NM   A          0.05     0.03              ELLIOT    77 CALO                    1/78
NM
NM   A  ELLIOT 77 IS SLAC 10.5 GEV PI+ P --> P NPI+- NEUTRALS.  FINDS THAT       1/78
NM   A  NEUTRAL SPECTRUM CAN BE EXPLAINED BY GAMMA, K0, LAMBDA, NEUTRON.         1/78

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CP      NEUTRAL HEAVY LEPTON PROD. CROSS SEC. (PROTON NUCLEON) (CM**2)
CP   A   0  1. E-29 OR LESS            FAISSNER  76 HLBC 0               1/77
CP   B   0  2.8E-35 OR LESS  CL=.90    BECHIS    78 SPEC  0              8/78
CP   C   0  8.2E-40 OR LESS  CL=.90    AGAKISHIE 80 SPRK 0 M=4GEV,TAU=E-7 S  2/82*
CP
CP   A  FAISSNER 76 LIMIT ASSUMES STABLE NEUTRAL WEAKLY INTERACTING LEPTON.  1/77
CP   A  ALSO RULES OUT DE RUJULA 75 INTERP. OF 5 KRISHNASWAMY 75 EVENTS AS  1/77
CP   A  (P NUCLEON --> L+ X, L+ --> LO X) UNLESS L+ MASS IS ABOVE 3 GEV.    1/77
CP
CP   B  BECHIS 78 IS 400 GEV FNAL EXPT. LOOKS FOR P NUCLEON --> L+,         8/78
CP   B  L+ --> LO X, LO --> MU PI OR E PI. RESULT IS CL=.90 FOR MASS OF LO  8/78
CP   B  < 1 GEV, LIFETIME BETW 10**-10 AND 10**-8 SEC.(VALID ONLY FOR CASES 8/78
CP   B  WHEN LO UNACCOMPANIED BY MUON OF P>10 GEV.)                         8/78
CP
CP   C  AGAKISHIEV 80 REANALYZED BEAM DUMP DATA FROM 70 GEV PROTON ON IRON  2/82*
CP   C  (ASRATYAN 78 PL 79B,497). ASSUMED DRELL-YAN PROD OF CHGD HVY LEPTON 2/82*
CP   C  PAIR FOLLOWED BY DECAY INTO NEUTRAL HVY LEPTON. ABOVE VALUE IS WHEN 2/82*
CP   C  LIMIT IS MOST STRINGENT. FOR OTHER MASS AND LIFE,SEE THEIR TABLE 1, 2/82*
CP   C  AND FOR LIMIT DEDUCED FOR PI NUCLEON INTERACTION,SEE THEIR TABLE 2. 2/82*

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NE      NEUTRAL HEAVY LEPTON PROD. CROSS SECTION (E+ E-)  (CM**2)          12/77
NE   A       4.5E-36 OR LESS  CL=.90   MEYER     77 SMAG E+E- 6.8 GEV (ECM)  12/77
NE
NE   A  MEYER 77 EXPT LOOKS FOR NARROW NEUTRAL RESONANCE IN E-PI AND MU-PI  12/77
NE   A  CHANNELS. VALUE GIVEN IS FOR MASS OF .5 GEV, AND IS PRODUCT OF CS*  12/77
NE   A  BR(TAU--> NEW NEUTRAL LEPTON)*BR(NEUTRAL LEPTON--> E OR MU PI). IF  12/77
NE   A  MASS OF NEUTRAL LEPTON IS 1.5 GEV, LIMIT BECOMES 2.5E-36. SEE S25K. 12/77

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TNU     LIMIT ON NL(TAU) PRODUCTION IN BEAM DUMP EXPERIMENT                 1/82*
TNU  A                                 FRITZE    80 HYBR                    1/82*
TNU
TNU  A  FRITZE 80 IS CERN SPS EXP WITH BEBC. NC/CC RATIO CORRESPONDS TO     1/82*
TNU  A  R=(PROMPT-NU(TAU)-INDUCED EVENTS)/(ALL PROMPT-NU EVENTS) <0.1.      1/82*
TNU  A  MIXING PROBABILITY P(NU(E)-->NU(TAU)) < 0.35 AT CL=.90.             1/82*

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REFERENCES FOR HEAVY LEPTON SEARCHES

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BEHREND  65 PRL 15 900          +BRASSE,ENGLER,GANSSAUGE+        (DESY+KARL)
BETOURNE 65 PL 17 70            +NGUYEN NGOC,PEREZ Y JORBA+            (ORSA)
BUDNITZ  66 PR 141 1313         +DUNNING,GOITEIN,RAMSEY,WALKER,WILSON(HARV)
BARNA    68 PR 173 1391         +COX,MARTIN,PERL,TAN,TONER,ZIPF+(SLAC+STAN)
BOLEY    68 PR 167 1275         +ELIAS,FRIEDMAN,HARTMANN,KENDALL+ (MIT+CEA)

LIBERMAN 69 PRL 22 663          +HOFFMAN,ENGELS,IMRIE+(HARV+CASE+MCGI+SLAC)
ROTHE    69 NP B10 241          K.W.ROTHE,A.M.WOLSKY                   (PENN)
LICHTENS 70 PR D1 825           LICHTENSTEIN,ASH,BERKELMAN,HARTILL+  (CORN)
RAMM     70 NATURE 227 1323     C.A.RAMM                               (CERN)
    ALSO 72 NATURE 237 388      CLARK,ELIOFF,FIELD,FRISCH,JOHNSON+      (LBL)

RAMM     71 NAT.PH.SC.230 145 C.A.RAMM                                 (CERN)
GOLOVKIN 72 PL 42B 136          +GRACHEV,KHODYREV,KUBAROVSKY+          (SERP)
ANSORGE  73 PR D7 26            +BAKER,KRZESINSKI,NEALE,RUSHBROOKE+   (CAVE)
BACCI    73 PL 44B 530          +PARISI,PENSO,SALVINI,STELLA+   (ROMA+FRAS)
BARISH   73 PRL 31 410          +BARTLETT,BUCHHOLZ,HUMPHREY+     (CIT+FNAL)

BERNARDI 73 NC 17A 383          BERNARDINI,BOLLINI,BRUNINI+(CERN+BGNA+FRAS)
    ALSO 70 LNC 4 1156          ALLES-BORELLI,BERNARDINI,BOLLINI+     (CERN)
BUSHNIN  73 NP B58 476          +DUNAYTZEV,GOLOVKIN,KUBAROVSKY +       (SERP)
    ALSO 72 PL 42B 136          GOLOVKIN,GRACHEV,SHODYREV +            (SERP)
EICHTEN  73 PL 46B 281          +DEDEN+(AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
HANSON   73 NCL 7 587           +LEONG,NEWMAN,LAW,LITKE+(MIT+HARV+CEA+HAIF)

ASRATYAN 74 PL 49B 488          +GERSHTEIN,KAFTANOV,KUBANTZEV,LAPIN+ (SERP)
BARISH   74 PRL 32 1387         +BARTLETT,BUCHHOLZ,MERRITT +     (CIT+FNAL)
CRONIN   74 PR D10 3093         +FRISCH,SHOCHET,BOYMOND,MERMOD + (EFI+PRIN)
GITTLESO 74 PR D10 1379         GITTLESON,KIRK+        (HARV+ROCH+COLU+FNAL)
ORITO    74 PL 48B 165          +VISENTIN,CERADINI,CONVERSI +    (FRAS+ROMA)

BENVENUT 75 PRL 35 1486         BENVENUTI,CLINE,FORD+ (HARV+PENN+WISC+FNAL)
BINTINGE 75 PRL 34 982          BINTINGER,CURRY+        (EFI+HARV+PENN+WISC)
BACCI    77 PL 71B 227          +DEZORZI,PENSO,STELLA+           (ROMA+FRAS)
KRISHNAS 75 PL 57B 105          KRISHNASWAMY,MENON+          (BOMBAY+OSAKA)
    ALSO 75 PRL 35 628          DE RUJULA,GEORGI,GLASHOW               (HARV)
    ALSO 75 PRAMANA 5 78        RAJASEKARAN,SARMA                      (TIFR)

FAISSNER 76 PL 60B 401          +HASERT+(AACH+BELG+CERN+EPOL+MILA+OXF+LOUC)
BARANOV  77 PL 70B 269          +VOLKOV,GERSHTEIN,IVANILOV +           (SERP)
    ALSO 77 SJNP 26 57          BARANOV,VOLKOV,GERSHTEIN,IVANILOV     +(SERP)
BENVENU1 77 PRL 38 1110         BENVENUTI,CLINE+ (FNAL+HARV+PENN+RUTG+WISC)
    ALSO 77 PRL 38 1187         ALBRIGHT,SMITH,VERMASEREN         (FNAL+STON)
    ALSO 77 PRL 38 1190         BARGER,GOTTSCHALK+     (WISC+ZARAGOZA+RHEL)
BENVENU2 77 PRL 38 1183         BENVENUTI,CLINE+ (FNAL+HARV+PENN+RUTG+WISC)

ELLIOT   77 PR D15 1851         +FORTNEY,GOSHAW,LAMSA,LOOS+      (DUKE+ALBA)
MEYER    77 PL 70B 469          +NGUYEN,ABRAMS,ALAM+    (SLAC+LBL+NWES+HAWA)
ASRATYAN 78 PL 76B 237          ASRATYAN,KUBANTSEV                     (ITEP)
BALTAY   78  TOKYO CONF.        C.BALTAY (19TH INTL. CONF. ON HEP)     (COLU)

BECHIS   78 PRL 40 602          +CHANG,DOMBECK,ELLSWORTH,GLASSER,LAU+ (UMD)
BOSETTI  78 PL 73B 380          +DEDEN +       (AACH+BONN+CERN+LOIC+OXF+SACL)
CNOPS    78 PRL 40 144          +CONNOLLY,KAHN,KIRK,MURTAGH +    (BNL+COLU)
ERRIQUEZ 78 PL 77B 227                BARI+BIRM+BRUX+EPOL+RHEL+SACL+LOUC
HOLDER   78 PL 74B 277          +KNOBLOCH,MAY +  (CERN+DORT+HEID+SACL+BGNA)
SMITH    78  NU 78 CONF         J.SMITH                                (COLU)

ARMITAGE 79 NP B150 87          +BENZ,BOBBINK+ (CERN+DARE+FOM+MCHS+UTRECHT)
BARANOV  79 PL 81B 261          +IVANILOV,KONTUSHKO,KORABLEV+          (SERP)
    ALSO 79 SJNP 29 622         BARANOV,+VOLKOV,IVANILOV,KONYUSHKO,+  (SERP)

AGAKISHI 80 SJNP 32 345         AGAKISHIEV,VOVENKO,GORYACHEV,MUKHIN   (SERP)
AZIMOV   80 JETPL 32 665        YA.I.AZIMOV,V.A.KHOZE                  (KONS)
BARBER   80 PRL 45 1904         +BECKER,BEI+        (AACH+DESY+MIT+NIKO+BHEP)
BUSSIERE 80 NP B174 1           +GIACOMELLI,LESQUOY+        (BGNA+SACL+LAPP)
FRITZE   80 PL 96B 427          AACH+BONN+CERN+LOIC+OXF+SACL COLLABORATION
LEBRITTO 80 PL 89B 271          LEBRITTON,MCCAL,MELISSINOS+   (ROCH+BNL+NSF)

BERGER   81 PL 99B 489          +GENZEL+(AACH+BERG+DESY+HAMB+UMO+SIEG+WUPP)
BRANDELI 81 PL 99B 163          BRANDELIK+  (AACH+BONN+DESY+HAMB+LOIC+OXF+)
CLARK    81 PRL 46 299          +JOHNSON,KERTH,LOKEN+      (UCB+LBL+FNAL+PRIN)
HAYES    82 PR (SUBMITTED)      +PERL,ALAM,BOYARSKI,BREIDENBACH+ (SLAC+LBL)
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REVIEWS

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PERL     81  SLAC-PUB-2752      M.L.PERL, PHYS. IN COLL. CONF, V.P.I.(SLAC)

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WEAK GAUGE BOSON SEARCHES

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M      W BOSON MASS LIMITS (GEV)
M    A   0    1.7    OR MORE  CL=.99   BERNARDIN 65 HYBR +   NEU N. CERN      2/74
M    A   0    2.0    OR MORE  CL=.90   BURNS     65 OSPK +   NEU N. BNL       2/74
M    B   0    3.8    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.2 2/74
M    B   0    4.5    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.5 2/74
M    B   0    4.7    OR MORE  CL=.90   BARISH    73 ASPK +   W+ TO LEP+NEU=.8 2/74
M    C   0    5.0    OR MORE  CL=.95   BERGESON  73 ELEC                      1/76
M    D   0 NONE WITH MASS 10-20 GEV    BUSSER    74 WIRE +-0 P-P,52.7 GEV CM  8/76
M    E   0 NONE WITH MASS 5.5-8.5 GEV ABRAMOV    77 CNTR +-                  12/77
M
M    A  LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU, E+ NEU, OR  ORNS)  2/74
M
M    B  BARISH 73 LOOKED FOR (NEU N) TO (W+ MU- N), W+ TO (MU+ NEU) AT NAL.  2/74
M    B  RESULT GIVEN FOR THREE ASSUMED BR-FRACS. W+ TO (LEPTON NEU)/ALL.     2/74
M
M    C  BERGESON 73 LOOKED AT ENERGY DISTR OF NEU-INDUCED MUON FLUX UNDER-   1/76
M    C  GROUND. SCALE INVARIANCE OF THE INELASTIC STRUCT FN ASSUMED.         1/76
M
M    D  BUSSER 74 IS CERN ISR EXPT. LOOKED FOR ELECTRONS OF LARGE            8/76
M    D  TRANSVERSE MOMENTUM. RESULT QUOTED ABOVE IS MODEL DEPENDENT.         8/76
M
M    E  ABRAMOV 77 IS 70 GEV P-CU EXPT AT SERP LOOKING AT DIRECT MUONS OF   12/77
M    E  HIGH TRANSVERSE MOM. RESULT IS MODEL DEPENDENT.                     12/77

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C      W BOSON PRODUCTION CROSS SECTION (10**-36 CM**2)
C    A   0    6.0    OR LESS              ANKENBRAN 71 CNTR +- W TO(MU NEU)=1.0  2/74
C
C    A  ANKENBRANDT 71 LOOKED FOR (P N)TO(W HADRONS), W TO (MU NEU) AT BNL.  2/74
C    A  THIS ASSUMES BR OF W TO MU NEU IS 1.  IN GENERAL THIS VALUE IS       2/74
C    A  6.0/BR, WHERE BR=(W TO MU NEU)/(W TO ALL).                           2/74

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ZOM     ZO BOSON MASS LIMITS IN E+ E- ANNIHILATION (GEV)                     2/82*
ZOM  A   0    51.    OR MORE  CL=.95   BARTEL    81 JADE                    2/82*
ZOM  B   0    40.    OR MORE  CL=.95   BERGER    81 PLUT                    2/82*
ZOM
ZOM     ABOVE LIMITS ARE IN STANDARD SU(2)XU(1) MODEL. FOR BOUND-PLOTS IN    2/82*
ZOM     EXTENDED MODELS WITH TWO OR MORE ZO'S, SEE INDIVIDUAL PAPERS.        2/82*
ZOM
ZOM  A  BARTEL 81 AT DESY-PETRA STUDIED E+E- -->E+E-,MU+MU- UP TO WCM=36GEV 2/82*
ZOM  A  IN STANDARD MODEL WITH FREE ZO MASS AND WITH COUPLINGS FIXED AT LOW 2/82*
ZOM  A  Q2 VALUES(SIN(THETA/W)**2=.23).                                     2/82*
ZOM
ZOM  B  BERGER 81 AT DESY-PETRA ANALYZED E+E- -->E+E-,MU+MU-,TAU+TAU- DATA  2/82*
ZOM  B  AT WCM=27.5-31.6 GEV IN STANDARD MODEL. CL=.95 CONTOUR IN GV**2 AND 2/82*
ZOM  B  GA**2 PLANE IS INCONSISTENT W. NU E RESULT IF MZ BELOW ABOVE LIMIT. 2/82*

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S       SCALAR BOSON MASS LIMITS (GEV)
S    A   0    10.0   OR MORE  CL=.90   CONVERSI  73 ASPK  0 E+E- FRASCATI     3/74
S
S    A  CONVERSI 73 LOOKED FOR QED VIOLATION IN E+E- SCATTERING AT 2.9 GEV   3/74
S    A  AND ASSUMED W BOSON MASS=10 GEV.  FOR MW=15 GEV, MS LIMIT= 6.5 GEV   3/74

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REFERENCES FOR WEAK GAUGE BOSON SEARCHES

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BERNARDI 65 NC 38 608           BERNARDINI,BIENLEIN,BOHM,DARDEL,+      (CERN)
BURNS    65 PRL 15 42           +GIULIANOS,HYMAN,LEDERMAN,LEE +   (COLU+BNL)
ANKENBRA 71 PR D3 2582          ANKENBRANDT,LARSEN,LEIPUNER+      (BNL+YALE)

BARISH   73 PRL 31 180          +BARTLETT,BUCHHOLZ,HUMPHREY+      (CIT+FNAL)
BERGESON 73 PRL 31 66           +CASSIDAY,HENDRICKS                   (UTAH)
CONVERSI 73 PL 46B 269          +D'ANGELO,GATTO,PAOLUZI               (ROMA)
BUSSER   74 PL 48B 371          +CAMILLERI,DI LELLA +       (CERN+COLU+ROCK)
ABRAMOV  77 SJNP 25 41          +ANISIMOVA,BONDARENKO,GRIDASOV +      (SERP)

BARTEL   81 PL 99B 281          JADE C.(DESY+HAMB+HEID+LANC+MCHS+RHEL+TOKY)
BERGER   81 ZPHY C7 289         PLUTO C.(AACH+BERG+DESY+HAMB+UMO+SIEG+WUPP)

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FREE QUARK SEARCHES

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SEARCHES FOR INTEGRALLY CHARGED QUARKS APPEAR ALONG WITH OTHER SIMILAR SEARCHES IN 'OTHER NEW PARTICLE SEARCHES' SECTION BELOW.

Note on Free Quark Searches

Five and nine instances of charge -1/3 and +1/3 respectively have been reported by Fairbank's group at Stanford (LARUE 77, 79, and 81) using magnetic levitation of superconducting niobium balls. These events are shown in Fig. 1. There has as yet been no independent confirmation of the existence of free quarks.

The best searches for quarks in cosmic rays yield upper limits on the flux of quarks of about

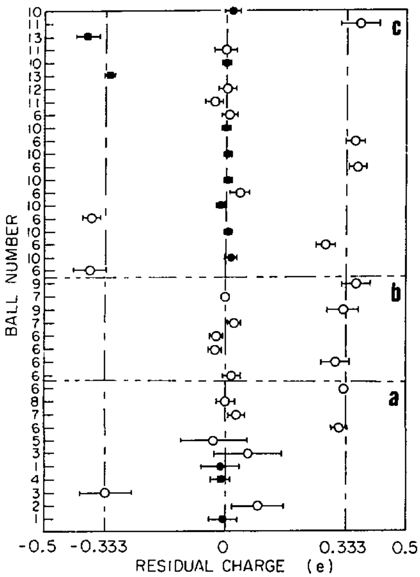

Fig. 1. Residual charge measurements in chronological order from LARUE 77 (a), 79 (b), and 81 (c). Ball radius 140 (open circles), 116 (solid squares), and 98 μm (solid circles). Figure adapted from LARUE 81: La Rue, Phillips, and Fairbank, Phys. Rev. Lett. 46, 967 (1981).

10^{-11} cm^{-2} $ster^{-1}$ sec^{-1}. Cross-section upper limits established from proton accelerator experiments and calculations based on production models[1] imply that free quarks, if they exist, have a mass greater than about 5 GeV. Mass limits from photon and electron beam searches are slightly lower, but more reliable, depending only on the QED calculations for quark pair production. Limits on free quark concentrations in stable matter vary enormously depending on the source of matter and the technique.

The largely negative result of quark searches does not prove that free quarks do not exist, but indicates that they are hard to find. De Rujula, Giles, and Jaffe[2] have considered the question of unconfined quarks in a framework of a renormalizable, spontaneously broken version of QCD, and conclude that: (1) production cross sections are small, (2) interaction cross sections with nucleons are very large, and (3) the physical masses of quarks are probably very large. On this basis, primordial quarks would be expected to be nonintegrally charged, superheavy nucleon complexes.

We group quark searches by experimental technique - proton beams, photon beams, neutrino beams, electron beams, e^+e^- annihilations, cosmic rays, and stable matter. Proton beam experiments generally measure quark production cross sections (we quote these in section C), differential cross-section ratios (sections AF and RPI), or differential cross sections (sections IC and D). The photon beam experiment measures cross section per equivalent quanta (section DG), and the neutrino experiment measures the ratio of quark events over total events (section NEU). Searches with electron beams may measure differential cross sections (section G) and set limits on the quark mass (section M). Searches in e^+e^- annihilation present the ratio to the μ-pair cross section (section EE). Cosmic ray experiments measure quark flux (section F), and searches in stable matter measure quark concentration (section RHO). Most of the accelerator and cosmic ray experiments have searched for fractionally charged particles, but some have searched for massive stable particles which would have low velocity. The latter searches are usually sensitive to a range of charges and may appear in the section below on Other New Particle Searches.

We have relied heavily on the review of L. W. Jones[3] for data prior to April 1977.

References

1. T. K. Gaisser and F. Halzen, Phys. Rev. D11, 3157 (1975).
2. A. de Rujula, R. C. Giles, and R. L. Jaffe, Phys. Rev. D17, 285 (1978).
3. L. W. Jones, Rev. Mod. Phys. 69, 717 (1977).

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C         QUARK PRODUCTION CROSS SECT. FROM PROTON BEAM EXPTS. (CM**2)
C           0  2.0E-34 OR LESS  CL=.90   BINGHAM    64  HBC Q= -1/3 M=.5-2.0GEV   3/77
C           0  1.0E-34 OR LESS  CL=.90   BINGHAM    64 HLBC Q= -2/3 M=.5-2.5GEV   3/77
C           0  2.0E-35 OR LESS           BLUM       64  HBC Q= -1/3 M=0-2.5GEV    3/77
C      A    0  9.5E-36 OR LESS           HAGOPIAN   64  HBC Q= +1/3 M=.5-2.5GEV   3/77
C           0  1.0E-34 OR LESS           LEIPUNER   64 CNTR Q= -1/3 M=0-2.0GEV    3/77
C           0  4.0E-34 OR LESS           MORRISON   64  HBC Q= -1/3 M=.5-2.5GEV   3/77
C           0  1.0E-33 OR LESS           MORRISON   64  HBC Q= -2/3 M=.5-2.5GEV   3/77
C      B    0  2.0E-35 OR LESS           FRANZINI   65 CNTR Q= -2/3 M=0-2.5GEV    3/77
C      C    0  3.2E-39 OR LESS  CL=.90   ALLABY     69 CNTR Q= -1/3 M=2GEV        1/76
C      C    0  5.5E-38 OR LESS  CL=.90   ALLABY     69 CNTR Q= -2/3 M=2GEV        1/76
C      C    0  1.8E-35 OR LESS  CL=.90   ALLABY     69 CNTR Q= +1/3 M=2GEV        1/76
C      C    0  1.0E-35 OR LESS  CL=.90   ALLABY     69 CNTR Q= +2/3 M=2GEV        1/76
C      D    0  4.0E-37 OR LESS  CL=.90   ANTIPOV1   69 CNTR Q= -2/3 M=0-5GEV      2/74
C      D    0  3.0E-39 OR LESS  CL=.90   ANTIPOV2   69 CNTR Q= -1/3 M=4.5-5GEV    1/76
C      D    0  3.0E-37 OR LESS  CL=.90   ANTIPOV2   69 CNTR Q= -2/3 M=2-5GEV      1/76
C      E    0  1.0E-36 OR LESS  CL=.90   ANTIPOV    71 CNTR Q= -4/3 M=4GEV        1/76
C      F    0  3.0E-34 OR LESS           BOTT-BODE  72 CNTR Q=+-1/3 M=0-22GEV     2/74
C      F    0  6.0E-34 OR LESS           BOTT-BODE  72 CNTR Q=+-2/3 M=0-13GEV     2/74
C      G    0  1.0E-32 OR LESS  CL=.90   ALPER      73 SPEC Q=  2/3 M=4-24 GEV    1/76
C      G    0  1.0E-32 OR LESS  CL=.90   ALPER      73 SPEC Q=  4/3 M=4-24 GEV    1/76
C      H    0  1.0E-35 OR LESS           LEIPUNER   73 CNTR Q=  1/3 M=0-12GEV     2/74
C      H    0  1.0E-35 OR LESS           LEIPUNER   73 CNTR Q=  2/3 M=0-12GEV     2/74
C      H    0  5.0E-31 OR LESS           LEIPUNER   73 CNTR Q=  4/3 M=0-12GEV     2/74
C      I    0  5.0E-39 OR LESS  CL=.90   NASH       74 CNTR Q= -1/3 M=4- 9GEV     2/77
C      I    0  5.0E-38 OR LESS  CL=.90   NASH       74 CNTR Q= -2/3 M=4-11GEV     2/77
C      J    0  4.0E-35 OR LESS  CL=.90   FABJAN     75 CNTR Q=  1/3 M=0-20 GEV    1/77
C      J    0  8.0E-35 OR LESS  CL=.90   FABJAN     75 CNTR Q=  2/3 M=0-20 GEV    1/77
C      K    0  1.0E-35 OR LESS  CL=.90   BASILE1    78 SPEC Q=+-1/3 M=0-20 GEV    2/79
C      L    0  1.0E-33 OR LESS  CL=.90   BASILE1    78 SPEC Q=+-1/3 M=0-26 GEV    2/79
C
C      A  HAGOPIAN 64 CROSS SECTION INFERRED FROM FLUX DATA.                      3/77
C
C      B  FRANZINI 65 CROSS SECTION INFERRED FROM FLUX DATA.                      3/77
C
C      C  ALLABY 69 IS A CERN 27 GEV P+BE EXPT.  STUDIES MASSES 0-2.7GEV          1/76
C      C  ASSUMING NN=NNQQ.  CROSS SECTIONS ASSUME ISOTROPIC PROD. IN CM.         1/76
C      C  CROSS SECTIONS AT 2GEV ARE GIVEN HERE.  SEE FIG.9 FOR MASS DEPEN.       1/76
C
C      D  ANTIPOV1 69 IS A SERPUKHOV 70 GEV P EXPT.  MASS LIMIT FROM NN=NNQQ.     2/74
C      D  ANTIPOV1 69 AND ANTIPOV2 69 ARE SERPUKHOV 70GEV P EXPTS.  ANTIPOV2      1/76
C      D  GIVES RESULTS FOR M=2-5GEV ASSUMING NN-->NNQQ, HADRONIC OR LEPTONIC     1/76
C      D  QUARKS.  WE QUOTE TYPICAL VALUES.                                       1/76
C
C      E  ANTIPOV 71 IS A SERPUKHOV 70 GEV P+AL EXPT.  STUDIES DIQUARK MASSES     1/76
C      F  1.9-4.4GEV.  WE SHOW 4GEV VALUE.  SEE THEIR FIG.2 FOR MASS DEPEN.       1/76
C
C      F  BOTT-BODENHAUSEN 72 IS A CERN ISR 26+26 GEV P+P EXPERIMENT.             2/74
C
C      G  ALPER 73 IS CERN ISR 26+26 GEV P+P EXPT. ASSUMES ISOTROPIC C.M.         1/76
C      G  PRODUCTION.  SENSITIVE TO ANY Q>2/3.                                    1/76
C
C      H  LEIPUNER 73 IS AN NAL 300 GEV P EXPERIMENT.                             2/74
C
C      I  NASH 74 IS FNAL EXPT USING 200 AND 300 GEV PROTONS. SEE FIG 2,PG861     2/77
C      I  FOR OTHER MASS VALUES AND VARIOUS PRODUCTION MECHANISMS.                2/77
C
C      J  FABJAN 75 IS CERN ISR P+P EXPT.  INCLUDES RESULTS OF BOTT-BODE 72       1/77
C      J  EXPT.  RESULTS  ARE FOR ECM=53 GEV.                                     1/77
C
C      K  BASILE1 78 IS CERN-ISR EXPT WITH ECM=52.5 GEV.                          2/79
C
C      L  THE ABOVE RESULT IS FOR ECM=62 GEV, FROM AN EARLIER EXP (BASILE 77)     2/79

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AF        QUARK PRODUCTION FLUX (FLUX QUARKS / FLUX CHARGED PARTICLES)
AF     A    0  6.2E-10 OR LESS           FABJAN     75 CNTR     M=0-20 GEV        2/80
AF     B    0  1.78E-9 OR LESS  CL=.90   BASILE     77 SPEC Q= +1/3 M=0-26GEV     1/78
AF     B    0  1.05E-9 OR LESS  CL=.90   BASILE     77 SPEC Q= -1/3 M=0-26GEV     1/78
AF     C    0  5.11E-11OR LESS  CL=.90   BASILE1    78 SPEC Q=+-1/3 M=0-21 GEV    2/79
AF     D    0  4.E-11  OR LESS           BOZZOLI    79 CNTR     Q=-2/3, 1<M<3    12/79
AF     D    0  2.E-11  OR LESS           BOZZOLI    79 CNTR     Q=-4/3, 2<M<6    12/79
AF     D    0  3.E-11  OR LESS           BOZZOLI    79 CNTR     Q=+2/3, 1<M<3    12/79
AF     D    0  3.E-10  OR LESS           BOZZOLI    79 CNTR     Q=+4/3, 2<M<6    12/79
AF
AF     A  FABJAN 75 REPORTS BOTH FLUX AND CROSS SECTION (ABOVE)
AF
AF     B  BASILE 77 IS A CERN-ISR PP EXP AT ECM=62.2 GEV COVERING PT UP TO 1      2/76
AF     B  GEV BASILE 77 FIND ONE QUARK CANDIDATE WITH M .LT. .169 GEV.            2/78
AF     B  THEY DO NOT CLAIM THIS AS A QUARK.                                      2/76
AF
AF     C  BASILE 78 IS CERN-ISR EXPT WITH ECM=52.5 GEV.                           2/79
AF
AF     D  BOZZOLI 79 SEARCHED FOR QUARKS WITH LIFETIME > 1.E-8 SEC IN 200        12/79
AF     D    GEV/C P BE INTERACTIONS USING RF SEPERATOR AS MASS SPECTOMETER.      12/79

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RPI       QUARK PRODUCTION CROSS SECTION  ( CS(QUARK) / CS(PION) )               12/81*
RPI    A    0  9. E-11 OR LESS  CL=.95   BUSSIERE   80 CNTR Q= +4/3 M=4-6 GEV    12/81*
RPI    A    0  1.5E-10 OR LESS  CL=.95   BUSSIERE   80 CNTR Q= +2/3 M=1-3 GEV    12/81*
RPI    A    0  9. E-12 OR LESS  CL=.95   BUSSIERE   80 CNTR Q= -2/3 M=1.5-2.5    12/81*
RPI    A    0  5. E-12 OR LESS  CL=.95   BUSSIERE   80 CNTR Q= -4/3 M=3-6 GEV    12/81*
RPI    A    0  9. E-17 OR LESS  CL=.95   BUSSIERE   80 CNTR *Q=-2/3 M=1.5-3 GEV  12/81*
RPI    A    0  5. E-12 OR LESS  CL=.95   BUSSIERE   80 CNTR *Q=-4/3 M=2.5-6 GEV  12/81*
RPI
RPI    A  BUSSIERE 80 IS CERN-SPS EXPT WITH 200-240 GEV PROTONS ON BE AND AL     12/81*
RPI    A  TARGET. LAST TWO CARDS WITH *Q ARE FOR LEPTON-TYPE QUARKS MEASURED     12/81*
RPI    A  AFTER BEAM DUMP. FOR LIMITS AT OTHER MASS RANGES, SEE THEIR FIG.6.     12/81*

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IC        QUARK INVARIANT PROD. CROSS SECT. FROM PROTON BEAMS  (CM**2/GEV**2)
IC     A    0  5.1E-39 OR LESS  CL=.90   ANTREASYA 77 SPEC Q= +1/3 M=0-6.3 GEV  11/77
IC     A    0  8.8E-39 OR LESS  CL=.90   ANTREASYA 77 SPEC Q= -1/3 M=0-6.3 GEV  11/77
IC     A    0  1.3E-39 OR LESS  CL=.90   ANTREASYA 77 SPEC Q= +2/3 M=0-8   GEV  11/77
IC     A    0  2.2E-39 OR LESS  CL=.90   ANTREASYA 77 SPEC Q= -2/3 M=0-8   GEV  11/77
IC     B       4. E-39 OR LESS  CL=.90   STEVENSON 79 CNTR Q=  2/3 M>5 GEV      12/79
IC     B    0  5. E-38 OR LESS  CL=.90   STEVENSON 79 CNTR Q=  1/3 M>5 GEV      12/79
IC
IC     A  ANTREASYAN 77 LOOKS FOR HIGH TRANSVERSE MOM QUARKS IN 400 GEV P-CU     11/77
IC     A  INTERACTIONS AT FNAL.                                                  11/77
IC
IC     B  STEVENSON 79 IS 300 GEV P-CU EXPT AT FNAL. SENSITIVE TO PARTICLES      12/79
IC     B  WITH LIFETIMES BETWEEN 2.5E-5 AND 1.E-3 SEC.                           12/79

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D         QUARK PROD. DIFF. CROSS SEC. FROM PROTON BEAM EXPTS.  (CM**2/SR-GEV)
D      A    0  1.5E-36 OR LESS           DORFAN     65 CNTR BE TARG  M=3-7GEV     2/74
D      A    0  3.0E-36 OR LESS           DORFAN     65 CNTR FE TARG  M=3-7GEV     2/74
D      B    0  7.2E-39 OR LESS  CL=.90   ALLABY     69 CNTR Q=-1/3  THETA= 0 MR   1/76
D      B    0  5.2E-38 OR LESS  CL=.90   ALLABY     69 CNTR Q=-2/3  THETA=6.5MR   1/76
D      B    0  2.6E-35 OR LESS  CL=.90   ALLABY     69 CNTR Q=+1/3  THETA=44 MR   1/76
D      B    0  1.3E-35 OR LESS  CL=.90   ALLABY     69 CNTR Q=+2/3  THETA=44 MR   1/76
D      C    0  7.0E-38 OR LESS  CL=.90   ANTIPOV2   69 CNTR Q=-1/3    M=0-5GEV    1/76
D      C    0  4.0E-38 OR LESS  CL=.90   ANTIPOV2   69 CNTR Q=-2/3    M=0-2.5GEV  1/76
D      D    0  1.6E-36 OR LESS  CL=.90   ANTIPOV    71 CNTR Q=-4/3  THETA=47 MR   1/76
D      D    0  3.8E-36 OR LESS  CL=.90   ANTIPOV    71 CNTR Q=-4/3  THETA=47 MR   1/76
D      E    0  5.6E-36 OR LESS  CL=.90   NASH       74 CNTR Q=-1/3                2/77
D      E    0  5.0E-35 OR LESS  CL=.90   NASH       74 CNTR Q=-2/3    M GT 1.76   2/77
D      E    0  8.5E-35 OR LESS  CL=.90   NASH       74 CNTR Q=-2/3    M LT 1.76   2/77
D      F    0  1.6E-33 OR LESS  CL=.90   ALBROW     75 SPEC Q=+-4/3  M=5-20 GEV   1/77
D      G    0  5.0E-34 OR LESS  CL=.90   JOVANOVIC  75 CNTR Q=1/3  M=7-15 GEV     2/76
D      G    0  2.0E-34 OR LESS  CL=.90   JOVANOVIC  75 CNTR Q=1/3  M=15-26 GEV   11/75
D      G    0  1.3E-34 OR LESS  CL=.90   JOVANOVIC  75 CNTR Q=2/3  M=10-26 GEV   11/75
D      G    0  8.0E-35 OR LESS  CL=.90   JOVANOVIC  75 CNTR Q=4/3  M=10-26 GEV   11/75
D      H    0  3.7E-36 OR LESS  CL=.90   BALDIN     76 CNTR Q=-2/3  M=1.4-6 GEV   1/77
D      H    0  2.0E-36 OR LESS  CL=.90   BALDIN     76 CNTR Q=-4/3  M=2.7-12GEV   1/77
D
D      A  DORFAN 65 IS A 30 GEV/C P EXPERIMENT AT BNL.   V=.18-.995               2/74
D
D      B  SEE FOOTNOTE C IN SUBSECTION C ABOVE.                                   2/76
D
D      C  SEE FOOTNOTE D IN SUBSECTION C ABOVE.                                   2/76
D
D      D  FIRST ANTIPOV 71 VALUE IS FOR M=1.9-2.3,2.7-4.4GEV, SECOND IS FOR       1/76
D      D  M=2.3-2.7GEV.  SEE ALSO NOTE E IN SECTION C ABOVE.                      1/76
D
D      E  NASH 74 IS FNAL EXPT USING 200 AND 300 GEV PROTONS.  VALUES ARE FOR     2/77
D      E  A 1MRAD LAB PROD. ANGLE AND OUTGOING MOMENTUM AT MAX OF FOUR BODY       2/77
D      E  PHASE SPACE FOR QUARK-PAIR PROD.  SEE TABLE I PG. 860 FOR OTHER         2/77
D      E  LIMITS.                                                                 2/77
D
D      F  ALBROW 75 IS A CERN ISR EXPT WITH ECM=53 GEV. THETA=40 MR. SEE          1/77
D      F  FIG. 5 FOR MASS RANGES UP TO 25 GEV.                                    1/77
D
D      G  JOVANOVICH 75 FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.        11/75
D      G  THIS IS A CERN ISR 26+26, 22+22 GEV P+P EXPERIMENT.                     2/76
D
D      H  BALDIN 76 IS A 70 GEV SERP EXP.  VALUES ARE PER AL NUCLEUS AT           1/77
D      H  THETA=0.  ASSUMES STABLE PARTICLE INTERACTING WITH MATTER IN SAME       1/77
D      H  MANNER AS ANTIPROTON.                                                   1/77

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DG        QUARK PROD. DIFF. CROSS SEC. FROM PHOTOPROD. (CM**2/SR-EQUIV.QUANTA)
DG     A       5.0E-35 OR LESS  CL=.90   GALIK      74 CNTR      THETA=1.2,7 DEG. 11/76
DG
DG     A  GALIK 74 IS 20 GEV(MAX) GAMMA CU EXPT. USING SLAC 20 GEV SPTRMETER.    11/76

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NEU       QUARK PRODUCTION IN NEUTRINO BEAMS (QUARK FLUX/NU EVENT)                7/79
NEU        *LEP QUARK  INDICATES LEPTONIC QUARK                                  12/81*
NEU        *STR QUARK  INDICATES STRONG QUARK                                    12/81*
NEU         0  5.0E-3  OR LESS  CL=.90   BASILE2    78 CNTR NUMU BEAM AT SPS      7/79
NEU    A    0  1.5E 5  OR LESS  CL=.90   BASILE     80 CNTR Q=1/3    *STR QUARK  12/81*
NEU    A    0  1.7E-5  OR LESS  CL=.90   BASILE     80 CNTR Q=2/3    *STR QUARK  12/81*
NEU    A    0  9.6E-6  OR LESS  CL=.90   BASILE     80 CNTR Q=1/3    *LEP QUARK  12/81*
NEU    A    0  1.1E-5  OR LESS  CL=.90   BASILE     80 CNTR Q=2/3    *LEP QUARK  12/81*
NEU
NEU    A  BASILE 80 ASSUMES A STRONG QUARK ABSORPTION LENGTH THREE TIMES THE     12/81*
NEU    A  NORMAL HADRONIC ABSORPTION LENGTH IN LEAD.                             12/81*

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M         LIMIT ON QUARK MASS FROM ELECTRON BEAMS         (GEV/C**2)
M          *LEP QUARK  INDICATES LEPTONIC QUARK
M          *STR QUARK  INDICATES STRONG QUARK
M              0.85    OR MORE  CL=.99   BATHOW     67 CNTR Q=1/3    *LEP QUARK   3/77
M              0.90    OR MORE  CL=.99   BATHOW     67 CNTR Q=2/3    *LEP QUARK   3/77
M              0.70    OR MORE  CL=.90   FOSS       67 CNTR Q=1/3    *LEP QUARK   3/77
M              0.84    OR MORE  CL=.90   FOSS       67 CNTR Q=2/3    *LEP QUARK   3/77
M              1.0     OR MORE           BELLAMY    68 CNTR Q=1/3    *LEP QUARK   3/77
M              1.5     OR MORE           BELLAMY    68 CNTR Q=2/3    *LEP QUARK   3/77
M              0.5     OR MORE           BELLAMY    68 CNTR Q=1/3    *STR QUARK   3/77
M              0.75    OR MORE           BELLAMY    68 CNTR Q=2/3    *STR QUARK   3/77
M      A       3.6     OR MORE  CL=.90   GALIK      74 CNTR Q=1/3    *STR QUARK   7/76
M      A       4.5     OR MORE  CL=.90   GALIK      74 CNTR Q=2/3    *STR QUARK   7/76
M      A       1.4     OR MORE  CL=.90   GALIK      74 CNTR Q=1/3    *LEP QUARK   7/76
M      A       1.8     OR MORE  CL=.90   GALIK      74 CNTR Q=2/3    *LEP QUARK   7/76
M
M      A  FIRST TWO MASS LIMITS ARE FOR STRONGLY INTERACTING QUARKS.INFERRED      7/76
M      A  FROM CROSS-SEC LIMITS USING ORELL MODEL. LAST TWO ARE FOR LEPTONIC      7/76
M      A  QUARKS. EXPT USES PHOTOPRODUCTION ON COPPER.                            7/76

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EE        QUARK PRODUCTION CROSS SEC. IN E+ E-. (RATIO TO CS(E+E- -->MU+MU-))     1/82*
EE     A    0 1.0 E-2  OR LESS  CL=.90   BARTEL     80 JADE Q=2/3 M=2-12 GEV      2/82*
EE     A    0 5.0 E-2  OR LESS  CL=.90   BARTEL     80 JADE Q=1,4/3,5/3 M=2-12    2/82*
EE     B    0 2.3 E-4  OR LESS  CL=.90   WEISS      81 SMK2 Q=-2/3 M=1.9-2.6GEV   1/82*
EE     B    0 0.8 E-4  OR LESS  CL=.90   WEISS      81 SMK2 Q= 2/3 M=1.8-2. GEV   1/82*
EE
EE     A  BARTEL 80 IS DESY PETRA EXPT WITH WCM=27-35 GEV. FIRST LIMIT IS FOR     2/82*
EE     A  BOTH E+E- -->Q QBAR AND Q QBAR X, SECOND FOR Q QBAR X. FOR MASS-        2/82*
EE     A  DEPENDENCE, SEE THEIR FIGS 8,9,10,11.                                   2/82*
EE
EE     B  WEISS 81 IS SLAC SPEAR EXPT. FIRST VALUE IS FOR E+E- -->Q QBAR X        1/82*
EE     B  AND SECOND FOR E+E- -->Q QBAR. SEE THEIR TABLES FOR LIMITS IN           1/82*
EE     B  SURROUNDING MASS REGIONS 1 TO 3 GEV AND 1 TO 2.8 GEV RESPECTIVELY.      1/82*

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F        QUARK FLUX FROM COSMIC RAY EXPERIMENTS  (NUMBER/CM**2-SR-SEC)
F         *TD IN THE RIGHT HAND COLUMNS INDICATES A SEARCH FOR MASSIVE
F            QUARKS USING TIME DELAY AFTER AIR SHOWERS, SENSITIVE TO A RANGE
F            OF CHARGES
F         *AS IN THE RIGHT HAND COLUMNS INDICATES A SEARCH IN AIR SHOWERS
F         ALL SEARCHES ARE AT SEA LEVEL UNLESS OTHERWISE INDICATED
F           0 1.6E-8   OR LESS  CL=.90   BOWEN      64 CNTR Q=-1/3  ALT=2750M   3/77
F           0 2.0E-7   OR LESS  CL=.90   SUNYAR     64 CNTR Q=1/3               3/77
F           0 8.7E-9   OR LESS  CL=.90   DELISE     65 CNTR Q=1/3   ALT=2750M   3/77
F           0 1.8E-8   OR LESS  CL=.90   DELISE     65 CNTR Q=2/3   ALT=2750M   3/77
F           0 5.0E-8   OR LESS  CL=.90   MASSAM     65 CNTR Q=2/3               3/77
F     A     0 1.4E-10  OR LESS           BARTON     66 CNTR Q=2/3               3/77
F           0 1.5E-9   OR LESS  CL=.90   BUHLER-BR  66 CNTR Q=1/3   ALT= 450M   3/77
F           0 1.4E-9   OR LESS  CL=.90   BUHLER-BR  66 CNTR Q=2/3   ALT= 450M   3/77
F           0 2.6E-9   OR LESS           KASHA      66 CNTR Q=1/3               3/77
F           0 2.1E-9   OR LESS           KASHA      66 CNTR Q=2/3               3/77
F           0 4.5E-10  OR LESS  CL=.90   LAMB       66 CNTR Q=1/3               3/77
F           0 1.6E-9   OR LESS  CL=.90   LAMB       66 CNTR Q=2/3               3/77
F     B     0 1.4E-10  OR LESS           BARTON     67 CNTR Q=2/3               3/77
F     C     0 1.6E-7   OR LESS           BUHLER-1   67 CNTR Q=4/3   ALT= 450M   3/77
F     C     0 4.5E-10  OR LESS  CL=.90   BUHLER-2   67 CNTR Q=1/3   ALT= 450M   3/77
F     C     0 1.7E-10  OR LESS           BUHLER-2   67 CNTR Q=2/3   ALT= 450M   3/77
F           0 1.7E-10  OR LESS  CL=.90   GOMEZ      67 CNTR Q=1/3               3/77
F           0 3.4E-10  OR LESS  CL=.90   GOMEZ      67 CNTR Q=2/3               3/77
F           0 2.0E-9   OR LESS  CL=.90   KASHA      67 CNTR Q=2/3               3/77
F     D     0 3.0E-10  OR LESS           BJORNBOE   68 CNTR M=5GEV OR MORE *TD  2/74
F     E     0 1.8E-10  OR LESS  CL=.90   BRIATORE   68 CNTR Q=1/3               5/76
F     E     0 1.8E-10  OR LESS  CL=.90   BRIATORE   68 CNTR Q=2/3               5/76
F     E     0 3.7E-8   OR LESS  CL=.90   BRIATORE   68 CNTR Q=4/3               5/76
F     F     0 2.2E-8   OR LESS           FRANZINI   68 CNTR V=.5-.9C  M=2GEV UP 2/74
F           0 6.6E-11  OR LESS  CL=.95   GARMIRE    68 CNTR Q=1/3               3/77
F           0 8.8E-11  OR LESS  CL=.95   GARMIRE    68 CNTR Q=2/3               3/77
F           0 3.1E-10  OR LESS  CL=.90   HANAYAMA   68 CNTR Q=1/3               3/77
F           0 2.4E-8   OR LESS  CL=.95   KASHAL     68 OSPK V=.5-.75C M=5-15GEV 2/74
F           0 1.2E-10  OR LESS  CL=.90   KASHA2     68 CNTR Q=2/3               3/77
F           0 1.3E-10  OR LESS  CL=.90   KASHA3     68 CNTR Q=4/3               3/77
F     G     0 5.0E-11  OR LESS           CAIRNS     69 CC    Q=2/3              3/77
F     H     0 5.0E-11  OR LESS  CL=.90   FUKUSHIMA  69 CNTR Q=1/3               2/74
F     H     0 7.5E-10  OR LESS  CL=.90   FUKUSHIMA  69 CNTR Q=2/3               2/74
F   I       1  EVENT CLAIMED             MCCUSKER   69 CC    Q=2/3         *AS  2/74
F           0 5.0E-10  OR LESS           BOSIA      70 CNTR Q=1/3   ALT=3500M   1/78
F           0 2.5E-10  OR LESS           BOSIA      70 CNTR Q=2/3   ALT=3500M   1/78
F     J     1  EVENT CLAIMED             CHU        70 HLBC                *AS  5/76
F           0 1.9E-9   OR LESS  CL=.90   FAISSNER   70 CNTR Q=1/3               3/77
F           0 9.8E-11  OR LESS  CL=.90   KRIDER     70 CNTR Q=1/3   ALT=750M    3/77
F           0 1.6E-10  OR LESS  CL=.90   KRIDER     70 CNTR Q=2/3   ALT=750M    3/77
F           0 1.3E-10  OR LESS  CL=.90   CHIN       71 CNTR Q=1/3               3/77
F           0 5.7E-11  OR LESS  CL=.90   CHIN       71 CNTR Q=1/3   ALT=2770M   3/77
F           0 3.0E-10  OR LESS  CL=.90   CLARK      71 CC    Q=1/3         *AS  3/77
F           0 3.0E-11  OR LESS  CL=.90   CLARK      71 CC    Q=2/3         *AS  3/77
F           0 1.0E-10  OR LESS  CL=.90   HAZEN      71 CC    Q=1/3,2/3     *AS  2/77
F           0 4.1E-10  OR LESS           BEUCHAMP   72 CNTR Q=4/3   ALT=2750M   3/77
F           0 1.0E-10  OR LESS  CL=.90   BOHM       72 CNTR Q=1/3          *AS  2/74
F           0 1.0E-10  OR LESS  CL=.90   BOHM       72 CNTR Q=2/3          *AS  2/74
F           0 8.3E-11  OR LESS  CL=.90   COX        72 ELEC Q=1/3   ALT=2750M   3/77
F           0 9.6E-11  OR LESS  CL=.90   COX        72 ELEC Q=2/3   ALT=2750M   3/77
F           0 2.2E-10  OR LESS  CL=.90   CROUCH     72 CNTR Q=2/3               3/77
F     K     0 3.0E-8   OR LESS           DARDO      72                     *TD  3/77
F           0 4.0E-9   OR LESS  CL=.95   EVANS      72 CC    Q=1/3         *AS  1/77
F           0 1.5E-9   OR LESS           TONWAR     72 CNTR M.GT.10GEV     *TD  3/77
F           0 8.0E-11  OR LESS           ASHTON     73 CNTR Q=1/3          *AS  3/77
F     L     0 1.7E-8   OR LESS  CL=.90   HICKS      73 CNTR Q=1/3               1/76
F     L     0 1.7E-8   OR LESS  CL=.90   HICKS      73 CNTR Q=2/3               1/76
F           0 1.0E-7   OR LESS  CL=.90   CLARK      74 CC    Q=1/6         *AS  1/77
F           0 7.0E-10  OR LESS  CL=.90   CLARK      74 CC    Q=1/4         *AS  1/77
F           0 8.0E-11  OR LESS  CL=.90   CLARK      74 CC    Q=1/3         *AS  1/77
F           0 2.0E-11  OR LESS  CL=.90   CLARK      74 CC    Q=2/3         *AS  1/77
F     M     0 3.0E-10  OR LESS  CL=.95   KIFUNE     74 CNTR Q=1/3               7/76
F           0 1.2E-11  OR LESS  CL=.90   HAZEN      75 CC    Q=1/3         *AS  7/76
F           0 7.0E-11  OR LESS  CL=.90   KRISOR     75 CNTR Q=1/3               3/77
F           0 5.0E-11  OR LESS  CL=.90   KRISOR     75 CNTR Q=2/3  GAMMA = 10   3/77
F           0 1.5E-10  OR LESS  CL=.90   KRISOR     75 CNTR Q=2/3  GAMMA GT1000 3/77
F           0 1.0E-9   OR LESS           BRIATORE   76 ELEC                *TD  1/77
F     N     3  EVENTS CLAIMED            YOCK       78 CNTR                     2/79
F
F     A  BARTON 66 HAD 220000 G/CM**2 EXTRA SHIELDING                           3/77
F
F     B  BARTON 67 HAD 6000 G/CM**2 EXTRA SHIELDING                             3/77
F
F     C  BUHLER-1 67 AND BUHLER-2 67 HAD 760 G/CM**2 EXTRA SHIELDING            3/77
F
F     D  BJORNBOE 68 -TWO EXPERIMENTS HAVING 1650 AND 3600 G/CM**2 SHIELDING    3/77
F
F     E  BRIATORE 68 SEARCHES FOR LEPTONIC QUARKS WITH 6300 G/CM2 SHIELDING     3/77
F     E  BRIATORE 68 GIVES (1.1+-1.8)E-10 FOR Q=4/3  . WE CONV. TO CL=.90       3/77
F
F     F  FRANZINI 68 MEASURES VELOCITY DIRECTLY BY TOF                          3/77
F
F     G  CAIRNS 69 OBSERVED 4 POSSIBLE QUARK CANDIDATES                         3/77
F
F     H  FUKUSHIMA 69 DOES NOT RULE OUT QUARKS HEAVIER THAN 10 GEV.             7/76
F
F   I    MC CUSKER 69 CLAIMS 1 CANDIDATE.    LATER SIMILAR EXPTS. SEE MONE.     2/74
F
F     J  Q=2/3 IF MASS LT 6.5 GEV. Q=1/3 IF MASS = 8 GEV.                       5/76
F     J  COULD BE AN EARLY-TIME NORMALLY CHARGED COSMIC RAY. SEE ALLISON 70.    2/77
F
F     K  DARDO 72 HAD 7000 G/CM**2 EXTRA SHIELDING                              3/77
F
F     L  HICKS 73 LOOKED AT LARGE ZENITH ANGLES, THUS USING THE ATMOSPHERE      1/76
F     L  AS AN EXTENDED FILTER FOR HADRONIC QUARKS. THEIR SEARCH PUTS AN        1/76
F     L  UPPER LIMIT ON LEPTONIC QUARK FLUX IN COSMIC RAYS.                     1/76
F
F     M  KIFUNE 74 LOOKED AT LARGE ZENITH ANGLES. FROM THEIR FLUX LIMIT,THEY    7/76
F     M  GET A LOWER LIMIT ON QUARK MASS OF 20 GEV.                             7/76
F
F     N  YOCK 78 EVENTS HAVE TAU > 10**-8 SEC, CHARGES OF +-.70,+-.68,+-.42,    2/79
F     N  AND MASSES >4.4, 4.8, AND 20 GEV RESPECTIVELY.  MEASURES BETA AND      2/79
F     N  DE/DX IN OSPK-SCINTILLATOR COSMIC RAY TELESCOPE.  IF TAKEN AS QUARK,   2/79
F     N  THE OBSERVED FLUX WOULD BE 2.4E-9.                                     7/79
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RHO      QUARK CONCENTRATION IN MATTER (QUARKS PER NUCLEON)
RHO   A    0 1.0E-22   OR LESS             HILLAS    59                                3/77
RHO   B    0 1.0E-10   OR LESS             BENNETT   66 SOLAR SPECTRUM                 3/77
RHO        0 1.0E-17   OR LESS             CHUPKA    66 METORITES                      3/77
RHO        0 1.0E-16   OR LESS             GALLINARO 66   GRAPHITE LEVITOMETER         3/77
RHO        0 4.0E-19   OR LESS             STOVER    67 IRON LEVITOMETER               2/74
RHO        0 1.0E-17   OR LESS             BRAGINSKI 68 GRAPHITE LEVITOMETER           3/77
RHO        0 1.0E-20   OR LESS             RANK      68 OIL DROPS                      3/77
RHO   C    0 1.0E-18   OR LESS             RANK      68 SEA WATER                      3/77
RHO   C    0 1.0E-17   OR LESS             RANK      68 SEA SALT, ETC.                 3/77
RHO   C    0 1.0E-18   OR LESS             RANK      68 LAKE WATER                     3/77
RHO   D    0 1.0E-24   OR LESS             COOK      69  SEAWATER                      2/74
RHO   D    0 1.0E-23   OR LESS             COOK      69  ROCK SAMPLES                  2/74
RHO   D    0 1.0E-23   OR LESS             COOK      69 LAVA                           3/77
RHO   D    0 5.0E-23   OR LESS             COOK      69 LIMESTONE                      3/77
RHO        0 1.0E-15   OR LESS             ELBERT    70 ION SPECTROMETER               3/77
RHO        0 5.0E-19   OR LESS             MORPURGO  70 GRAPHITE LEVITOMETER           3/77
RHO   E    0 1.0E-21   OR LESS             STEVENS   76 DEEP OCEAN SEDIMENT            3/77
RHO   E    0 1.0E-22   OR LESS             STEVENS   76 LUNAR SOIL                     3/77
RHO   F    0 5.0E-15   OR LESS             BLAND     77 TUNGSTEN-OXIDE DUST            8/77
RHO        0 3.0E-21   OR LESS             GALLINARO 77 IRON LEVITOMETER               7/77
RHO   G    2 EVENTS Q=+0.324+-.009         LARUE     77 NIOBIUM-TUNGSTEN LEVITOM       7/77
RHO   G    1 EVENT  Q=-0.331+-.070         LARUE     77 NIOBIUM-TUNGSTEN LEVITOM       7/77
RHO   H    0 2. E-19   OR LESS             MULLER    77 CNTR 2.5<M<7.7 GEV/C2         12/79
RHO   H    0 1. E-13   OR LESS             MULLER    77 CNTR FOR M<.3                 12/79
RHO   H    0 9. E-15   OR LESS             MULLER    77 CNTR .3<M<2.5 GEV/C2          12/79
RHO        0 5.0E-28   OR LESS             OGORODNIK 77 SEAWATER                      12/79
RHO        0 5.0E-27   OR LESS             OGORODNIK 77 SEDIMENT,LAVA                 12/79
RHO   I    0 5.0E-15   OR LESS             BOYD      78              TUNGSTEN IONS     8/78
RHO   J    0 5.0E-16   OR LESS  CL=.67     BOYD2     78 HYDROGEN                       1/79
RHO   K    0 1.E-21    OR LESS             LUND      78 SEA WATER       Q=+-2/3       12/81*
RHO   K    0 1.E-23    OR LESS             LUND      78 FRESH WATER     Q=+-2/3       12/81*
RHO   L    0 5.6E-15   OR LESS             PUTT      78 TUNGSTEN BEADS                 2/79
RHO   M    0 1.0E-22   OR LESS             SCHIFFER  78 NIOBIUM, TUNGSTEN+IRON         2/79
RHO   N    0 6.4E-16   OR LESS  CL=.67     BOYD      79 HELIUM                        12/79
RHO        3 EVENTS Q=+0.330+-.024         LARUE     79 NIOBIUM BALL LEVITATION        7/79
RHO          4.7E-21   QUARKS/NUCLEON      LARUE     79 NIOBIUM BALL LEVITATION        7/79
RHO   O    0 8.0E-29   OR LESS             OGORODNIK 79 SEA WATER                     10/81*
RHO   O    0 4.0E-28   OR LESS             OGORODNIK 79 CLAYS,SILTS,CONCRETIONS       10/81*
RHO        0 1. E-21   OR LESS             MARINELLI 80 STEEL SPHERE LEVITATION       12/81*
RHO   Q    0 2. E-20   OR LESS  CL=.95     HODGES    81 MERCURY(NATIVE,REFINED)        2/82*
RHO   R    4 EVENTS Q=-.343+-.011 (5)      LARUE     81 NIOBIUM BALL LEVITATION        1/82*
RHO   R    4 EVENTS Q=+.328+-.007 (9)      LARUE     81 NIOBIUM BALL LEVITATION        1/82*
RHO
RHO   A  HILLAS 59 WAS INSENSITIVE TO QUARKS ACCORDING TO SUNYAR 64.              3/77
RHO
RHO   B  BENNETT 66 LIMIT INFERRED BY JONES 76.                                   3/77
RHO
RHO   C  RANK 68 USES U.V. SPECTROSCOPY.                                          3/77
RHO
RHO   D  COOK 69 USES MOLECULAR BEAMS.                                            3/77
RHO
RHO   E  STEVENS 76 USES AN ION SPECTROMETER.                                     3/77
RHO
RHO   F  BLAND 77 IS A MILLIKAN OIL-DROP TYPE EXPT USING TUNSTEN PARTICLES.       8/77
RHO   F  NO FRACTIONAL CHARGE WAS FOUND ON A TOTAL SAMPLE OF 3.E-10 GRAMS         8/77
RHO
RHO   G  LARUE 77 SEES RESIDUAL CHARGE LISTED ABOVE TRANSFERRED TO A              7/77
RHO   G  NIOBIUM BALL FROM A TUNGSTEN SUBSTRATE, CORRESPONDING TO A DENSITY       7/77
RHO   G  OF 1.E-23.                                                               7/77
RHO
RHO   H  MULLER 77 SEARCHES FOR CHARGE 1 QUARKS IN HYDROGEN USING A              12/79
RHO   H  CYCLOTRON AS A MASS SPECTOGRAPH.                                        12/79
RHO
RHO   I  BOYD 78 USES VAN-DE-GRAFF AS MASS SPECTOMETER TO SEARCH FOR Q=1/3        8/78
RHO
RHO   J  BOYD2 78 USES VAN-DE-GRAFF AS MASS SPECTOMETER TO SEARCH FOR Q=1         1/79
RHO   J  WITH MASS < 1.75 GEV.                                                    1/79
RHO   J  STABLE CHARGE 1 QUARKS WITH MASS < 1.75 GEV.                             1/79
RHO
RHO   K  LUND 78 FRESH WATER RESULT IS FROM ANALYSIS OF ELECTRODES. SEE          12/81*
RHO   K  THEIR TABLE 1 FOR TEMPERATURE DEPENDENCES AND Q=+-4/3 RESULTS.          12/81*
RHO
RHO   L  PUTT 78 IS A MILIKAN OIL-DROP TYPE EXPT. RESULT APPLIES TO Q>.2.         2/79
RHO
RHO   M  SCHIFFER 78 LOOKS FOR QUARKS ACCELERATED BY A 1 MEV ELECTROSTATIC        2/79
RHO   M  FIELD ONTO A SI DETECTOR FROM HEATED W, FE AND NB FILAMENTS.             2/79
RHO
RHO   N  BOYD 79 USES HE BEAM WITH A VAN-DE-GRAFF AS MASS SPECTROMETER.          12/79
RHO
RHO   O  OGORODNIKOV 79 IMPROVED 77 LIMITS.  ELECTRIC FIELD GATE WAS USED IN 10/81*
RHO   O  DESORPTION TO REMOVE NEUTERIZED BKGD PARTICLES FROM ADSORBED QUARKS 10/81*
RHO   O  WITH UNCOMPENSATED FRACTIONAL CHARGE.  VALUES ARE FOR NEGATIVE CHGS 10/81*
RHO   O  AND AT SOURCE TEMP 25 CENTI-DEG.  FOR OTHER CASES, SEE THEIR TABLE. 10/81*
RHO
RHO   Q  HODGES 81 IS A MILLIKAN OIL-DROP TYPE EXPT USING MERCURY DROPS.          2/82*
RHO   Q  FOUND NO Q=+-1/3 IN TOTAL 1.8E-4GRAMS. SET ALSO LIMITS FOR Q=+-.16.      2/82*
RHO
RHO   R  LARUE 81 SAW 4 Q=-1/3 AND 4 Q=1/3 EVENTS OUT OF 21 NEW MEASUREMENTS      1/82*
RHO   R  THESE AND EARLIER EVS GIVE ABOVE AVERAGE CHARGE WITH NUMBER OF EVS       1/82*
RHO   R  IN BRACKETS.                                                             1/82*

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REFERENCES FOR QUARK SEARCHES


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HILLAS    59 NATURE 184 892     HILLAS,CRANSHAW                         (AERE)

BINGHAM   64 PL 9 201           +DICKINSON,DIEBOLD,KOCH,LEITH+   (CERN+EPOL)
BLUM      64 PRL 13 353A        +BRANDT,COCCONI,CZYZEWSKI,DANYSZ+     (CERN)
BOWEN     64 PRL 13 728         BOWEN,DELISE,KALBACH,MORTARA          (ARIZ)
HAGOPIAN  64 PRL 13 280         +SELOVE,EHRLICH,LEBOY,LANZA,RAHM+(PENN+BNL)
LEIPUNER  64 PRL 12 423         LEIPUNER,CHU,LARSEN,ADAIR         (BNL+YALE)
MORRISON  64 PL 9 199           MORRISON                              (CERN)
SUNYAR    64 PR 136B 1157       SUNYAR,SCHWARZSCHILD,CONNORS           (BNL)

DELISE    65 PR 140B 458        DELISE,BOWEN                          (ARIZ)
DORFAN    65 PRL 14 999         +EADES,LEDERMAN,LEE,TING              (COLU)
FRANZINI  65 PRL 14 196         +LEONTIC,RAHM,SAMIOS,SCHWARTZ     (BNL+COLU)
MASSAM    65 NC 40A 589         MASSAM,MULLER,ZICHICHI                (CERN)

BARTON    66 PL 21 360          BARTON,STOCKEL                        (NPOL)
BENNETT   66 PRL 17 1196        W.R.BENNETT                           (YALE)
BUHLER-B  66 NC 45A 520         BUHLER-BROGLIN,FORTUNATO,MASSAM+      (CERN)
CHUPKA    66 PRL 17 60          CHUPKA,SCHIFFER,STEVENS                (ANL)
GALLINAR  66 PL 23 609          GALLINARO,MORPURGO                    (GENO)
KASHA     66 PR 150 1140        KASHA,LEIPUNER,ADAIR              (BNL+YALE)
LAMB      66 PRL 17 1068        LAMB,LUNDY,NOVEY,YOVANOVITCH           (ANL)
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BARTON	67 PASL 90 E7	BARTON	(NPOL)
BATHOW	67 PL 25B 163	BATHOW,FREYTAG,SCHULZ,TESCH	(DESY)
BUHLER-1	67 NC 49A 209	BUHLER-BROGLIN,FORTUNATO,MASSAM+	(CERN)
BUHLER-2	67 NC 51A 837	BUHLER-BROGLIN,DALPIAZ,MASSAM,ZICHICHI	(CERN)
FOSS	67 PL 25B 166	+GARELICK,HOMMA,LOBAR,OSBORNE,UGLUM	(MIT)
GOMEZ	67 PRL 18 1022	+KOBRAK,MOLINE,MULLINS,ORTH,VANPUTTEN+	(CIT)
KASHA	67 PR 154 1263	+LEIPUNER,WANGLER,ALSPECTOR,ADAIR	(BNL+YALE)
STOVER	67 PR 164 1599	+MORAN,TRISCHKA	(SYRA)
BELLAMY	68 PR 166 1391	+HOFSTADTER,LAKIN,PERL,TONER	(STAN+SLAC)
BJORNBOE	68 NC B53 241	+DAMGARD,HANSEN,CHATTERJEE+	(BOHR+BERN)
BRAGINSK	68 JETP 27 51	BRAGINSKII,ZELDOVICH,MARTYNOV	(MOSU)
BRIATORE	68 NC 57A 850	+CASTAGNOLI,BOLLINI,MASSAM+	(TORI+CERN)
FRANZINI	68 PRL 21 1013	FRANZINI,SHULMAN	(COLU)
GARMIRE	68 PR 166 1280	GARMIRE,LEONG,SREEKANTAN	(MIT)
HANAYAMA	66 CJP 46 S734	+HARA,HIGASHI,KITAMURA,MIONO+	(OSAK)
KASHA1	68 PR 172 1297	+STEFANSKI	(ILL+YALE)
KASHA2	68 PRL 20 217	KASHA,LARSEN,LEIPUNER,ADAIR	(BNL+YALE)
KASHA3	68 CJP 46 S730	KASHA,LARSEN,LEIPUNER,ADAIR	(BNL+YALE)
RANK	68 PR 176 1635	D.M.RANK	(MICH)
ALLABY	69 NC 64A 75	+BIANCHINI,DIDDENS,DOBINSON,HARTUNG+	(CERN)
ANTIPOV1	69 PL 29B 245	+KARPOV,KHROMOV,LANDSBERG,LAPSHIN+	(SERP)
ANTIPOV2	69 PL 30B 576	+BOLOTOV,DEVISHEV,DEVISHEVA,ISAKOV+	(SERP)
CAIRNS	69 PR 186 1394	+MCCUSKER,PEAK,WOOLCOTT	(SYDNEY)
COOK	69 PR 188 2092	+DEPASQUALI,FRAUENFELDER,PEACOCK +	(ILL)
FUKUSHIM	69 PR 178 2058	FUKUSHIMA,KIFUNE,KONDO,KOSHIBA+	(TOKY)
MCCUSKER	69 PRL 23 658	MCCUSKER,CAIRNS	(SYDNEY)
BOSIA	70 NC 66A 167	G.BOSIA,L.BRIATORE	(TORI)
CHU	70 PRL 24 917	CHU,KIM,BEAM,KWAK	(CMU+ROSE+KANS)
ALSO	70 PRL 25 550	ALLISON,DERRICK,HUNT,SIMPSON,VOYVODIC	(ANL)
ELBERT	70 NP B20 217	+ERWIN,HERB,NIELSEN,PETRILAK,WEINBERG	(WISC)
FAISSNER	70 PRL 24 1357	+HOLDER,KRISOR,MASON,SAWAF,UMBACH	(AACH)
KRIDER	70 PR D1 835	KRIDER,BOWEN,KALBACH	(ARIZ)
MORPURGO	70 NIM 79 95	MORPURGO,GALLINARO,PALMIERI	(GENO)
ANTIPOV	71 NP B27 374	+KACHANOV,KUTJIN,LANDSBERG,LEBEDEV +	(SERP)
CHIN	71 NC 2A 419	CHIN,HANAYAMA,HARA,HIGASHI,TSUJI	(OSAK)
CLARK	71 PRL 27 51	+ERNST,FINN,GRIFFIN,HANSEN,SMITH+ (	BL)
HAZEN	71 PRL 26 582	W.E.HAZEN	)
BEUCHAMP	72 PR D6 1211	BEUCHAMP,BOWEN,COX,KALBACH	(
BOHM	72 PRL 28 326	+DIEMONT,FAISSNER,FASOLD,KRISOR+	(A
BOTT-BOD	72 PL 40B 693	BOTT-BODENHAUSEN,CALDWELL+	(CERN+M.
COX	72 PR D6 1203	COX,BEUCHAMP,BOWEN,KALBACH	(AR
CROUCH	72 PR D5 2667	CROUCH,MORI,SMITH	(CA
DARDO	72 NC 9A 319	DARDO,NAVARRA,PENENGO,SITTE	(TOR,
EVANS	72 PRSE A70 143	+FANCEY,MUIR,WATSON	(EDIN+LEED)
TONWAR	72 JPA 5 565	TONWAR,NARANAN,SREEKANTAN	(TIFR)
ALPER	73 PL 46B 265	(CERN+LIVP+LUND+BOHR+RHEL+STOH+BERG+LOUC)	
ASHTON	73 JPA 6 577	ASHTON,COOPER,PARVARESH,SALEH	(DURH)
HICKS	73 NC 14A 65	+FLINT,STANDIL	(MANI)
LEIPUNER	73 PRL 31 1226	+LARSEN,SESSOMS,SMITH,WILLIAMS+	(BNL+YALE)
CLARK	74 PR D10 2721	+FINN,HANSEN,SMITH	(LLL)
GALIK	74 PR D9 1856	+JORDAN,RICHTER,SEPPI,SIEMANN +	(SLAC+FNAL)
KIFUNE	74 JPSJ 36 629	+HIEDA,KUROKAWA,TSUNEMOTO,KIMURA+	(TOKY+KEK)
NASH	74 PRL 32 858	+YAMANOUCHI,NEASE,SCULLI	(FNAL+CORN+NYU)
ALBROW	75 NP B97 189	+BARBER,RENZ+(CERN+DARE+FOM+LANC+MCHS+UTRE)	
FABJAN	75 NP B101 349	+GRUHN,PEAK,SAULI,CALDWELL+	(CERN+MPIM)
HAZEN	75 NP B95 189	+HODSON,WINTERSTEIN,GREEN,KASS+	(MICH+LEED)
JOVANOVI	75 PL 56B 105	JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)	
KRISOR	75 NC 27A 132	KRISOR	(AACH)
BALDIN	76 SJNP 22 264	+LEPTOGRADOV,VISHNEVSKII,GRISHEVICH+	(JINR)
BRIATORE	76 NC 31A 553	+DARDO,PIAZZOLI,MANNOCCHI+	(LCGT+FRAS+FREI)
STEVENS	76 PR D14 716	+SCHIFFER, CHRPKA	(ANL)
ANTREASY	77 PRL 39 513	ANTREASYAN,COCCONI,CRONIN,FRISCH+	(EFI+PRIN)
BASILE	77 NC 40A 41	+CARA ROMEO,CIFARELLI,GIUSTI+	(CERN+BGNA)
BLAND	77 PRL 39 369	+BOCOBO,EUBANK,ROYER	(SAN FRAN STATE)
GALLINAR	77 PRL 38 1255	GALLINARO,MARINELLI,MORPURGO	(GENO)
LARUE	77 PRL 38 1011	+FAIRBANK,HEBARD	(STAN)
ALSO	79 LARUE	AND ERRATUM	
MULLER	77 SCIENCE 196 521	MULLER,ALVAREZ,HOLLEY+STEPHENSON	(LBL)
OGORODNI	77 JETP 45 857	OGORODNIKOV,SAMOILOV,SOLNTSEV	(KIAE)
BASILE1	78 NC 45A 171	+CARAROMEO,CIFARELLI,CONTIN +	(CERN+BGNA)
BASILE2	78 NC 45A 281	+CARAROMEO,CIFARELLI,CONTIN+	(CERN+BGNA)
BOYD	78 PRL 40 216	+ELMORE,MELISSINOS,SUGARBAKER	(ROCH)
BOYD2	78 PL 72B 484	+ELMORE,NITZ,OLSEN,SUGARBAKER,WARREN+	(ROCH)
LUND	78 RAD. ACTA 25 75	T.LUND,R.BRANDT,Y.FARES	(PHIL)
PUTT	78 PR D17 1466	G.D.PUTT, P.C.M.YOCK	(AUCK)
SCHIFFER	78 PR D17 2241	+RENNER,GEMMELL,MOORING	CHIC+ANL
YOCK	78 PR D18 641	P.C.M. YOCK	(AUCK)
BOYD	79 PRL 43 1288	+BLATT,DONOGHUE,DRIES,HAUSMAN,SUTTER	(OSU)
BOZZOLI	79 NP B159 363	+BUSSIERE,GIACOMELLI+ (BGNA+LAPP+SACL+CERN)	
LARUE	79 PRL 42 142	+FAIRBANK,PHILLIPS	(STAN)
ALSO	79 PRL 42 1019	ERRATUM	
OGORODNI	79 JETP 49 953	OGORODNIKOV,SAMOILOV,SOLNTSEV	(KIAE)
STEVENSO	79 PR D20 82	M.L.STEVENSON	(LBL)
BARTEL	80 ZPHY C6 295	JADE C.(DESY+HAMB+HEID+LANC+MCHS+RHEL+TOKY)	
BASILE	80 LNC 29 251	+BERBIERS,CONTIN+(BGNA+CERN+FRAS+ROMA+PARI)	
BUSSIERE	80 NP B174 1	+GIACOMELLI,LESQUOY+	(BGNA+SACL+LAPP)
MARINELL	80 PL 94B 433	M.MARINELLI,G.MORPURGO	(GENO)
ALSO	80 PL 94B 427	M.MARINELLI,G.MORPURGO	(GENO)
HODGES	81 PRL 47 1651	+ABRAMS,BADEN,BLAND,JOYCE,ROYER+	(UCR+SFSU)
ALSO	81 PRIVATE COMM.	R.BLAND	(SFSU)
LARUE	81 PRL 46 967	G.S.LARUE,J.D.PHILLIPS,W.M.FAIRBANK	(STAN)
WEISS	81 PL 101B 439	+ABRAMS,ALAM,BLOCKER,BLONDEL+	(SLAC+LBL+UCB)

REVIEW ARTICLES

ZAITSEV	74 SJNP 19 456	+LANDSBERG	(SERP)
JONES	76 RMP 49 717	L.W.JONES	(MICH)
LYONS	80 OXFORD-NP-78/80	L.LYONS, TALK AT UK HEP FORUM, APR. 80	(OXF)

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MAGNETIC MONOPOLE SEARCHES

Note on Magnetic Monopole Searches

(by W. P. Trower, Virginia Polytechnic Institute and State University)

Although the idea that magnetic monopoles might exist is suggested by the usual formulation of Maxwell's equations, no observed phenomenon requires them for its explanation.[1] Monopoles first became interesting with the assertion that a single monopole anywhere in the universe would result in electric charge quantization everywhere.[2] The sole predicted property of this monopole was the magnitude of its least magnetic charge $e/2\alpha$, the Dirac charge. A monopole of two Dirac charges has been suggested,[3] and an electrically charged monopole, a dyon, proposed.[4] Observed pure multi-photon showers were attributed to virtual monopole pair-production/-annihilation.[5] Monopoles have become indispensable to many gauge theories, and most grand unification theories require a monopole of mass $> 5 \times 10^{15}$ GeV. Estimates of the monopole number density at the earth have been made.[6]

Experiments to detect monopoles have essentially been based on either ionization or magnetic induction. Ionization experiments have relied on the fact that an elementary relativistic magnetic charge would produce more ionization than a relativistic electrical charge. Massive monopoles would have, however, lower velocities, $\beta \sim 10^{-3}$, and would thus reduce the prospects for ionization measurements. The theory of monopole energy loss at these velocities is currently confused, but progress is being made.[7] It is however likely that prospects for ionization identification of massive monopoles will remain diminished.

Induction experiments measure the value of the monopole magnetic charge by detecting changes in magnetic flux induced when a monopole passes through a superconductor (CABRERA 75). These measurements are independent of monopole electric charge, mass, and velocity.

Stable Particles

MAGNETIC MONOPOLE SEARCHES

With the recent attribution of large mass to the monopole, searches in matter are less appealing as the ferromagnetic trapping energies become comparable to terrestrial gravitational binding. Accelerators do not possess sufficient energy to produce real monopoles. Cosmic ray searches hold increased promise. Possibly monopole evidence will be obtained from direct astrophysical observation.

The following compilation with the indicative experimental limits should be used as a directory to the literature.

References

1. J. D. Jackson, CERN-77-17 (1977).
2. P. A. M. Dirac, Proc. Royal Soc. of London A133, 60 (1931).
3. J. Schwinger, Phys. Rev. 144, 1087 (1966).
4. J. Schwinger, Science 165, 757 (1969).
5. M. A. Ruderman and D. Zwanziger, Phys. Rev. Lett. 22, 146 (1969).
6. G. Lazarides, Q. Shafi, and T. F. Walsh, Phys. Lett. 100B, 21 (1981).
7. See, e.g., S. P. Ahlen and K. Kinoshita, to be published in Phys. Rev. D (1982).


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C      MONOPOLE   X-SECTION              ACCELERATOR EXPTS      MASS   CHARGE
C      (EVENTS)    (CM**2)                                      (GEV)    (G)
C    A    0        < 2 E-35              BRADNER   59 EMUL     < 1       1      4/82*
C    B    0        < 1 E-35              FIDECARO  61 CNTR     < 3     < 4      4/82*
C    C    0        < 1 E-40              AMALDI    63 EMUL     < 3     < 2     12/75
C    D    0        < 2 E-40              PURCELL   63 CNTR     < 3     < 2     12/75
C    E    0        < 1 E-41              GUREVICH  72 EMUL     < 5              3/74
C    F    0        < 6 E-42              CARRIGAN  73 CNTR     < 12    < 24     3/74
C    G    0        < 5 E-42              CARRIGAN  74 CNTR     < 13    < 24    12/75
C    H    0        < 2 E-30              BURKE     75 OSPK                      1/78
C    I    0        < 1 E-38              CARRIGAN  75 HLBC                      1/76
C    J    0        < 5 E-43              EBERHARD  75 INDU     < 12    < 10     1/75
C    K    0        < 2 E-36              GIACOMELLI 75 PLAS    < 30    < 3      2/76
C    L    0                              DELL      76 SPRK                      4/82*
C    M    0        < 4 E-33              STEVENS   76 SPRK                      4/82*
C    N    0        < 1 E-40              ZRELOV    76 CNTR     < 5     < 2      1/80
C    O    0        < 1 E-37              CARRIGAN  78 CNTR     < 20    < 24     2/79
C    P    0        < 1 E-37              HOFFMANN  78 PLAS     < 30    < 3      2/79
C    Q    0        < 9 E-37              KINOSHITA 82 PLAS     < 30    < 3      2/82*
C
C    A  BRADNER 59 -- 6 GEV PROT AT BEVATRON.                                   4/82*
C    B  FIDECARO 61 -- 28 GEV PROT AT CERN-PS.                                  4/82*
C    C  AMALDI 63 -- 28 GEV PROT AT CERN-PS. PROT AND NUCL TARGETS.            12/75
C    D  PURCELL 63 -- 30 GEV PROT AT AGS.                                      12/75
C    E  GUREVICH 72 -- 70 GEV PROT AT SERPUKHOV.                                3/74
C    F  CARRIGAN 73 -- 300 GEV PROT AT FNAL.                                    3/74
C    G  CARRIGAN 74 -- 400 GEV PROT AT FNAL.                                   12/75
C    H  BURKE 75 -- 300 GEV NEUT AT FNAL.  MULTIPHOTON EVENTS.                  1/78
C    I  CARRIGAN 75 -- REEXAMINES CERN NEUTRINO EXPTS. NEUT ENERGY <8 GEV.      1/76
C    J  EBERHARD 75 -- 300,400 GEV PROT ON AL AT FNAL.  ROSS 73 DETECTOR.       2/76
C    K  GIACOMELLI 75 -- ECM=60 GEV AT CERN-ISR.                                2/76
C    L  DELL 76 -- 22<ECM<62 GEV PROT AT CERN-ISR.  MULTIPHOTON EVENTS.         4/82*
C    M  STEVENS 76 -- 300 GEV PROT AT FNAL. MULTIPHOTON EVENTS.                 4/82*
C    N  ZRELOV 76 -- 70 GEV PROT AT IHEP.  CERENKOV RADIATION POLARIZATION.     1/80
C    O  CARRIGAN 78 -- 23<ECM<63 GEV AT CERN-ISR.                               2/79
C    P  HOFFMANN 78 -- ECM=56 GEV AT CERN-ISR.                                  2/79
C    Q  KINOSHITA 82 -- ECM=29 GEV IN E+E- AT SLAC-PEP.  PLASTIC SHEETS.        2/82*
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F      MONOPOLE       FLUX               COSMIC RAYS            MASS    CHARGE
F      (EVENTS)  (/CM**2/SEC/SR)                               (GEV)     (G)
F    A    0        < 2 E-11              MALKUS    51 EMUL              < 1-3     4/82*
F    B    0        < 5 E-15              CARITHERS 66 ELEC     < 15     < 3      12/75
F    C    0        < 1 E-19              FLEISCH3  69 PLAS              > 2       2/76
F    D    1          1 E-13              PRICE     75 PLAS     > 200      2      12/75
F    E    0        < 2 E-15              BARTLETT  81 PLAS                        2/82*
F    F    0        < 2 E-40              BONNARDEA 81 COSM                        2/82*
F    G    0        < 1 E-13              KINOSHITA 81 PLAS     > 1                2/82*
F    H    0        < 5 E-11              ULLMAN    81 CNTR     < E+17             2/82*
F    I    1        6.1 E-10              CABRERA   82 INDU               1+-.06   4/82*
F
F    A  MALKUS 51 -- SEA LEVEL ACCELERATOR/CONCENTRATOR.                          4/82*
F    B  CARITHERS 66 -- SEA LEVEL CONCENTRATOR.                                  12/75
F    C  FLEISCHER3 69 -- OBSIDIAN AND MICA.                                      12/75
F    D  PRICE 75 -- ANNOUNCES EVENT.                                             11/76
F    D              ALVAREZ 75, FLEISCHER 75, FRIEDLANDER 75, ROSS 76            11/76
F    D              EXPLAIN IT AS A FRAGMENTING NUCLEUS.                         11/76
F    D              EBERHARD 75 DISCUSSES CONFLICT WITH OTHER EXPERIMENTS.       11/76
F    D              HAGSTROM 77 REINTERPRETS AS ANTINUCLEUS.                      3/77
F    D              PRICE 78 REASSESSES.                                          7/79
F    E  BARTLETT 81 -- FNAL BC MAGNET. LEXAN.                                     2/82*
F    F  BONNARDEAU 81 -- INTERSTELLAR FLUX INFERRED FROM NEUTRON STARS.           2/82*
F    G  KINOSHITA 81 -- CR-39 ON WHITE MOUNTAIN CA. BETA > 0.02.                  2/82*
F    H  ULLMAN 81 -- SENSITIVE TO VERTICAL VELOCITIES 100-350 KM/SEC.             2/82*
F    I  CABRERA 82 -- SENSITIVE ONLY TO MAGNETIC CHARGE.                          4/82*
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D      MONOPOLE      DENSITY                                    MASS    CHARGE
D      (EVENTS)                                                (GEV)     (G)
D    A    0        < 2 E-3/GRAM          GOTO      63 EMUL              < 1-3    12/75
D    B    0        < 2 E-2/GRAM          PETUKHOV  63 CNTR                       12/75
D    C    0        < 1 E-2/GRAM          FLEISCH1  69 PLAS              < 1-120   4/82*
D    D    0        < 1 E-4/GRAM          FLEISCH2  69 PLAS              > 0      12/75
D    E    0        < 2 E-13 M**3         SCHATTEN  70 ELEC                        4/77
D    F    0        < 6 E-7/GRAM          KOLM      71 CNTR              < 140    12/75
D    G    0        < 2 E-4/GRAM          ROSS      73 INDU              > .05     2/76
D    H    0        < 5 E-1/GRAM          CABRERA   75 INDU              > .04     5/82*
D    I    0        < 6 E-4/GRAM          CARRIGAN  76 CNTR                        1/77
D    J    0        < 2 E-4/PROT          BRODERICK 79 COSM                       12/81*
D
D    A  GOTO 63 -- ADIRONDACK MOUNTAIN MAGNETITE AND TWO METEROITES.             12/75
D    B  PETUKHOV 63 -- SIKHOTE-ALIN METEORITE.                                   12/75
D    C  FLEISCHER1 69 -- MN NODULES OCEAN SEDIMENTS LAST 16 E+6 YEARS.            4/82*
D    D  FLEISCHER2 69 -- MN EARTH CRUST.                                         12/75
D    E  SCHATTEN 70 -- LUNAR MAGNETIC WAKE.                                       4/77
D    F  KOLM 71 -- DEEP SEAWATER.                                                 2/76
D    G  ROSS 73 -- LUNAR DUST.                                                    2/76
D    H  CABRERA 75 -- ELEVEN TERRESTRIAL MATERIALS.                               4/82*
D    I  CARRIGAN 76 -- AIR AND SEAWATER.                                          1/77
D    J  BRODERICK 79 -- 42-CM ABSORPTION IN NEUTRAL GALACTIC HYDROGEN.           12/81*
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REFERENCES FOR MAGNETIC MONOPOLE SEARCHES

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MALKUS    51 PR 83 895          MALKUS                                    (CHIC)
BRADNER   59 PR 114 603         +ISBELL                                    (LBL)
FIDECARO  61 NC 22 657          +FINOCCHIARO+GIACOMELLI                   (CERN)
AMALDI    63 NC 28 773          +BARONI,MANFREDINI,BRADNER+(ROMA+UCSD+CERN)
GOTO      63 PR 132 387         +KOLM,FORD                      (TOKY+MIT+BRAN)
PETUKHOV  63 NP 49 87           +YAKIMENKO                                (LEBD)
PURCELL   63 PR 129 2326        +COLLINS,FUJII,HORNBOSTEL,TURKOT (HARV+BNL)
CARITHER  66 PR 149 1070        CARITHERS,STEFANSKI,ADAIR             (YALE+BNL)

FLEISCH1  69 PR 177 2029        FLEISCHER,JACOBS,SCHWARTZ+            (GESC+FSU)
FLEISCH2  69 PR 184 1393        FLEISCHER,HART,JACOBS+      (GESC+UNCS+GSCO)
FLEISCH3  69 PR 184 1398        FLEISCHER,PRICE,WOODS                     (GESC)
    ALSO  70 JAP 41 958         FLEISCHER,HART,JACOBS,PRICE,SCHWARTZ+(GESC)

SCHATTEN  70 PR D1 2245         SCHATTEN                                  (NASA)
KOLM      71 PR D4 1285         +VILLA,ODIAN                          (MIT+SLAC)
GUREVICH  72 PL 38B 549         +KHAKIMOV,MARTEMIANOV+       (KIAE+NOVO+SERP)
    ALSO  70 PL 31B 394         GUREVICH,KHAKIMOV+           (KIAE+NOVO+SERP)
    ALSO  72 JETP 34 917        BARKOV,GUREVICH+             (KIAE+NOVO+SERP)

CARRIGAN  73 PR D8 3717         +NEZRICK,STRAUSS                          (FNAL)
ROSS      73 PR D8 698          +EBERHARD,ALVAREZ,WATT                (LBL+SLAC)
    ALSO  70 SCI 167 701        ALVAREZ,EBERHARD,ROSS,WATT            (LBL+SLAC)
    ALSO  71 PR D4 3260         EBERHARD,ROSS,ALVAREZ,WATT            (LBL+SLAC)
CARRIGAN  74 PR D10 3867        +NEZRICK,STRAUSS                          (FNAL)

BURKE     75 PL 60B 113         +GUSTAFSON,JONES,LONGO                    (MICH)
CABRERA   75 PH D THESIS        CABRERA                                   (STAN)
CARRIGAN  75 NP B91 279         +NEZRICK                                  (FNAL)
    ALSO  71 PR D3 56           CARRIGAN,NEZRICK                          (FNAL)
EBERHARD  75 PR D11 3099        +ROSS,TAYLOR,ALVAREZ,OBERLACK     (LBL+MPIM)
GIACOMEL  75 NC 28A 21          GIACOMELLI,ROSSI+        (BGNA+CERN+SACL+ROMA)

PRICE     75 PRL 35 487         +SHIRK,OSBORNE,PINSKY            (UCB+HOUSTON)
    ALSO  75 LBL-4260           LUIS ALVAREZ                               (LBL)
    ALSO  75 LBL-4289           PHILIPPE EBERHARD                          (LBL)
    ALSO  75 PRL 35 1412        R.L. FLEISCHER,R.M.WALKER             (GESC+WUSL)
    ALSO  75 PRL 35 1167        M.W. FRIEDLANDER                          (WUSL)
    ALSO  76 LBL-4665           RONALD ROSS                                (LBL)
    ALSO  77 PRL 38 729         RAY HAGSTROM                               (LBL)
    ALSO  78 PR D18 1382        PRICE,SHIRK,OSBORNE,PINSKY(LBL,UCB,HOUSTON)

CARRIGAN  76 PR D13 1823        +NEZRICK,STRAUSS                          (FNAL)
DELL      76 LNC 15 269         +UTO,YUAN,AMALDI+         (CERN+BNL+ROMA+ADEL)
STEVENS   76 PR D14 2207        +COLLINS,FICENEC,TROWER,FISCHER+     (VPI+BNL)
ZRELOV    76 CZJP B26 1306      +KOLLAROVA,KOLLAR,LUPILTSEV,PAVLOVIC+(JINR)

CARRIGAN  78 PR D17 1754        +STRAUSS,GIACOMELLI                  (FNAL+BGNA)
HOFFMANN  78 LNC 23 357         +KANTARDJIAN,DILIBERTO,MEDDI+        (CERN+ROMA)
BRODERIC  79 PR D19 1046        BRODERICK,FICENEC,TEPLITZ,TEPLITZ          (VPI)

BARTLETT  81 PR D24 612         +SOD,FLEISCHER,HART,MOGRO CAMPERO(COLO+GESC)
BONNARDE  81 PR D23 323         M.BONNARDEAU                              (MPIM)
KINOSHIT  81 PR D24 1707        K.KINOSHITA,P.B.PRICE                      (UCB)
ULLMAN    81 PRL 47 289         J.D.ULLMAN                            (LEHM+BNL)

CABRERA   82 PRL 47 1378        CABRERA                                   (STAN)
KINOSHIT  82 PRL 48 77          KINOSHITA,PRICE,FRYBERGER             (UCB+SLAC)
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STEVENS   73  VPI-EPP-73-5      D.M.STEVENS                                (VPI)
CARRIGAN  77  FERMILAB-77/42    R.A.CARRIGAN,JR.                          (FNAL)
CRAVEN    81  FERMILAB-81/37    R.E.CRAVEN,W.P.TROWER,RA.CARRIGAN(VPI+FNAL)
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CHARM SEARCHES AND EVIDENCE

Data on specific charmed states are listed in separate sections in the appropriate places in the Data Card Listings: D, F, and Λ_c - Stable Particles; D^*, F^* - Mesons; Σ_c - Baryons.

Evidence for charm not directly relatable to a given state is listed in this section. Neutrino-induced dilepton events are summarized. Short-lived tracks in emulsions are also dealt with.

Tri-muon production in neutrino interactions is summarized in the Other New Particle Searches section.

Neutrino-induced Dilepton Events

Many neutrino experiments have now observed dilepton events. These data are summarized in subsections Y, V0, V0A, and VAP. Bubble chamber experiments have observed neutrino-induced μ^-e^+ events associated with strange particle production in the reaction

$$\nu N \to \mu^- e^+ K^0 \text{ (or } \Lambda) + \text{anything.}$$

Production of charmed particles (C) in neutrino interactions would be expected to give rise to such events via the mechanism

$$\nu_\mu N \to \mu^- C + \text{hadrons}$$
$$\quad\quad\quad\quad \hookrightarrow \ell^+ \nu_\ell + \text{hadrons} \quad ,$$

where the Cabibbo-favored transition would predict a strange particle among the hadrons. Thus the appearance of neutrino-induced opposite-sign dimuon events, μ^-e^+ events, and associated strange particles can be understood via the charm mechanism. (For another potential explanation see the Heavy Lepton Searches section above.)

Recent experiments show that like-sign dileptons, on the other hand, are produced much in excess of theoretical expectations. See section Y below.

Short-Lived Tracks in Emulsions

The mean life of a weakly decaying charmed meson or baryon of mass M (in GeV) is expected to be in the range[1]

$$\tau = (10^{-11} \text{ to } 10^{-13} \text{ sec}) \times 1/M^5$$

with a corresponding mean path length for lab momentum p (in GeV/c) of

$$\ell = \frac{pc\tau}{M} = (30\mu \text{ to } 3000\mu) \times p/M^6 \ .$$

Thus even at Fermilab energies, the decays of such particles are hard to observe directly in most bubble, streamer, or other chambers, so emulsion is often used. We list data for these experiments in subsections CC and EM below.

Recent experiments using special bubble chambers, emulsions, and silicon detectors have been able to identify the particular charm state with some degree of confidence and to estimate the mean life. These measurements are listed in the separate sections associated with the particular states.

Charm Searches

Experimental evidence for charm production has now been accumulated in various reactions.

Sections CP and CPI include several types of evidence for associated charm production in pN and πN collisions: the prompt 1μ and 1e signals; low-mass $\mu^+\mu^-$ pairs with missing energy; opposite-sign μe events; observations of D and Λ_c in the hadronic final states; as well as hadronic charm decay in association with a lepton trigger. Observations of prompt muons in beam dump experiments are listed in section BD.

Sections CG, MU, and D include evidence in photon, muon, and neutrino beam experiments. Charmed baryon production in e^+e^- reactions is listed in section CE; further information can be obtained from the Listings.

References

1. M. K. Gaillard, B. W. Lee, and J. L. Rosner, Rev. Mod. Phys. 47, 277 (1975).

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PROPERTIES OF THE CHARMED D, D*, F, F*, LAMBDA/C+, AND SIGMA/C+
STATES ARE LISTED IN SEPARATE SECTIONS.
THE FOLLOWING SECTION CONTAINS INFORMATION ON SEARCHES FOR
OTHER CHARMED PARTICLE STATES AND SEARCHES FOR THE ABOVE STATES
IN NEW COLLISION PROCESSES.
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CE      CHARMED BARYON PRODUCTION IN (E+ E-) COLLISIONS    (CM**2)
CE   A                                PICCOLO   77 SMAG                 1/78
CE   B     (5.6E-35)OR LESS  CL=.90   FERGUSON  78 SMAG                 2/79
CE
CE   A  PICCOLO 77 LOOK AT INCLUSIVE PBAR AND LAMBDA PROD IN 3.7-7.6 GEVECM  1/78
CE   A  E+E- AT SLAC. FINDS SHARP RISE IN CS BETW 4.4 AND 5 GEV. EVIDENCE    1/78
CE   A  FOR PROD OF CHARMED BARYON IN THAT REGION.                           1/78
CE
CE   B  FERGUSON 78 FIND INCREASE IN ANTISIGMA+- PROD BY E+ E- (SLAC)        2/79
CE   B  BETWEEN 4 AND 7 GEV (ECM) OF DELTA-R (ASIG+-)=0.12+-0.05 CONSISTENT  2/79
CE   B  WITH CHARMED BARYON PRODUCTION MODELS. LIMIT IS ON                  12/79
CE   B  C.S.*BR(LAMBDAC- --> ASIG+- PI-+ PI-).                              12/79
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CG      CHARMED HADRON PRODUCTION CROSS SECTIONS (GAMMA NUCLEON)  (CM**2)
CG   A  60 EVENTS                        KNAPP      76 SPEC LAMBDABAR PI-PI-PI+  2/77
CG   B   0  1.1E-31 OR LESS  CL=.95      QUINN      76 HBC      B++ M-            9/77
CG   B   0  1.2E-31 OR LESS  CL=.95      QUINN      76 HBC      B+ MC             9/77
CG   C  94  (7.2+-2.9)E-31               ATIYA      79 SPEC     DO-->K+- PI-+    12/79
CG   D   1 EVENT                         ADAMOVICH  80 SPEC     DOBAR-->K+3(PI)-  1/80
CG   E     (5.25+-1.40)E-31              ASTON      80 SPEC     DOBAR-->K+ PI-   12/81*
CG
CG   A  KNAPP 76 SEES A PEAK AT M=2.26+-0.01 GEV/C**2. WIDTH IS 40+-20 MEV,  2/77
CG   A  CONSISTENT WITH ZERO WIDTH STATE (RESOLUTION=30 MEV). NO PEAK SEEN   2/77
CG   A  IN LAMBDABAR PI+ PI+ PI-. THEY ALSO SEE A LAMBDABAR (4PI)O PEAK AT    2/77
CG   A  2.5 GEV CASCADING DOWN TO THE PEAK AT 2.26. EXPT USED WIDE-BAND       2/77
CG   A  PHOTON BEAM AT FNAL.                                                  2/77
CG
CG   B  QUINN 76 USED A 9.3 GEV PHOTON BEAM AT SLAC. SEE TABLES 1 AND 3 FOR   2/77
CG   B  INDIVIDUAL CHANNELS. ABOVE LIMITS ARE FOR ALL CHANNELS WITH ONE OR    2/77
CG   B  NO MISSING NEUTRALS.                                                  2/77
CG
CG   C  ATIYA 79 IS FNAL EXPT USING 50-200 GEV PHOTONS. C.S. ASSUMES         12/79
CG   C  BRANCHING RATIO OF DO-->K+-P-+ =.018.                                12/79
CG
CG   D  ADAMOVICH 80 SEES THE PRODUCTION AND DECAY OF A DOBAR IN EMULSION     1/80
CG   D  EXPOSED TO SPS GAMMA BEAM IN CONJUNCTION WITH OMEGA SPECTROMETER.     1/80
CG
CG   E  ASTON 80 IS CERN-SPS OMEGA-SPECTROMETER EXP WITH 20-70 GEV PHOTONS. 12/81*
CG   E  ABOVE INCLUSIVE DOBAR CS ASSUMES BR OF DOBAR-->K+ PI- = .026+-.004. 12/81*
CG   E  FOR CS VALUES AND LIMITS FOR OTHER CHANNELS, SEE THEIR TABLE 1-2.   12/81*
CG   E  DBAR-PROD. SEEMS MAINLY VIA (CHARMED-BARYON DBAR) ASSOC.PRODUCTION. 12/81*

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MU      CHARMED HADRON C.S. OR EVIDENCE IN MU NUCLEON INTERACTIONS (CM**2)   12/79
MU       FOR PHOTON-GLUON FUSION MODEL REFERRED TO BELOW SEE LEVEILLE AND     4/82*
MU       WEILER NP B147. 147 (1979) AND REFERENCES CITED THEREIN.             4/82*
MU   A     (3. E-33)APPROX               BAUER      79 SPEC    270 GEV MU+ BEAM 12/79
MU   B                                   AUBERT1    80 CALO    280 GEV MU+ BEAM  4/82*
MU   C                                   AUBERT2    80 CALO    280 GEV MU+ BEAM 12/81*
MU   D     (6.9 +1.9 -1.4) E-33          CLARK      80 SPEC    209GEV MU+- BEAM  9/81*
MU   E                                   AUBERT     81 SPEC    250GEV MU+ ON FE  2/82*
MU
MU   A  BAUER 79 SEES 449 DIMUONS, 64 TRIMUONS. THE MAJORITY OF DIMUONS      12/79
MU   A  APPEARS TO COME FROM ASSOCIATED PRODUCTION AND SEMILEPTONIC DECAY    12/79
MU   A  OF CHARMED MESONS. SEE ALSO LISTINGS UNDER SECTION MU OF OTHER       12/79
MU   A  STABLE PARTICLE SEARCHES.                                            12/79
MU
MU   B  AUBERT1 80 SEE 745 DIMUON EVENTS.  DIFFERENTIAL CROSS SECTION IS      4/82*
MU   B  CONSISTENT WITH THE PHOTON GLUON FUSION MODEL FOR C CBAR PRODUCTION   4/82*
MU
MU   C  AUBERT2 80 SEE 5260 TRIMUON EVENTS (MU+ N-->MU+ MU+ MU- X). EVENTS   12/81*
MU   C  WITH ENERGY DEPOSITED IN CALORIMETER GT 20GEV ARE IN EXCESS OF QED. 12/81*
MU   C  DIFFERENTIAL CS WITH CUTS ARE GIVEN IN THEIR FIG.3-4.  SYSTEMATICS   12/81*
MU   C  IN DCS AND LARGE MISSING ENERGY SUPPORT PHOTON-GLUON FUSION MODEL.   12/81*
MU
MU   D  CLARK 80 ANALYZED 20072 DIMUONS AT FNAL.  0.81+-0.1 OF THEM ARE       9/81*
MU   D  ATTRIBUTED TO ASSOC. PROD OF CHARM DECAYING TO MUONS.  VALUE ABOVE    9/81*
MU   D  IS DIFFRACTIVE CHARM MUOPROD C.S.  EXTRAPOLATED PHOTON C.S.(Q**2=0)   9/81*
MU   D  IS (750 +180 -130)NB ((560 +200 -120)NB) FOR 178-(100-)GEV PHOTON.   9/81*
MU   D  FOR F2(CCBAR) AND COMPARISON OF DATA WITH MODELS. SEE CLARK2 80.      9/81*
MU
MU   E  AUBERT 81 AT CERN-SPS ANALYZE WRONG-SIGN TRIMUONS,2 EVS (MU+MU+MU+)   2/82*
MU   E  AND 1 EVENT (MU+MU-MU-). (FOR CORRECT-SIGN TRIMUONS,SEE AUBERT 80.)   2/82*
MU   E  SET CL=.90 LIMIT FOR DO DOBAR TRANS.-PROBABILITY < 0.20.              2/82*

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CPI     CHARMED HADRON PRODUCTION CROSS SECTION (PI NUCLEON)   (CM**2)
CPI  A   0 1.5 TO 3.7 E-30 OR LESS      BALTAY    75 HBC      15 GEV PI+P       7/76
CPI  A   0 0.2 TO 35  E-30 OR LESS      BALTAY    75 HBC      15 GEV PI+P       7/76
CPI  B      8. E-33 OR LESS  CL=.90     APEL      76 ASPK     40 GEV/C PI-      1/78
CPI  C   0 0.5 TO 15 E-30 OR LESS       BUNNELL   76 STRC     CL=.97            1/77
CPI  D   0  1. TO 8. E-31  OR LESS      CESTER    76 SPEC     15 GEV/C PI-      2/77
CPI  E   0  4. TO 8. E-32  OR LESS      GHIDINI   76 SPEC     19 GEV/C PI P     2/77
CPI  F   0  4. E-30 OR LESS  CL=.95     HAGOPIAN  76 DBC  SHORT LIVED 2-5GEV    2/76
CPI  F   1  7. E-31 OR LESS  CL=.95     HAGOPIAN  76 DBC  LONG LIVED 1.9-2GEV   2/76
CPI  F   0  3. E-31 OR LESS  CL=.95     HAGOPIAN  76 DBC  LONG LIVED1-1.9,2-5   2/76
CPI  G   0  3. E-28 OR LESS             KLEMS     76 HYBR 200 GEV/C PI- DEUT    1/80
CPI  H   0  3.8E-31 OR LESS  CL=.95     BLANAR    77 SPEC    200 GEV/C PI+      4/77
CPI  I        0.028 OR LESS  CL=.90     BRANSON   77 SPEC PI+ SEE NOTE I        7/77
CPI  I        0.041 OR LESS  CL=.90     BRANSON   77 SPEC PI- SEE NOTE I        7/77
CPI  J      2.6E-30 OR LESS  CL=.95     GODDARD   77 HBC  DOBAR C++             1/78
CPI  K   0  5.7E-34 OR LESS             JONCKHEER 77 STRC    225 GEV/C PI-      1/78
CPI  L   0  9. E-30 OR LESS  CL=.90     ANTIPOV   78 SPEC 55 GEV/C PI- BE       1/80
CPI  L   0  2. E-29 OR LESS  CL=.95     ANTIPOV2  78 SPEC 55 GEV/C PI- BE       1/80
CPI  M      2.4E-   OR LESS  CL=.90     BALLAM    78 HBC  18 GEV/C PI+P,PI-P    1/79
CPI  M      .3E-29 OR LESS   CL=.90     BALLAM    78 HBC  ASSOC.PROD OF D+D-    1/79
CPI  N      6.7E-32 OR LESS  CL=.9799   CESTER    78 SPEC 10.5 GEV/C PI- N      1/78
CPI  O      5. E-30 OR LESS  CL=.9      ANTIPOV   79 SPEC 55 GEV/C PI- U        9/81*
CPI  P  12 40. E-30                     ALLISON   80 HBC  ASSOC.PROD OF CHARM   9/81*
CPI  P   6 35. E-30                     ALLISON   80 HBC  INCL. CHGD D PROD.    9/81*
CPI  Q                                  ANDERSON  80 SPEC J/PSI+(C CBAR)+X      9/81*
CPI  R   5 (1 9+-1.1)E-29               BARLOUTAU 80 BEBC    70 GEV/C PI- N     1/82*
CPI  S      4. E-32 (SEMI-INCL CS*BR)   BROMBERG  80 SPEC DO --> KO PHI         9/81*
CPI  T   1 EVENT                        ADEVA     81 HYBR PI- P-->DO D          1/82*
CPI
CPI  A  BALTAY 75 SENSITIVE TO CHARMED PARTICLES WITH M=1.5 TO 4.0 GEV AND     7/76
CPI  A  TAU LT 10**-11 WHICH THEN DECAY INTO STRANGE PARTICLES.                7/76
CPI  A  THE FIRST VALUE ABOVE IS FOR ASSOC PROD OF CHARMED PARTICLES.          7/76
CPI  A  SEE THEIR TABLE 1 FOR SPECIFIC DECAY MODES.  THE SECOND RANGE OF       7/76
CPI  A  VALUES IS FOR INCLUSIVE PROD OF CHARMED MESONS AND BARYONS WITH        7/76
CPI  A  CHARGES -2 TO +2. SEE HIS TABLE 2 FOR SPECIFIC DECAY MODES.            7/76
CPI
CPI  B  APEL 76 IS SERP EXPT. LOOKS FOR PI- P --> DO ADO N, DO --> KO PIO.     1/78
CPI
CPI  C  BUNNELL 76 IS A SLAC 15.5 GEV PI+P EXPT. ALL POSSIBLE 2 TO 5-BODY      1/77
CPI  C  MASS COMBINATIONS WERE STUDIED FOR NARROW RESONANCES PRODUCED IN       1/77
CPI  C  COINCIDENCE WITH SINGLE MUONS. MASS RANGE STUDIED WAS UP TO 3.1GEV.    1/77
CPI  C  SEE TABLE 1 ON PG 87 FOR DETAILED RESULTS OF INDIVIDUAL CHANNELS.      1/77
CPI
CPI  D  CESTER 76 LOOKS AT MASS RANGE 1.8 TO 2.5 GEV. SEE TABLE 1 FOR          2/77
CPI  D  INDIVIDUAL CHANNELS. VALUES GIVEN ARE CROSS-SEC/NUCLEON ON CARBON.     2/77
CPI
CPI  E  GHIDINI 76 LOOKED FOR CHARMED MESONS OF MASS GT 1.5 GEV AND BARYONS    2/77
CPI  E  OF MASS GT 2.0 GEV. LIMITS ARE CL=.95. LIMITS FOR MOST CHANNELS LIE    2/77
CPI  E  IN THE ABOVE RANGE.  SEE TABLE 2 FOR INDIVIDURL CHANNELS.              2/77
CPI
CPI  F  HAGOPIAN 76 IS A SLAC 15GEV PI+ D EXPT.  ALL POSSIBLE TWO AND THREE    2/76
CPI  F  BODY MASS COMBINATIONS WERE STUDIED FOR NARROW RESONANCES WITH MASS    2/76
CPI  F  1.5-5GEV FOR MESONS AND 2-5GEV FOR BARYONS.  INDIVIDUAL LIMITS FOR     2/76
CPI  F  TWO AND THREE BODY DECAY FROM MANY REACTIONS ARE GIVEN.                2/76
CPI  F  VEES WERE STUDIED FOR THE POSSIBILITY OF A NEW LONG LIVED (MEAN        2/76
CPI  F  LIFE 1E-11 SEC. OR MORE) NEUTRAL PARTICLE.  ONE CANDIDATE WITH MASS    2/76
CPI  F  1.9-2 GEV WAS FOUND.  SECOND LONG LIVED LIMIT FOR M=1-1.9, 2-5 GEV.    2/76
CPI
CPI  G  KLEMS 76 LOOKS FOR ASSOCIATED PROD OF CHARMED MESON IN SEMILEPTONIC    1/80
CPI  G  DECAY MODE. SEE THEIR FIG.2 AND 3 FOR C.S. UPPER LIMIT VS MASS.        1/80
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CPI  H  BLANAR 77 IS FNAL EXPT.  LIMIT IS FOR CS*BR TO MUONS.  ASSUMES           4/77
CPI  H  DIFFRACTIVE CHARMED 2GEV MESON PAIR PRODUCTION.  OTHER LIMITS FOR        4/77
CPI  H  PI AND P BEAMS GIVEN IN TABLE 1.                                         4/77
CPI
CPI  I  BRANSON 77 MEASURES (PI NUC -->J C CBAR)/(PI NUC -->J ANYTHING)          7/77
CPI  I  WITH J,C, AND CBAR ALL DECAYING TO MUONS. FNAL EXPT. FIRST VALUE         7/77
CPI  I  ABOVE IS FOR 225 GEV/C PI+ BEAM, SECOND IS FOR 225 GEV/C PI- BEAM.       7/77
CPI
CPI  J  GODDARD 77 IS A SLAC PI+ P EXP  AT 4.51 GEV ECM.                         1/78
CPI
CPI  K  JONCKHEERE 77 LOOKS FOR CORRELATION BETW VOS AND PROMPT MUONS TO         1/78
CPI  K  SIGNAL DECAY OF CHARMED PARTICLE.                                        1/78
CPI
CPI  L  ANTIPOV 78 SEARCHED FOR PI- BE --> DO DOBAR X WHERE DO --> K+ PI-.       1/80
CPI  L  ANTIPOV2 78 SEARCHED FOR DO C X WHERE DO--> K PI, C IS ANY               1/80
CPI  L  CHARMED PARTICLE WITH SEMIMUONIC DECAY. BOTH ARE SERPUKHOV EXPTS.        1/80
CPI
CPI  M  BALLAM 78 IS SLAC EXPT SEARCHING FOR SEMIELECTRONIC DECAY MODE OF        1/79
CPI  M  ASSOC. PRODUCED CHARMED PARTICLES. FIRST VALUE ABOVE IS FOR C.S.*        1/79
CPI  M  SUM OF BRANCHING RATIOS INTO ELECTRON ANYTHING.  SECOND VALUE USES       1/79
CPI  M  KNOWN BR FOR D+-->E K TO YIELD CS.                                       1/79
CPI
CPI  N  CESTER 78 IS INL EXPT, LOOKS FOR PI- N-->D*- X, D*- --> DOBAR PI-,       1/78
CPI  N  DOBAR-->K+ PI-. VALUE CORRESPONDS TO A ROUGH LIMIT OF 2*10**-31          1/78
CPI  N  CM**2 FOR DOBAR PROD AND DECAY TO KPI.                                   1/78
CPI
CPI  O  ANTIPOV 79 LOOKED FOR PI- U --> DO DOBAR X. DO --> K- PI+ (DOBAR-->      9/81*
CPI  O  K+ PI-) AND SENSITIVE TO TAU(DO)>1.E-125.  ABOVE LIMIT IS FOR TAU        9/81*
CPI  O  AROUND 1.E-11 SEC.  FOR OTHER TAU(DO), SEE THEIR FIG. 3.                 9/81*
CPI
CPI  P  ALLISON 80 IS 340 GEV PI- P SPS EXP USING HIGH RESOLUTION OPTICS.        9/81*
CPI  P  FIRST VALUE ABOVE CORRESPONDS TO CHARM LIFE 3.E-13 S.  SECOND VALUE      9/81*
CPI  P  COMES FROM OBSERVED 8 CHGD 3 PRONG EVENTS (WITH 2 BKGD) AND ASSUMES      9/81*
CPI  P  MEAN LIFETIME 1.E-12 SEC AND 3 PRONG B.R. 0.4 FOR CHGD D DECAYS.         9/81*
CPI
CPI  Q  ANDERSON 80 IS AN FNAL 225 GEV PI- EXP.  LOOKED FOR MULTI-MUONS IN       9/81*
CPI  Q  PI- C,CU,W --> J/PSI (D DBAR) X WITH J/PSI --> MU+ MU-, D(DBAR) -->      9/81*
CPI  Q  MU NUE X.  ASSUMING BR(D--> MU NUE X)=0.1, SET CL=.90 LIMITS             9/81*
CPI  Q  CS(J/PSI D DBAR)/CS(J/PSI) < .016 AND CS(2 J/PSI)/CS(J/PSI) < .005.      9/81*
CPI  Q  FOR LIMITS IN OTHER PROD AND DECAY MODELS. SEE THEIR TABLE 2.            9/81*
CPI
CPI  R  BARLOUTAUD 80 IS CERN SPS EXPT. OBSERVED SIGNAL OF 10.9+-5.9 SINGLE      1/82*
CPI  R  DIRECT ELECTRON CORRESPONDING TO E/PI RATIO OF (3.1+-1.7)E-5. ABOVE      1/82*
CPI  R  CS IS FOR PI- N-->D DBAR X ASSUMING ALL SINGLE ES COME FROM D-DECAY      1/82*
CPI
CPI  S  BROMBERG 80 IS AN FNAL 50 AND 100 GEV PI- P SEMI-INCL EXP. OBSERVED      9/81*
CPI  S  A PEAK IN FINAL (KO K+ K-) CONSISTENT WITH PI- P --> DO X.               9/81*
CPI  S  DO --> KO PHI. PHI --> K+ K-.  ABOVE VALUE IS SEMI-INCL CS*BR (I.E.      9/81*
CPI  S  LOWER BOUND FOR INCLUSIVE CS*BR).                                        9/81*
CPI
CPI  T  ADEVA 81 IS CERN SPS EXPT WITH 360 GEV/C PI- ON LEBC. SEEN ONE EV.       1/82*
CPI  T  OF ASSOC.PROD. OF DO DOBAR, DO-->K- PI+ 2PIO, DOBAR-->K+ PI+ 2PI-.       1/82*
CPI  T  SEE LISTING FOR DO LIFE TIME.                                            1/82*

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CP      CHARMED HADRON PRODUCTION CROSS SECTION (P NUCLEON)   (CM**2)
CP   A   0  1. E-33 OR LESS             AUBERT     75 SPEC    PI+ K-             2/76
CP   A   0  4. E-33 OR LESS             AUBERT     75 SPEC    K+ PI-             2/76
CP   A   0  1. E-33 OR LESS             AUBERT     75 SPEC    K+ K-              2/76
CP   A   0  8. E-33 OR LESS             AUBERT     75 SPEC    PI+ PI-            2/76
CP   A   0  7. E-33 OR LESS             AUBERT     75 SPEC    P K-               2/76
CP   A   0  2. E-33 OR LESS             AUBERT     75 SPEC    K+ PBAR            2/76
CP   A   0  4. E-32 OR LESS             AUBERT     75 SPEC    P PI-              2/76
CP   A   0  2. E-33 OR LESS             AUBERT     75 SPEC    PI+ PBAR           2/76
CP   B   0  5. TO 20. E-30   OR LESS    AAHLIN     76 HBC     BARYON,M LT 2GEV   2/77
CP   B   0 15. TO 100.E-30   OR LESS    AAHLIN     76 HBC     BARYON,M 2-3 GEV   2/77
CP   B   0 10. TO 35. E-30   OR LESS    AAHLIN     76 HBC     MESON, M 1-2 GEV   2/77
CP   C   0  0.05 TO 1.35E-27 OR LESS    ALBROW     76 SPEC    K PI, K P          1/78
CP   D   0  2. E-30 OR LESS             BINTINGER  76 SPEC    M=2 GEV/C**2       1/77
CP   D   0  5. E-32 OR LESS             BINTINGER  76 SPEC    M=4 GEV/C**2       1/77
CP   E   0  9. E-30 OR LESS  CL=.95     ALDER      77 SPEC    DO --> K- PI+     12/77
CP   E   0  9. E-30 OR LESS  CL=.95     ALDER      77 SPEC    DOBAR--> K+ PI-   12/77
CP   F        0.04  OR LESS  CL=.90     BRANSON    77 SPEC    SEE NOTE F BELOW   7/77
CP   G   0  1.6E-31 OR LESS  CL=.95     DITZLER    77 SPEC    DO --> K- PI+      1/78
CP   G   0  2.9E-31 OR LESS  CL=.95     DITZLER    77 SPEC    DOBAR --> K+ PI-   1/78
CP   H   0  1.6E-29 OR LESS  CL=.95     BAUM       78 SPEC PP-->D DBAR ANYTHNG   2/79
CP   I  32 (7.0+-3.6)E-29               CLARK      78 SPEC PP-->D DBAR ANYTHNG   2/79
CP   J   0  1.0E-31 OR LESS             LAUTERBAC  78 SPEC    D+,DO TO K MU NU  12/79
CP   K      2.6E-29 OR LESS  CL=.95     BRANSON    79      PP-->DODOBAR + D+D-  12/79
CP   K      5.9E-29 OR LESS  CL=.95     BRANSON    79      PP-->DODOBAR + D+D-  12/79
CP   L     (1.3 TO 6.0)E-29             BROWN      79 SPEC                      12/79
CP   M     (1.01+-0.23)E-29             CHILINGAR  79 SPEC D DBAR INCLUSIVE     12/79
CP   N     (7 TO 20)E-3                 DIAMANTBE  79 CNTR D,DBAR --> MU         12/79
CP   O      6.7E-28 OR LESS  CL=.95     DISHAW     79 CALO 400 GEV PP --> DBAR  12/79
CP   P  92(1.5-20)E-28                  DRIJARD    79 SFM     D+ -->K-PI+       12/79
CP   Q     (3.0 TO 6.2)E-30             DRIJARD2   79 SFM  LAM/C+ TO KOBAR+ P   12/79
CP   Q     (3.3 TO 6.7)E-30             DRIJARD2   79 SFM  LAM/C+ TO K- DEL++   12/79
CP   R     (0.7 TO 1.8)E-30             GIBONI     79 SPEC LAM/C+ -->K- PI+ P   12/79
CP   R     (0.7 TO 1.3)E-30             GIBONI     79 SPEC LAM/C+-->LAM (3PI)+  12/79
CP   S     (2.3+-0.3)E-30               LOCKMAN    79 SPEC LAM/C+-->K- PI+ P    12/79
CP   S     (2.8+-1.0)E-30               LOCKMAN    79 SPEC LAM/C+-->LAM (3PI)+  12/79
CP   T     (2.2+-0.9)E-29               RITCHIE    80 CNTR                       9/81*
CP   U   8 (2.0 TO 5.0)E-29             SANDWEISS  80 STPC                       9/81*
CP   V     (1.8+-.7)E-28                BASILE     81 SFM  ASSOC.DBAR LAM/C+     1/82*
CP   W  47 (5.8+-2.9)E-28               BASILE2    81 SFM  ASSOC. DO DBAR PROD   2/82*
CP   X  53 (0.84+-.32)E-27              IRION      81 SPEC E-TRIGG.LAM/C+DECAY   1/82*
CP   X  21 (0.45+-.32)E-27              IRION      81 SPEC E+TRIGG.LAM/C-DECAY   1/82*
CP
CP   A  AUBERT 75 IS A BNL 30 GEV EXPT.  LOOKS FOR P BE --> JPRIME ANYTHING      2/76
CP   A  WHERE JPRIME DECAYED VIA THE CHANNEL SHOWN.  ABOVE VALUES ARE            2/76
CP   A  FOR M=2.25GEV AND ASSUME A WIDTH SMALL COMPARED TO THE RESOLUTION.       2/76
CP   A  UPPER LIMITS ARE ALSO GIVEN FOR THE ABOVE CHANNELS AND P PBAR FOR        2/76
CP   A  M=3.1 AND 3.7 GEV.  THOSE LIMITS RANGE FROM 7E-36 TO 4E-33.              2/76
CP   A  MA 77 SAYS AUBERT 75 LIMITS SHOULD BE AN ORDER OF MAG. LARGER.           2/77
CP
CP   B  AAHLIN 76 IS A 19 GEV/C P-P EXPT AT CERN. VALUES GIVEN ARE CL=.975.      2/77
CP   B  SEE TABLE 2B, PG 479 FOR INDIVIDUAL LAMBDA (OR KS) +PIONS CHANNELS.      2/77
CP
CP   C  ALBROW 76 IS ISR EXPT, ECM=53GEV. SEE THEIR TABLE 2B,PG 377 FOR          1/78
CP   C  INDIVIDUAL MESON AND BARYON CHANNELS. EXAMINES MASS RANGE 2-4 GEV.       1/78
CP
CP   D  BINTINGER 76 IS CROSS-SEC TIMES BR INTO K- PI+.  WE SHOW TWO VALUES      1/77
CP   D  FROM THEIR FIG.4 WHICH COVERS MASS RANGE 1.7-4 GEV.  SIMILAR LIMITS      1/77
CP   D  ARE GIVEN FOR K+ PI- AND PI+ PI- CHANNELS.  LIMITS ARE PROPORTIONAL      1/77
CP   D  TO CS*BR FOR J/PSI INTO MU+ MU-, TAKEN=1ONB FOR ABOVE VALUES.            1/77
CP
CP   E  ALDER 77 IS CERN-ISR EXPT AT ECM=53 GEV.                                12/77
CP
CP   F  BRANSON 77 MEASURES (P NUC -->J C CBAR)/(P NUC  ->J ANYTHING) WITH       7/77
CP   F  J,C, AND CBAR ALL DECAYING TO MUONS.FNAL EXPT USING 225 GEV/C BEAM.      7/77
CP
CP   G  DITZLER 77 IS FNAL 400GEV P EXPT.  ABOVE LIMITS ARE FOR                  1/78
CP   G  BRIK PI)*DSIGMA/DY AT Y(CM)=-0.4.                                        1/78
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CP    H  BAUM 79 IS ISR EXPT AT ECM=55 GEV. MEASURES CS*BR(D-->E)*BR(D-->MU)  2/79
CP    H  <.92 MICROBNS AT THIS ENERGY.                                          2/79
CP
CP    I  CLARK 78 IS CERN-ISR EXPT LOOKING FOR E+- MU-+ EVENTS. ERROR IS        2/79
CP    I  STATISTICAL ONLY. ASSUMES THE SEMILEPTONIC BRANCHING FRACTIONS OF      2/79
CP    I  THE D INTO ELECTRONS AND MUONS AS 10 PERCENT EACH.                     2/79
CP
CP    J  LAUTERBACH 78 RESULT BASED ON POLARIZATION OF PROMPT MUONS IN 400     12/79
CP    J  GEV P-NUCLEON INTERACTIONS. IF B.R. OF D-->MU =.07, CS<7 E-31.        12/79
CP
CP    K  FIRST BRANSON 79 VALUE IS AT ECM=19.4 GEV, SECOND AT ECM=27.4 GEV.    12/79
CP
CP    L  BROWN 79 SEES PROMPT 1 MUON SIGNAL IN 400 GEV PROTONS ON STEEL.       12/79
CP    L  UNCERTAINTY IN C.S. IS DUE TO MODEL DEPENDENCE.                       12/79
CP
CP    M  CHILINGAROV 79 ANALYZE CERN ISR EXPT AT 53 AND 63 GEV ECM FOR LOW     12/79
CP    M  MASS LEPTON PAIR PRODUCTION. VALUE ABOVE IS C.S. PER UNIT OF          12/79
CP    M  RAPIDITY NEAR Y=0.                                                    12/79
CP
CP    N  DIAMANTBERGER 79 USES 400 GEV PROTONS ON FE AND LOOKS FOR MISSING     12/79
CP    N  ENERGY IN MU+MU- PRODUCTION INDICATIVE OF FINAL STATE NEUTRINOS.      12/79
CP
CP    O  DISHAW 79 IS A CALORIMETRIC EXPT AND LOOKS FOR LOW ENERGY TAIL OF     12/79
CP    O  ENERGY DISTRIBUTUIONS DUE TO ENERGY LOST TO WEAKLY INTERACTING        12/79
CP    O  PARTICLES. ASSUMES SEMILEPTONIC B.R.=0.11.                            12/79
CP
CP    P  DRIJARD 79 IS CERN-ISR EXPERIMENT AT ECM=53 GEV.  FOUND A PEAK AT     12/79
CP    P  DMASS IN K- PI+ PI+ MASS DISTRIBUTION WHEN MASS OF AT LEAST ONE OF    12/79
CP    P  TWO (K-PI+) PAIRS IS REQUIRED INSIDE THE K*(892) REGION. CORRECTED    12/79
CP    P  FOR BRANCHING RATIO. SEE TABLE 3 FOR C.S. ESTIMATION.                 12/79
CP
CP    Q  DRIJARD2 79 IS CERN ISR EXPT AT 53 GEV ECM. SEES MASS ENHANCEMENT     12/79
CP    Q  AT 2.26 GEV IN BOTH CHANNELS. RANGE IN VALUES DUE TO MODEL            12/79
CP    Q  DEPENDENCE. VALUES ARE SIGMA*BR FOR MODES SHOWN.                      12/79
CP
CP    R  GIBONI 79 IS CERN ISR EXPT AT 63 GEV ECM.SEES MASS ENHANCEMENT NEAR   12/79
CP    R  2.255 GEV IN BOTH CHANNELS. VALUES ARE SIGMA*BR FOR MODES SHOWN.      12/79
CP    R  SIGMA*BR FOR LAM(3PI)+ MODE CHANGED BY AUTHOR.  SEE DIBITONO 79.       4/82*
CP
CP    S  LOCKMAN 79 IS A CERN ISR EXPT AT 53 AND 62 GEV ECM. SEES A MASS       12/79
CP    S  ENHANCEMENT AT 2.29 GEV IN BOTH CHANNELS. VALUES ARE SIGMA*BR FOR     12/79
CP    S  MODES SHOWN AND FOR 0.75<X<0.90 IN ONE HEMISPHERE.                    12/79
CP
CP    T  RITCHIE 80 IS AN FNAL 350 GEV PROTON FE EXP.  MEASURED PROMPT MUONS    9/81*
CP    T  IN LOW PT SMALL XF REGION. (CF BROWN 79).  CS VALUE IS FROM PROMPT     9/81*
CP    T  1 MUON RATE ASSUMING LINEAR A DEP AND SEMILEPTONIC BR OF 0.08.         9/81*
CP
CP    U  SANDWEISS 80 IS AN FNAL EXP WITH 350 GEV PROTONS ON NE STRC.           9/81*
CP    U  OBSERVED SHORT LIVED PARTICLES ASSOC. WITH MUONS.  ABOVE CHARM C.S.    9/81*
CP    U  VALUES ARE OBTAINED IN TWO MODELS ASSUMING THESE EVENTS AS CHGD D.     9/81*
CP
CP    V  BASILE 81 IS CERN-ISR EXPT AT WCM=62 GEV. LOOKED FOR P P-->DBAR LAM    1/82*
CP    V  /C+ WITH DBAR-->E- X AND LAM/C+ -->P K- PI+. ABOVE CS ASSUMES BR'S     1/82*
CP    V  .085 AND .022 FOR RESPECTIVE DECAYS AND PROD.MODEL WITH LAM/C+ FOR-    1/82*
CP    V  WARD AND DBAR CENTRAL. WHICH GIVES MOST REASONABLE E-/PI- RATIO.       1/82*
CP
CP    W  BASILE2 81 IS CERN ISR EXP. AT WCM=62 GEV. STUDIED P P-->D0 DBAR X     2/82*
CP    W  WITH OBSERVED D0-->K- PI+ AND TRIGGERED DBAR-->E- K+ X. ABOVE CS       2/82*
CP    W  ASSUMES BR(D0-->K-PI+)=.03+-.006. BR(DBAR-->E- K+ X)=.043+-.012 AND    2/82*
CP    W  IN A MODEL GIVING LOWEST CS,I.E. CENTRAL PROD. OF BOTH D0 AND DBAR.    2/82*
CP
CP    X  IRION 81 IS CERN-ISR EXPT AT WCM=63 GEV. FIRST VALUE IS FOR P P-->     1/82*
CP    X  DBAR LAM/C X FROM E- TRIGGERED LAM/C+ -->K- P PI+ EVENTS ASSUMING      1/82*
CP    X  BR(D-->E X)=.08 AND BR(LAM/C+ -->K-P PI+)=.022. SECOND IS FOR P P      1/82*
CP    X  --> LAM/C- LAM/C+ FROM E+ TRIGG. LAM/C- -->K+ PBAR PI- EVENTS.         1/82*
CP    X  ESTIMATES DEPENDS ON MODELS. SEE THEIR TABLE1 FOR VALUES IN OTHER      1/82*
CP    X  MODELS AND C.S. UPPER LIMITS FOR DBAR D+.D DBAR+.LAM/C DBAR+ PRODS.    1/82*

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CN       CHARMED HADRON PRODUCTION CROSS SECTION (N NUCLEON)  (CM**2)
CN    A    0  1.9E-31 OR LESS              BLESER     75 SPEC K+PI-, M=1.8 GEV     2/77
CN    A    0  1.0E-31 OR LESS              BLESER     75 SPEC K+PI-, M=2.5 GEV     2/77
CN    A    0  1.0E-31 OR LESS              BLESER     75 SPEC K- P , M=2.5 GEV     2/77
CN    B    0  2.5E-29 OR LESS  CL=.975     WARD       75 HBC     KS PI+ PI-        1/77
CN    C    0  4. E-32 OR LESS              ABOLINS    76 SPEC    PI+ PI-           1/77
CN    C    0  7. E-32 OR LESS              ABOLINS    76 SPEC    PBAR P            1/77
CN    C    0  4. E-32 OR LESS              ABOLINS    76 SPEC    K- PI+            1/77
CN    C    0  6. E-32 OR LESS              ABOLINS    76 SPEC    K- P              1/77
CN    D 0-2 SEE COMMENT D BELOW            BINKLEY    76 SPEC                      1/77
CN    E    0 1.-10.E-31 OR LESS            ABOLINS    78 SPEC                      6/78
CN    F    0  2. E-31 OR LESS  CL=.90      BBDMPST    78 SPEC   C+ TO LAMBDA PI+   7/79
CN    T    0  2.5E-31 OR LESS  CL=.90      BBDMPST    78 SPEC   D+- TO K0 PI+-     7/79
CN    G    0  3.4E-31 OR LESS  CL=.95      LIPTON     78 SPEC                      8/78
CN    H    0  2.0E-31 OR LESS  CL=.95      SPELBRING  78 SPEC K+- PI-+, M=1.86GEV  8/78
CN    I    0  3.8E-31 OR LESS  CL=.90      BBDMPSST   79 SPEC D0 --> K- PI+       12/79
CN    I    0  3.2E-31 OR LESS  CL=.90      BBDMPSST   79 SPEC D0BAR --> K+ PI-    12/79
CN    I    0  1.3E-30 OR LESS  CL=.90      BBDMPSST   79 SPEC D+ --> K- PI+ PI+   12/79
CN    I    0  1.1E-30 OR LESS  CL=.90      BBDMPSST   79 SPEC D- --> K+ PI- PI-   12/79
CN    I    0  5.9E-31 OR LESS  CL=.90      BBDMPSST   79 SPEC F+ --> K+ K- PI+    12/79
CN    I    0  4.8E-31 OR LESS  CL=.90      BBDMPSST   79 SPEC F- --> K+ K- PI-    12/79
CN    I    0  1.3E-30 OR LESS  CL=.90      BBDMPSST   79 SPEC LAM/C+ -->P K- PI+  12/79
CN    I    0  2.3E-31 OR LESS  CL=.90      BBDMPSST   79 SPEC LAM/C+ -->P K0BAR   12/79
CN
CN    A  BLESER 75 USES NEUTRONS UP TO 300 GEV/C, BE TARGET. EXAMINES MASS      2/77
CN    A  RANGE UP TO 3.5 FOR KPI, UP TO 4.0 FOR KP.                             2/77
CN
CN    B  WARD 75 IS N-P EXPT WITH MOM UP TO 24 GEV/C. THIS VALUE IS FOR MASS    1/77
CN    B  RANGE 1.5-2.5 GEV.  SEE TABLE 1 PG 31 FOR UPPER LIMITS ON C++.C+,      1/77
CN    B  C0.D+.D0.D- DECAYS INTO VARIOUS FINALSTATES IN MASS RANGE 1.5-5GEV.    1/77
CN    B  UPPER LIMIT FOR SEEING DECAY OF CHGD CHARMED PARTICLE INTO V0 FOR      1/77
CN    B  TAU GT 10**-11 SEC GIVEN AS 1.5*EXP(T) FOR V0 =LAMBDA OR SIGMA, AND    1/77
CN    B  3.0*EXP(T) FOR V0=K0. HERE, T=10*-11/TAU, CS GIVEN IN MICROBARNS.      1/77
CN
CN    C  ABOLINS 76 IS FNAL EXPT. USES NEUTRONS UP TO 300 GEV/C ON BE TARG.     1/77
CN    C  TYPICAL VALUES ABOVE ARE FOR M=3.0 GEV. SEE FIG 4 FOR MASS RANGE       1/77
CN    C  2-4 GEV. OBSERVES POSSIBLE K- PI+ ENHANCEMENT AT 2.29+-.03 GEV.        1/77
CN
CN    D  BINKLEY 76 MEASURES BR(C TO MU + OTHERS)*R WHERE R IS THE RATIO OF     1/77
CN    D  THE CROSS-SEC FOR PRODUCING THE J/PSI TOGETHER WITH A C-CBAR PAIR      1/77
CN    D  TO THE TOTAL CROSS-SEC FOR PRODUCING THE J/PSI AT THIS ENERGY. THE     1/77
CN    D  EXPT WAS A 300 GEV/C FNAL RUN, AND SAW 2 TRI-MUON EVENTS. THIS GAVE    1/77
CN    D  A .90 CL UPPER LIMIT OF .003 FOR THE MEASURED QUANTITY DESCRIBED       1/77
CN    D  ABOVE.                                                                 1/77
CN
CN    E  ABOLINS 78 IS A 250 GEV/C N-BE EXPT LOOKING FOR NARROW ENHANCEMENTS    6/78
CN    E  IN RANGE 1.7-3.5 GEV. CHANNELS EXAMINED ARE PI+PI-, K+-PI-+, K P,      6/78
CN    E  PBAR P. POSSIBLE K-PI+ PEAK AT 2.29 SEEN IN ABOLINS 76 NOT SEEN        6/78
CN    E  HERE.  STATISTICS HERE ARE 5 TIMES ABOLINS 76 STATISTICS.              6/78
CN    E  IF SAME PSI PRODUCTION MODEL WERE ASSUMED HERE AS WAS USED IN          6/78
CN    E  ABOLINS 76. THE 78 LIMITS WOULD BE SMALLER BY A FACTOR OF 3.           6/78
CN
CN    F  BBDMPST 78 IS A SERP EXPT USING 45 GEV NEUTRONS. VALUES ARE
CN    F  SIGMA*BR FOR MODES SHOWN AND FOR XF>0.5.
CN    G  LIPTON 78 IS 300 GEV N-BE EXPT AT FNAL. VALUE QUOTED IS  FOR           8/78
CN    G  ASSOC CHARM PROD WITH ONE CHARMED PARTICLE --> ELECTRON AND THE        8/78
CN    G  OTHER --> MUON.                                                        8/78
CN
CN    H  SPELBRING 78 IS 300 GEV N-BE EXPT AT FNAL. VALUE QUOTED IS FOR         8/78
CN    H  PROD OF D0 AND ANOTHER CHARMED PARTICLE WITH D0 --> K PI AND           8/78
CN    H  SECOND CHARMED PARTICLE DECAYING TO PROMPT MUON.                       8/78
CN
CN    I  BBDMPSST 79 IS SAME EXPERIMENT AS BBDMSST 78.                         12/79

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CAP      CHARMED HADRON PRODUCTION CROSS SECTION (PBAR NUCLEON)  (CM**2)
CAP   A    0  5. E-29 OR LESS  CL=.95     CARLSSON   75 HBC     PBAR P ANYTHING   2/77
CAP   A    0  3. E-29 OR LESS  CL=.95     CARLSSON   75 HBC     PBAR P PI+ PI-    2/77
CAP   B    0 0.8 TO 4.4 E-30   OR LESS    CESTER     76 SPEC    12.4 TO 15 GEV/C  2/77
CAP   C    0 0.15 TO 1. E-29   OR LESS    JACHOLKOW  78 BEBC    12GEV/C PBAR P    7/79
CAP
CAP   A  CARLSSON 75 IS A 9GEV PBAR P CERN EXPT.  LIMITS ARE FOR P PBAR PEAK    2/77
CAP   A  IN CHANNELS INDICATED. K KBAR CHANNELS CHECKED BUT NO LIMITS GIVEN.    2/77
CAP
CAP   B  CESTER 76 LOOKS AT MASS RANGE 1.8 TO 2.5 GEV. SEE TABLE 1 FOR          2/77
CAP   B  INDIVIDUAL CHANNELS. VALUES GIVEN ARE CROSS-SEC/NUCLEON ON CARBON.     2/77
CAP
CAP   C  JACHOLKOWSKA 78 IS CERN EXPT LOOKING FOR NARROW PEAKS IN K0+PIONS      7/79
CAP   C  AND LAMBDA+PIONS SPECTRA. SEE TABLES 1 AND 2 FOR INDIVID CHANNELS.     7/79

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BD       BEAM DUMP EXPTS SEARCHING FOR NEUTRAL PENETRATING PARTICLES AND        6/78
BD       PROMPT NEUTRINOS FROM UNKNOWN SOURCES                                  6/78
BD    A                                   ALIBRAN    78 HYBR     400 GEV PROTONS  6/78
BD    A  ALIBRAN 78 IS CERN SPS EXPT. SEE EXCESS PROD OF PROMPT ENEU AND        6/78
BD    A  ENEUBAR EVENTS. COULD BE EXPLAINED BY (CHARMED D PRODUCTION C.S.)      6/78
BD    A  *BR(D-->E+ NEU X)=32+15/-10 MICROBARNS.                                6/78
BD
BD    B                                   ASRATYAN   78 CALO                      1/80
BD    B  ASRATYAN 78 ESTIMATE (D DBAR PROD. C.S.)*BR(D-->E X) AS (1.9+-1.5)     1/80
BD    B  OR (0.5+-0.4) MICROBARN FOR A**1.5 OR A**1 RESPECTIVELY.               1/80
BD
BD    C                                   BOSETTI2   78 HYBR     400 GEV PROTONS  6/78
BD    C  BOSETTI2 78 IS CERN SPS EXPT. OBSERVES PROMPT NEUTRINOS, WITH EQUAL    6/78
BD    C  FLUXES OF NEU AND NEUBAR OF BOTH E AND MU TYPES. COULD COME FROM       6/78
BD    C  DECAY OF SHORT-LIVED LIGHT PARTICLES OF NEW TYPE. TAU LEPTONS AND      6/78
BD    C  AXIONS EXCLUDED. CHARM (D DBAR) PRODUCTION WOULD HAVE TO HAVE          6/78
BD    C  100-400 MICROBARN CROSS SECTION TO EXPLAIN RESULTS.                    6/78
BD
BD    D                                   HANSL      78 WIRE     400 GEV PROTONS  6/78
BD    D  HANSL 78 IS CERN SPS EXPT. SEES PROMPT NEUTRINO FLUX CONSISTENT        6/78
BD    D  WITH EQUAL AMOUNTS OF ENEU,ENEUBAR,MUNEU,MUNEUBAR. COULD BE            6/78
BD    D  EXPLAINED AS CHARM(D DBAR) PRODUCTION WITH ABOUT 30 MICROBARN          6/78
BD    D  CROSS SECTION.                                                         6/78
BD
BD    E                                   COTEUS     79 CSPK                      7/79
BD    E  COTEUS 79 IS BNL EXPT. SEES NO EXCESS N.C. RATE IN BEAM DUMP. SETS     7/79
BD    E  LIMIT FOR CS(PROD)*CS(INT) OF PENETRATING PARTICLES < 5E-68 CM**4      7/79
BD    E  (CL=.90).                                                              7/79
BD
BD    F                                   FRITZE     80 HYBR                      1/82*
BD    F  FRITZE 80 IS CERN SPS EXPT. RATIO OF PROMPT (E+ + E-) TO (MU+ +MU-)    1/82*
BD    F  RATES IS 0.59+0.85-0.29/(TON E+1T PROTONS) AT CL=.90. IF PROMPT        1/82*
BD    F  NEUTRINOS ARE FROM D DECAYS CS(P NUC --> D DBAR X) IS ABOUT            1/82*
BD    F  20 MICROBARN/NUCLEON FOR LINEAR A DEP.                                 1/82*
BD
BD    G   D                               JACQUES    80 HLBC     28 GEV PROTONS   9/81*
BD    G  JACQUES 80 IS BNL EXP.  SET LIMIT CS(P NUCLEON--> D DBAR X) <          9/81*
BD    G  1.5 E-28 CM**2 ASSUMING BR(D-->NUE X)=0.1 FROM NON-OBSERVATION OF      9/81*
BD    G  NUE-INDUCED EVENTS.                                                    9/81*
BD
BD    H                                   SOUKAS     80 CALO     28 GEV PROTONS   9/81*
BD    H  SOUKAS 80 IS BNL EXP.  OBSERVED EXCESS OF 48 NU EVENTS (NC+CC).        9/81*
BD    H  NUE AND NUMU EVENTS ARE NOT SEPARATED(IF CHARM,NUE APPROX.EQ.NUMU).    9/81*
BD    H  VISIBLE ENERGY DISTRIBUTION IS SIMILAR TO NON-BEAM DUMP RUN.  NOT      9/81*
BD    H  CONCLUDED TO BE CHARM.                                                 9/81*

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Y        CHARMED HADRON EVIDENCE IN NEUTRINO NUCLEON --> 2 LEPTONS ANYTHING
Y         SEE ALSO SECTION 'NEU' IN 'HEAVY LEPTON SEARCHES' AND
Y         SECTION 'T' IN 'OTHER NEW PARTICLE SEARCHES' AND VC AND VOA BELOW.
Y     A  14MU+MU-   0MU-MU-   0MU+MU+      BENVENU1  75 SPEC    PREDOM. NEU BEAM   2/76
Y     A  51MU+MU-   7MU-MU-   3MU+MU+      BENVENU3  75 SPEC    6/7 NEU BEAM       2/76
Y     A   5MU+MU-   0MU-MU-   2MU+MU+      BENVENU5  75 SPEC    9/10ANTINEU BEAM   2/76
Y         4MU+MU-   4 OTHER MU PAIRS       BARISH    76 SPEC    NEU BEAM           7/76
Y     B   32 DIMUON EVENTS                 ASRATYAN  77 SPEC    NEU BEAM           1/78
Y     C  4MU+E-   6MU-E+                   BALLAGH   77 HLBC .55 NEUBAR..45 NEU   12/77
Y     D  81 EVENTS MU-E+                   BALTAY    77 HLBC    PREDOM. NEU BEAM   8/77
Y     E   1 EVENT   MU-E+                  BARISH    77 OBC     NEU BEAM           3/77
Y     F  67 MU MU                          BARISH2   77 SPEC FNAL 45-205GEV NEU    1/78
Y     F  28 MU MU                          BARISH2   77 SPEC FNAL 45-205 ANTINEU   1/28
Y     G                                    BLIETZACKE 77 RVUE                      1/78
Y     H  17 EVENTS MU-E+                   BOSETTI   77 HYBR                       7/77
Y     I  11 MU-E+                          DEDEN     77 HLBC                      12/77
Y     J  15 MU-E+                          HAIDT     77 HLBC                       1/78
Y     K 257MU+MU-                          HOLDER    77 SPEC    INCIDENT NEU      12/77
Y     K  58MU+MU-                          HOLDER    77 SPEC    INCIDENT ANEU     12/77
Y     L  47 MU-MU-                         HOLDER2   77 SPEC    NEU BEAM          12/77
Y     L   9 MU+MU+                         HOLDER2   77 SPEC    NEUBAR BEAM       12/77
Y     M  46 MU-MU-   199 MU+ MU-           BENVENUTI 78 SPEC PREDOM. NEU BEAM      1/79
Y     M   2 MU+MU+    49 MU+ MU-           BENVENUTI 78 SPEC PREDOM. NEUBAR BEAM   1/79
Y     N  10MU-MU+  3MU-MU-   5MU-E+        BOSETTI1  78 HYBR    NEU BEAM           6/78
Y     N   2MU+MU-  1MU+E-                  BOSETTI1  78 HYBR    NEUBAR BEAM        6/78
Y     O  15 MU- E+                         ERRIQUEZ  78 BEBC    NEU BEAM           1/79
Y     P 94 MU+MU-                          ARMENISE  79 HYBR    NEU BEAM           1/80
Y     Q       MU- E+                       BARANOV2  79 HLBC    NEU BEAM           9/81*
Y     R  12 MU+E-                          BERGE     79 HLBC    NEUBAR BEAM        7/79
Y     S  67 MU-MU-                         DEGROOT   79 SPEC    NEU BEAM           1/80
Y     S  19 MU+MU+                         DEGROOT   79 SPEC    NEUBAR BEAM        1/80
Y     T 21 MU+MU-                          ARMENISE  80 HLBC    NEUBAR INDUCED    12/81*
Y     T 11 MU+MU-                          ARMENISE  80 HLBC    NEU INDUCED       12/81*
Y     U  34 MU+MU- 35 MU E                 BALLAGH   80 HYBR    NEU BEAM           2/80
Y     V  54MU+MU-  8MU-MU-   0MU+MU+       BALLAGH2  80 HYBR    NEU AND NEUBAR     9/81*
Y     W   3 MU+E+                          AMMOSOV2  81 HYBR    NEUBAR INDUCED     2/82*
Y     X  49 MU-E+  14 MU+E-                BALLAGH   81 HYBR NUMU,NUMUBAR IND.     2/82*
Y     X   2 E-MU+   2 E-E+  1 E+E-         BALLAGH   81 HYBR NUE.NUEBAR IND        2/82*
Y     Y 495 MU-MU+ 74 MU-MU-               JONKER    81 CALO    NEU INDUCED        2/82*
Y     Y 285 MU+MU- 52 MU+MU+               JONKER    81 CALO    NEUBAR INDUCED     2/82*
Y     Z  11 MU-MU- 100 MU-MU+              NISHIKAWA 81 SPEC NEU BEAM P(MU)>9GEV   1/82*
Y     1  81 MU-MU- 525 MU-MU+              TRINKO    81 SPEC NEU    P(MU)>10 GEV   1/82*
Y     1  11 MU+MU+ 104 MU+MU-              TRINKO    81 SPEC NEUBAR P(MU)>10 GEV   1/82*
Y
Y     A  BENVENUTI 75 ARE FNAL NEUTRINO NUCLEON EXPERIMENTS WHICH LOOKED FOR    2/76
Y     A  TWO OR MORE MUONS IN THE FINAL STATE.  NO TRIMUON EVENTS WERE SEEN.    2/76
Y     A  AUTHORS STATE THAT THESE DIMUON EVENTS REQUIRE THE EXISTENCE OF ONE    2/76
Y     A  OR MORE NEW PARTICLES WITH M=2-4GEV AND TAU=10**-10SEC. OR LESS.       2/76
Y     A  BENVENUTI4 75 SHOW THAT THE OBSERVED PROPERTIES OF THESE EVENTS        2/76
Y     A  DO NOT AGREE WITH HYPOTHESES OF HEAVY LEPTON OR INTERMEDIATE VECTOR    2/76
Y     A  BOSON.  THEY SUGGEST A HADRON (Y) WITH A NEW QUANTUM NUMBER.           2/76
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Y     B  ASPATYAN 77 IS SERPUKHOV EXPT. FINDS R=(DIMUONS/SINGLE MUON EVENTS)  1/78
Y     B  GT (6.2+-1.7)E-3 FOR NEU BEAM AND LT .011 FOR NEUBAR BEAM.            1/78
Y
Y     C  BALLAGH 77 IS AN FNAL EXPT. MEASURES (NEUMU N-->MU- E+ X)/(ALL NUMU 12/77
Y     C  C.C.)=(.34+.23-.13)*10**-2 AND (NEUMUBAR N-->MU+ E- X)/(ALL NUMUBAR 12/77
Y     C  C.C.)=(.15+.14-.08)*10**-2. RATIO OF ANTINEU TO NEU FRACTIONS IS    12/77
Y     C  (0.45+0.6-0.3).
Y
Y     D  BALTAY 77 IS FNAL EXPT IN NEON-H2 MIXTURE.                           8/77
Y
Y     E  BARISH 77 EVENT COULD BE NEU P TO MU+ B++. SEE CHARMED BARYON NOTE   3/77
Y     E  AND LAMBDA/C+ SECTION ABOVE.                                          3/77
Y
Y     F  BARISH2 77 FINDS DIMUON TO SINGLE MUON RATE CONSISTENT WITH CHARM.   1/78
Y
Y     G  BLETZACKER 77 EXPLAINS TRIMUON AND LIKE SIGN DIMUON PROD AS ASSOC   12/77
Y     G  PROD OF CHARM.                                                       12/77
Y
Y     H  BOSETTI 77 IS FNAL 15-FT CHAMBER EXPT.                                7/77
Y
Y     I  DEDEN 77 IS CERN WIDE BAND EXPT, EMAX=2 GEV.11+-5 EVENTS ABOVE A    12/77
Y     I  BACKGROUND OF 6 EVENTS.                                              12/77
Y
Y     J  HAIDT 77 IS SAME EXPT AS VONKROGH 76 LISTED UNDER S29VO. MEASURES     1/78
Y     J  (NEUMU N-->MU-E+X)/(NEUMU N-->MU-X)=(.63+-.21)E-2 FOR T(E+)>.8 GEV.  1/78
Y     J  THESE EVENTS HAVE AN AVERAGE OF 2.0+-0.6 KO PER EVENT.                1/78
Y
Y     K  HOLDER 77 IS CERN NARROW-BAND BEAM EXPT IN WHICH ALL MOMENTA ARE     12/77
Y     K  MEASURED.ENERGY SPECTRA,ANG.CORRELATIONS,PT DISTRIBUTIONS ALL IN     12/77
Y     K  AGREEMENT WITH PROD AND DECAY OF CHARMED PARTICLE.                   12/77
Y
Y     L  HOLDER2 77 IS 200GEV NARROW BAND EXPT. AFTER BACKGROUND SUBTRACTION 12/77
Y     L  THE RATE OF LIKE-SIGN DIMUON EVENTS TO CHARGED CURRENT EVENTS IS    12/77
Y     L  (3+-2)*10**-4. MAY COME FROM ASSOC PROD OF CHARM-ANTICHARM PAIR.    12/77
Y
Y     M  BENVENUTI 78 IS FNAL EXPT. MEASURE PROMPT DIMUON RATIO                1/79
Y     M  (MU-MU+)/(MU-MU+)=.06+-.05 FOR P(MU)>5 GEV/C AND =.12+-.05 FOR        1/79
Y     M  P(MU)>10 GEV/C. (MU-MU-) MAY COME FROM ASSOCIATED CHARM PRODUCTION.   1/79
Y     M  ABOVE 80 GEV, THE RATIO OF DIMUON TO SINGLE-MUON EVENTS IS            1/79
Y     M  (0.65+-0.13)*10**-2 FOR NEU AND (0.70+-0.25)*10**-2 FOR NEUBAR.       1/79
Y     M  FOR PMU > 5 GEV/C.                                                    1/79
Y
Y     N  BOSETTI1 78 IS A CERN NE-HBC EXPT USING 200 GEV NARROW BAND BEAM.     6/78
Y     N  RATE FOR (MU-E+ + MU-MU+)/MU- IN NEU BEAM IS 0.013+-0.004.            6/78
Y     N  RATE FOR (MU+E- + MU+MU-)/MU+ IN NEUBAR BEAM IS 0.012+-0.005.         6/78
Y
Y     O  ERRIQUEZ 78 IS CERN SPS EXPT. FINDS (NUMU N-->MU- E+ X)/(ALL NUMU     1/79
T     O  C.C.)=(.41+-.15)*10**-2 (TE+>.3GEV). DIRECT E+ PROD. VIA N.C. IS      1/79
Y     O  <0.2 TIMES C.C.  LIFETIME OF POSSILE E+ PARENT PARTICLE IS LESS       1/79
Y     O  THAN 3*10**-12 SEC.                                                   1/79
Y
Y     P  ARMENISE 79 IS A CERN SPS EXPT. FINDS R=(MU+MU-)/(SINGLE MU- EVTS)    1/80
Y     P  =(0.72+-0.14)E-2. UPPER LIMIT FOR D LIFETIME IS 0.8 E-12SEC(CL=0.9)   1/80
Y
Y     Q  BARANOV2 79 REPORTS 3 MU-E+ EVENTS AT SKAT(SERPUKHOV).  ONE WITH VO   9/81*
Y     Q  MAY BE LAMBDA/C+ TO E+ NEU LAMBDA.  ANOTHER COULD BE D+ OR LAMBDA/    9/81*
Y     Q  C+(++) DECAY, BUT THIS AND THE THIRD CAN BE DUE TO HEAVY LEPTON.      9/81*
Y
Y     R  BERGE 79 IS FNAL EXPT IN 15FT CHAMBER USING H-NE MIXTURE. RATE FOR    7/79
Y     R  (MU+E- K)/(MU+ X)=0.36+-0.11.                                         7/79
Y
Y     S  DEGROOT 79 IS CERN WIDE BAND EXPT. RATES ARE (MU-MU-)/(1MU-)=         1/80
Y     S  (3.4+-1.8)E-5, (MU-MU-)/(MU-MU+)=(.041+-.022), (MU+MU+)/(1MU+)=       1/80
Y     S  (4.3+-2.3)E-5. (MU+MU+)/(MU-MU+)=(.042+-.023).                        1/80
Y
Y     T  ARMENISE 80 IS CERN-SPS EXP WITH BEBC EXPOSED TO WIDE-BAND NEUBAR   12/81*
Y     T  BEAM.  21 DIMUONS BY NEUBAR INCLUDE 6 BKGDS AND CORRESPOND TO 1.0+- 12/81*
Y     T  0.5 VOS PER DIMUON EVENT IN AGREEMENT WITH GIM MODEL.  SEE ALSO     12/81*
Y     T  SECTION Y IN BOTTOM SEARCHES.                                       12/81*
Y
Y     U  BALLAGH 80 EVENTS INCLUDE DIRECT OBSERVATION OF PROD. AND VISIBLE     1/80
Y     U  SEMI-LEPTONIC DECAY OF SHORT-LIVED PARTICLES (1 CHGD. 2 NEUTRAL,      1/80
Y     U  AND 1 UNDETERMINDED CHARGE).                                          1/80
Y
Y     V  BALLAGH2 80 AT FNAL GIVE (MU+MU-)/(1MU)=(0.39+-0.1)E-2 FOR P(MU)> 4   9/81*
Y     V  GEV/C.  MU-MU- ARE CONSISTENT WITH BKGD.  ESTIMATE 30.3 MU-MU+(NEU-   9/81*
Y     V  INDUCED) AND 5.7 MU+MU- (NEU-INDUCED) CORRESPONDING TO (MU-MU+)/      9/81*
Y     V  (1MU-)=(.37+-.1)E-2 AND (MU+MU-)/(1MU+)=(.5+-.3)E-2 FOR P(MU)>4GEV.   9/81*
Y
Y     W  AMMOSOV2 81 AT FNAL FOUND 4 MU+E+ EVENTS WITH ESTIMATED 1 BKGD.       2/82*
Y     W  3 EVS HAVE ASSOC.VO. RATE(MU+E+)/(MU+)=(4.8+5.3-3.2)E-4 FOR E(NUBAR   2/82*
Y     W  )>10GEV,P(MU)>4GEV,P(E+)>.4GEV IS MUCH HIGHER THAN QCD ESTIMATION.    2/82*
Y
Y     X  BALLAGH 81 AT FNAL GIVE (MU-E+)/(1MU)=(.73+-.11)E-2, (MU+E-)/(1MU)=   2/82*
Y     X  (1.1+-0.3)E-2 FOR P(E)>.3GEV. EVENTS ARE CONSISTENT WITH CHARM PROD   2/82*
Y     X  MODEL EXCEPT FOR EXCESS AROUND RECOIL MASS=6 GEV IN MU+E-(AND MU+     2/82*
Y     X  MU-) EVENTS. NUE AND NUEBAR INDUCED DILEPTON RATE IS APPROX. 0.01.    2/82*
Y
Y     Y  JONKER 81 IS CERN-SPS EXP. OPPOSITE SIGN DIMUONS ARE CONSISTENT       2/82*
Y     Y  WITH CHARM PROD AND DECAY. SAME-SIGN YIELD IS MUCH HIGHER THAN QCD.   2/82*
Y     Y  RATIO(SAME/OPP.)=(.14+-.04+-.03)((.18+-.06+-.03)) FOR NEU(NEUBAR).    2/82*
Y
Y     Z  NISHIKAWA 81 IS FNAL EXPT. RATIO (MU-MU-)/(MU- RISES TO (2.5+-1.0)    1/82*
Y     Z  E-3 AT E(VIS)=250 GEV. LIKE-SIGN MUONS SEEM NOT FROM HEAVY LEPTON     1/82*
Y     Z  OR QUARKS HEAVIER THAN CHARM. THEY MAY COME FROM ASSOC.PROD OF        1/82*
Y     Z  CHARM ANTI-CHARM THOUGH 1ST ORDER QCD LIES 10**-2 BELOW DATA.         1/82*
T
Y     1  TRINKO 81 IS FNAL EXPT. (PROMPT MU-MU-)/1MU- =(0.34+-0.09)E-3 AND     1/82*
Y     1  (PR.MU-MU+)/1MU- =(0.27+-0.03)E-2 BOTH FOR P(MU)>10 GEV. MU-MU- EVS   1/82*
Y     1  ARE TWO ORDERS OF MAG LARGER THAN LEADING QCD CHARM-ANTICHARM PROD.   1/82*
Y
Y                                    COMMENT
Y        A SYSTEMATIC DESCRIPTION OF OPPOSITE-SIGN DILEPTONS AND ASSOCIATED    4/82*
Y        VOS IS GIVEN BY A CHARM PRODUCTION MODEL.  ON THE OTHER HAND, THE     4/82*
Y        LIKE-SIGN DILEPTON RATE IN NEUTRINO AND ANTINEUTRINO REACTIONS HAS    4/82*
Y        BEEN MEASURED TO BE MUCH HIGHER THAN THEORETICAL EXPECTATION.         4/82*
Y        (SEE AMMOSOV2 81, JONKER 81, NISHIKAWA 81, AND TRINKO 81 ABOVE.)      4/82*
Y        FOR THEORY STATUS SEE EG. BARGER, KEUNG, PHILLIPS, PR D24 244(1981)   4/82*

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VO        NUMBER OF VOS PER EVENT IN NEUTRINO NUCLEON--> MU- E+ VO ANYTHING     11/79
VO         WHERE THE VO IS A KOS OR A LAMBDA (SEE ALSO SECTION Y AND VOA)      11/79
VO   A   1                                 DEDEN     75 HLBC                     2/76
VO   A   1                                 BLIETSCHA 76 HLBC                     2/76
VO   B   4                                 VONKROGH  76 HLBC                     2/76
VO      15    0.6        0.2               BALTAY    77 HLBC                    11/79
VO      11    1.84       0.63       0.53   BOSETTI   77 HYBR    KOS/(MU-E+)EVENT 11/79
VO   C   3                                 DEDEN     77 HLBC                    12/77
VO       8    1.7        0.7               BOSETTI1  78 HYBR    KOS/(MU-L+)EVENT 11/79
VO       5    1.2        0.5               ERRIQUEZ  78 BEBC                     1/79
VO   D   9    0.53       0.25       0.20   ARMENISE  79 HYBR    KO/(MU+MU-)EVENT  1/80
VO   D   3    0.03       0.06       0.04   ARMENISE  79 HYBR    LAMDA/(MU+MU-)EV  1/80
VO   E   1                                 BARANOV   79 HLBC                     7/79
VO   F  13    1.1        0.3               BALLAGH   81 HYBR    KO/(MU-E+)EVENT   2/82*
VO   F   2    0.07       0.07     0.03     BALLAGH   81 HYBR    LAMDA/(MU-E+)EV.  2/82*
VO
VO   A  THE DEDEN 75 AND BLIETSCHAU 76 EVENTS ARE FROM CERN                      2/76
VO   A  GARGAMELLE NEUTRINO EXPOSURES.  THE MASSES OF THE E+ VO SYSTEM FOR       2/76
VO   A  THE TWO EVENTS ARE 1.24, 1.91 GEV FOR LAMBDA OR 0.65, 1.57 FOR KO.       2/76
VO
VO   B  THE VON KROGH 76 EVENTS ARE FROM AN FNAL 15 FT NEON BUBBLE CHAMBER       2/76
VO   B  EXPOSURE.  ALL FOUR E+ EVENTS FOUND HAVE ASSOCIATED KOS.                 2/76
VO
VO   C  DEDEN 77 EVENTS INCLUDE THOSE OF DEDEN 75 AND BLEITSCHAU 76.            12/77
VO
VO   D  ARMENISE 79 IS A CERN SPS EXPT.                                          1/80
VO
VO   E  BARANOV 79 EVENT FROM SKAT(SERPUKHOV). MAY BE LAMBDA/C+ TO E+NEU         7/79
VO   E  LAMBDA.                                                                  7/79
VO
VO   F  BALLAGH 81 IS FNAL EXPT. MOST VO'S ARE KO'S SUGGESTING THAT EVS ARE      2/82*
VO   F  PREDOM.D-MESON PROD AND DECAY AND THAT BR(L/C+-->LAM E+ X)IS SMALL.      2/82*
VO            . . . . . . . . . . .
VO  AVG       0.106      0.069    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)

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VOA       NUMBER OF VOS PER EVENT IN ANTINEUTRINO NUCLEON-->MU+E-VO ANYTHING    12/79
VOA        WHERE VO IS A KOS,LAMBDA OR LAMBDABAR(SEE ALSO SECTION Y AND VO)     12/79
VOA  A   0                                 BERGE     77 HLBC                     3/77
VOA  B   8    1.8        0.7               BERGE     79 HLBC                    12/79
VOA  C   3    0.6        0.6      0.3      BALLAGH   81 HYBR (KO+LAMBDA)/(MU+E-)  2/82*
VOA
VOA  A  BERGE 77 USED FNAL 15 FT CHAMBER FILLED WITH H-NEON. SAW TWO            3/77
VOA  A  POSSIBLE MU E EVENTS, COMMENSURATE WITH PREDICTED BACKGROUND.           3/77
VOA  A  NEITHER WITH ASSOCIATED VO.                                             3/77
VOA
VOA  B  BERGE79 QUOTES 21+-8 NEUTRAL STRANGE PARTICLES FOR 12(MU+E-). WE       12/79
VOA  B  DIVIDE.                                                                12/79
VOA
VOA  C  BALLAGH 81 IS FNAL EXPT.                                                2/82*
VOA           . . . . . . . . . . .
VOA AVG       0.95       0.55     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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VAP       NUMBER OF VOS PER EVENT IN ANTI-NEUTRINO NUCLEON-->SAME-SIGN          2/82*
VAP        DILEPTON ANYTHING;WHERE THE VO IS A KOS OR A LAMBDA(SEE ALSO SEC.Y)  2/82*
VAP  A   3    1.0        1.2      1.0      AMMOSOV2  81 HYBR    VO/(MU+E+)EVENT  2/82*
VAP
VAP  A  AMMOSOV2 81 IS FNAL EXPT.                                               2/82*

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R1        CHARMED HADRON BRANCHING RATIO INTO (MU NEU ANYTHING)/TOTAL
R1   A   8    A FEW PERCENT                BENVENU2  75 SPEC    FNAL NEUTRINO NU  2/76
R1   B 315 APPROX 0.15                     HOLDER    77 SPEC                     12/77
R1   C        0.19  OR LESS                BAUM      77                          12/77
R1   D   3    0.15       0.18       0.07   DEDEN     77 HLBC                      1/78
R1
R1   A  BENVENUTI2 75 LOOKS AT ANTINEUTRINO NUCLEON --> MUON HADRONS.  SEES      2/76
R1   A  EXCESS EVENTS ABOVE INCIDENT ENERGY 30 GEV.  COMPARES BENVENUTI1 75      2/76
R1   A  DIMUON EVENTS WITH EXCESS EVENTS TO GET BRANCHING RATIO.                 2/76
R1
R1   B  HOLDER 77 VALUE IS FROM NEU AND ANEU INDUCED DIMUON EVENTS OF           12/77
R1   B  OPPOSITE SIGN. SEE SEC. Y LISTING ABOVE. BR CALCULATED USING EFF        12/77
R1   B  BASED ON DECAY OF D+(1850) TO KO MU+ NEU.                               12/77
R1
R1   C  BAUM 77 PUTS UPPER LIMIT ON E+- MU-+ PROD AT ISR. INFERS BR ABOVE       12/77
R1   C  FROM THIS, ASSUMING THAT ALL DIRECT ELECTRONS COME FROM THE D.          12/77
R1
R1   D  DEDEN 77 IS FOR CHARMED BARYON --> LAMBDA LEPTON+ NEU ANYTHING.          1/78
R1   D  SEES 3 NEU N --> MU- E+ VO X EVENTS AND EXCESS OF 42+-20 NEU N -->       1/78
R1   D  MU- LAMBDA X EVENTS OVER EXPECTED ASSOC. PROD..  SUGGESTS CHRM.BAR.      1/78

R2        CHARMED HADRON (ASSOC. VO) BRANCHING RATIO INTO SEMILEPTONICS/ALL
R2   A   2    0.1   OR MORE                BLIETSCHA 76 HLBC    M=2.5-4 GEV       2/76
R2
R2   A  THIS BR.RATIO AND MASS ARE REQD. BY OBSERVED RATE AND CHARM SCHEME.     2/76

R3        CHARMED HADRON BRANCHING RATIO INTO (E NEU ANYTHING)                  12/77
R3   A        0.11       0.03              BRANDEL2  77 SPEC E+E- 4-5.2 GEV(ECM) 12/77
R3   A        0.16       0.06              BRANDEL2  77 SPEC E+E- 4-5.2 GEV(ECM) 12/77
R3            0.082      0.019             FELLER    78 SMAG E+E- 3.9-7.4GEV ECM 11/79
R3
R3   A  FIRST BRANDELIK 77 VALUE USES INCLUSIVE ELECTRON EVENTS. SECOND         12/77
R3   A  VALUE(ERROR STAT ONLY) USES EVENTS WITH A SECOND ELECTRON.              12/77

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CC        CHARMED HADRON EVIDENCE IN COSMIC RAYS
CC       SEE ALSO THE REVIEW BY K.NIU, PROC. 19 INTL. CONF. ON HEP. TOKYO,       4/82*
CC       1978, P.447.                                                            4/82*
CC
CC   A   1 EVENT                           NIU       71 EMUL                     9/76
CC   A  NIU 71 DETECTS CHGD PARTICLE DECAYING INTO HADRON+PIO. MASS=1.78GEV      9/76
CC   A  AND TAU=2.2 E-14 IF SECONDARY IS PION. MASS=2.95 GEV AND TAU=3.6         9/76
CC   A  E-14 IF IT IS PROTON. POSSIBLE EVIDENCE OF PAIR PRODUCTION.              9/76
CC
CC   B   8 EVENTS                          TASAKA    73 EMUL                     9/76
CC   B  SAME TYPE AS NIU EVENT. TAU BETW 1.5 AND 175 E-13.                       9/76
CC
CC   C   1 EVENT                           SUGIMOTO  75 EMUL                     1/77
CC   C  SAME TYPE AS NIU EVENT. TWO SUCH PARTICLES PRODUCED TOGETHER.            1/77
CC   C  TAU1=6.E-13. DECAYS TO CHARGED PRONG + ETA. TAU2=4.E-12, DECAYS TO       1/77
CC   C  CHARGED PRONG + PIO. MASSES OF BOTH PARTICLES ARE ABOUT 2.0 GEV IF       1/77
CC   C  DECAY PRONG IS PROTON, 1.7 IF DECAY PRONG IS KAON, AND 1.55 IF           1/77
CC   C  DECAY PRONG IS PI. COMBINED MASS OF THE TWO NEW PARTICLES = 4.1 GEV      1/77
CC   C  OR 3.8 GEV ASSUMING THE DECAY PRONGS TO BE KAONS OR PIONS                1/77
CC   C  RESPECTIVELY. CONSISTENT WITH LAMBDA/C+ LAMBDABAR/C-.SEE GAISSER 76      1/77
CC
CC   D   4 EVENTS                          SAWAYANAG 79 EMUL                     1/80
CC   D  SAWAYANAGI 79 ANALYZE BRAZIL-JAPAN COLLAB DATA AT MT. CHACALTAYA.        1/80
CC   D  THE VERY HIGH RATE 4/24 OF X-PARTICLE EVENTS MAY BE DUE TO HIGH          1/80
CC   D  ENERGY OF THE INCIDENT HADRONS (APPROXIMATELY 10**5 GEV).                1/80

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EM      CHARMED HADRON OBSERVATIONS IN MISC. EMUL.EXPTS. WHERE LIFETIME SEEN  3/77
EM   1   2 EVENTS                            HOSHINO   75 EMUL TAU E-12 TO E-14     4/82*
EM   A   1 EVENT                             JAIN      75 EMUL TAU APROX. 10E-13    2/77
EM   B   2 EVENTS                            KOMAR     75 EMUL    TAU .LT. E-15     4/77
EM   C   1 EVENT                             BURHOP    76 EMUL    TAU APPROX E-13   3/77
EM   D   0  1.5E-30 OR LESS   CL=.90         COREMANS  76 EMUL    TAU E-12 TO E-14  3/77
EM   E   3 EVENTS (SEMILEPTONIC)             BANNIK    77 EMUL TAU E-13 TO E-15    12/79
EM   F   1 EVENT                             BANNIK2   77 EMUL TAU APPROX E-14     12/79
EM   G   0    7.E-30 OR LESS   CL=.90        BOZZOLI   77      300.400 GEV P-NUCL   1/78
EM   H   0    0.0018 OR LESS   CL=.90        MUNDRA    77 EMUL +- TAU E-12 TO E-14  1/78
EM   I   9 EVENTS                            KOMAR     78 EMUL    TAU=1.2 E-14      1/80
EM   J   1 EVENT  PAIR PROD                  USHIDA    78 EMUL 400 GEV P-NUCLEUS    2/79
EM   K   3 EVENTS                            ALLASIA   79 HYBR TAU APPROX E-13     12/79
EM   L   1                                   ANGELINI  79 HYBR    TAU=2 TO 5 E-13  12/79
EM   M   2                                   ANGELIN2  79 HYBR    NEU BEAM          1/80
EM   N   1 EVENT  (SEMILEPTONIC)             FUCHI     79 EMUL    TAU APPROX E-13  12/79
EM   O   1 EVENT  PAIR PROD                  FUCHI2    79 EMUL 400 GEV P-NUCLEUS   12/79
EM   P   9 EVENTS                            KOMAR     79 EMUL 400 GEV P NUCLEUS   12/79
EM   Q   1 EVENT                             KOMAR2    79 EMUL 200 GEV PI- NUCLEUS 12/79
EM   R   6 EVENTS                            ADAMOVICH 81 SPEC CHARM PAIR PHOTOPRO  1/82*
EM   S   4 EVENTS                            FUCHI     81 EMUL CHARM PAIR PROD.     1/82*
EM   T   5 EVENTS                            TOLSTOV   81 EMUL 70GEV P, 50GEV PI-   2/82*
EM
EM   1  HOSHINO 75 IS FNAL 205 GEV PROTON EXPT.  SEES TWO EVENTS, ONE            4/82*
EM   1  NEUTRAL DECAY AND ONE CHARGED DECAY WITH SHORT LIFTIMES.                 4/82*
EM
EM   A  JAIN 75 IS A FNAL 300 GEV PROTON EXPT. EVENT SHOWS DECAY OF NEUTRAL   2/77
EM   A  INTO HADRON-E-NEU, TAKING PLACE .019 CM FROM THE PROD VERTEX. MAY      2/77
EM   A  BE LEPTONIC DECAY OF CHARMED PARTICLE.                                 2/77
EM
EM   B  KOMAR 75 IS FNAL 200 GEV/C PROTON EXPT.  SEE 2 EVENTS WITH SINGLE       4/77
EM   B  ELECTRON EMITTED FROM NEAR INTERACTION.                                 4/77
EM
EM   C  BURHOP 76 EXPT DONE AT FERMILAB HIGH ENERGY NEUTRINO BEAM. USED A      3/77
EM   C  COMBINATION OF EMULSION AND SPARK CHAMBERS. THEY SEE A PARTICLE        3/77
EM   C  WITH .AU=ABOUT 6 E-13 SEC DECAYING TO V0 + 3 CHGD TRACKS.  DECAY       3/77
EM   C  MODE APPEARS DIFFERENT FROM PREVIOUSLY OBSERVED MODES OF CHARMED       3/77
EM   C  HADRON DECAYS. SEE READ 79 FOR FURTHER ANALYSIS AND DISCUSSION.        7/79
EM
EM   D  COREMANS 76 USED 300 GEV/C PROTONS. AND LOOKED FOR ABOVE LIFETIMES.   3/77
EM
EM   E  BANNIK 77 USES 70 GEV PROTON BEAM AT SERPUKHOV.                       12/79
EM
EM   F  BANNIK2 77 USES 60 GEV PI- BEAM AT SERPUKHOV. MASS APPROX 2.4 GEV.   12/79
EM
EM   G  BOZZOLI 77 IS FNAL EXPT LOOKING FOR ASSOC PROD OF CHARMED PARTICLES   1/78
EM   G  WITH TAU=3E-15 TO 3E-13 SECONDS AND MASS LT 4.5 GEV.                   1/78
EM
EM   H  MUNDRA 77 IS FNAL 400GEV P EXPT. ABOVE VALUE IS RATIO TO PI+- PROD.   1/78
EM
EM   I  KOMAR 78 IS 400 GEV/C PROTON EXPT AT FNAL. C.S. APPROX 1E-28 CM**2.   1/80
EM
EM   J  USHIDA 78 SEES TWO NEUTRALS WITH TAUS 3.02E-14 AND 1.18E-12 IF         2/79
EM   J  MESONS. 4.21E-14 AND 1.23E-12 IF BARYONS. ASSUMES MESON DECAY MODES   2/79
EM   J  K-E+NU AND PI0 K0. BARYON DECAY MODES XI-E+NU AND PI0 XI0.             2/79
EM
EM   K  ALLASIA 79 USES WIDE BAND NEU BEAM AT CERN. SEES DECAY OF NEUTRAL     12/79
EM   K  SHORT-LIVED PARTICLE.                                                 12/79
EM
EM   L  ANGELINI 79 IS NEU BEAM EXP AT CERN-SPS. SEE ALSO BURHOP 76.          12/79
EM
EM   M  ANGELINI2 79 EVENTS INCLUDE LAM/C+ -->PI+K-P WITH ESTIMATED DECAY      1/80
EM   M  TIME (7.3+-0.1)*E-13 SEC.                                              1/80
EM
EM   N  FUCHI 79 IS 400 GEV P NUCLEUS EXPT AT FNAL.                           12/79
EM
EM   O  FUCHI2 79 EVENT GIVES TAU 2.8-4.4E-13. SEE ALSO USHIDA 78.            12/79
EM
EM   P  KOMAR 79 EVENTS GIVE TAU APPROX 1.5E-14 SEC. CS/NUCLEON=1.2E-28.     12/79
EM
EM   Q  KOMAR2 79 EVENT MAY BE CHARMED BARYON TO E+E- HADRONS VIA N. C.       12/79
EM
EM   R  ADAMOVICH 81 IS CERN SPS EXPT WITH 20-70 GEV TAGGED PHOTONS. SEEN 6  1/82*
EM   R  EVENTS OF CHARM PAIR PROD. IN EMULSION OF WHICH ONE IS (LAMBDA/C+    1/82*
EM   R  DOBAR). SEE LISTINGS FOR LIFETIMES OF CHGD AND NEUTRAL D'S.          1/82*
EM
EM   S  FUCHI 81 IS EMULSION EXPT EXPOSED TO CERN SPS 340 GEV/C PI- BEAM.    1/82*
EM   S  ALL NEUTRAL DECAYS ARE CONSISTENT WITH D0(D0BAR) LEADING TO TAU(D0)  1/82*
EM   S  =(3.1+2.0-1.6)E-13 SEC. CS(PI N-->C CBAR X)=(44+-27)E-30 CM**2.       1/82*
EM
EM   T  TOLSTOV 81 OBSERVED 2 SEMILEPTONIC AND 3 HADRONIC DECAY EVENTS OF     2/82*
EM   T  NEUTRAL PARTICLES WITH LIFETIMES(0.02.0.05.0.05.0.1.1.5)*10**-13      2/82*
EM   T  SEC.  PARTICLE IDENTIFICATION IS POOR AND NO DISCUSSION OF            2/82*
EM   T  DETECTION EFFICIENCY IS GIVEN SO NO MEAN LIFE IS OBTAINABLE.          2/82*

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D       CHARMED HADRON PRODUCTION IN NEU NUCLEON INTERACTIONS(RATIO TO C.C.)  1/79
D    A  64    0.007     0.002               BALTAY    78 HLBC D0--> K0 PI+ PI-      1/79
D    A  11    0.001     0.001               BALTAY    78 HLBC D+--> K0 PI+          1/79
D    B        0.01  OR LESS                 BERGE     78 HBC  DECAY TO LAMBDA PIS  12/79
D    B        0.02  OR LESS                 BERGE     78 HBC  DECAY TO K0 PIONS    12/79
D    C   2    0.041     0.024               BLIETSCHA 79 HBC  D*+ PRODUCTION/C.C.   1/80
D    D  29                                  ARMENISE  81 HYBR CHARMED BARYONS       2/82*
D    E   2    0.0017    0.0010              GRASSLER  81 HBC  LAM/C+-->P K- PI+     1/82*
D
D    A  BALTAY 78 IS FNAL EXPT. NO D0 SEEN IN N.C. EVENTS.                     1/79
D
D    B  BERGE 79 ALSO SET NEU P --> MU- D1--> K0 N(PI)) X/C.C. <0.01 AT      12/79
D    B  CL= 0.9.                                                              12/79
D
D    C  BLIETSCHAU 79 IS CERN BEBC EXPT. SEES ONE EVENT NEU P-->MU- P D*+      1/80
D    C  AND ONE EVENT NEU P-->MU- P D*+ PI+ PI-, WHERE D*+-->D0 PI+ IN BOTH   1/80
D    C  CASES.                                                                 1/80
D
D    D  ARMENISE 81 ANALYZED CERN-SPS 55000 C.C. NEU EVENTS FOR ALL CHARMED   2/82*
D    D  BARYON DECAY MODE WHICH INCLUDE LAMBDA0 OR (K0BAR PI. FOUND EXCESS    2/82*
D    D  29 EVENTS IN Q=1 CHANNEL AROUND M=2.25GEV AND CS*BR=(14.3+-7.4)E-40  2/82*
D    D  CM**2, FOR Q=2 CHANNEL CS*BR < 3.3E-40 CM**2 AT CL=.90.               2/82*
D
D    E  GRASSLER 81 IS CERN BEBC EXPT. SEEN 2 EVENTS INTERPRETED AS           1/82*
D    E  NEU P --> MU- PI+ (LAMBDA/C+ --> P K- PI+). ABOVE VALUE IS FOR        1/82*
D    E  CS(NEU P --> MU- (LAM/C+ --> LAMBDA PI+) X) /C.C.                     1/82*
D         . . . . . . . . . .
U   AVG         0.0020    0.0013  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)

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DA      CHARMED HADRON PRODUCTION IN NEUBAR NUCLEON REACTION (RATIO TO C.C.)  1/82*
DA   A   0      0.08  OR LESS   CL=.90    FANOURAKI 80 HBC  LOW EN. NEUBAR BEAM  1/82*
DA   B   0      0.002 OR LESS   CL=.90    AMMOSOV   81 HLBC D- --> K0 PI-        1/82*
DA   B   0      0.003 OR LESS   CL=.90    AMMOSOV   81 HLBC D0BAR-->K0 PI+ PI-   1/82*
DA
DA   A  FANOURAKIS 80 IS BNL EXPT WITH LOW ENERGY NEUBAR BEAM (E ABOUT 1.3    1/82*
DA   A  GEV). LOOKED FOR DELTA(Q)=-DELTA(S) EVENTS. ABOVE LIMIT CORRESPONDS  1/82*
DA   A  TO CS(NEUBAR P --> MU+ CHARM) < 3.8 E-40 CM**2.                      1/82*
DA
DA   B  AMMOSOV 81 IS FNAL EXP. QUARK-PARTON MODEL FIT SUGGESTS 0.06+-0.02   1/82*
DA   B  OF V0'S IS FROM CHARM PROD. NO OBSERVATION OF PEAKS IN INVAR. MASS   1/82*
DA   B  LEADS TO ABOVE LIMITS.                                               1/82*

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REFERENCES FOR CHARMED HADRON SEARCHES


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NIU       71 PTP 46 1644       +NIKUNO,MAEDA                       (TOKY+YOKOHAMA)
TASAKA    73 PTP 50 1879       +YAMAMOTO                                    (KONA)

AUBERT    75 PRL 35 416        +BECKER,BIGGS,BURGER,CHEN+               (MIT+BNL)
     ALSO 77 MA
BALTAY    75 PRL 34 1118       +CAUTIS,COHEN,CSORNA,KALELKAR + (COLU+BING)
BENVENU1  75 PRL 34 419        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU2  75 PRL 34 597        BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
     ALSO 74 PRL 33 984        AUBERT,BENVENUTI+     (HARV,PENN,WISC,FNAL)

BENVENU3  75 PRL 35 1199       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU4  75 PRL 35 1203       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BENVENU5  75 PRL 35 1249       BENVENUTI,CLINE,FORD+ (HARV,PENN,WISC,FNAL)
BLESER    75 PRL 35 76         +GOBBI,KENAH,KEREN+    (FNAL+NWES+ROCH+SLAC)
CARLSSON  75 NP B99 451        +EKSPONG,HOLMGREN,NILSSON+        (STOH+LIVP)
DEDEN     75 PL 58B 361              (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)

HOSHINO   75 PTP 53 1859       +KURAMATA,MAEDA+      (NAGO+YOKO+TOKY+AICH)
JAIN      75 PRL 34 1238       P. L. JAIN, B. GIRARD                  (BUFF)
KOMAR     75 JETPL 21 239      +ORLOVA,TRETYAKOVA,CHERNYAYSKII        (LEBD)
     ALSO 76 SJNP 24 275       KOMAR,ORLOVA,TRETYAKOVA,CHERNYAVSKII (LEBD)
SUGIMOTO  75 PTP 53 1540       +SATO,SAITO                       (TMAS+TOKY)
WARD      75 NP B101 29        +ANSORGE,CARTER,MOUNT,NEALE+           (CAVE)

AAHLIN    76 NP B107 476       +ALPGARD,ANDERSEN,BERGVATN+(OSLO+STOH+HELS)
ABOLINS   76 PRL 37 417        +CARDIMONA,MATTHEWS,SIDWELL+ (MSU+OSU+CARL)
ALBROW    76 NP B114 365       CERN+DARE+FOM+LANC+LIVP+MCHS+RHEL+UTR+LUND
APEL      76 SJNP 24 507       +BERTOLUCCI,VIKTOROV,VINCELLI+  (SERP+CERN)
BARISH    76 PRL 36 939        +BARTLETT,BODEK,BROWN,BUCHHOLZ + (CIT+FNAL)
BINKLEY   76 PRL 37 578        +GAINES,PEOPLES,KNAPP+  (FNAL+COLU+HAWA+ILL)

BINTINGE  76 PRL 37 732        BINTINGER,LUNDY,AKERLOF+   (FNAL+MICH+PURD)
BLIETSCH  76 PL 60B 207              (AACH+BRUX+CERN+EPOL+MILA+ORSA+LOUC)
BUNNELL   76 PRL 37 85         +CHENG,DELPAPA,DORFAN,DOUNGVAN+ (UCSC+SLAC)
BURHOP    76 PL 65B 299         (LOUC+FNAL+BELG+DUUC+CERN+LOIC+ROMA+STRB+I
CESTER    76 PRL 37 1178       +FITCH,KADEL,WEBB,WHITTAKER +      (PRIN+BNL)

COREMANS  76 PL 65B 480        +SACTON+     (BELG+DUUC+LOUC+ROMA+STRB+WARS)
GHIDINI   76 NP B111 189       +NAVACH,ODWELL,KENYON+         (OMEGA GROUPS)
HAGOPIAN  76 PRL 36 296        +WILKINS,WIND,HAGOPIAN,ALBRIGHT+ (FSU+BRAN)
KLEMS     76 APP B7 497        +KO,LANDER,PELLETT+     (UCD+CRAC+WASH+WARS)
KNAPP     76 PRL 37 882        +LEE,LEUNG,SMITH +       (COLU+HAWA+ILL+FNAL)
QUINN     76 PR D14 2957       D. J. QUINN, R. H. MILBURN             (TUFTS)
VONKROGH  76 PRL 36 710        +FRY,CAMERINI,CLINE+     (WISC+LBL+CERN+HAWA)

ALDER     77 PL 66B 401        +BLOCK+ (AACH+UCR+CERN+HARV+LAUS+MUNI+NWES)
ASRATYAN  77 PL 71B 439        +EPSTEIN,GRIGORIEV,KALGANOV +    (ITEP+SERP)
BALLAGH   77 PRL 39 1650       +BINGHAM,BOSETTI,FRETTER+    (LBL+HAWA+WASH)
BALTAY    77 PRL 39 62         +HIBBS,HYLTON,KALELKAR,ORANCE +   (COLU+BNL)
BANNIK    77 JETPL 25 550      +BOBODZHANOV,SALOMOV,SUNTSZINYAN+      (JINR)
BANNIK2   77 JETPL 26 275      +BOBODZHANOV,LESKIN,MUKHTAROV+         (JINR)
BARISH    77 PR D15 1          +DERRICK,DOMBECK,MUSGRAVE +       (ANL+PURD)
BARISH2   77 PRL 39 981        +BARTLETT,BODEK,BROWN +      (CIT+FNAL+ROCH)
BAUM      77 PL 68B 279        +BLOCK,BOHM+ (AACH+UCR+CERN+HARV+MUNI+NWES)

BERGE     77 PRL 38 266        +DIBIANCA,EMANS +       (FNAL+SERP+ITEP+MICH)
BLANAR    77 PRL 38 192        +BOYER,FAISSLER,GARELICK,GETTNER +    (NEAS)
BLETZACK  77 PRL 38 1241       BLETZACKER,NIEH,SONI                (STON+UCSB)
BOSETTI   77 PRL 38 1248       +GALTIERI,LYNCH +       (LBL+CERN+HAWA+WISC)
BOZZOLI   77 LNC 19 32         +CAMPANINI,CAPILUPPI,GESSAROLI+ (BGNA+FIRZ)
BRANDEL2  77 PL 70B 387        BRANDELIK +       (AACH+DESY+HAMB+MPIM+TOKY)

BRANSON   77 PRL 38 580        +SANDERS,SMITH,THALER,ANDERSON+  (PRIN+EFI)
DEDEN     77 PL 67B 474        +       (AACH+BELG+CERN+EPOL+MILA+LALO+LOUC)
DITZLER   77 PL 71B 451        +FINLEY,JOHNSON,LOEFFLER + (PURD+MICH+FNAL)
GOODARD   77 PR D16 2733       +GILBERT,KEY,GORDON,LAI              (TNTO+BNL)
HAIDT     77 JPG 3 1                      (BERKELEY+CERN+HAWAII+WISCONSIN)

HOLDER    77 PL 69B 377        +KNOBLOCH,MAY+    (CERN+DORT+HEID+SACL+BGNA)
HOLDER2   77 PL 70B 396        +KNOBLOCH,MAY+    (CERN+DORT+HEID+SACL+BGNA)
JONCKHEE  77 PR D16 2073       JONCKHEERE,COOK,CSORNA +      (WASH+LALO+UCD)
     ALSO 76 PL 64B 221        COOK,CSORNA,HOLMGREN+         (WASH+LALO+UCD)
MA        77 PRL 38 172        MA,OH                                   (MSU)
MUNDRA    77 LNC 18 554        +PUTT,STUTELEY,YOCK                    (AUCK)
PICCOLO   77 PRL 39 1503       +PERUZZI,LUKE,LUTH+      (SLAC+LBL+NWES+HAWA)

ABOLINS   78 PL 73B 355        +MATTHEWS,SIDWELL +      (MSU+CARL+FNAL+OSU)
ALIBRAN   78 PL 74B 134         (AACH+BARI+BERG+BRUX+CERN+EPOL+MILA+ORSA+)
ANTIPOV   78 JETPL 28 457      +BEZZUBOV,BUDANOV,BUSHNIN,GORIN+       (SERP)
ANTIPOV2  78 JETPL 28 461      +BEZZUBOV,BUDANOV,GORIN,DENISENKO+     (SERP)
ASRATYAN  78 PL 79B 497        +EPSTEIN,FAKHRUTDINOV+            (ITEP+SERP)
BALLAM    78 PRL 40 741        +BOUCHEZ,CARROLL,CHADWICK+ (SLAC+DUKE+LOIC)
BALTAY    78 PRL 41 73         +CAPOUMBALIS,FRENCH,HIBBS,HYLTON+(COLU+BNL)
BAUM      78 PL 77B 337        +BLOCK,BOEHM+(AACH+UCR+CERN+HARV+MUNI+NWES)
BBDMPST   78 SJNP 28 340       BERL+BUDA+DUBNA+MOSCOW+PRAG+SOFI+TBILISI
BENVENUT  78 PRL 41 725        BENVENUTI+    (FNAL+HARV+OSU+PENN+RUTG+WISC)
     ALSO 78 PRL 41 1204       BENVENUTI+    (FNAL+HARV+OSU+PENN+RUTG+WISC)
BERGE     78 PR D18 1359       +BOGERT,CUNDY,DIBIANCA+(FNAL+UCB+HAWA+MICH)
BOSETTI1  78 PL 73B 380        +DEDEN +      (AACH+BONN+CERN+LOIC+OXF+SACL)
BOSETTI2  78 PL 74B 143        +DEDEN +      (AACH+BONN+CERN+LOIC+OXF+SACL)

CESTER    78 PRL 40 139        +FITCH,KADEL,WEBB,WHITTAKER +      (PRIN+BNL)
CLARK     78 PL 77B 339        +DARRIULAT,EGGERT +           (CERN+SACL+ZURI)
ERRIQUEZ  78 PL 77B 227              BARI+BIRM+BRUX+EPOL+RHEL+SACL+LOUC
FELLER    78 PRL 40 1677       +LITKE,MADARAS,RONAN+   (LBL+SLAC+NWES+HAWA)
FERGUSON  78 PL 79B 161        +BUCHANAN,NODULMAN,POSTER +       (UCLA+SLAC)
     ALSO 79 PR D19 1535       FERGUSON+BUCHANAN,NODULMAN +      (UCLA+SLAC)

HANSL     78 PL 74B 139        +HOLDER,KNOBLOCH+(CERN+DORT+HEID+SACL+BGNA)
JACHOLKO  78 NP B142 53        JACHOLKOWSKA+     (ORSA+BELG+CERN+LOIC+MONS)
KOMAR     78 JETPL 28 453      +ORLOVA,SALMANOVA,TRETYAKOV+           (LEBD)
LAUTERBA  78 PR D17 2507       M.J.LAUTERBACH                         (YALE)
LIPTON    78 PRL 40 608        +GOBBI,KEREN,ROSEN,RUCHTI+ (NWES+ROCH+FNAL)
SPELBRIN  78 PRL 40 605        SPELBRING,GOBBI,KEREN +     (NWES+ROCH+FNAL)
USHIDA    78 LNC 23 577        +FUCHI,HOSHINO+        (AICHI+NAGOYA+YOKOHAMA)
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ALLASIA   79 PL 87B 287         (ANKA+BRUX+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
ANGELINI  79 PL 80B 428         (ANKA+BRUX+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
ANGELIN2  79 PL 84B 150         (ANKA+BRUX+CERN+DUUC+LOUC+KEYN+PISA+ROMA+)
ANTIPOV   79 JETPL 30 343      +BEZZUBOV,BUDANOV,GORIN,DENISOV+        (SERP)
ARMENISE  79 PL 86B 115        +ERRIQUEZ+         (BARI+CERN+EPOL+MILA+ORSA)
ATIYA     79 PRL 43 414        +HOLMES,KNAPP,LEE+              (COLU+ILL+FNAL)

BARANOV   79 PL 81B 261        +IVANILOV,KONYUSHKO,KORABLEV+          (SERP)
BARANOV2  79 SJNP 29 622       +VOLKOV,IVANILOV,KONYUSHKO,KORABLEV+ (SERP)
BAUER     79 PRL 43 1551       +KILEY,BALL,CHANG,CHEN,GHOOS+      (MSU+FNAL)
BBDMPSST  79 SJNP 29 46        BERL+BUDA+DUBNA+MOSC+PRAG+SERP+SOFIA+TBILI
BERGE     79 PL 81B 85         +BOGERT,ENDORF,HANFT+ (FNAL+SERP+ITEP+MICH)

BLIETSCH  79 PL 86B 108        BLIETSCHAU+         (AACH+BONN+CERN+MPIM+OXF)
BRANSON   79 PR D20 337        +MCDONALD,SANDERS,SMITH,THALER+  (PRIN+EFI)
BROWN     79 PRL 43 410        +BARISH,BARTLETT,BODEK,SHAEVITZ+ (CIT+STAN)
CHILINGA  79 PL 83B 136        CHILINGAROV,CLARK+             (CERN+SACL+ETH)
     ALSO 79 NP B151 29        CHILINGAROV,CLARK+             (CERN+SACL+ETH)
COTEUS    79 PRL 42 1438       +DIESBURG,FINE,LEE,SOKOLSKY+ (COLU+ILL+BNL)

DEGROOT   79 PL 86B 103        +HANSL,HOLDER     (CERN+DORT+HEID+SACL+BGNA)
DIAMANTB  79 PRL 43 1774       DIAMANT-BERGER,DISHAW,FAESSLER+  (STAN+CIT)
DISHAW    79 PL 85B 142        +DIAMANT-BERGER,FAESSLER,LIU+     (SLAC+CIT)
DRIJARD   79 PL 81B 250        +FISCHER,GEIST+         (CERN+CDEF+HEID+KARL)
DRIJARD2  79 PL 85B 452        +FISCHER+     (CERN+CDEF+DORT+HEID+LAPP+WARS)

FUCHI     79 NC 51A 18         +HOSHINO,KURAMATA+   (NAGOYA+AICHI+YOKOHAMA)
FUCHI2    79 PL 85B 135        +HOSHINO,KURAMATA,NIU+   (NAGOYA+AICHI+YOKO)
GIBONI    79 PL 85B 437        AACH+CERN+HARV+MUNI+NWES+UCR COLLABORATION
     ALSO 79  THESIS-HARVARD   D.DIBITONO                              (HARV)
KOMAR     79 SJNP 29 40        +ORLOVA,SALMANOVA,TRETYAKOVA +         (LEBD)
KOMAR2    79 SJNP 29 50        +ORLOVA,TRETYAKOVA,CHERNYAVSKII        (LEBD)
LOCKMAN   79 PL 85B 443        +MEYER,RANDER,SCHLEIN,WEBB+       (UCLA+SACL)
READ      79 PR D19 1287        (FNAL+BELG+DUUC+LOIC+LOUC+KEYN+MULHOUSE+)
SAWAYANA  79 PR D20 1037       K. SAWAYANAGI                          (WASEDA)

ADAMOVIC  80 PL 89B 427        ADAMOVICH+(PHOTON-EMUL,OMEGA-PHOTON COLLS.)
ALLISON   80 PL 93B 509        BRUX+CERN+OXF+PADO+ROMA+RHEL+TRST COLLAB.
ANDERSON  80 PR D21 3075       +COLEMAN,KARHI,NEWMAN+          (EFI+ILL+PRIN)
ARMENISE  80 PL 94B 527        +       (BARI+BIRM+LIBH+EPOL+RHEL+SACL+LOUC)
ASTON     80 PL 94B 113        +(BONN+CERN+EPOL+GLAS+LANC+MCHS+LALO+LPTP+)
AUBERT1   80 PL 94B 96         +BASSOMPIERRE+(EUROPEAN MUON COLLABORATION)
AUBERT2   80 PL 94B 101        +BASSOMPIERRE+(EUROPEAN MUON COLLABORATION)

BALLAGH   80 PL 89B 423        +BINGHAM+       (UCB,LBL,FNAL,HAWA,WASH,WISC)
BALLAGH2  80 PR D21 569        +BINGHAM+       (UCB+LBL+FNAL+HAWA+WASH+WISC)
BARLOUTA  80 NP B172 25        BARLOUTAUD,BIRO+ (BGNA+GLAS+RHEL+SACL+TORI)
BROMBERG  80 PR D22 1513       +DICKEY,FOX,GOMEZ+        (CIT+FNAL+ILLC+IND)

CLARK     80 PRL 45 682        +JOHNSON,KERTH,LOKEN+    (UCB+LBL+FNAL+PRIN)
CLARK2    80 PRL 45 1465       +JOHNSON,KERTH,LOKEN+    (UCB+LBL+FNAL+PRIN)
     ALSO 81 PR D24 559        GOLLIN,SHOEMAKER,SURKO+       (PRIN+LBL+FNAL)
FANOURAK  80 PR D21 562        FANOURAKIS,RESVANIS+         (ATHU+ATEN+WISC)
FRITZE    80 PL 96B 427        AACH+BONN+CERN+LOIC+OXF+SACL COLLABORATION

JACQUES   80 PR D21 1206       +KALELKAR,MILLER,PLANO+      (RUTG+STEV+COLU)
RITCHIE   80 PRL 44 230        +BODEK,COLEMAN,MARSH+  (ROCH+CIT+FNAL+STAN)
SANDWEIS  80 PRL 44 1104       SANDWEISS,CARDELLO,COOPER+         (YALE+FNAL)
SOUKAS    80 PRL 44 564        +WANDERER,WENG,BREGMAN+(BNL+HARV+ORNL+PENN)

ADAMOVIC  81 PL 99B 271        ADAMOVICH+(PHOTON-EMUL,OMEGA-PHOTON COLLS.)
ADEVA     81 PL 102B 285       +AGUILAR-BENITEZ+  (LEBC-EHS COLLABORATION)
AMMOSOV   81 NP B177 365       +DENISOV,ERMOLOV+       (SERP+FNAL+ITEP+MICH)
AMMOSOV2  81 PL 106B 151       +DENISOV,ERMOLOV+       (SERP+FNAL+ITEP+MICH)
ARMENISE  81 PL 104B 409       +FOGLI-MUCIACCIA+(BARI+CERN+EPOL+MILA+LALO)
AUBERT    81 PL 106B 419       +BASSOMPIERRE+(EUROPEAN MUON COLLABORATION)

BALLAGH   81 PRD 24 7          +BINGHAM+       (UCB+LBL+FNAL+HAWA+WASH+WISC)
BASILE    81 NC 63A 230        +ROMEO,CIFARELLI+       (CERN+BGNA+FRAS+PGIA)
BASILE2   81 NC 65A 457        +ROMEO,CIFARELLI+       (CERN+BGNA+FRAS+PGIA)
FUCHI     81 LNC 31 199        +HOSHINO,MIYANISHI+     (NAGO+AICH+TOKY+YOKO)
GRASSLER  81 PL 99B 159        +LANSKE,SCHULTE+  (AACH+BONN+CERN+MPIM+OXF)

IRION     81 PL 99B 455        +SEEBRUNNER+       (AACH+CERN+HARV+MUNI+NWES)
JONKER    81 PL 107B 241       CHARM COLLAB.      (ANIK+CERN+HAMB+ITEP+ROMA)
NISHIKAW  81 PRL 46 1555       NISHIKAWA+          (NWES+CIT+FNAL+ROCH+ROCK)
TOLSTOV   81 JETPL 33 232      +SHABRATOVA,BOBODZHANOV,TSIN-YAN+      (JINR)
TRINKO    81 PR D23 1889       +BENVENUTI+ (WISC+PENN+FNAL+HARV+OHIO+RUTG)

                               REVIEWS REFERRED TO IN DATA CARDS

GAISSER   76 PR D14 3153       T.K.GAISSER,F.HALZEN                (BART+WISC)
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BOTTOM HADRON SEARCHES

SEE ALSO THE LISTINGS FOR THE B(5200) AND THE LAMBDA/B0(5500).

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HD      CROSS SECTION FOR THE PRODUCTION OF A (B, ANTI-B) PAIR IN
HD      HADRONIC REACTIONS (CM**2/NUCLEON).
HD
HD   A       8. E-33 OR LESS  CL=.90   COLEMAN   80 SPEC 225 GEV/C PI- NUCL   8/81*
HD   B      50. E-33 OR LESS  CL=.90   DIAMANT-B 80 SPEC 400 GEV/C P FE       8/81*
HD   C   30 (3.8+-1.2) E-35            BASILE     81 SFM  P P --> LAM/B0 E+ X 1/82*
HD   D                                 DRIJARD    82 SFM  P P 63 GEV ECM      4/82*
HD
HD   A  COLEMAN 80 LOOK FOR PI- NUCLEON --> B BBAR ANYTHING, FOLLOWED BY      8/81*
HD   A  B --> J/PSI X, ANTI-B --> MU X (AND THE CHARGE CONJUGATE DECAYS).     8/81*
HD
HD   B  DIAMANT-BERGER 80 LOOK FOR P FE --> J/PSI MU X, P FE --> MU MU MU     8/81*
HD   B  X, AND P FE --> MU+ MU+ X.  TABLE 2 OF THEIR PAPER GIVES CS LIMITS    8/81*
HD   B  FOR SEVERAL FINAL STATES.                                             8/81*
HD
HD   C  BASILE 81 IS P P AT 62 GEV ECM AT THE CERN-ISR.  A 6-STANDARD-        4/82*
HD   C  DEVIATION PEAK IS SEEN IN THE P K- PI+ PI- MASS SPECTRUM WHEN         4/82*
HD   C  TRIGG...NG ON AN E+ AND KEEPING ONLY THE K- PI+ IN THE D0 REGION.     4/82*
HD   C  SEE THE LAMBDA/B0 LISTING FOR THE MASS OF THE PEAK.  THE ABOVE        4/82*
HD   C  CROSS SECTION IS AFTER THE ABOVE AND OTHER CUTS ARE MADE.             4/82*
HD
HD   D  DRIJARD 82, WITH SAME ACCELERATOR, ENERGY, AND DETECTOR AS BASILE     4/82*
HD   D  81, SEE NO LAMBDA/B0 PEAK, AND CLAIM THAT NEITHER EXPERIMENT HAS      4/82*
HD   D  THE SENSITIVITY TO SEE SUCH A SIGNAL.                                 4/82*
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BE      BOTTOM HADRON PRODUCTION IN (E+ E-) COLLISIONS.  SEE ALSO THE
BE      LISTING FOR THE B(5200).
BE
BE   A                                  ALI       79      ECM=9.4-17 GEV      8/81*
BE   B                                  BARTEL    80 JADE ECM=27-35 GEV       4/82*
BE   C                                  BERGER    80 PLUT ECM=12-31.6 GEV     8/81*
BE
BE   A  ALI 79 ANALYZE SPHERICITY AND THRUST DATA TAKEN BY PLUTO AND TASSO   6/81*
BE   A  AT DESY-PETRA.  SUGGEST ONSET OF A (B-QUARK ANTI-B-QUARK) THRESHOLD  6/81*
BE   A  IN THE ENERGY RANGE 9.4<ECM<13.0 GEV.                                8/81*
BE
BE   B  BARTEL 80 IS JADE COLLABORATION AT DESY-PETRA.  AN UPPER LIMIT OF    4/82*
BE   B  2E-9 SEC IS GIVEN FOR THE B-MESON LIFETIME, ASSUMING ITS MASS IS     4/82*
BE   B  5 GEV.                                                               4/82*
BE
BE   C  BERGER 80 MEASURE INCLUSIVE MUON PRODUCTION BY PLUTO AT DESY-PETRA.  8/81*
BE   C  BR(B-QUARK-->MU X) IS BETWEEN 0 AND 0.33.                            8/81*
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MU      BOTTOM HADRON PROD. CROSS SECTION IN MU NUCLEON INTERACTION (CM**2).  2/82*
MU      SEE ALSO SECTION MU IN CHARM SEARCHES.                               2/82*
MU
MU   A      1.2E-35  OR LESS  CL=.90   AUBERT    81 SPEC   250GEV MU+ ON FE  2/82*
MU
MU   A  AUBERT 81 IS MU+ N AT THE CERN SPS.  OBSERVE TWO MU+MU+MU+ AND       2/82*
MU   A  ONE MU+MU-MU- WRONG-SIGN EVENTS.                                     2/82*
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Y       BOTTOM HADRON PRODUCTION IN NEUTRINO NUCLEON --> 2 LEPTONS ANYTHING 12/81*
Y       AND ANTINEUTRINO NUCLEON --> 2 LEPTONS ANYTHING.  SEE ALSO SECTIONS 12/81*
Y       Y, VO, AND VAP IN CHARM SEARCHES.                                   12/81*
Y
Y    A  21 MU+MU-                      ARMENISE  80 HLBC    NEUBAR BEAM     12/81*
Y    B   2 MU+E+(M>5.6GEV)             AMMOSOV   81 HYBR    NEUBAR INDUCED   2/82*
Y    C   6 MU+E-,MU+MU- (5<W<6.5GEV)   BALLAGH   81 HYBR    NEUBAR INDUCED   2/82*
Y
Y    A  ARMENISE 80 IS AT THE CERN-SPS WITH BEBC EXPOSED TO A WIDE-BAND     12/81*
Y    A  ANTINEUTRINO BEAM.  OBSERVED PEAK AT W AROUND 6 GEV IN DIMUON       12/81*
Y    A  EVENTS MAY BE DUE TO BOTTOM BARYON PRODUCTION.                      12/81*
Y
Y    B  AMMOSOV 81 AT FNAL OBSERVED 2 MU+E+ EVENTS WITH W>5.6GEV, PERHAPS    2/82*
Y    B  DUE TO B-BARYON PRODUCTION AND DECAY.  RATIO TO CHARGED CURRENT IS   2/82*
Y    B  (2.+3.3-1.6)E-3.                                                     2/82*
Y
Y    C  BALLAGH 81 AT FNAL OBSERVE EXCESS IN SAME MASS REGION AS             2/82*
Y    C  ARMENISE 80.                                                         2/82*
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REFERENCES FOR BOTTOM HADRON SEARCHES


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ALI       79 PL 83B 375        ALI,KOERNER,WILLRODT,KRAMER      (DESY+HAMB)
ARMENISE  80 PL 94B 527        +       (BARI+BIRM+LIBH+EPOL+RHEL+SACL+LOUC)
BARTEL    80 ZPHY C6 295       JADE C.(DESY+HAMB+HEID+LANC+MCHS+RHEL+TOKY)
BERGER    80 PRL 45 1533       PLUTO C.(AACH+BERG+DESY+HAMB+UMD+STEG+WUPP)
COLEMAN   80 PRL 44 1313       +ANDERSON,KARHI,NEWMAN,+       (EFI+ILL+PRIN)
DIAMANTB  80 PRL 44 507        DIAMANT-BERGER,DISHAW,+       (STAN+SLAC+CIT)

AMMOSOV   81 PL 106B 151       +DENISOV,ERMOLOV,+      (SERP+FNAL+ITEP+MICH)
AUBERT    81 PL 106B 419       +BASSOMPIERRE+(EUROPEAN MUON COLLABORATION)
BALLAGH   81 PRD 24 7          +BINGHAM,+      (UCB+LBL+FNAL+HAWA+WASH+WISC)
BASILE    81 LNC 31 97         +BONVICINI,CARA ROMEO+(CERN+BGNA+FRAS+PGIA)
DRIJARD   82 PL 108B 361       +FISCHER,+   (CERN+CDEF+DORT+HEID+LAPP+WARS)
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TOP HADRON SEARCHES

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TE      TOP HADRON PRODUCTION IN (E+ E-) COLLISONS
TE   A  NONE ECM=22-31.6 GEV           BARTEL1   79 JADE R                   8/81*
TE   B  NONE ECM=22-31.6 GEV           BARTEL2   79 JADE <S>                 8/81*
TE   C  NONE                           BARBER    79 MRKJ R,<S>,<T>          12/81*
TE   D  NONE ECM=22-31.6 GEV           BERGER    79 PLUT R,<S>,<T>,MU        8/81*
TE   E  NONE ECM=30-36 GEV             BARBER    80 MRKJ R,<T>,MU            8/81*
TE   F  NONE ECM=12-31.6 GEV           BERGER    80 PLUT MU                  8/81*
TE   G  NONE ECM=33-35.8 GEV           BARTEL    81 JADE MU                  2/82*
TE                                                                           8/81*
TE                                  COMMENTS
TE      ALL ABOVE MEASUREMENTS ARE DONE AT DESY-PETRA. THE LAST COLUMN       8/81*
TE      SPECIFIES MEASURED QUANTITIES.                                       8/81*
TE                                                                           8/81*
TE   B  BARTEL2 79 OBSERVE NO SIGNIFICANT ACCUMULATION OF SPHERICAL EVENTS.  8/81*
TE
TE   D  BERGER 79 FIND R=3.88+0.22 WHICH ALONG WITH SPHERICITY AND THRUST    8/81*
TE   D  BEHAVIORS IS AGAINST OPEN TOP ANTI-TOP CHANNEL BELOW 30GEV. FINAL    8/81*
TE   D  MUONS ARE ALSO CONSISTENT WITH EXPECTATION WITHOUT TOP QUARK STATE.  8/81*
TE
TE   E  BARBER 80 FIND NO EVIDENCE FOR AN OPEN TOP ANTI-TOP THRESHOLD IN R,  8/81*
TE   E  THRUST DIST. AND INCLUSIVE MUONS. ENERGY SCAN IN THE RANGE 29.9<ECM  8/81*
TE   E  <31.6GEV REVEALS NO HADRON RESONANCE CORRESPONDING TO A (TOP-QUARK   8/81*
TE   E  ANTI-TOP-QUARK) BOUND STATE.                                         8/81*
TE
TE   F  BERGER 80  MEASURES INCLUSIVE MUONS WITH MOMENTUM >2 GEV/C. AGREE    8/81*
TE   F  WITH EXPECTED SEMILEPTONIC DECAYS FROM CHARMED AND BOTTOM MESONS.    8/81*
TE
TE   G  BARTEL 81 MEASURES INCLUSIVE MUONS WITH MOMENTUM  >1.4 GEV/C. AGREE  2/82*
TE   G  WITH EXPECTED SEMILEPTONIC DECAYS FROM CHARMED AND BOTTOM MESONS.    2/82*
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REFERENCES FOR TOP HADRON SEARCHES


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BARTEL1   79 PL 88B 171        JADE C.(DESY+HAMB+HEID+MCHS+LANC+RHEL+TOKY)
BARTEL2   79 PL 89B 136        JADE C.(DESY+HAMB+HEID+MCHS+LANC+RHEL+TOKY)
BARBER    79 PL 85B 463        MARK-J COLLAB.    (AACH+DESY+MIT+AIKO+BHEP)
BERGER    79 PL 86B 413        PLUTO C.(AACH+BERG+DESY+HAMB+UMD+SIEG+WUPP)
BARBER    80 PRL 44 1722       MARK-J COLLAB.    (AACH+DESY+MIT+AIKO+BHEP)
BERGER    80 PRL 45 1533       PLUTO C.(AACH+BERG+DESY+HAMB+UMD+SIEG+WUPP)
BARTEL    81 PL 99B 277        +CORDS+(DESY+HAMB+HEID+LANC+MCHS+RHEL+TOKY)
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OTHER STABLE PARTICLE SEARCHES

We collect here those searches which do not fit neatly into one of the above search categories. These include axion searches (section AX), supersymmetric partner searches (SYM), trimuon and four-lepton production in neutrino and anti-neutrino reactions (T, FL), and heavy particle searches in accelerator experiments (EE, CH, CS, D, ICH, RPI, BD) and in cosmic rays (F).

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AX      AXION (AO) PRODUCTION RATIO TO PIO PROD CROSS-SEC.                      6/78
AX       FOR THEORY AND REVIEW SEE WEINBERG PRL 40, 223 (1978): WILCZEK
AX       PRL 40, 279 (1978): DONNELLY PR D18, 1607 (1978): BARSHAY ET AL.,
AX       PRL 46, 1361 (1981): AND BARROSO+MUKHOPADHYAV PL 106, 91 (1981).
AX       FOR INVISIBLE-AXION THEORY SEE E.G. WISE, GEORGI AND GLASHOW
AX       PRL 47, 402 (1981), AND FOR VERY HEAVY AXION THEORY SEE E.G. TYE
AX       PRL 47, 1035 (1981).  FOR K --> PI AO SEE ALSO E.G., GOLDMAN
AX       AND HOFFMAN, PRL 40, 220 (1978): FRERE ET AL., PL 103B, 129 (1981).
AX            1. E-8    OR LESS  CL=.90   ALIBRAN   78 HYBR    BEAM DUMP         6/78
AX            6. E-9    OR LESS  CL=.95   ASRATYAN  78 CALO    BEAM DUMP        12/79
AX    A       5.4E-14   OR LESS  CL=.90   BELLOTTI  78 HLBC    FOR MASS=1.5 MEV  1/79
AX    A       4.1E- 9   OR LESS  CL=.90   BELLOTTI  78 HLBC    FOR MASS=1 MEV    1/79
AX    A       1.5E- 8   OR LESS  CL=.90   BELLOTTI  78 HLBC    BEAM DUMP         1/79
AX    B       1. E-8    OR LESS  CL=.90   BOSETTI   78 HYBR    BEAM DUMP         6/78
AX    C                                   DONNELLY  78                          12/79
AX            0.5E-8    OR LESS  CL=.90   HANSL1    78 WIRE    BEAM DUMP         6/78
AX    D                                   MICELMACH 78                          12/79
AX    E                                   VYSOTSSKI 78                           1/80
AX    F                                   BECHIS    79 CNTR                     12/79
AX    G                                   CALAPRICE 79         CARBON            9/81*
AX    H       1. E-8    OR LESS  CL=.90   COTEUS    79 OSPK    BEAM DUMP         7/79
AX    I       1. E-3    OR LESS  CL=.95   DISHAW    79 CALO    400 GEV P P      12/79
AX    J                                   ZHITNITSK 79         HEAVY AXION       9/81*
AX    K   0                               FAISSNER  80 OSPK BEAM DUMP,AO-->E+E-  1/82*
AX    L      1.E-8      OR LESS  CL=.90   JACQUES   80 HLBC    28 GEV PROTONS    9/81*
AX    L      1.E-14     OR LESS  CL=.90   JACQUES   80 HLBC    BEAM DUMP         9/81*
AX    M                                   SOUKAS    80 CALO    28GEV P   B.DUMP  9/81*
AX    N   0                               ASANO     81 CNTR STOPPED K+-->PI+ AO  2/82*
AX    O  12                               FAISSNE1  81 OSPK CERN PS NU WIDEBAND  5/82*
AX    P  15                               FAISSNE2  81 OSPK BEAM DUMP,AO-->2GAM  2/82*
AX    Q   8                               KIM       81 CSPK 26 GEV P NUC-->AO X  1/82*
AX    R   0                               ZEHNDER   81 CNTR BA*-->(AO-->2GAM)BA  1/82*
AX    S                                   EDWARDS   82 CBAL J/PSI-->GAMMA+AO     4/82*
AX
AX    A  BELLOTTI 78 FIRST VALUE COMES FROM SEARCH FOR A-->E+E-. SECOND          1/79
AX    A  VALUE COMES FROM SEARCH FOR A-->2GAMMA, ASSUMING MASS<2*MASS(E-).       1/79
AX    A  FOR ANY MASS SATISFYING THIS,LIMIT IS ABOVE VALUE*(MASS**-4).           1/79
AX    A  THIRD VALUE USES DATA OF PL 60B 401 AND QUOTES CS(PROD)*CS(INTER-       1/79
AX    A  ACTION)<1D**-67 CM**4.                                                  1/79
AX
AX    B  BOSETTI 78 QUOTES CS(PROD)*CS(INTERACT)< 2.E-67 CM**4                   6/78
AX
AX    C  DONNELLY 78 EXAMINES DATA FROM REACTOR NEUTRINO EXPTS OF REINES 76     12/79
AX    C  AND GURR 74 AS WELL AS SLAC BEAM DUMP EXPT. EVIDENCE IS NEGATIVE.      12/79
AX
AX    D  MICELMACHER 78 FINDS NO EVIDENCE OF AXION EXISTENCE IN REACTOR         12/79
AX    D  EXPTS OF REINES 76 AND GURR 74. (SEE REF UNDER DONNELLY 78 BELOW).     12/79
AX
AX    E  VYSOTSSKII 78 DERIVED LOWER LIMIT FOR THE AXION MASS. 25 KEV FROM       1/80
AX    E  LUMINOSITY OF THE SUN AND 200 KEV FROM RED SUPERGIANTS.                 1/80
AX
AX    F  BECHIS 79 LOCKED FOR THE AXION PRODUCTION IN LOW ENERGY ELECTRON       12/79
AX    F  BREMSSTRAHLUNG AND THE SUBSEQUENT DECAY INTO EITHER 2 GAMMAS OR        12/79
AX    F  E+ E-. NO SIGNAL FOUND. C.L.=0.90 LIMITS FOR MODEL PARAMETER(S)        12/79
AX    F  ARE GIVEN.                                                             12/79
AX
AX    G  CALAPRICE 79 SAW NO AXION EMISSION FROM EXCITED STATES OF CARBON.       9/81*
AX    G  SENSITIVE TO AXION MASS BETWEEN 1 AND 15 MEV.                           9/81*
AX
AX    H  COTEUS 79 IS A BEAM DUMP EXPERIMENT AT BNL.                            12/79
AX
AX    I  DISHAW 79 IS A CALORIMETRIC EXPERIMENT AND LOOKS FOR LOW ENERGY        12/79
AX    I  TAIL OF ENERGY DISTRIBUTUIONS DUE TO ENERGY LOST TO WEAKLY             12/79
AX    I  INTERACTING PARTICLES.                                                 12/79
AX
AX    J  ZHITNITSKII 79 ARGUE THAT A HEAVY AXION BY YANG (3<M<40 MEV)            9/81*
AX    J  CONTRADICTS EXPERIMENTAL MUON ANOM. MAGNETIC MOMENTS.                   9/81*
AX
AX    K  FAISSNER 80 IS SIN BEAM DUMP EXPT WITH 590 MEV PROTONS LOOKING FOR      1/82*
AX    K  AO-->E+ E- DECAY. ASSUMING AO/PI0=5.5E-7,OBTAINED DECAY RATE LIMIT      1/82*
AX    K  20/(AO MASS) MEV/SEC (CL=.90),WHICH IS ABOUT 10**-7 BELOW THEORY        1/82*
AX    K  AND INTERPRETED AS UPPER LIMIT TO MASS(AO) < 2* MASS(E-).               1/82*
AX
AX    L  JACQUES 80 IS A BNL BEAM DUMP EXP.  FIRST LIMIT ABOVE COMES FROM        9/81*
AX    L  NON-OBSERVATION OF EXCESS NC-TYPE EVENTS (CS(PROD)*CS(INTERACT) <       9/81*
AX    L  7.E-68 CM**4,CL=0.90).  SECOND LIMIT IS FROM NON-OBSERVATION OF         9/81*
AX    L  AXION DECAYS INTO TWO GAMMAS OR E+E-, AND FOR AXION MASS A FEW MEV.     9/81*
AX
AX    M  SOUKAS 80 AT BNL OBSERVED NO EXCESS OF NC-TYPE EVENS IN BEAM DUMP.      9/81*
AX
AX    N  ASANO 81 IS KEK EXPT. SET BR(K+ -->PI+ AO) < 3.8E-8 AT CL=.90.          2/82*
AX
AX    O  FAISSNER1 81 SEE EXCESS MU E EVENTS. SUGGEST AXION INTERACTIONS.        5/82*
AX
AX    P  FAISSNER2 81 IS SIN 590MEV PROTON BEAM DUMP. OBSERVED 14.5+-5.0 EVS     2/82*
AX    P  OF 2 GAMMA DECAY OF LONG-LIVED NEUTRAL PENETRATING PARTICLE WITH        2/82*
AX    P  M(2 GAMMA) < APPROX. 1 MEV. AXION INTERPR. WITH ETA-AO MIXING GIVES     2/82*
AX    P  M(AO)=(250+-25)KEV, TAU(2 GAMMA)=(7.3+-3.7)E-3 SEC FROM ABOVE RATE.     2/82*
AX
AX    Q  KIM 81 ANALYZED 8 CANDIDATES FOR AO-->2 GAMMA OBTAINED BY AACHEN-       1/82*
AX    Q  PADOVA EXPT AT CERN WITH 26 GEV PROTONS ON BE. ESTIMATED AXION MASS     1/82*
AX    Q  IS ABOUT 300 KEV AND LIFE IS (0.86 TO 5.6)E-3 S DEPENDING MODELS.       1/82*
AX    Q  FAISSNER, PRIV. COMM, SAYS AXION PROD. UNDERESTIMATED AND MASS          4/82*
AX    Q  OVERESTIMATED.  CORRECT VALUE AROUND 200 KEV.                           4/82*
AX    R  ZEHNDER 81 LOOKED FOR BA*-->AO BA TRANSITION WITH AO-->2 GAMMA.         1/82*
AX    R  OBTAINED 2GAMMA COINCIDENCE RATE < 2.2E-5 /SEC(CL=.95) EXCLUDING        1/82*
AX    R  MASS(AO)>160 KEV(OR 200 KEV DEPENDING ON HIGGS MIXING).                 1/82*
AX    R  HOWEVER, SEE BARROSO + MUKHOPADHYAY, REF. ABOVE.                        4/82*
AX
AX    S  EDWARDS 82 LOOKED FOR J/PSI-->GAMMA+AXION DECAYS BY LOOKING FOR         4/82*
AX    S  EVENTS WITH A SINGLE GAMMA (OF ENERGY APPROX. 1/2 THE J/PSI MASS),      4/82*
AX    S  PLUS NOTHING ELSE IN THE DETECTOR. THEY FIND                            4/82*
AX    S  BR(J/PSI-->GAMMA+AXION)<1.4E-5 AT CL=.90.  THIS RESULT IS               4/82*
AX    S  INCONSISTENT WITH THE AXION INTERPRETATION OF THE FAISSNER2 81          4/82*
AX    S  RESULT.                                                                 4/82*

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T       TRIMUON PRODUCTION IN NEUTRINO NUCLEON INTERACTIONS
T        SEE ALSO SECTION 'NEU' IN 'HEAVY LEPTON SEARCHES' AND
T        SECTION 'Y' IN 'CHARMED HADRON SEARCHES'. FOR EXTENSIVE DISCUSSION,
T        SEE ALBRIGHT 78 (PR D18, 108), HANSL 78 (NP B142, 381), AND KANE 79
T        (PR D19, 1978).
T
T     A   2 EVENTS MU- MU MU              BARISH    77 SPEC    NEU BEAM          7/77
T     A  BARISH 77 EVENTS CONTAIN FAST MU- AND 2 ADDITIONAL MUONS WITH LOW       7/77
T     A  ENGERY IN DIMUON REST FRAME. SLOW MUONS COULD COME FROM EITHER          7/77
T     A  VIRTUAL PHOTON OR VECTOR MESON OR FROM ASSOC PROD OF CHARMED            7/77
T     A  PARTICLES WHICH DECAY LEPTONICALLY.                                     7/77
T
T     B   6 SEEN                          BENVENUTI 77 NEUL    5/6NEU,1/6NEUBAR 12/77
T     B  BENVENUTI 77 IS FNAL EXPT. CAN BE EXPLAINED BY PROD OF NEW HEAVY       12/77
T     B  LEPTON --> MU- NEUBAR NEW LIGHTER LEPTON --> MU+ MU- NEU.              12/77
T
T     C                                   BLETZACKE 77 RVUE                     12/77
T     C  BLETZACKER 77 EXPLAINS TRIMUON AND LIKE SIGN DIMUON PROD AS ASSOC      12/77
T     C  PROD OF CHARM.                                                         12/77
T
T     D   3 SEEN                          HOLDER    77 SPEC                     12/77
T     D  HOLDER 77 EVENTS ARE MU-MU-M+ AND MU-MU+MU+ WITH NEU BEAM, AND          12/77
T     D  MU+MU-MU- WITH NEUBAR BEAM. RATE RELATIVE TO CHARGED CURRENT EVENTS    12/77
T     D  IS 4*10**-5.                                                           12/77
T
T     E                                   ALBRIGHT  78 RVUE                     12/79
T     E  ALBRIGHT 78 COMPARES DATA OF TRIMUON AND FOUR-MUON EVENTS LISTED       12/79
T     E  ABOVE WITH SIX MODELS.                                                 12/79
T
T     F   7 SEEN                          BENVENUTI 78 NEUL                      8/78
T     F  BENVENUTI 78 IS FNAL EXPT. 6 OF THE EVENTS ARE SEEN USING A 95 PCNT     8/78
T     F  NEU BEAM, 1 USING AN 83 PCNT NEUBAR BEAM. SEE NORI 78 FOR LIMITS        8/78
T     F  OF THE PROB THAT THE TRIMUONS ARE PRODUCED BY A NEW SHORT-LIVED         8/78
T     F  SOURCE OF NEUTRINOS.                                                    8/78
T
T     G  76 EVENTS MU- MU- MU+            HANSL2    78 SPEC    NEU BEAM          1/79
T     G  HANSL2 78 IS CERN SPS EXPT. RATE RELATIVE TO SINGLE MUON EVENTS IS      1/79
T     G  (3.0+-.4)*10**-5 FOR E(NEU)>30 GEV. CAN BE EXPLAINED AS C.C.            1/79
T     G  INTERACTIONS WITH ADDITIONAL LOW MASS MU PAIRS. NO EVIDENCE FOR NEW     1/79
T     G  HEAVY LEPTON.                                                           1/79
T
T     H  39 MU-MU-MU+ SEEN                BENVENUTI 79 NEUL    NEU BEAM          7/79
T     H  BENVENUTI 79 INCLUDES 9 EVENTS FROM BENVENUTI 77 AND 78. RATE           7/79
T     H  RELATIVE TO SINGLE MUON EVENTS IS (1.1+-.5)*10**-4 FOR E(NEU)>100       7/79
T     H  GEV.  CONSISTENT WITH E.M. AND DIRECT PRODUCTION OF MU PAIRS.           7/79
T     H  CHARM ASSOC PROD MAY ACCOUNT FOR 20 PERCENT OF PRODUCTION.  NO          7/79
T     H  EVIDENCE FOR NEW HEAVY LEPTONS OR HEAVY QUARKS.                         7/79
T
T     I   8 MU+MU+MU-                     DEGROOT   79 SPEC    NEUBAR BEAM      12/79
T     I  DEGROOT 79 IS CERN SPS EXPT. RATE RELATIVE TO SINGLE MUON EVENTS       12/79
T     I  IS (1.8+-0.6)E-5 FOR E(NEU)>=30 GEV AND P(MU)>=4.5 GEV/C. COULD BE     12/79
T     I  EXPLAINED AS C.C. INTERACTION ACCOMPANIED BY A MUON PAIR OF EITHER     12/79
T     I  HADRONIC OR E.M. ORIGIN AS IN NEU CASE. NEGATIVE SIGNAL FOR HEAVY      12/79
T     I  LETPON.                                                                12/79

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FL      FOUR-LEPTON PRODUCTION IN NEUTRINO-NUCLEON INTERACTIONS                  2/79
FL    A   1 2MU+ 2MU-                     HOLDER    78 SPEC                      2/79
FL    B   1 2E- E+ MU+                    LOVELESS  78 HBC                       2/79
FL
FL    A  HOLDER 78 EVENT IS FROM CERN-SPS EXPT. RATE RELATIVE TO MU+MU-          2/79
FL    A  EVENTS IS 1.4E-4.                                                       2/79
FL
FL    B  LOVELESS 78 EVENT IS FROM FNAL EXPT. EVENT ALSO HAS 1 KOS AND 7         2/79
FL    B  GAMMAS.                                                                 2/79

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MU      DI- AND TRI-MUON PRODUCTION IN MU NUCLEON INTERACTIONS
MU      SEE ALSO SECTION 'MU' IN HEAVY LEPTON SEARCHES AND CHARM SEARCHES       10/81*
MU    A  11 TRIMUON EVENTS                CHANG     77 SPEC                     12/77
MU    A  32 DIMUON EVENTS                 CHANG     77 SPEC                     12/77
MU    B 450 MU+MU-  223 MU-MU- EVENTS     LEBRITTON 80 SPEC M(VIRTUAL PHOTON-   12/81*
MU    B 158 MU-MU-MU+ EVENTS              LEBRITTON 80 SPEC NUCLEON) < 4.5 GEV  12/81*
MU
MU    A  CHANG 77 DIMUON RATE IS GT 5*10**-4 THAT OF INCLUSIVE MUON RATE.       12/77
MU    A  CROSS SECTION UNCORRECTED FOR ACCEPTANCE IS 5*10**-36 CM**2/NUCLEON    12/77
MU
MU    B  LEBRITTON 80 IS BNL EXP.  LOOKED FOR MUOPRODUCTION OF SHORT-           12/81*
MU    B  LIVED PARTICLES BELOW CHARM THRESHOLD. TRIMUONS ARE CONSISTENT WITH    12/81*
MU    B  QED TRIDENT PLUS RHO DECAY AND DIMUONS ALSO WITH KNOWN SOURCES.  AT    12/81*
MU    B  CL=.90 CS(MU-N-->M+ X)*BR(M+ -->MU+ X) < 1.64 E-34 CM**2 AND CS(MU-    12/81*
MU    B  N-->M- X)*BR(M- -->MU- X)<.01E-34 CM**2 WITH M+- SHORT-LIVED MESON.    12/81*

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EE      HEAVY PARTICLE PRODUCTION CROSS-SECTION IN E+ E- REACTION                2/82*
EE      (RATIO TO CS(E+E- -->MU+MU-)). SEE ALSO SECTION EE IN QUARK SEARCHES     2/82*
EE      AND SECTION EE IN MAGNETIC MONOPOLE SEARCHES.                            2/82*
EE    A   0 5.0 E-2  OR LESS  CL=.90   BARTEL    80 JADE Q=(3,4,5)/3 2-12GEV     2/82*
EE    B   0 1.6 E-2  OR LESS  CL=.95   KINOSHITA 82 PLAS Q=3-180,M<14.5GEV       2/82*
EE
EE    A  BARTEL 80 IS DESY PETRA EXPT WITH WCM=27-35 GEV. ABOVE LIMIT IS FOR     2/82*
EE    A  INCLUSIVE PAIR PROD AND RANGES BETWEEN 1.E-1 - 1.E-2 DEPENDING ON       2/82*
EE    A  MASS AND PROD MOMENTUM DIST. (SEE THEIR FIGS.9,10,11).                  2/82*
EE
EE    B  KINOSHITA 82 IS SLAC PEP EXPT AT WCM=29 GEV USING LEXAN AND CR-39       2/82*
EE    B  PLASTIC SHEETS SENSITIVE TO HIGHLY IONIZING PARTICLES.                  2/82*

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CH      HEAVY PARTICLE PRODUCTION CROSS SECTION (CM**2)
CH    A   0  1. E-31 OR LESS              LEIPUNER  73 CNTR +- M=3-11 GEV        5/76
CH    B    0.3-1.3E-31 OR LESS            CARROLL   78 SPEC    M=2.-2.5 GEV      1/79
CH
CH    A  LEIPUNER 73 IS AN NAL 300 GEV P EXPT. WOULD HAVE DETECTED PARTICLES     4/76
CH    A  WITH LIFETIME GREATER THAN 200 NSEC.                                    4/76
CH
CH    B  CARROLL 78 LOOK FOR NEUTRAL, S=-2 DIHYPERON RESONANCE IN                1/79
CH    B  P P --> 2K+ X. CS VARIES WITHIN ABOVE LIMITS OVER MASS RANGE AND        1/79
CH    B  PLAB=5.1-5.9 GEV/C.                                                     1/79

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Stable Particles

OTHER STABLE PARTICLE SEARCHES


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CS      HEAVY PARTICLE PRODUCTION CROSS-SECTION (CM**2/NUCLEON)
CS   A    0  2.5E-35 OR LESS              GUSTAFSON 76 CNTR 0  TAU GT 10**-7       1/77
CS
CS   A  GUSTAFSON 76 IS A 300 GEV FNAL EXPT LOOKING FOR HEAVY (M GT 2 GEV)        1/77
CS   A  LONGLIVED NEUTRAL HADRONS IN THE M4 NEUTRAL BEAM. THE ABOVE TYPICAL       1/77
CS   A  VALUE IS FOR M=3 GEV AND ASSUMES AN INTERACTION CROSS SECTION OF          1/77
CS   A  1 MB.  VALUES AS A FUNCTION OF MASS AND INTERACTION CROSS SECTION         1/77
CS   A  ARE GIVEN IN FIG. 2.                                                      1/77

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D       HEAVY PARTICLE PRODUCTION DIFFERENTIAL CROSS SECTION (CM**2/SR-GEV)
D    A    0  1.5E-36 OR LESS              DORFAN    65 CNTR BE TARGET  M=3-7GEV   5/76
D    A    0  3.0E-36 OR LESS              DORFAN    65 CNTR FE TARGET  M=3-7GEV   5/76
D         0  2.4E-35 OR LESS  CL=.90      BINON     69 CNTR Q=- M=1-1.8 GEV       3/77
D    B    0  2.4E-35 OR LESS  CL=.90      ANTIPOV1  71 CNTR Q=- M=1.2-1.7,2.1-4   3/77
D    C    0  1.2E-35 OR LESS  CL=.90      ANTIPOV2  71 CNTR Q=- M=2.2-2.8         3/77
D    D    0  5.8E-34 OR LESS  CL=.90      ALPER     73 SPEC +- M=1.5-24 GEV       5/76
D    E    0  1. E-31 OR LESS  CL=.90      APPEL     74 CNTR +- M=3.2-7.2 GEV      2/76
D    F    0  2.2E-33 OR LESS  CL=.90      ALBROW    75 SPEC Q=+-1  M=4-15 GEV     1/77
D    F    0  1.1E-33 OR LESS  CL=.90      ALBROW    75 SPEC Q=+-2  M=6-27 GEV     1/77
D    G    0  8. E-35 OR LESS  CL=.90      JOVANOVIC 75 CNTR +- M=15-26 GEV        2/76
D    G    0  1.5E-34 OR LESS  CL=.90      JOVANOVIC 75 CNTR Q=+-2, M=3-10 GEV     2/76
D    G    0  6. E-35 OR LESS  CL=.90      JOVANOVIC 75 CNTR Q=+-2, M=10-26 GEV    2/76
D    H    0  2.6E-36 OR LESS  CL=.90      BALDIN    76 CNTR Q=-1, M=2.1-9.4 GEV   1/77
D
D    A  DORFAN 65 IS A 30 GEV/C P EXPT AT BNL.  UNITS ARE PER GEV MOMENTUM        5/76
D    A  PER NUCLEUS.                                                              5/76
D
D    B  ANTIPOV1 71 LIMIT INFERRED FROM FLUX RATIO. 70 GEV P EXPERIMENT.          3/77
D
D    C  ANTIPOV2 71 IS FROM SAME 70 GEV P EXP. AS ANTIPOV1 71 AND BINON 69.       3/77
D
D    D  ALPER 73 IS CERN ISR 26+26 GEV P+P EXPT.  P>.9 GEV, .2< BETA <.65.         5/76
D
D    E  APPEL 74 IS NAL 300 GEV P+W EXPERIMENT. STUDIES FORWARD PRODUCTION        2/76
D    E  OF HEAVY (UP TO 24 GEV) CHARGED PARTICLES WITH MOMENTA 24-200GEV(-)       2/76
D    E  AND 40-150GEV (+CHG).  ABOVE TYPICAL VALUE IS FOR 75 GEV AND IS           5/76
D    E  PER GEV MOMENTUM PER NUCLEON.                                             5/76
D
D    F  ALBROW 75 IS A CERN ISR EXPT WITH ECM=53 GEV. THETA=40 MR. SEE            1/77
D    F  FIG. 5 FOR MASS RANGES UP TO 35 GEV.                                      1/77
D
D    G  JOVANOVICH 75 IS A CERN ISR 26+26 AND 15+15 GEV P+P EXPERIMENT.           2/76
D    G  FIG.4 COVERS RANGES Q=1/3 TO 2 AND M=3 TO 26 GEV.                         2/76
D    G  VALUE IS PER GEV MOMENTUM.                                                5/76
D
D    H  BALDIN 76 IS A 70 GEV SERP EXP.  VALUE IS PER AL NUCLEUS AT               1/77
D    H  THETA=0.  FOR OTHER CHARGES IN RANGE -0.5 TO -3.0, CL=.90 LIMIT IS        1/77
D    H  (2.6E-36)/ABS(CHARGE) FOR MASS RANGE (2.1 TO 9.4GEV)*ABS(CHARGE).         1/77
D    H  ASSUMES STABLE PARTICLE INTERACTING WITH MATTER AS DO ANTIPROTONS.        1/77

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ICH     LONGLIVED HEAVY PARTICLE INVARIANT C.S. (CM**2/GEV**2/NUCLEON)            1/79
ICH  A    0  1.1E-37 OR LESS  CL=.90      CUTTS     78 CNTR MASS=4-10 GEV         1/79
ICH  B    0  3.0E-37 OR LESS  CL=.90      VIDAL     78 CNTR MASS=4.5-6 GEV       12/79
ICH  C    0  6. E-33 OR LESS  CL=.90      ARMITAGE  79 SPEC     M=1.87 GEV        7/79
ICH  C    0  1.5E-33 OR LESS  CL=.90      ARMITAGE  79 SPEC     M=1.5-3.0 GEV     7/79
ICH  D    0                               BOZZOLI   79 CNTR Q=+-(2/3,1,4/3,2)     1/80
ICH
ICH  A  CUTTS 78 IS P BE EXPT AT FNAL SENSITIVE TO PARTICLES OF TAU>5E-8SEC       1/79
ICH  A  VALUE IS FOR -.3<X<0 AND PT=0.175.
ICH
ICH  B  VIDAL 78 IS FNAL 400 GEV PROTON EXPT. VALUE IS FOR X=0 AND PT=0.          2/79
ICH  B  PUTS LIFETIME LIMIT OF <5*10**-8 SEC ON PARTICLE IN THIS MASS RANGE       2/79
ICH
ICH  C  ARMITAGE 79 IS CERN-ISR EXPT AT ECM=53 GEV. VALUE IS FOR X=0.1 AND        7/79
ICH  C  PT=0.15. OBSERVED PARTICLES AT M=1.87 GEV ARE FOUND ALL CONSISTENT        7/79
ICH  C  WITH BEING ANTIDEUTERONS.                                                 7/79
ICH
ICH  D  BOZZOLI 79 IS CERN-SPS 200 GEV P N EXPERIMENT. LOOKS FOR PARTICLE         1/80
ICH  D  WITH TAU LARGER THAN 10**-8 SEC. SEE THEIR FIG.11-18 FOR PRODUCTION       1/80
ICH  D  CROSS SECTION UPPER LIMITS VS MASS.                                       1/80

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RPI     LONGLIVED HEAVY PARTICLE PRODUCTION (CS(HEAVY PARTICLE)/CS(PION) )       12/81*
RPI  A    0                               BUSSIERE  80 CNTR Q=+-(2/3,1,4/3,2)    12/81*
RPI
RPI  A  BUSSIERE 80 IS CERN-SPS EXPT WITH 200-240 GEV PROTONS ON BE AND AL       12/81*
RPI  A  TARGET. SEE THEIR FIG.6-7 FOR CS RATIO VS MASS.                          12/81*

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CA      CROSS-SEC FOR PROC AND CAPT OF LONG-LIVED MASSIVE PARTICLES (CM**2)
CA   A    0  0.1-9E-36 OR LESS            FRANKEL   74 CNTR TAU=1 TO 1000 HRS     7/76
CA   B    0  1.4-9E-36 OR LESS            FRANKEL   75 CNTR TAU=50 MS TO 10 HRS   2/77
CA   C    0   2-20E-34 OR LESS            ALEKSEE1  76 ELEC TAU=100 MS TO 1 DAY   4/77
CA   C    0  0.2-8E-34 OR LESS            ALEKSEE2  76 ELEC TAU=5 MS TO 1 DAY     3/77
CA
CA   A  FRANKEL 74 LOOKS FOR PARTICLES PRODUCED IN THICK AL TARGETS BY            7/76
CA   A  300-400 GEV/C PROTONS.                                                    7/76
CA
CA   B  FRANKEL 75 IS EXTENSION OF FRANKEL 74.                                    2/77
CA
CA   C  ALEKSEEV(1,2) 76 ARE 61-70 GEV P SERP EXPT. CS IS PER PB NUCLEUS.         3/77

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F       HEAVY PARTICLE FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)
F         0  5.0E-11 OR LESS  CL=.90   JONES     67 ELEC     M=5 TO 15 GEV      3/77
F         0  3.0E-10 OR LESS           BJORNBOE  68 CNTR     M ABOVE 5 GEV      4/77
F         0  3.0E-8  OR LESS           DARDO     72 CNTR                        4/77
F         0  1.5E-9  OR LESS           TONWAR    72 CNTR     M GT 10 GEV        4/77
F    A    5  6. E-9  OR MORE           YOCK      74 CNTR     M GT 6 GEV         1/76
F         0  7. E-10 OR LESS  CL=.90   YOCK      75 ELEC +- Q GT 7 OR LT -7E    9/76
F         0  1.0E-9  OR LESS           BRIATORE  76 ELEC                        4/77
F    B       1.3E-9  OR LESS  CL=.90   BHAT      78 CNTR +- M GT 1 GEV          1/80
F         3  4.3+-1.3 E-11             GOODMAN   79 ELEC     M>= 5 GEV          7/79
F    C    3  3.0E-9                    YOCK      80 SPRK     M APPROX.=4.5 MP  10/81*
F    D    0  3.5E-11 OR LESS  CL=.90   ULLMAN    81 CNTR PLANCK-MASS E+19GEV    2/82*
F    D    0  7. E-11 OR LESS  CL=.90   ULLMAN    81 CNTR M=1.E-16GEV OR LESS    2/82*
F    E    3  2. E-9                    YOCK      81 SPRK Q=+-1 M ABOUT 4.5MP    1/82*
F    E    3                            YOCK      81 SPRK FRACTIONALLY CHGD      1/82*
F
F    A  YOCK 74 EVENTS COULD BE TRITONS.                                        1/76
F
F    B  BHAT 78 IS AT KOLAR GOLD FIELDS. LIMIT IS FOR TAU > 10**-6 SEC.         1/80
F
F    C  YOCK 80 EVENTS ARE WITH CHARGE EXACTLY OR APPROX. EQUAL TO UNITY.      10/81*
F
F    D  ULLMAN 81 IS SENSITIVE FOR HEAVY SLOW SINGLY CHARGE PARTICLE            2/82*
F    D  REACHING EARTH WITH VERTICAL VELOCITY 100-350 KM/S.                     2/82*
F
F    E  YOCK 81 SAW ANOTHER 3 EVENTS WITH Q=+-1 AND M ABOUT 4.5MP AS WELL       1/82*
F    E  AS 2 EVS WITH M>5.3MP,Q=+-.75+-.05 AND M>2.8MP,Q=+-.70+-.05 AND 1       1/82*
F    E  EVENT WITH M=19.3+-3.1MP,Q=+-.89+-.06 AS POSSIBLE HEAVY CANDIDATES.     1/82*

TCH     TACHYON FLUX IN COSMIC RAYS (NUMBER/CM**2-SEC-SR)                      10/81*
TCH  A    0  2.3E-10 OR LESS  CL=.95   BHAT      79 CNTR                       10/81*
TCH  A  BHAT 79 IS AT OOTACAMUND(2200M ABOVE SEA).  NO SIGNAL IN 3621 HOURS    10/81*

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C       LIGHT (BETWEEN MU AND E MASSES) PARTICLE MASS(UNITS-ELECTRON MASSES)
C         0   NONE BETWEEN 6 AND 25     BELOUSOV  60 CNTR  SPINOR,TAU>1 E-8     5/76
C         0   NONE BETWEEN 2 AND 25     GORBUNOV  60 CC    SPINOR,TAU>1 E-9     5/76
C         0   NONE BETWEEN 5 AND 175    COWARD    63 CNTR  SPINOR,TAU>22 E-10   5/76
C         0   NONE BETWEEN 5 AND 175    COWARD    63 CNTR  SCALAR,TAU>68 E-10   5/76
C    A    0   NONE BETWEEN 2 AND 13     BLAGOV    75 CNTR SPINOR,TAU>2E-10SEC   2/76
C    A    0   NONE BETWEEN 2 AND 10.6   BLAGOV    75 CNTR SCALAR,TAU>2E-10SEC   2/76
C    B    0   NONE BETWEEN 110 AND 180 VIERTEL    78 CNTR TAU >2.E-5 SEC        1/80
C
C    A  BLAGOV 75 BOUNDS ON LIFETIME DEPEND ON MASS AND IMPROVE AS MASS         4/77
C    A  DECREASES.  AT 2 GEV THE EXPERIMENT IS SENSITIVE TO TAU>3E-11 SEC       4/77
C    A  FOR SPINOR, TAU>5E-11 SEC FOR SCALAR.                                   4/77
C
C    B  VIERTEL 78 SEARCHES FOR MU+ -->X+ NEU. FINDS BR<8.5E-6 IN MASS          1/80
C    B  RANGE GIVEN ABOVE (CL=.90). BEST LIMIT BR<5.E-7 (CL=.90) IS  FOUND      1/80
C    B  AT MASS=8C MEV.                                                         1/80

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SYM     SUPERSYMMETRIC PARTNER OF MUON                                         10/81*
SYM  A    0   NONE BETWEEN 3 AND 15GEV BARBER    80 MRKJ    E+E- -->PARTNERS 10/81*
SYM
SYM  A  BARBER 80 SEARCHED FOR SPIN-0 PARTNERS OF MUONS.  NO INCREASE OF       10/81*
SYM  A  ACOPLANAR MUONS WAS OBSERVED.  ABOVE MASS LIMIT IS CL=.95.             10/81*

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CON     CONCENTRATION OF HEAVY (CHARGE+1) STABLE PARTICLES IN MATTER
CON   2.E-22 TO 1.E-21 OR LESS         SMITH     79 SPEC WATER,M=6-350 MPROT  7/79

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H       HIGGS BOSON MASS LIMIT (GEV)                                            1/82*
H    A    0  0.409   OR MORE           DZHELYADI 81       ETAPRIM-->ETA HIGGS   1/82*
H
H    A  DZHELYADIN 81 OBTAINED BR(ETA PRIM-->ETA MU+MU-)<1.5E-5 (CL=.90)        1/82*
H    A  WHICH EXCLUDES A LIGHT HIGGS BOSON IN MU+MU- CHANNEL.                   1/82*

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BD   A                                 LOSECCO   81 CALO    28 GEV PROTONS      1/82*
BD
BD   A  LOSECCO 81 IS BNL EXPT. SEES NO SLOW NEUTRALS AT TOF. LIMIT FOR CS(     1/82*
BD   A  PROD)*CS(INT) RATIO OF HVY LEPTONS TO PROMT NEUS IS 2.2E-2(CL=.90).     1/82*
BD   A  NO EXCESS N.C.EVS LEADS TO CSP*CSI*ACCEPTANCE<2.26E-71 CM**4/NUC**2     1/82*
BD   A  (CL=.90)FOR LIGHT NEUTRALS. ACC. DEPENDS ON MODELS (0.1 TO 4.E-4).      1/82*

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ION     HIGHLY IONIZING PARTICLE FLUX  (UNITS NUMBER/M**2-YR)
ION       0   10.4)  OR LESS  CL=.95   KINOSHITA 81 PLAS Z/BETA 30-100          2/82*

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REFERENCES FOR OTHER NEW PARTICLE SEARCHES

BELOUSOV 60 JETP 11 1143 +RUSAKOV,TAMM,CERENKOV (LEBD)
GORBUNOV 60 JETP 11 51 +SPIRIDONOV,CERENKOV (LEBD)
COWARD 63 PR 131 1782 +GITTELMAN,LYNCH,RITSON (STAN)
DORFAN 65 PRL 14 995 +EADES,LEDERMAN,LEE,TING (COLU)
JONES 67 PR 164 1584 (MICH+WISC+LBL+UCLA+MINN+COSU+COLO+MURA)

BJORNBOE 68 NC B53 241 +DAHGARD,HANSEN,CHATTERGEE+ (BOHR+BERN)
BINON 69 PL 30B 510 DUTEIL,KACHANOV,KHROMOV,KUTYIN+ (SERP)

ANTIPOV1 71 PL 34B 164 +DENISOV,DONSKOV,GORIN,KACHANOV+ (SERP)
ANTIPOV2 71 NP B31 235 +DENISOV,DONSKOV,GORIN,KACHANOV+ (SERP)
DARDO 72 NC 9A 319 DARDO,NAVARRA,PENENGO,SITTE (TORI)
TONWAR 72 JPA 5 569 TONWAR,NARANAN,SREEKANTAN (TIFR)
ALPER 73 PL 46B 265 (CERN+LIVP+LUND+BOHR+RHEL+STOH+BERG+LOUC)
LEIPUNER 73 PRL 31 1226 +LARSEN,SESSOMS,SMITH,WILLIAMS+ (BNL+YALE)

APPEL 74 PRL 32 428 +BOURQUIN,GAINES,LEDERMAN,PAAR+ (COLU+FNAL)
FRANKEL 74 PR D9 1932 +FRATI,RESVANIS,YANG,NEZRICK (PENN+FNAL)
YOCK 74 NP B76 175 P.C.M.YOCK (UNIV OF AUCKLAND)

ALBROW 75 NP B97 189 +BARBER,BENZ+(CERN+DARE+FOM+LANC+MCHS+UTRE)
BLAGOV 75 YAD.FIZ. 21,300 +KOMAR,MURASHOVA,SYREISHCHIKOVA+ (LEBD)
FRANKEL 75 PR D12 2561 +FRATI,RESVANIS,YANG,NEZRICK (PENN+FNAL)
JOVANOVI 75 PL 56B 105 JOVANOVICH+ (MANI+AACH+CERN+GENO+HARV+TORI)
YOCK 75 NP B86 216 P.C.M. YOCK (UNIV OF AUCKLAND+SLAC)

ALEKSEE1 76 SJNP 22 531 ALEKSEEV,ZAITSEV,KALININA,KRUGLOV+ (JINR)
ALEKSEE2 76 SJNP 23 633 ALEKSEEV,ZAITSEV,KALININA,KRUGLOV+ (JINR)
BALDIN 76 SJNP 22 264 +VERTOGRADOV,VISHNEVSKII,GRISHKEVICH+(JINR)
BRIATORE 76 NC 31A 553 +DARDO,PIAZZOLI,MANNOCCHI+ (LCGT+FRAS+FREI)
GUSTAFSO 76 PRL 37 474 GUSTAFSON,AYRE,JONES,LONGO,MURTHY (MICH)

BARISH 77 PRL 38 577 +BARTLETT,BODEK,BROWN + (CIT+FNAL+ROCK)
BENVENUT 77 PRL 38 1110 BENVENUTI,CLINE+ (FNAL+HARV+PENN+RUTG+WISC)
BLETZACK 77 PRL 38 1241 BLETZACKER,NIEH,SONI (STON+UCSB)
CHANG 77 PRL 39 519 +CHEN,VAN GINNEKEN (MSU+FNAL)
HOLDER 77 PL 70B 393 +KNOBLOCH,MAY+ (CERN+DORT+HEID+SACL+BGNA)

ALBRIGHT 78 PR D18 108 +SMITH,VERMASEREN (FNAL+STON+PURD)
ALIBRAN 78 PL 74B 134 AACH+BARI+BERG+BRUX+CERN+EPOL+MILA+ORSA+
ASRATYAN 78 PL 79B 497 +EPSTEIN,FAKHRUTDINOV+ (ITEP+SERP)
BELLOTTI 78 PL 76B 223 +FIORINI,ZANOTTI (MILA)
BENVENUT 78 PRL 40 488 BENVENUTI+ (FNAL+HARV+PENN+RUTG+WISC)
BHAT 78 PRAM 10 115 +RAMANA MURTY (TIFR)
BOSETTI 78 PL 74B 143 +DEDEN+ (AACH+BONN+CERN+LOIC+OXF+SACL)

CARROLL 78 PRL 41 777 +CHIANG,JOHNSON,KYCIA,KI + (BNL+PRIN)
CUTTS 78 PRL 41 363 +DULUDE + (BROW+FNAL+ILL+BARI+MIT+WARS)
DONNELLY 78 PR D18 1607 +FREEDMAN,LYTEL,PECCEI,SCHWARTZ (STAN)
ALSO 76 PRL 37 315 REINES,GURR,SOBEL
ALSO 74 PRL 33 179 GURR,REINES,SOBEL
HANSL1 78 PL 74B 139 +HOLDER,KNOBLOCH+(CERN+DORT+HEID+SACL+BGNA)
HANSL2 78 PL 77B 114 +HOLDER,KNOBLOCH+(CERN+DORT+HEID+SACL+BGNA)
ALSO 78 NP B142 381 HANSL,HOLDER+ (CERN+DORT+HEID+SACL+BGNA)

HOLDER 78 PL 73B 105 +KNOBLOCH,MAY+ (CERN+DORT+HEID+SACL+BGNA)
LOVELESS 78 PL 78B 505 +BENADA+ (WISC+LBL+UCB+FNAL+HAWA+WASH)
MICELMAC 78 LNC 21 441 MICELMACHER,PONTECORVO (JINR)
MORI 78 PRL 40 432 +BENVENUTI+ (FNAL+HARV+PENN+RUTG+WISC)
VIDAL 78 PL 77B 344 +HERB,LEDERMAN,SNYDER+ (COLU+FNAL+STON+UCB)
VIERTEL 78 LNC 22 235 +HAHN,SCHACHER (BERN)
VYSOTSSK 78 JETPL 27 502 VYSOTSSKII+(INST.APPL.MATH.,USSR ACA. SCI.)

ARMITAGE 79 NP B150 87 +BENZ,BOBBINK+ (CERN+DARE+FOM+MCHS+UTRECHT)
BHAT 79 JPG 5 L13 BHAT,GOPALAKRISHNAN,GUPTA,TONWAR (TIFR)
BECHIS 79 PRL 42 1511 +DOMBECK+ (UMD+COLU+A.F.R.R.I.-BETHESDA)
BENVENUT 79 PRL 42 1024 BENVENUTI+ (FNAL+HARV+OSU+PENN+RUTG+WISC)
BOZZOLI 79 NP B159 363 +BUSSIERE,GIACOMELLI (BGNA+CERN+LAPP+SACL)
CALAPRIC 79 PR D20 2708 CALAPRICE,DUNFORD,KOUZES,MILLER+ (PRIN)
COTEUS 79 PRL 42 1438 +DIESBURG,FINE,LEE,SOKOLSKY+ (COLU+ILL+BNL)

DEGROOT 79 PL 85B 131 +HANSL,HOLDER+ (CERN+DORT+HEID+SACL+BGNA)
DISHAW 79 PL 85B 142 +DIAMANT-BERGER,FAESSLER,LIU+ (SLAC+CIT)
GOODMAN 79 PR D19 2572 +ELLSWORTH,ITO,MACFALL,SIOHAN + (UMD)
SMITH 79 NP B149 525 +BENNETT (RHEL)
ZHITNITS 79 SJNP 29 517 ZHITNITSKII,SKOVPEN (NOVO)

BARBER 80 PRL 45 1904 +BECKER,BEI+ (AACH+DESY+MIT+NIKO+BHEP)
BARTEL 80 ZPHY C6 295 JADE C.(DESY+HAMB+HEID+LANC+MCHS+RHEL+TOKY)
BUSSIERE 80 NP B174 1 +GIACOMELLI,LESQUOY+ (BGNA+SACL+LAPP)
FAISSNER 80 PL 96B 201 +FRENZEL,HEINRIGS,PREUSSGER,SAMM,SAMM(AACH)

JACQUES 80 PR D21 1206 +KALELKAR,MILLER,PLANO+ (RUTG+STEV+COLU)
LEBRITTO 80 PL 89B 271 LEBRITTON,MCCAL,MELISSINOS+ (ROCH+BNL+NSF)
SOUKAS 80 PRL 44 564 +WANDERER,WENG,BREGMAN+(BNL+ ARV+ORNL+PENN)
YOCK 80 PR D22 61 YOCK (AUCK)

ASANO 81 PL 107B 159 +KIKUTANI,KUROKAWA+ (KEK+TOKY+OSAK)
DZHELYAD 81 PL 105B 239 +GOLOVKIN,KONSTANTINOV,KONSTANTINOV+ (SERP)
FAISSNE1 81 ZPHY C10 95 FAISSNER,FRENZEL,GRIMM,HANSL,HOFFMAN+(AACH)
FAISSNE2 81 PL 103B 234 FAISSNER,FRENZEL,HEINRIGS,PREUSSGER+ (AACH)
KIM 81 PL 105B 55 B.R.KIM,CH.STAMM (AACH)

KINOSHIT 81 PR D24 1707 K.KINOSHITA,P.B.PRICE (UCB)
LOSECCO 81 PL 102B 209 +SULAK,GALIK,HORSTKOTTE+ (MICH+PENN+BNL)
ULLMAN 81 PRL 47 289 J.D.ULLMAN (LEHM+BNL)
YOCK 81 PR D23 1207 P.C.M.YOCK (AUCK)
ZEHNDER 81 PL 104B 494 A.ZEHNDER (ETH)

EDWARDS 82 PRL 48 903 +PARTRIDGE,PECK+ (CIT+HARV+PRIN+STAN+SLAC)
KINOSHIT 82 PRL 48 77 KINOSHITA,PRICE,FRYBERGER (UCB+SLAC)

****** ********* ********* ********* ********* ********* ********* ********
****** ********* ********* ********* ********* ********* ********* ********

S=0, C=0 MESON STATES

$\pi^{\pm}$

8 CHARGED PION(140,JPG=0--) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

π^{0}

9 NEUTRAL PION(135,JPG=0--) I=1

SEE STABLE PARTICLE DATA CARD LISTINGS

η

14 ETA(549,JPG=0-+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS

$\rho(770)$

9 RHO(770,JPG = 1-+) I=1

Note on the ρ^0 Mass and Width

Because of the broadness of the ρ meson, its shape is not very well described by a Breit-Wigner formula, which is a narrow-resonance approximation. Although most experimental distributions can be well described by a relativistic Breit-Wigner formula with a P-wave width and an additional shape parameter (PISUT 68), the resulting resonance parameters will clearly depend on this model. A consistent set of such determinations (PISUT 68, ESTABROOKS 74, BARTALUCCI 78, WICKLUND 78, HEYN 80) yields $m_{\rho^0} = (769 \pm 3)$ MeV, $\Gamma_{\rho^0} = (154 \pm 3)$ MeV.

Attempts have been made to determine the ρ pole position in a more model-independent way (LANG 79, BOHACIK 80). It is comforting that these determinations agree perfectly with the above mass average (LANG 79, however, finds a somewhat smaller width).

Independent support comes from an SU(4)-generalization of the Gell-Mann-Okubo mass formula, which in the limit of exactly ideal mixing can be written (MONTONEN 75)

$$\rho = \frac{2(\psi K^* - \phi D^*) + \omega(D^* - K^*)}{2(\psi - \phi) - (D^* - K^*)} \; .$$

Since the masses of the vector mesons on the right-hand side have all been determined to a much better precision than that of the ρ, they can be used to determine that the mass of the ρ = (768 ± 2) MeV. The theoretical error due to non-ideal mixing is only of the order of ±1.5 MeV.

Thus we conclude that the mass of the ρ is (769 ± 3) MeV, somewhat lower than quoted in the 1976-80 editions.

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                     9  RHO MASS (MEV)

M       WE NO LONGER LIST S-WAVE BREIT-WIGNER FITS, PBAR P DATA WITH HIGH
M       COMBINATORIAL BACKGROUND, AND INSIGNIFICANT OR DOUBTFUL DATA.
M       SEE ALSO THE MINI-REVIEW ABOVE.

M   CHARGED ONLY
M   R       (760.0)    (9.0)          CARMONY   64 HBC  +  3.5 PI+P,TCUT 4
M   R       (768.0)    (5.0)          BLIEDEN   65 MMSP -  3-5 PI- P          6/66
M   R       (765.0)    (5.0)          ALFF-STEI 66 HBC  +  2-3 PI+ P          6/66
M   R       (760.0)    (5.0)          HAGOPIAN1 66 HBC  -  3.0 PI- P          6/56
M   R       (765.0)    (5.0)          HAGOPIAN2 66 HBC  -  2.14 PI-,TCUT12    9/67
M   R 2775  (753.5)    (10.5)         JACOBS    66 HBC  -  2-3PI-,T CUT 20    6/68
M   R       (758.0)    (10.0)         JAMES     66 HBC  +  2.1 PI+,TCUT2.5    8/66
M   R       (749.0)    (3.0)          WEST      66 HBC  -  2.1 PI- P          10/66
M   R       (768.0)    (5.0)          MILLER    67 HBC  -  2.7 PI-,T CUT20    9/66
M   R       (773.0)    (2.0)          BATON     68 HBC  -  2.8 PI-,T CUT13    7/69
M
M  Z   900  767.       6.             EISNER    67 HBC  -  4.2 PI-,T CUT10    1/73
M  A  9650  766.8      1.5            PISUT     68 RVUE -  1.7-3.2PI-,CT10    6/68
M  X  6500  766.       7.             BYERLY    73 OSPK -  5. PI- P           2/74
M           . . . . . . . . . .
M   AVG     766.8      1.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

MO  NEUTRAL ONLY
MO  R  300 (760.0)    (10.0)          ABOLINS   63 HBC    0 3.5 PI+P
MO  R  500 (770.0)    (10.0)          GOLDHABER 64 HBC    0 3.7 PI+P
MO  R       (750.0)    (5.0)          ALFF-STEI 66 HBC    0 2-3 PI+ P         6/66
MO  R       (775.0)    (5.0)          HAGOPIAN1 66 HBC    0 3.0 PI- P         6/66
MO  R       (770.)     (5.)           HAGOPIAN2 66 HBC    0 2.1 PI-,TCUT 12   2/67
MO  R 4207  (758.0)    (7.5)          JACOBS    66 HBC    0 2-3PI-,T CUT 20   6/68
MO  R       (765.0)    (8.0)          JAMES     66 HBC    0 2.1 PI+ P         6/66
MO  R       (760.0)    (3.0)          WEST      66 HBC    0 2.1 PI- P         10/66
MO  P 4000  (765.)     (5.0)          ASBURY 2  67 CNTR   0 GAMMA + PB        1/73
MO  R       (768.0)    (2.0)          BACON     67 HBC    0 1.7 PI-P          9/67
MO  R       (761.)     (3.)           HUME      67 HBC    0 2.4 PI- P         7/67
MO  R       (770.0)    (4.0)          MILLER    67 HBC    0 2.7 PI-,T CUT20   9/66
MO  R       (775.0)    (2.0)          ARMENISE  68 DBC    C 5.1 PI+D          6/68
MO  R       (768.4)    (2.4)          MALAMUD   69 RVUE   0 2-4 PI-P          1/73
MO  P       (765.0)    (10.0)         ALVENSLEB 70 CNTR   C GAMMA A,TCUT.01   1/73
MO  P       (775.)     (5.)           GLADDING  73 CNTR   0 2.9-4.7 GAMMA P   2/74
MO  H       (778.)     (2.)           HYAMS     73 ASPK   0 17.PI-P,PI+PI-N   1/74
MO  H       (770.)     (9.)           ESTABROOK 74 RVUE   0 17 PI-P,PI+PI-N  12/75
MO  G       (775.)     (2.)           GRAYER    74 ASPK   0 17.PI-P,PI+PI-N   2/74
MO  D       (776.3)    (0.4)          ROOS      75 RVUE   0 PHASE SHIFTS     12/75
MO  CH      (769.5)    (0.7)          LANG      79 RVUE 0                     1/82*
MO
MO     2250  775.0      3.0           HYAMS     68 OSPK   0  11.2 PI- P       9/68
MO A  13300  769.2      1.5           PISUT     68 RVUE   0 1.7-3.2PI-,CT10   1/73
MO     1700  774.0      3.0           REYNOLDS  69 HBC    0 2.26 PI- P       12/78
MO     140K  767.7      1.9           BIGGS     70 CNTR   0 PHOTOPROD.        1/73
MO     1930  767.0      4.0           BALLAM    72 HBC    0 2.8 GAMMA P       1/73
MO     2430  770.0      4.0           BALLAM    72 HBC    0 4.7 GAMMA P       1/73
MO Z  11200  773.5      1.7           JACOBS    72 HBC    0 2.8 PI- P         1/73
MO     6800  764.0      3.0           RATCLIFF  72 ASPK   0 15. PI-P,TCUT.3   2/74
MO C  32000  775.0      4.0           PROTOPOPE 73 HBC    0 7.1 PI+P,TCUT.4   2/74
MO     4100  767.       4.            ENGLER    74 DBC    0 6. PI+N,PI+PI-P  12/75
MO    76000  768.0      1.0           DEUTSCHMA 76 HBC    0 16. PI+ P         4/78
MO E         767.6      2.7           BARTALUCC 78 CNTR   0 BREMS,E+E-P      12/77
MO X         769.0      3.0           WICKLUND  78 ASPK   0 3,4,6 PI+-PN      4/78
MO E         776.1      2.6           BECKER    79 ASPK   0 17.PI-P POLARIZ  12/79
MO C H       768.0      4.0           BOHACEK   80 RVUE 0                     1/82*
MO E B       770.       2.            HEYN      80 RVUE    PION FORM FACTOR   9/81*
MO          . . . . . . . . . .
MO  AVG     769.65     0.74    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                               (SEE IDEOGRAM BELOW )
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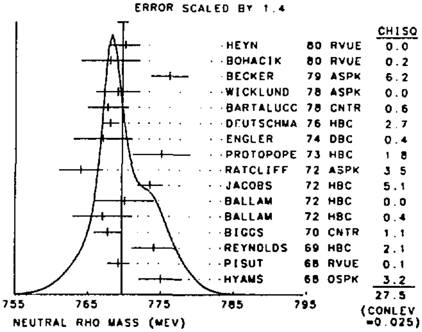
WEIGHTED AVERAGE = 769.65 ± 0.74
ERROR SCALED BY 1.4



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M        ----------NOTES----------

M   A    FROM FIT OF 3-PARAMETER RELATIVISTIC P-WAVE BREIT WIGNER TO TOTAL
M   A    MASS DISTRIBUTION.
M   B    HEYN 80 INCLUDES ALL SPACELIKE AND TIMELIKE F(PI)
M   B    VALUES UNTIL 1978.
M   C    FROM POLE EXTRAPOLATION
M   D    ENERGY-DEPENDENT ANALYSIS OF BATON 70, HYAMS 73.
M   D    PROTOPOPESCU 73 PHASE SHIFTS.
M   E    PURE P-WAVE SYSTEM.
M   G    FROM FIT OF 3-PARAMETER RELATIVISTIC BREIT-WIGNER TO
M   G    HELICITY ZERC PART OF P-WAVE INTENSITY. BECKER 79
M   G    INCLUDES DATA OF GRAYER 74.
M   H    FROM PHASE_SHIFT ANALYSIS OF GRAYER 74 DATA.
M   P    FROM PHOTOPRODUCTION. MODEL DEPENDENT.
M   R    INCLUDED IN PISUT 68 RVUE
M  X     PHASE SHIFT ANALYSIS. SYSTEMATIC ERRORS ADDED CORRESPONDING
M  X     TO SPREAD OF DIFFERENT FITS.
M  Z     MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N).SEE K* TYPED NOTE

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                  9  (RHO0) - (RHO+-) MASS DIFFERENCE (MEV)

D  A  3600   -5.       5.                FOSTER    68 HBC  +-0 PBAR P AT REST  12/78
D    22950    2.4      2.1               PISUT     68 RVUE     PI N TO RHO N    6/68
D  A  3000   -4.0      4.0               REYNOLDS  69 HBC   -0 2.26 PI- P      12/78
D            . . . . . . . . . .
D   AVG       0.3      2.2    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

D  A     FROM QUOTED MASSES OF CHARGED AND NEUTRAL MODES

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                  9  RHO WIDTH (MEV)

W        WE NO LONGER LIST S-WAVE BREIT-WIGNER FITS. PBAR P DATA WITH HIGH
W        COMBINATORIAL BACKGROUND, AND INSIGNIFICANT OR DOUBTFUL DATA.
W        SEE FURTHER MINI-REVIEW ABOVE.

W    CHARGED ONLY
W    R        (77.0)   (20.0)            CARMONY   64 HBC   +   3.5 PI+P,TCUT 4
W    R       (100.0)                     ALFF-STEI 66 HBC   +   2-3 PI+ P          6/66
W    R       (127.0)    (5.0)            BLIEDEN   66 MMSP  -   3-5 PI- P          6/66
W    R       (150.0)   (20.0)            HAGOPIAN1 66 HBC   -   3.0 PI- P          6/66
W    R       (135.0)   (20.0)            HAGOPIAN2 66 HBC   -   2.16 PI-,TCUT12    9/67
W    R 2775  (137.1)   (20.0)            JACOBS    66 HBC   -   2-3"I-,T CUT 20    6/68
W    R       (147.0)   (19.0)            JAMES     66 HBC   +   2.1 PI+,TCUT2.5    8/66
W    R       (149.0)   (13.0)            WEST      66 HBC   -   2.1 PI- P         10/66
W    R       (153.0)   (13.0)            MILLER    67 HBC   -   2.7 PI-,T CUT20    9/66
W    R       (150.0)    (5.0)            BATON     68 HBC   -   2.8 PI- P          7/69
W
W       900   146.      13.              EISNER    67 HBC   -   4.2 PI-,T CUT10    9/67
W  A   9650   148.2      4.1             PISUT     68 RVUE  -   1.7-3.2PI-,CT10    6/68
W  X   6500   146.      12.              BYERLY    73 OSPK  -   5. PI- P           2/74
W             . . . . . . . . . .
W    AVG      147.8      3.7   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

WO   NEUTRAL ONLY
WO   R  300  (90.0)   (10.0)             ABOLINS   63 HBC    0 3.5 PI+P
WO   R  500 (130.0)                      GOLDHABER 64 HBC    0 3.7 PI+P
WO   R      (100.0)                      ALFF-STEI 66 HBC    0 2-3 PI+ P           6/66
WO   R      (120.0)   (10.0)             HAGOPIAN1 66 HBC    0 3.0 PI- P           6/66
WO   R      (135.0)   (20.0)             HAGOPIAN2 66 HBC    0 2.14 PI-P,LOW T     9/67
WO   R 4207 (122.2)   (15.0)             JACOBS    66 HBC    0 2-3PI-,T CUT 20     6/68
WO   R      (103.0)   (13.0)             JAMES     66 HBC    0 2.1 PI+ P           6/66
WO   R      (173.0)   (13.0)             WEST      66 HBC    0 2.1 PI- P          10/66
WO   P 4000 (230.)     (5.)              ASBURY 2  67 CNTR   0 GAMMA + PB          1/73
WO   R      (148.0)    (8.0)             BACON     67 HBC    0 1.7 PI-P            9/67
WO   R      (152.)    (15.)              HUWE      67 HBC    0 2.4 PI- P           7/67
WO   R      (160.0)   (15.0)             MILLER    67 HBC    0 2.7 PI-,T CUT20     9/66
WO   R      (167.0)    (6.0)             ARMENISE  68 DBC    0 5.1 PI+D            6/68
WO   P      (160.0)   (10.0)             LANZEROTT 68 CNTR   0 GAMMA P             1/73
WO   R      (132.0)   (13.0)             MALAMUD   69 RVUE   0 2-4 PI-P            1/73
WO   P      (140.0)    (5.0)             ALVENSLEB 70 CNTR   0 GAMMA A,TCUT.01     1/73
WO   P      (147.)    (11.)              GLADDING  73 CNTR   0 BREMS.              2/74
WO   H      (152.)     (2.)              HYAMS     73 ASPK   0 17.PI-P,PI+PI-N     1/74
WO   H      (143.)    (13.)              ESTABROOK 74 RVUE   0 17 PI-P,PI+PI-N    12/75
WO   G      (163.)     (4.)              GRAYER    74 ASPK   0 17.PI-P,PI+PI-N     2/74
WO   D      (154.5)    (1.0)             ROOS      75 RVUE   0 PHASE SHIFTS       12/75

WO Z  2250   145.0      12.0             HYAMS     68 OSPK   0 11.2 PI- P          1/73
WO A 13300   163.0      15.0             PISUT     68 RVUE   0 1.7-3.2PI-,CT10     1/73
WO    1700   143.0       8.0             REYNOLDS  69 HBC    0 2.26 PI- P         12/78
WO    140K   146.1       2.9             BIGGS     70 CNTR   0 PHOTOPROD.          1/73
WO Z  2430   155.0      12.0             BALLAM    72 HBC    0 4.7 GAMMA P         1/73
WO Z  1930   145.0      13.0             BALLAM    72 HBC    0 2.8 GAMMA P         1/73
WO    6800   157.0       8.0             RATCLIFF  72 ASPK   0 15. PI-P,TCUT.3     2/74
WO C 32000   160.0      10.0             PROTOPOPE 73 HBC    0 7.1 PI+P,TCUT.4     2/74
WO    4100   146.       14.              ENGLER    74 DBC    0 6. PI+N,PI+PI-P    12/75
WO   76000   154.0       2.0             DEUTSCHMA 76 HBC    0 16. PI+ P           4/78
WO E         150.9       3.0             BARTALUCC 78 CNTR   0 BREMS,E+E-P        12/77
WO X         152.0       9.0             WICKLUND  78 ASPK   0 3,4,6 PI+-PN        4/78
WO G         161.8       7.6      7.2    BECKER    79 ASPK   0 17.PI-P POLARIZ    12/79
WO  CH      (148.0)     (1.3)            LANG      79 RVUE   0                     1/82*
WO C H       148.0       6.0             BOHACIK   80 RVUE   0                     1/82*
WO E B       155.        1.              HEYN      80 RVUE   0 PION FORM FACT.     9/81*
WO           . . . . . . . . . .
WO  AVG      153.7       1.0    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                                (SEE IDEOGRAM BELOW )

W        ----------NOTES----------

W   A    FROM FIT OF 3-PARAMETER RELATIVISTIC P-WAVE BREIT WIGNER TO TOTAL
W   A    MASS DISTRIBUTION.
W   B    HEYN 80 INCLUDES ALL SPACELIKE AND TIMELIKE F(PI)
W   B    VALUES UNTIL 1978.
W   C    FROM POLE EXTRAPOLATION
W   D    ENERGY-DEPENDENT ANALYSIS OF BATON 70, HYAMS 73.
W   D    PROTOPOPESCU 73 PHASE SHIFTS.
W   E    PURE P-WAVE SYSTEM.
W   G    FROM FIT OF 3-PARAMETER RELATIVISTIC BREIT-WIGNER TO
W   G    HELICITY ZERC PART OF P-WAVE INTENSITY. BECKER 79
W   G    INCLUDES DATA OF GRAYER 74.
W   H    FROM PHASE SHIFT ANALYSIS OF GRAYER 74 DATA.
W   P    FROM PHOTOPRODUCTION, MODEL DEPENDENT.
W   R    INCLUDED IN P'SUT 68 RVUE
W  X     PHASE SHIFT ANALYSIS. SYSTEMATIC ERRORS ADDED CORRESPONDING
W  X     TO SPREAD OF DIFFERENT FITS.
W  Z     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N).SEE K* TYPED NOTE
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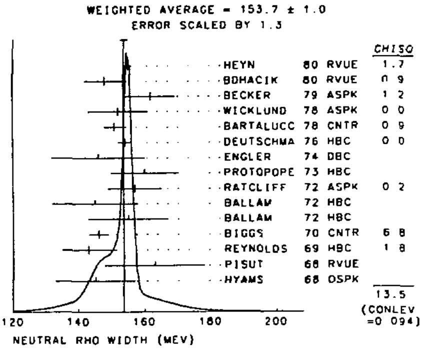


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                  9  RHO PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      RHO INTO 2PI                                       139+ 139
P2      RHO INTO 4PI                                       139+ 139+ 139+ 139
P3      RHO INTO PI GAMMA                                  139+   0
P4      RHO INTO E+ E-                                      .5+  .5
P5      RHO INTO PI ETA (VIOLATES G)                       139+ 548
P6      RHO INTO MU+ MU-                                   105+ 105
P7      RHO INTO PI+ PI- PI0 (VIOLATES G)                  139+ 139+ 134
P8      RHO INTO ETA GAMMA                                 548+   0

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                  9  RHO PARTIAL WIDTHS (KEV)

W1      RHO INTO (PI GAMMA)                               (G3)
W1          (35.0)    (10.0)          GOBBI      74 OSPK  - 23. PI-A,PI-PI0A 12/75
W1           67.        7.            BERG       80 SPEC  -  PI-A,PI- PI0 A    1/82*

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                  9  RHO BRANCHING RATIOS

R1      RHO INTO 4PI/2PI                                  (P2)/(P1)

R1      RHO+- INTO (PI+- PI+ PI- PI0) / (PI+- PI0)
R1          (0.002)OR LESS            FERBEL     66 HBC  +- PI+- P ABOVE 2.5 10/66
R1           0.0035   0.004           JAMES      66 HBC  +   2.1 PI+P          11/66

R1      RHO0 INTO (PI+ PI- PI+ PI-) / (PI+ PI-)
R1          (0.008)OR LESS            JAMES      66 HBC    0 2.1 PI+P           6/66
R1          (0.002)OR LESS            CHUNG      68 HBC    0 3.2,4.2 PI-P       7/67
R1          (0.002)OR LESS  CL=.90    HUSON      68 HLBC   0 16.0 PI- P         1/71
R1          (0.0015)R LESS  CL=.90    ERBE       69 HBC    0 2.5-5.8 GAMMA P   10/67
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<u>Note on the e^+e^- and $\mu^+\mu^-$ Decays</u>

Extraction of a ratio for $\rho^0 \to e^+e^-$ is complicated by interference with ω decay. In photoproduction, $\gamma A \to e^+e^-A$, there is substantial interference between the allowed $(\rho^0,\omega) \to e^+e^-$ decays. The interference in the colliding-beam reaction $e^+e^- \to \pi^+\pi^-$ is due to G-parity-violating mixing of the overlapping ρ^0 and ω resonances; it alters the results for the rate $\Gamma(\rho^0 \to e^+e^-)$ only by a small amount. Therefore at present we average only the values from the $e^+e^- \to \pi^+\pi^-$ experiments.

The same comment applies to the decay $\rho^0 \to \mu^+\mu^-$.

```
R3      RHO INTO(E+ E-)/(PI+PI-) (UNITS 10**-4)             (P4)/(P1)
R3
R3       SEE MINI-REVIEW ABOVE.
R3
R3  P    94   (0.65)    (0.14)          ASBURY 1  67 CNTR      PHOTOPRODUCTION  9/67
R3  H         (0.65)    (1.1)     (0.5) HERTZBACH 67 OSPK ASSUME SU(3)+MIXING 10/66
R3  A    33   (0.53)    (0.11)          ASTVACATU 68 OSPK ASSUME SU(3)+MIXING  6/68
R3             0.50      0.10           AUSLENDER 69 OSPK    E+E- COLLID.BEAM  9/68
R3  F         (0.49)    (0.12)   (0.15) BIGGS     70 CNTR     PHOTOPRODUCTION  6/70
R3             0.41      0.05           BENAKSAS  72 OSPK    E+E- COLL.BEAMS  12/72
R3           . . . . . . . . . .
R3  AVG        0.428     0.045    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3  A          NOT SEPARATED FROM OMEGA DECAY. ERROR STATISTICAL ONLY.
R3  F          ASSUMING RHO WIDTH 140 MEV. ERROR STATISTICAL ONLY.
R3  H          NOT SEPARATED FROM OMEGA DECAY.
R3  P          POSSIBLY LARGE RHO-OMEGA INTERFERENCE
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R4       RHO INTO (PI ETA)/(2PI)                            (P5)/(P1)
R4            (0.008)OR LESS             FERBEL     66 HBC  +- PI+- P ABOVE 2.5 11/66

R5       RHO INTO (MU+ MU-)/(PI+ PI-) (UNITS 10**-4)        (P6)/(P1)
R5
R5        SEE MINI-REVIEW ABOVE.
R5
R5   H         0.97      0.31     0.33  HYAMS      67 OSPK    11 PI- LI H       6/67
R5   R         0.82      0.16     0.36  ROTHWELL   69 CNTR    PHOTOPRODUCTION   4/70
R5   W         0.56      0.15           WEHMANN    69 OSPK     12 PI- ON C.FE   7/69
R5            . . . . . . . . . . .
R5   AVG       0.67      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5   H         HYAMS MASS RESOL. IS 20 MEV. THE OMEGA REGION WAS EXCLUDED.
R5   R         POSSIBLY LARGE RHO-OMEGA INTERFERENCE LEADS US TO INCREASE
R5   R         THE MINUS ERROR
R5   W         RESULT CONTAINS (11 +- 11) PER CENT CORRECTION USING SU(3)
R5   W         FOR CENTRAL VALUE. THE ERROR ON THE CORRECTION TAKES ACCOUNT
R5   W         OF POSSIBLE RHO-OMEGA INTERFERENCE AND THE UPPER LIMIT AGREES
R5   W         WITH THE UPPER LIMIT OF (OMEGA INTO MU+ MU-) FROM THIS EXPT.

R6       RHO  INTO (PI+ PI- PI0)/(PI+ PI-)                  (P7)/(P1)
R6   G        (0.01) OR LESS  CL=.84   ABRAMS     71 HBC     0 3.7 PI+ P       11/71
R6   G       MODEL DEPENDENT,ASSUMES I = 1,2,OR 3 FOR THE 3PI SYSTEM          11/71

R7       RHO INTO (ETA GAMMA)/TOTAL (UNITS 10**-4)          (P8)
R7   A        (3.6)      (0.9)             ANDREWS    77 CNTR  0 6.7-10 GAMMA CU  12/77
R7   B        (5.4)      (1.1)             ANDREWS    77 CNTR  0 6.7-10 GAMMA CU  12/77
R7   A    SOLUTION CORRESPONDING TO CONSTRUCTIVE OMEGA-RHO INTERFERENCE
R7   A    THE QUARK MODEL PREDICTS A RELATIVE DECAY PHASE OF ZERO.
R7   B    SOLUTION CORRESPONDING TO DESTRUCTIVE OMEGA-RHO INTERFERENCE

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REFERENCES FOR RHO

ANDERSON 61 PRL 6 365 — ANDERSON,BANG,BURKE,CARMONY,SCHMITZ (LRL)
ERWIN 61 PRL 6 626 — A.R.,R.MARCH,W.D.WALKER,E.WEST (WISC)

KENNEY 62 PR 126 736 — V P KENNEY,W D SHEPHARD,C D GALL (KENTUCKY)
SAMIOS 62 PRL 9 139 — SAMIOS,BACHMAN,LEA+ (BNL+CUNY+COLU+KNTY)
XUONG 62 PR 128 1849 — NGUYEN HUU XUONG,GERALD R LYNCH (LRL)

ABOLINS 63 PRL 11 381 — ABOLINS,LANDER,MEHLHOP,NGUYEN,YAGER (UCSD)
ALITTI 63 NC 29 515 — ALITTI,BATON,ARMENISE+(SACL+ORSA+BARI+BGNA)
CHADWICK 63 PRL 10 62 — CHADWICK,DAVIES,DERRICK,CRESTI + (OXF+PADO)
GUIRAGOS 63 PRL 11 85 — ZAVEN GUIRAGOSSIAN (LRL)
SACLAY 63 SIENA CONF 1 239 — SACLAY+ORSAY+BARI + BOLOGNA- COLLABORATION

BONDAR 64 NC 31 729 — BONDAR+ (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
CARMONY 64 DUBNA CONF I 486 — CARMONY,HOA,LANDER,NG.H.XUONG,YAGER (UCSD)
GOLDHABE 64 PRL 12 336 — GOLDHABER,BROWN,KADYK,SHEN+ (LRL+UCB)

ALYEA 65 PL 15 82 — ALYEA,CRITTENDEN,MARTIN,RHODE + (INDIANA)
ARMENISE 65 NC 37 361 — SACLAY+ORSAY+BARI+BOLOGNA COLLABORATION
BLIEDEN 65 PL 19 444 — CERN MISSING MASS SPECTROMETER GROUP (CERN)
CLARK 65 PR 139 B 1556 — A CLARK,CHRISTENSON,CRONIN,TURLAY(PRINCETO)
GUTAY 65 NC 39 381 — GUTAY,LANNUTTI,TULI (FSU)
LANZEROT 65 PRL 15 210 — LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
ZDANIS 65 PRL 14 721 — ZDANIS,MADANSKY,KRAEMER + (JHU+BNL)

ACCENSI 66 PL 20 557 — ACCENSI,ALLES-BORELLI,FRENCH,FRISK+ (CERN)
ALFF-STE 66 PR 145 1072 — ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
BALTAY 66 PR 145 1103 — +FRANZINI,LUTJENS,SEVERINS,TYCKO+(COLUMBIA)
BLIEDEN 66 NC 43 71 — CERN MISSING MASS SPECTROMETER GROUP (CERN)
CAMBRIDG 66 PR 146 994 — CAMBRIDGE BUBBLE CHAMBER GROUP (MIT+HARV+)
CASON 66 PR 148 1282 — N M CASON (WISCONSIN)
DEUTSCHM 66 PL 20 82 — DEUTSCHMANN,STEINBERG + (AACH+BERLIN+ CERN)
FERBEL 66 PL 21 111 — FERBEL (ROCHESTER)
FIDECARO 66 PL 23 163 — G+M FIDECARO,J POIRIER,P SCHIAVON (CERN)
HAGOPIAN166 PR 145 1128 — HAGOPIAN,SELOVE,ALITTI,BATON+ (PENN+SACLAY)
HAGOPIAN266 PR 152 1183 — HAGOPIAN,PAN (PENNSYLVANIA,LRL-BERKELEY)
HUSON 66 PL 20 91 — HUSON,ALLARD,DRIJARD,HENNESSY+ (ORSAY+EPOL)
JACOBS 66 UCRL-16877 — L.D.JACOBS (LRL)
JAMES 66 PR 142 896 — F E JAMES,KRAYBILL (YALE+BROOKHAVEN)
WEST 66 PR 149 1089 — WEST,BOYD,ERWIN,WALKER (WISCONSIN)

ALLES-BO 67 NC 50 A 776 — ALLES-BORELLI,FRENCH,FRISK,+ (CERN+BONN)
ASBURY 1 67 PRL 19 869 — +BECKER+BERTRAM+JOOS+JORDAN+ (DESY+COLU)
ASBURY 2 67 PRL 19 865 — +BECKER+BERTRAM+JOOS+JORDAN+ (DESY+COLU)
BACON 67 PR 157 1263 — +FICKINGER,HILL,HOPKINS,ROBINSON+ (BNL)
BANNER 67 PL 25 B 300 — +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BARLOW 67 NC 50A 701 — +LILLESTOL+MONTANET+ (CERN+CDEF+IRAD+LIVP)
BATON 67 PL 25 B 419 — J.BATON,G.LAURENS,J.REIGNIER (SACLAY)
ALSO 67 NP B 3 349 — J.BATON,G.LAURENS,J.REIGNIER (SACLAY)
CLEAR 67 NC 49A 399 — +JOHNSTON+COOPER+MANNER+ (TNTO+ANL+WISC)
DANYSZ 67 NC 51 A 801 — DANYSZ+FRENCH+SIMAK (CERN)
EISNER 67 PR 164 1699 — +JOHNSON+KLEIN+PETERS+SAHNI+YEN+ (PURDUE)
FRENCH 67 NC 52A 442 — +KINSON+MCDONALD+RIDDIFORD+ (CERN+BIRM)
HERTZBAC 67 PR 155 1461 — HERTZBACH,KRAEMER,MADANSKI,ZDANIS-(JHU+BNL)
HUWE 67 PL 24B 252 — +MARQUIT+OPPENHEIMER+SCHULTZ+WILSON (COLU)
HYAMS 67 PL 24B 634 — +KOCH+PELLETT+POTTER+VONLINDERN+(CERN+MPIM)
MILLER 67 PR 153 1423 — MILLER,GUTAY,JOHNSON,LOEFFLER + (PURDUE)
POIRIER 67 PR 163 1462 — +BISWAS,CASON,DERADO,KENNEY+ (NDAM+PENN)

ABC COLL 68 NP 84 501 — AACHEN+BERLIN+CERN COLLABORATION+
ARMENISE 68 NC 54A 999 — +GHIDINI,FORINO+ (BARI+BGNA+FIRZ+ORSAY)
ASTVACAT 68 PL 27 B 45 — ASTVACATUROV,AZIMOV,BALDIN+ (JINR+MOSCOW)
BATON 68 PR 176 1574 — J.P. BATON, G. LAURENS (SACLAY)
BLECHSCH 68 NC 53 A 1045 — *BLECHSCHMIDT,DOHO,ELSNER,+ (DESY+MCHS)*
ALSO 67 NC 52 A 1348
CHUNG 68 PR 165 1491 — S.U.CHUNG,O.I.DAHL,J.KIRZ,D.H.MILLER (LRL)
DONALD 68 NP B 6 174 — +EDWARDS,FRODESEN,BETTINI+ (LIVP+OSLO+PADO)
FOSTER 68 NP B 6 107 — +GAVILLET+LABROSSE+MONTANET+ (CERN+CDEF)
HUSON 68 PL 28B 208 — +LUBATTI,SIX,VEILLET,+ (ORSA+MILA+UCLA)
HYAMS 68 NP B 7 1 — +KOCH,POTTER,WILSON,VON LINDERN+(CERN+MPIM)
JONES 68 PR 166 1405 — +BLEULER,CALDWELL,ELSNER,HARTING+ (CERN)
JOHNSON 68 PR 176 1651 — +POIRIER,BISWAS,GUTAY+ (NDAM+PURD+SLAC)
KEY 68 PR 166 1430 — +PRENTICE+COOPER+MANNER+ (TNTO+ANL+WISC)
LAMSA 68 PR 166 1395 — +CASON+BISWAS+DERADO+GROVES+ (NOTREDAME)
LANZEROT 68 PR 166 1365 — LANZEROTTI,BLUMENTHAL,EHN,FAISSLER + (HARV)
MARATECK 68 PRL 21 1613 — +HAGOPIAN,+ (PENN+LRL+COLO+PURD+TNTO+WISC)
PISUT 68 NP B 6 325 — J.PISUT,M.ROOS (CERN)

AUGUSTI1 69 PL 28 B 508 — +BIZOT+BUON+HAISSINSKI+LALANNE+ (ORSAY)
AUGUSTI2 69 LNC 2 214 — +LEFRANCOIS,LEHMANN,MARIN,+ (ORSAY)
AUSLENDE 69 SJNP 9 69 — AUSLENDER,BUDKER,PANTUSOVA,PESTOV+ (NOVO)
ERBE 69 PR 188 2060 — GERMAN BUBBLE CHAMBER COLL. (DESY)
HAISSINS 69 ARGONNE CONF. 373 — J.HAISSINSKI (ORSAY)
JUHALA 69 PR 184 1461 — +LEACOCK,RHODE,KOPELMAN,LIBBY,+ (ISU+COLO)
MALAMUD 69 ARGONNE CONF.P.93 — E.MALAMUD, P.SCHLEIN (UCLA)
MILLER 69 PR 178 2061 — R.MILLER,LICHTMAN,WILLMANN (PURDUE)
MOTT 69 PR 177 1966 — +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
REYNOLDS 69 PR 184 1424 — +ALBRIGHT,BRADLEY,BRUCKER,HARMS+ (FSU)
ROOS 69 NP B 10 563 — M.ROOS,J.PISUT (CERN+BRATISLAVA)
ROTHWELL 69 PRL 23 1521 — +CHASE,EARLES,GETTNER,GLASS,WEINSTEI+(NEAS)
SCHAREN 69 ARGONNE CONF.306 — SCHARENGUIVEL (PURDUE)
WEHMANN 69 PR 178 2095 — +ENGELS,WILSON,+ (HARV+CASE+SLAC+CORN+MCGI)

ALVENSLE 70 PRL 24 786 — ALVENSLEBEN,BECKER,BERTRAM,CHEN,COHEN(DESY)
BATON 70 PL 33 B 528 — +LAURENS,REIGNIER (SACLAY)
BIGGS 70 PRL 24 1197 — +BRABEN,CLIFFT,GABATHULER,KITCHING+ (DARE)
BINGHAM 70 PRL 24 955 — +FRETTER,MOFFEIT,BALLAM+ (LRL+SLAC+TUFT)
GALLOWAY 70 PR D 1 3077 — +MOTT,ALYA,LEE,MARTIN,PRICKETT (IND)

ABRAMS 71 PR D 4 653 — +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
BLOODWOR 71 NP B 35 133 — BLOODWORTH,JACKSON,PRENTICE,YOON (TORONTO)
DEERY 71 PR D 3 635 — +BISWAS,CASON,GROVES,JOHNSON,+ (NOTRE DAME)

BAILLON 72 PL 38 B 555 — +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BALLAM 72 PR D 5 545 — +CHADWICK,BINGHAM,MILBURN,+ (SLAC+LBL+TUFT)
BASDEVAN 72 PL 41 B 178 — BASDEVANT,FROGGATT,PETERSEN (CERN)
BENAKSAS 72 PL 39 B 289 — +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
DRIVER 72 NP B 38 1 — +HEINLOTH,HOHNE,HOFMANN,RATHJE,+(DESY+HAMB)
EISENBER 72 PR D 5 15 — EISENBERG,BALLAM,DAGAN,+ (REHO+SLAC+TELA)
GRAYER 72 PHIL.CONF.PROC. 5 — +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
GRAYER 72 NP B 50 29 — +HYAMS,JONES,WEILHAMMER,BLUM,+ (CERN+MPIM)
JACOBS 72 PR D 6 1291 — L.D.JACOBS (SACLAY)
RATCLIFF 72 PL 38 B 345 — +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+ (SLAC)
TAKAHASH 72 PR D 6 1266 — TAKAHASHI,BARISH,+ (TOHO+PENN+NDAM+ANL)

BYERLY 73 PR D 7 637 — +ANTHONY,COFFIN,MEANLEY,MEYER,RICE,+ (MICH)
CHARLESW 73 NP B 65 253 — CHARLESWORTH,EMMS,BELL,+ (RHEL+BIRM+DURH)
GLADDING 73 PR D 8 3721 — +RUSSEL,TANNENBAUM,WEISS,THOMSON (HARV)
HYAMS 73 NP B 64 134 — +JONES,WEILHAMMER,BLUM,DIETL,+ (CERN+MPIM)
PROTOPOP 73 PR D 7 1280 — PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)

CARROLL 74 PR D 10 1430 — +MATTHEWS,WALKER+ (SLAC+DUKE+WISC+TNTO)
ENGLER 74 PR D 10 2070 — +KRAEMER,TOAFF,WEISSER,DIAZ+ (CARN+CASE)
ESTABROO 74 NP B 79 301 — P.ESTABROOKS,A.D.MARTIN (DURH)
GOBBI 74 PRL 33 1450 — +ROSEN,SCOTT,SHAPIRO+ (NWES+ROCH+CARN)
GRAYER 74 NP B 75 189 — G.GRAYER,HYAMS,BLUM,DIETL,+ (CERN+MPIM)
HABER 74 PR D10 1387 — +HODOUS,HULSIZER,KISTIAKOWSKY,LEVY+ (MIT)
NORDBERG 74 PL 51 B 106 — +ABRAMSON,ANDREWS,HARVEY,+ (CORN+ROCH)
SPITAL 74 PR D 9 126 — R.SPITAL,D.R.YENNIE (CORN)

MONTONEN 75 LNC 12 627 — C.MONTONEN,M.ROOS,N.TORNQVIST (HELS)
ROOS 75 NP B 97 165 — M.ROOS (HELS)

DEUTSCHM 76 NP B 103 426 — +KIRK,+(AACH+BERL+BONN+CERN+CRAC+HEID+WARS)

ANDREWS 77 PRL 38 198 — +FUKUSHIMA,HARVEY,LOBKOWICZ,MAY,+ (ROCH)

BALTAY 78 PR D 17 62 — +CAUTIS,COHEN,CSORNA,SMITH,YEH,+(COLU+BING)
BARTALUC 78 NC 44 A 587 — BARTALUCCI,BASINI,BERTOLUCCI, (DESY+FRAS)
QUENZER 78 PL 76 B 512 — +RIBES,RUMPF,BERTRAND,BIZOT,CHASE,+ (LALO)
WICKLUND 78 PRD 17 1197 — +AYRES,DIEBOLD,GREENE,KRAMER,PAWLICKI (ANL)

BECKER 79 NP B 151 46 — +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
LANG 79 PR D 19 956 — C.B.LANG,A.MAS-PARAREDA (GRAZ)

BERG 80 PRL 44 706 — +CHANDLEE,BIEL,HEPPELMANN,+(ROCH+FNAL+MINN)
BOHACIK 80 PR D 21 1342 — J.BOHACIK,H.KUHNELT (BRATISLAVA+WIEN)
HEYN 80 ZPHY C 7 169 — M.F.HEYN,C.B.LANG (GRAZ)

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ω(783)

I   OMEGA(783,JPG=1--) I=0

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                      I  OMEGA MASS (MEV)

M   R 2198 (783.4)    (0.7)          BALTAY     67 HBC     0.0 PBAR P         2/74
M   R      (784.0)    (0.7)          ATHERTON   70 HBC     3.6 PBAR P, 7 PI   2/74
M   SR 4800 (782.0)   (0.8)          DREN       74 HBC     2.3 PBAR P,SPI    12/75
M
M      2400  782.4     0.5           BIZZARRI   69 HBC      0 PBAR P          9/69
M       750  784.1     1.2           ABRAMOVIC  70 HBC      3.9 PI- P         2/74
M    F       783.2     1.6           BIGGS      70 CNTR    PHOTOPRODUCTION    2/74
M       248  783.4     1.0           BIZZARRI   71 HBC      0.0 P PBAR K+K-  11/71
M       510  781.0     0.6           BIZZARRI   71 HBC      0.0 P PBAR K1K1  11/71
M   D        783.7     1.0           COYNE      71 HBC     3.7 PI+ P         11/71
M       418  782.5     0.8           AGUILAR    72 HBC     3.9,4.6 K- P      12/72
M   B  7000  782.4     0.5           KEYNE      76 CNTR    PI-P, OMEGA N     12/75
M      2100  783.5     0.8           GESSAROLI  77 HBC     11 PI-P,OMEGA PI  12/77
M       535  782.7     0.9           APELODORN  78 HBC     7.2 PB P,PB P OM   4/78
M      1430  781.8     0.6           COOPER     78 HBC     .7-.8 PB P,5 PI    4/78
M      3000  782.6     0.8           BENKHEIRI  79 OMEG    9-12 PI+- P       12/79
M            783.3     0.4           CORDIER    80 WIRE    E+E-,PI+PI-PI0    9/81*
M     33260  782.5     0.8           ROOS       80 RVUE    0-3.6 PBAR P      12/79
M             . . . . . . . . . . .
M   AVG      782.62    0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

M   B    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESCL.=4.8 MEV FWHM
M   D    FROM BEST-RESOLUTION SAMPLE OF COYNE 71
M   F    FROM OMEGA-RHO INTERFERENCE IN THE PI+PI- MASS SPECTRUM
M   F    ASSUMING OMEGA WIDTH 12.6 MEV.
M   R    INCLUDED IN ROOS 77,79 RVUE
M   S    ERROR INCLUDES 0.5 MEV MASS SCALE ERROR
M

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                      I  OMEGA FULL WIDTH (MEV)

W        750   8.8     3.0           ABRAMOVIC  70 HBC      3.9 PI- P         6/70
W             11.2     2.7           ATHERTON   70 HBC     3.6 PBAR P, 7 PI   5/70
W        510  10.3     1.4           BIZZARRI   71 HBC      0.0 P PBAR K1K1  11/71
W        248  12.8     3.0           BIZZARRI   71 HBC      0.0 P PBAR K+K-  11/71
W       4270   9.5     1.0           COYNE      71 HBC     3.7 PI+ P         11/71
W        418  13.3     2.            AGUILAR    72 HBC     3.9,4.6 K- P      12/72
W              9.1     0.8           BENAKSAS1  72 OSPK    E+E- COLL.BEAMS    2/73
W             10.5     1.5           BORENSTE1  72 HBC     2.18 K-P           7/77
W   E    940   7.70    1.65          BROWN      72 MMS     2.5 PI- P,N MMS   12/72
W   B  20000  10.22    0.49          KEYNE      76 CNTR    PI-P, OMEGA N     12/75
W       2100   9.4     2.5           GESSAROLI  77 HBC     11 PI-P,OMEGA PI  12/77
W       1430  12.0     2.0           COOPER     78 HBC     .7-.8 PB P,5 PI    4/78
W              9.0     0.8           CORDIER    80 WIRE    E+E-,PI+PI-PI0    9/81*
W             . . . . . . . . . . .
W   AVG        9.90    0.29    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   B    OBSERVED BY THRESHOLD-CROSSING TECHNIQUE. MASS RESCL.=5.8 MEV FWHM
W   E    ERROR TAKES ACCOUNT OF SYSTEMATICS ADDED LINEARLY

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            1  OMEGA PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      OMEGA INTO PI+ PI- PI0                           139+ 139+ 134
P2      OMEGA INTO PI+ PI- (VIOLATES G)                  139+ 139
P3      OMEGA INTO PI0 GAMMA                             134+   0
P4      OMEGA INTO PI+ PI- GAMMA                         139+ 139+   0
P5      OMEGA INTO 2PI0 GAMMA                            134+ 134+   0
P6      OMEGA INTO ETA GAMMA                             548+   0
P7      OMEGA INTO E+ E-                                  .5+  .5
P8      OMEGA INTO MU+ MU-                               105+ 105
P9      OMEGA INTO ETA PI0 (VIOLATES C)                  548+ 134
P10     OMEGA INTO 3 GAMMA                                 0+   0+   0
P11     OMEGA INTO PI0 MU+ MU-                           134+ 105+ 105
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above. only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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      P 1          P 2         P 3
P 1 .8990+-.0051
P 2  -.3764  .0140+-.0021
P 3  -.9106    -.0400   .0870+-.0047
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            1  OMEGA BRANCHING RATIOS

R1      OMEGA INTO NEUTRAL/(PI+ PI- PI0)                    (P3+...)/(P1)
R1      20   0.11     0.02             BUSCHBECK 63 HBC     1.5 K-P
R1      35   0.08     0.03             KRAEMER   64 DBC     1.2 PI+D
R1      65   0.10     0.04             ALFF-STE1 66 HBC CORR.BY SCHULTZ(COL)  9/66
R1     850   0.134    0.026            DIGIUGNO  66 CNTR    1.4 PI-P           9/66
R1     348   0.097    0.016            FLATTE    66 HBC     1.8 K-P            9/66
R1           0.06     0.05      0.02   JAMES     66 HBC     2.1 PI+P           6/66
R1      19   0.10     0.03             BARASH    67 HBC     0.0 PBAR P         7/67
R1      46   0.15     0.04             AGUILAR   72 HBC     3.9,4.6 K- P      12/72
R1           . . . . . . . . . .
R1  AVG      0.1033   0.0091  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT      0.0968   0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      OMEGA INTO (PI+ PI-)/(PI+ PI- PI0). SEE ALSO R15 (P2)/(P1)
R2 R         (0.011)OR MORE  CL=.95   ABRAMOVIC 70 HBC     3.9 PI- P           6/70
R2 B         0.014    0.005    0.004  BIGGS     70 CNTR    PHOTOPRODUCTION    12/78
R2 R         (0.035)OR LESS  CL=.95   BIZZARRI  70 DBC     PBAR N AT REST     11/71
R2           (0.019)OR MORE  CL=.95   CHAPMAN   70 HBC     1.6-2.2 P PBAR      6/70
R2 R         0.022    0.009    0.01   ROOS      70 RVUE                        6/70
R2 S         0.021    0.028    0.009  RATCLIFF  72 ASPK    15.PI- P,N 2PI     12/72
R2           (0.0115)OR MORE          BURNS     73 HBC     .6-1.1 PBAR P      12/75
R2  C        (0.04)   (0.02)          LYONS     77 HBC     3-4 K-P,LAM OMEG   12/77
R2 B    RE-EVALUATED UNDER R2 BY BEHREND 71 USING MORE ACCURATE OMEGA
R2 B    TO RHO PHOTOPRODUCTION CROSS-SECTION RATIO.
R2  C   ASSUMING COMPLETE RHO-OMEGA COHERENCE
R2 R    ROOS 70 COMBINES ABRAMOVICH 70 AND BIZZARRI 70
R2 S    SIGNIFICANT INTERFERENCE EFFECT OBSERVED.NB OF OMEGA INTO 3PI
R2 S    COMES FROM AN EXTRAPOLATION.
R2           . . . . . . . . . .
R2  AVG      0.0157   0.0040  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT      0.0155   0.0024 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      OMEGA INTO (PI0 GAMMA) / (PI+ PI- PI0)              (P3)/(P1)
R3           0.13     0.04             JACQUET   69 HLBC                      10/67
R3           0.081    0.020            BALDIN    71 HLBC    2.9 PI+ P         11/71
R3           0.109    0.025            BENAKSAS2 72 OSPK    E+E- COLL.BEAMS    2/73
R3           0.084    0.013            KEYNE     76 CNTR    PI-P, OMEGA N     12/75
R3           . . . . . . . . . .
R3  AVG      0.0898   0.0097  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT      0.0968   0.0057 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      OMEGA INTO (PI+ PI- GAMMA)/(PI+ PI- PI0)            (P4)/(P1)
R4           (0.05) OR LESS  CL=.90   FLATTE    66 HBC     1.8 K-P             9/66
R4           (.066)OR LESS   CL=.90   KALBFLEI  75 HBC     2.2 K- P,GAMMA +   12/75

R6      OMEGA INTO (MU+ MU-)/(PI+ PI- PI0)(UNITS 10**-3) (P8)/(P1)
R6           (1.2)   OR LESS          GALTIERI  65 HBC     2.7 K-P
R6           (1.7)   OR LESS CL=.74   FLATTE    66 HBC     1.8 K-P             9/66
R6           (0.2)   OR LESS          WILSON    69 OSPK    12 PI- ON C,FE      9/69

R7      OMEGA INTO (2PI0 GAMM)/(PI0 GAMMA)                  (P5)/(P3)
R7           (0.1)   OR LESS          BARMIN    64 PXBC    1.3-2.8 PI-P
R7           (0.14)  OR LESS          BALDIN    71 HLBC    2.9 PI+ P          11/71
R7           (0.15)  OR LESS CL=.90   BENAKSAS2 72 OSPK    E+E- COLL. BEAMS    2/73
R7           (0.18)  OR LESS CL=0.95  KEYNE     76 CNTR    PI-P,OMEGA N        7/77

R8      OMEGA INTO (ETA PI0 + ETA GAMMA)/(PI+ PI- PI0)   (P9+P6)/(P1)
R8           (0.017)OR LESS  CL=.90   FLATTE    66 HBC     1.8 K-P             9/66
R8           (0.045)OR LESS  CL=.95   JACQUET   69 HLBC                        4/70

R9      OMEGA INTO (NEUTRALS) / (CHARGED)                (P3+...)/(P1+P2...)
R9           0.124    0.021            FELDMAN   67 OSPK    1.2 PI- P           3/67
R9           . . . . . . . . . .
R9  FIT      0.0953   0.0056 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R10     OMEGA INTO (2PI0 GAMMA)/(PI+PI-PI0)                 (P5)/(P1)
R10          (0.08) OR LESS  CL=.95   JACQUET   69 HLBC                        4/70

R11     OMEGA INTO (ETA GAMMA)/(PI0 GAMMA)                  (P6)/(P3)
R11          0.010    0.045            APEL      72 CSPK    4-8 PI- P,N 3GAM    2/73

R12     OMEGA INTO (PI0 MU+ MU-) / TOTAL (UNITS 10**-3)  (P11)
R12          0.096    0.023            DZHELYAD1 81 CNTR    25-33 PI-P,OME N    1/82*

R13     OMEGA INTO (E+ E-)/TOTAL (UNITS 10**-4)             (P7)
R13 A   33   (0.65)   (0.13)           ASTVACATU 68 OSPK ASSUME SU(3)+MIXING   6/68
R13 Z        (0.40)   (0.21)           BOLLINI1  68 CNTR    1.7 PI-P            9/68
R13 E        (0.92)   (0.07)           AUGUSTI1  69 OSPK    E+E-, 2PI           2/72
R13          0.83     0.10             BENAKSAS1 72 OSPK    E+E-, 3PI           2/73
R13          0.675    0.069            CORDIER   80 WIRE    E+ E-,3PI          12/79
R13          . . . . . . . . . .
R13 AVG      0.725    0.072   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R13 A        NOT RESOLVED FROM RHO DECAY. ERROR STATISTICAL ONLY.
R13 E        RESCALED BY US TO CORRESPOND TO OMEGA WIDTH 10.1 MEV.
R13 Z        MASS RESOLUTION OF BOLLINI 1 IS +-10 MEV.HIS ERROR IS +-.15
R13 Z        WITHOUT RHO-OMEGA INTERFERENCE. COMPLETE INTERFERENCE WOULD
R13 Z        CHANGE VALUE BY +-35 PER CENT. THEREFORE WE INCREASED ERROR.

R14     OMEGA INTO NEUTRALS / TOTAL                         (P3+...)
R14          0.084    0.015            BOLLINI   68 CNTR    2.1 PI- P           6/68
R14          0.079    0.019            DEINET    69 OSPK    1.5 PI- P           9/69
R14          0.075    0.025            BIZZARRI  71 HBC     0.0 P PBAR         11/71
R14     42   0.073    0.018            BASILE    72 CNTR    1.67 PI- P          2/73
R14          . . . . . . . . . .
R14 AVG      0.0788   0.0092  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R14 FIT      0.0870   0.0047 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R15     OMEGA INTO (PI PI)/(TOTAL). SEE ALSO R2             (P2)
R15          0.032    0.028    0.019  AUGUSTI2  69 OSPK     E+E- COLL.BEAMS    8/69
R15          (0.003)OR MORE  CL=.95   GOLDHABER 69 HBC       3.7-4.0 PI+P     11/69
R15          (0.014)OR MORE  CL=.95   ALLISON   70 HBC     1.3-1.7 PBAR P      6/70
R15 B        (0.0080) (0.0028) (0.0022)IGGS     70 CNTR    PHOTOPRODUCTION    12/78
R15          0.0122   0.0030          ALVENSLEB 71 CNTR    PHOTOPRODUCTION    11/71
R15          0.013    0.012    0.009  MOFFEIT   71 HBC     2.8,4.7 GAMMA P    11/71
R15          0.036    0.024    0.018  BENAKSAS  72 OSPK     E+E- COLL.BEAMS   12/72
R15 F        (0.035)  (0.018)         BRANDENBU 76 ASPK    13.K-P,PI+PI-      12/79
R15 F        (0.041   (0.03)   (0.02) HOLMGREN  77 HBC     4.2 K-P,PI+PI-     12/79
R15          0.016    0.009    0.007  QUENZER   78 CNTR    E+E- COLL.BEAMS     4/78
R15 F        (0.010)  (0.001)         WICKLUND  78 ASPK    3,4,6 PI+-PN       12/79
R15 B   RE-EVALUATED UNDER R2 BY BEHREND 71 USING MORE ACCURATE OMEGA
R15 B   TO RHO PHOTOPRODUCTION CROSS-SECTION RATIO.
R15 F   FROM A MODEL DEPENDENT ANALYSIS ASSUMING COMPLETE COHERENCE.
R15          . . . . . . . . . .
R15 AVG      0.0133   0.0027  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R15 FIT      0.0140   0.0021 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R17     OMEGA INTO (2 PI0 GAMMA) / (ALL NEUTRALS)           (P5)/(P3+...)
R17          (0.19) OR LESS  CL=.90   DEINET    69 OSPK                        9/69
R17 D        (0.22)   (0.07)          DAKIN     72 OSPK    1.4 PI- P,N MMO    12/72
R17 D      SEE R18

R18     OMEGA INTO (PI0 GAMMA) / (ALL NEUTRALS)             (P3)/(P3+...)
R18          (0.81) OR MORE  CL=.90   DEINET    69 OSPK                        9/69
R18 D        (0.78)   (0.07)          DAKIN     72 OSPK    1.4 PI- P,N MMO    12/72
R18 D      ERROR STATISTICAL ONLY.AUTHORS OBTAIN GOOD FIT ALSO ASSUMING
R18 D      PI0 GAMMA AS THE ONLY NEUTRAL DECAY.

R19     OMEGA INTO (ETA GAMMA)/TOTAL (UNITS 10**-4)         (P6)
R19 A        (3.0)    (2.5)    (1.8)  ANDREWS   77 CNTR  0 6.7-10 GAMMA CU    12/77
R19 B        (29.0)   (7.0)           ANDREWS   77 CNTR  0 6.7-10 GAMMA CU    12/77
R19 A   SOLUTION CORRESPONDING TO CONSTRUCTIVE OMEGA-RHO INTERFERENCE
R19 A   THE QUARK MODEL PREDICTS A RELATIVE DECAY PHASE OF ZERO
R19 B   SOLUTION CORRESPONDING TO DESTRUCTIVE OMEGA-RHO INTERFERENCE

R20     OMEGA INTO (PI0 MU+ MU-) / ( MU+ MU-)               (P11)/(P8)       12/78
R20 S   30   (1.2)    (0.6)           DZHELYAD1 79 CNTR  0 25-33 PI- P        12/79
R20 S   SUPERSEDED BY DZHELYADIN 81 RESULT ABOVE.

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REFERENCES FOR OMEGA


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MAGLIC    61 PRL 7 178           B MAGLIC,ALVAREZ,ROSENFELD,STEVENSON  (LRL)
PEVSNER   61 PRL 7 421           PEVSNER,KRAEMER,NUSSBAUM,RICHARD+(JHU+NWES)
XUONG     61 PRL 7 327           NGUYEN HUU XUONG,GERALD R LYNCH       (LRL)

ALFF      62 PRL 9 325           ALFF,BERLEY,COLLEY,GELFAND + (COLU+RUTGERS)
ARMENTER  62 CERN CONF 90        R ARMENTEROS,R BUDDE +      (CERN+CDEF+EPOL)
STEVENSO  62 PR 125 687          STEVENSON,ALVAREZ,MAGLIC,ROSENFELD    (LRL)

ARMENTER  63 SIENA CONF 1 296    ARMENTEROS,EDWARDS,JACOBSEN+    (CERN+CDEF)
BARMIN    63 SIENA CONF 1 207    BARMIN,DOLGOLENKO,KRESTNIKOV+         (ITEP)
BUSCHBEC  63 SIENA CONF 1 166    BUSCHBECK,CZAPP+     (VIENNA+CERN+AMSTERDAM)
GELFAND   63 PRL 11 436          GELFAND,MILLER,NUSSBAUM,PATAU+  (COLU+RUTG)
MURRAY    63 PL 7 358            MURRAY,FERROLUZZI,HUWE,SHAFER,SOLMITZ+(LRL)

BARMIN    64 JETP 18 1289        BARMIN,DOLGOLENKO,KRESTNIKOV +       (ITEP)
KRAEMER   64 PR 136 B 496        KRAEMER,MADANSKY,MEER+      (JHU+NWES+WOOD)

BINNIE    65 PL 18 348           BINNIE,DUANE,JANE,W JONES+       (LOIC+MCHS)
GALTIERI  65 PRL 14 279          A BARBARO GALTIERI,R D TRIPP          (LRL)
MILLER D  65 CU-237(NEVIS 131)   DAVID C MILLER  (THESIS)         (COLUMBIA)
ZDANIS    65 PRL 14 721          ZDANIS,MADANSKY,KRAEMER,HERTZBACH+(JHU+BNL)

ALFF-STE  66 PR 145 1072         ALFF-STEINBERGER,BERLEY,BRUGGER+(COLU+RUTG)
DIGIUGNO  66 NC 44A 1272         DI GIUGNO,PERUZZI,TROISE+  (NAPL+FRAS+TRST)
FLATTE    66 PR 145 1050         +HUWE,MURRAY,BUTTON-SHAFER,SOLMITZ+   (LRL)
JAMES     66 PR 142 896          F E JAMES,KRAYBILL         (YALE+BROOKHAVEN)

BALTAY    67 PRL 18 93           +FRANZINI,SEVERIENS,YEH,ZANELLO  (COLUMBIA)
BARASH    67 PR 156 1399         BARASH,KIRSCH,MILLER,TAN          (COLUMBIA)
FELDMAN   67 PR 159 1219         +FRATI,GLEESON,HALPERN,NUSSBAUM+      (PENN)
HERTZBAC  67 PR 155, 1461        HERTZBACH,KRAEMER,MADANSKI,ZDANIS+(JHU+BNL)

ASTVACAT  68 PL 27 B 45          ASTVACATUROV,AZIMOV,BALDIN+   (JINR+MOSCOW)
BOLLINI   68 NC 56 A 531         +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
BOLLINI1  68 NC 57 A 404         +BUHLER,DALPIAZ,MASSAM+     (CERN+BGNA+STRB)
KEY       68 PR 166 1430         +PRENTICE+COOPER+MANNER     (TNTO+ANL+WISC)
PISUT     68 NP B 6 325          J.PISUT,M,ROOS                        (CERN)
WEHMANN   68 PRL 20 748          +ENGELS+ (HARVARD+CASE+SLAC+CORNELL+MCGILL)

AUGUSTI1  69 PL 28 B 513         +BENAKSAS,BUON,GRACCO,HAISSINSKI,+  (ORSAY)
AUGUSTI2  69 LNC 2 214           +LEFRANCOIS,LEHMANN,MARIN,+          (ORSAY)
BIZZARRI  69 NP B 14 169         +FOSTER,GAVILLET,MONTANET,+     (CERN+CDEF)
DANBURG   69 UCRL-19275          JEROME S. DANBURG, THESIS              (LRL)
DEINET    69 PL 30 B 426         +MENZIONE,MULLER,BUNIATOV+      (KARL+CERN)
ERWIN     69 NP B 9 364          +WALKER,GOSHAW,WEINBERG     (WISC+PRIN+VAND)
GOLDHABE  69 PRL 23,1351         +BUTLER,COYNE,HALL,MACNAUGHTON,TRILLING(LRL)
JACQUET   69 NC 63 A 743         +NGUYEN-KHAC,HAATUFT,HALSTEINSLI(EPOL+BERG)
MILLER    69 PR 178 2061         R.MILLER,LICHTMAN,WILLMANN          (PURDUE)
STRUGALS  69 PL 29 B 532         +CHUVILO,FENYVES,+          (WARS+JINR+BUDA)
WILSON    69 PRIVATE COMM.       RICHARD WILSON (SEE ALSO PR 178 2095)(HARV)

ABRAMOVI  70 NP B 20 209         ABRAMOVICH,BLUMENFELD,BRUYANT,+       (CERN)
BIZZARRI  70 PRL 25 1385         +CIAPETTI,DORE,GASPERO,GUIDONI,+(ROMA+SYRA)
ALLISON   70 PRL 24 618          +COOPER,FIELDS,RHINES                  (ANL)
ATHERTON  70 NP B 18 221         +BLAIR,CELNIKER,DOMINGO,FRENCH+  (CERN+IPN)
BIGGS     70 PRL 24 1201         +CLIFFT,GABATHULER,KITCHING,RAND      (DARE)
CASON     70 PR D 1 851          +ANDREWS,BISWAS,GROVES,HARRINGTON,+   (NDAM)
CHAPMAN   70 NP B 24 445         +DAVIDSON,GREEN,LYS,ROE,VANDER VELDE (MICH)
DANBURG   70 PR D 2 2564         +ABOLINS,DAHL,DAVIES,HOCH,KIRZ,MILLER+(LRL)
FLATTE    70 PR D 1 1            STANLEY M. FLATTE                      (LRL)
GOLDHABE  70 PHILA.CONF.P.59     GERSON GOLDHABER,REVIEW                (LRL)
HAGOPIAN  70 PRL 25 1050         S. AND V.HAGOPIAN,BOGART,SELOVE  (FSU+PENN)
ROOS      70 DNPL/R7 P.173       PROC. DARESBURY STUDY WEEKEND NO 1.  (CERN)

ABRAMS    71 PR D 4 653          +BARNHAM,BUTLER,COYNE,GOLDHABER,HALL,+(LBL)
ALVENSLE  71 PRL 27 888          ALVENSLEBEN,BECKER,BUSZA,CHEN,COHEN,+(DESY)
ANGELOW   71 SJNP 12 427         +GRAMENITSKY,KANASIRSKY,KERATSCHEW,+ (JINR)
BALDIN    71 SJNP 13 758         +VERGAKOV,TREBUKHOVSKY,SHISHOV        (ITEP)
BARDADIN  71 PR D4 2711          BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BEHREND   71 PRL 27 61           +LEE,NORDBERG,WEHMAN,+       (ROCH+CORN+FNAL)
BIZZARRI  71 NP B 27 140         +MONTANET,NILSSON,D-ANDLAU,+    (CERN+CDEF)
BLOODWOR  71 NP B 35 133         BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
CHAPMAN   71 PR D 3 39           +FURTNEY,FOWLER                       (DUKE)
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COYNE    71 NP B 32 333        +BUTLER,FANG-LANDAU,MACNAUGHTON        (LRL)
FIELDS   71 PRL 27 1749        +COOPER,RHINES,ALLISON             (ANL+OXF)
MATTHEWS 71 PRL 26 400         +PRENTICE,YOON,CARROLL,WALKER,+ (TNTO+WISC)
MOFFEIT  71 NP B 29 349        +BINGHAM,FRETTER,BALLAM+(LRL+UCB+SLAC+TUFT)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS  (BNL)
APEL     72 PL 41 B 234        +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BASILE   72 PHIL.CONF.PROC153  +BOLLINI,BROGLIN,DALPIAZ,FRABETTI,+ (CERN)
BENAKSAS 72 PL 39 B 289        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE,+(ORSA)
BENAKSAS172 PL 42 B 507        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BENAKSAS272 PL 42 B 511        +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BROWN    72 PL 42 B 117        +DOWNING,HOLLOWAY,HULD,BERNSTEIN+(ILL+ILLC)
DAKIN    72 PR D 6 2321        +HAUSER,KREISLER,MISCHKE        (PRINCETON)
EISENBER 72 PR D 5 15          EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
RATCLIFF 72 PL 38 B 345        +BULOS,CARNEGIE,KLUGE,LEITH,LYNCH,+  (SLAC)
BORENSTE 72 PR D 5 1559        BORENSTEIN,DANBURG,KALBFLEISCH,+ (BNL+MICH)

BINNIE   73 PR D 8 2789        +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)
BURNS    73 PR D 7 1310        +CONDON,KIM,MANDELKERN,PRICE,SCHULTZ  (UCI)

ESTABROO 74 NP B 81 70         ESTABROOKS,HYAMS,JONES,BLUM,    (CERN+MPIM)
GREGORIO 74 NC 20 A 437        M.A.GREGORIO                  (ICTP-TRIESTE)
KRAMER   74 PRL 33 505         +AYRES,DIEBOLD,GREENE,PAWLICKI+        (ANL)
OREN     74 NP B 71 189        +COOPER,FIELDS,RHINES,ALLISON+     (ANL+OXF)

EMMS     75 NP B98 1           +KINSON,STACEY,BELL,DALE+  (BIRM+DURH+RHEL)
KALBFLEI 75 PR D 11 987        KALBFLEISCH,STRAND,CHAPMAN        (BNL+MICH)
ROOS     75 NP B 97 165        M.ROOS                                (HELS)

BRANDENB 76 NP B 104 413       BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)
KEYNE    76 PR D 14 28         +BINNIE,CARR,DEBENHAM,GARBUTT,+ (LOIC+SHMP)
    ALSO 73 BINNIE

ANDREWS  77 PRL 38 198         +FUKUSHIMA,HARVEY,LOBKOWICZ,MAY,+     (ROCH)
BARTKE   77 NP B 118 360       + (AACH+BERL+BONN+CERN+CRAC+LOIC+WIEN+WARS)
GESSAROL 77 NP B 126 382       GESSAROLI,+    (BGNA+FIRZ+GENO+MILA+OXF+PAVI)
HOLMGREN 77 PL 66 B 191        +JONGEJANS,ENGELEN,+   (CERN+AMST+NIJM+OXF)
LYONS    77 NP B 125 207       +COOPER,CLARK                          (OXF)
ROOS     77 LNC 19 419         M.ROOS                            (HELSINKI)

APELDOOR 78 NP B 133 245       VAN APELDOORN,GRUNDEMAN,HARTING,+     (ZEEM)
COOPER   78 NP B 146 1         +GURTU,MONTANET,+      (TIFR+CERN+CDEF+MADR)
DUENZER  78 PL 76 B 512        +RIBES,RUMPF,BERTRAND,BIZOT,CHASE,+   (LALO)
WICKLUND 78 PR D 17 1197       +AYRES,DIEBOLD,GREENE,KRAMER,PAWLICKI (ANL)

BENKHEIR 79 NP B 150 268       BENKHEIRI,EISENSTEIN,+(EPOL+CERN+CDEF+LALO)
DZHELYAD 79 PL 84 B 143        DZHELYADIN,GOLOVKIN,GRITSUK,+         (SERP)

CORDIER  80 NP B 172 13        +DELCOURT,ESCHSTRUTH,FULDA,+          (LALO)
ROOS     80 LNC 27 321         +PELLINEN                             (HELS)

DZHELYAD 81 PL 102 B 296       DZHELYADIN,GOLOVKIN,KONSTANTINOV,+    (SERP)
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$\eta'(958)$

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2  ETA PRIME(958,JPG=0-+) I=0
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Note on the J^P Assignment of $\eta'(958)$

From the Dalitz plot analyses of the $\eta' \to \pi\pi\eta$ and $\eta' \to \pi^+\pi^-\gamma$ decays and from the observation of an $\eta' \to \gamma\gamma$ decay mode, all assignments except $J^{PC} = 0^{-+}$ and 2^{-+} are excluded. The Dalitz plot analyses favor spin 0, but cannot rule out spin 2. The indication of anisotropy in the decay of very forward-produced η' (KALBFLEISCH 73) has not been confirmed by BALTAY 74, thus again favoring spin 0, but still not ruling out spin 2 (LEDNICKY 77).

Two recent analyses, however, seem to have finally established the spin 0 assignment of the η'.

CERRADA 77 perform a partial-wave analysis of the $\eta\pi\pi$ system produced in the reaction $K^-p \to \eta'\Lambda$, taking into account the η' and Λ joint decay angular correlations. They conclude that J^P is unambiguously 0^- (see also DELAGUILA 77).

ROUSSARIE 77 analyze a large sample of events from the reaction $\pi^-p \to \eta'n$ at beam momenta just above threshold. They verify that the η' is produced in a relative S-wave state, and thus the Adair condition is satisfied by their total sample of some 1800 events. The decay angular distribution of the η' is consistent with isotropy, and thus ROUSSARIE 77 conclude that the spin cannot be 2.

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                 2  ETA PRIME MASS (MEV)

M           957.      1.             RITTENBER 69 HBC   1.7-2.7 K- P     9/69
M     3415  956.1     1.1            BASILE1   71 CNTR  1.6 PI- P,N X0  11/71
M      535  957.4     1.4            BASILE1   71 CNTR  1.6 PI- P,N X0  11/71
M     1414  958.2     0.5            DANBURG   73 HBC   2.2 K-P,LAM X0   2/74
M      400  958.      1.             JACOBS    73 HBC   2.9 K-P,LAM X0   1/74
M           957.46    0.33           DUANE     74 MMS   PI- P,N MM       1/74
M          . . . . . . . . . .
M   AVG     957.57    0.25   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 2  ETA PRIME WIDTH (MEV)

W     1000    0.28     0.10          BINNIE    79 MMS   0 PI- P,N MM    12/79

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                 2  ETA PRIME PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      ETA PRIME INTO PI+ PI- ETA                         139+ 139+ 548
                  P1(N)  ETAS DECAY INTO ALL NEUTRALS
                  P1(C)  ETAS DECAY CHARGED
P2      ETA PRIME INTO PI0 PI0 ETA                         134+ 134+ 548
                  P2(N)  ETAS DECAY INTO ALL NEUTRALS
                  P2(C)  ETAS DECAY CHARGED
P3      ETA PRIME INTO PI+ PI- GAMMA                       139+ 139+   0
                  (INCLUDING RHO GAMMA)
P4      ETA PRIME INTO GAMMA GAMMA                           0+   0
P5      ETA PRIME INTO OMEGA GAMMA                         782+   0
P6      ETA PRIME INTO RHO0 GAMMA                          769+   0
P10     ETA PRIME INTO PI+ PI- E+ E-                       139+ 139+  .5+  .5
P11     ETA PRIME INTO 2 PI                                139+ 139
P12     ETA PRIME INTO 3 PI                                139+ 139+ 134
P13     ETA PRIME INTO 4 PI                                139+ 139+ 139+ 139
P14     ETA PRIME INTO 5 PI
P15     ETA PRIME INTO 6 PI
P16     ETA PRIME INTO PI0 E+ E- (VIOLATES C IN            134+  .5+  .5
                                         BORN APPROX.)
P17     ETA PRIME INTO ETA E+ E- (VIOLATES C IN            548+  .5+  .5
                                         BORN APPROX.)
P18     ETA PRIME INTO PI0 RHO 0 (VIOLATES C)              134+ 769
P19     ETA PRIME INTO PI0 OMEGA (VIOLATES C)              134+ 782
P20     ETA PRIME INTO MU+ MU- GAMMA                       105+ 105+   0
P21     ETA PRIME INTO ETA MU+ MU-                         548+ 105+ 105
P22     ETA PRIME INTO PI0 MU+ MU-                         134+ 105+ 105

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle\delta P_i\,\delta P_i\rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle\delta P_i\,\delta P_j\rangle/(\delta P_i \cdot \delta P_j)$. *For the definitions of the individual* P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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          P 1         P 2         P 3         P 4         P 5
P 1 .4267+-.0174
P 2   -.6471    .2265+-.0206
P 3   -.2807     -.5018    .3005+-.0160
P 4    .0334     -.1086      .0042    .0187+-.0016
P 5    .0674     -.2094     -.1439     -.0078   .0276+-.0054

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Note on $\eta'(958)$ Branching Fractions

In our calculation of the branching fractions of the $\eta'(958)$, we use the decay modes $\eta\pi\pi$ (including $\eta\pi^0\pi^0$), $\rho^0\gamma$, $\omega\gamma$, and $\gamma\gamma$. It is assumed that the rate $\eta \to$ neutrals is 71.0%.

In the fit we do not use the constraint

$$R = \frac{\Gamma(\eta' \to \eta\pi^+\pi^-)}{\Gamma(\eta' \to \eta\pi^0\pi^0)} = 2$$

from I-spin conservation. The result of the fit is in agreement with it: $R = 1.8 \pm 0.2$.

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                 2  ETA PRIME PARTIAL WIDTHS (KEV)

W1      ETA PRIME INTO (GAMMA GAMMA)                     (G4)
W1   C  23   (5.8)    (2.3)          ABRAMS    79 SMAG    E+E-,E+E- RHO GA 12/79
W1   C THE SYSTEMATIC ERROR HAS BEEN ADDED LINEARLY.

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                 2  ETA PRIME BRANCHING RATIOS

                 SEE MINI-REVIEW ABOVE.

R1      ETA PRIME INTO (PI+ PI-ETA (NEUTRAL DEC.))/TOTAL (P1N)
R1      281    0.314    0.026        RITTENBER 69 HBC     1.7-2.7 K-P      9/69
R1         . . . . . . . . . .
R1  FIT        0.303    0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)
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R2      ETA PRIME INTO (PI+ PI- NEUTRALS) / TOTAL          (P1N+P2C+P5)
R2       33    0.35     0.06              BADIER    65 HBC      3.0 K-P         10/66
R2       39    0.4      0.1               LONDON    66 HBC      2.2 K-P         10/66
R2                . . . . . . . . . . .
R2  AVG        0.363    0.051   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT        0.393    0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      ETA PRIME INTO (PI+ PI- ETA (CHRGD.DECAY))/TOTAL (P1C)
R3        7    0.07     0.04              BADIER    65 HBC      3.0 K-P         10/66
R3       10    0.1      0.04              LONDON    66 HBC      2.2 K-P         10/66
R3      107    0.123    0.014             RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R3                . . . . . . . . . . .
R3  AVG        C 116    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT        ) 1237   0.0050 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      ETA PRIME INTO (PI+ PI- NEUTRALS (EXCLUDING        (P2C+P5)
R4          PI+ PI- ETA (NEUTR.DEC.))) / TOTAL
R4       42    0.045    0.029             RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R4                . . . . . . . . . . .
R4  FIT        0.0905   0.0069 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      ETA PRIME INTO (NEUTRALS) / TOTAL                  (P2N+P4)
R5      123    0.189    0.026             RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R5      535    0.185    0.022             BASILE1   71 CNTR     1.6 PI- P.N XO  11/71
R5                . . . . . . . . . . .
R5  AVG        0.187    0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT        .182     0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      ETA PRI  INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/TOTAL
R6                                                         (P3)
R6       35    14       0.09              BADIER    65 HBC      3.0 K-P         10/66
R6       20    . 2      0.1               LONDON    66 HBC      2.2 K-P         10/66
R6      298    0.329    0.033             RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R6                . . . . . . . . . . .
R6  AVG        0.319    0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT        0.301    0.016  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      ETA PRI  INTO (PI+ PI- GAMMA (INCLUDING RHO GAMMA))/(PI PI ETA)
R7                                                         (P3)/(P1+P2)
R7             .32      0.15              DAVIS     68 HBC      5.5 K- P         9/68
R7                . . . . . . . . . . .
R7  FIT        0.460    0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      ETA PRIME INTO (PI0 E+ E-)/TOTAL                   (P16)
R8          (0.013)OR LESS                RITTENBER 65 HBC             2.7 K-P   10/66

R9      ETA PRIME INTO (ETA E+ E-)/TOTAL                   (P17)
R9          (0.011)OR LESS                RITTENBER 65 HBC             2.7 K-P   10/66

R10     ETA PRI  INTO (PI0 RHO0)/TOTAL                     (P18)
R10         (   04) OR LESS               RITTENBER 65 HBC             2.7 K-P   10/66

R11     ETA PRIME INTO(GAMMA OMEGA)/TOTAL                  (P5)
R11 R       (0.06) OR LESS                RITTENBER 65 HBC             2.7 K-P   10/66
R11 R    INCLUDES PI0 OMEGA
R11         ( .05) OR LESS  CL=.90        KALBFLEI  75 HBC      2.2 K- P,GAMMA + 12/75

R12     ETA PRI  INTO (PI+ PI- E+ E-)/TOTAL                (P10)
R12         (  006)OR LESS                RITTENBER 65 HBC             2.7 K-P   10/66

R13     ETA PRI  INTO (2 PI)/TOTAL                         (P11)
R13         (0.07) OR LESS                LONDON    66 HBC      COMPILATION      10/66

R14     ETA PRIME INTO (3 PI)/TOTAL                        (P12)
R14         (0.07) OR LESS                LONDON    66 HBC      COMPILATION      10/66

R15     ETA PRIME INTO (4 PI)/TOTAL                        (P13)
R15         (0. 1) OR LESS                LONDON    66 HBC      COMPILATION      10/66

R16     ETA PRIME INTO (6 PI)/TOTAL                        (P15)
R16         (0.01) OR LESS                LONDON    66 HBC      COMPILATION      10/66

R17     ETA PRI  INTO (OMEGA GAMMA)/(PI+PI-ETA)            (P5)/(P1)
R17      68      068    0.013             ZANFINO   77 ASPK     8.4 PI-P         12/77
R17               . . . . . . . . . . .
R17 FIT          065    0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R18     ETA PRIME INTO (PI+ PI- GAM(INCL.RHO GAM))/(PI PI ETA + OMEGA GAM)
R18                                                        (P3)/(P1+P2+P5)
R18            0.25     0.14              DAUBER    64 HBC      1.95 K-P         10/66
R18               . . . . . . . . . . .
R18 FIT        0.441    0.034  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R19     ETA PRIME INTO (2 GAMMA)/TOTAL                     (P4)
R19      31    0.020    0.008    0.006 HARVEY    71 OSPK     3.65 PI- P,N XO  11/71
R19      68    0.0171   0.0033            DALPIAZ   72 CNTR     1.6 PI- P,N XO   12/72
R19              025    0.007             DUANE     74 MMS      PI-P,N MM        12/75
R19    6000      018    0.002             APEL      79 CNTR     15-40 PI- P      12/79
R19               . . . . . . . . . . .
R19 AVG        0.0183   0.0016  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 FIT        0.0187   0.0016 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R20     ETA PRIME INTO (PI+PI-)/TOTAL                      (P11)
R20         (0.02) OR LESS                RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R20         (0.08) OR LESS  CL=.95        DANBURG   73 HBC      2.2 K-P,LAM XO   2/74

R21     ETA PRI  INTO (PI+PI-PI0)/TOTAL                    (P12)
R21         (0.05) OR LESS                RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R21         (0.09) OR LESS  CL=.95        DANBURG   73 HBC      2.2 K-P,LAM XO   2/74

R22     ETA PRIME INTO (PI+PI+PI-PI-)/TOTAL                (P13)
R22         (0.01) OR LESS                RITTENBER 69 HBC      1.7-2.7 K-P      9/69
R22         (0 01) OR LESS  CL=.95        DANBURG   73 HBC      2.2 K-P,LAM XO   2/74

R23     ETA PRI  INTO (PI+PI+PI-PI-PI0)/TOTAL              (P14)
R23         (0 01) OR LESS                RITTENBER 69 HBC      1.7-2.7 K-P

R24     ETA PRI  INTO (PI+PI+PI-PI- NEUTRALS)/TOTAL        (P15+...)
R24         (C  1) OR LESS                RITTENBER 69 HBC      1.7-2.7 K-P      9/69

R25     ETA PRI  INTO (RHO0 GAMMA)/(ALL PI+ PI- GAMMA)     (P6)/(P3)
R25             C  5    0.20              AGUILAR   70 HBC      3.9-4.6K-P       1/71
R25  E 473     1.15     0.10              DANBURG   73 HBC      2.2 K-P,LAM XO   2/74
R25  F 473     (0 35) OR MORE  CL=.95     DANBURG   73 HBC      2.2 K-P,LAM XO   2/74
R25     137    1.01     0.15              JACOBS    73 HBC      2.9 K-P,LAM XO   1/74
R25               . . . . . . . . . . .
R25 AVG        1.082    0.077   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R25  E  EQUIVALENT STATEMENTS

R26     ETA PRIME INTO (PI0 PI0 ETA INTO 3 PI0)/TOTAL    (P2N(3PI0))
R26       4    0.12     0.06              BENSINGER 70 OBC      2.2 PI+ D        1/71
R27     ETA PRIME INTO (PI+ PI- GAMMA)/(PI+ PI- ETA(NEUTRAL DEC.))
R27                                                        (P3)/(P1N)
R27 K         (0.54)   (0.10)             AGUILAR   72 HBC      3.9,4.6 K- P     12/72
R27 K   NOT AVERAGED DUE TO COMPLICATION WITH M(953).SEE KALBFLEI 74.
R27     473    0.92     0.14              DANBURG   73 HBC      2.2 K-P,LAM XO   2/74
R27     192    1.11     0.18              JACOBS    73 HBC      2.9 K-P,LAM XO   1/74
R27               . . . . . . . . . . .
R27 AVG        0.99     0.11    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R27 FIT        0.992    0.075  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R28     ETA PRIME INTO (2 GAMMA)/(PI0 PI0 ETA(NEUTRAL DEC.))
R28                                                        (P4)/(P2(N))
R28      16    0.188    0.058             APEL      72 OSPK     3.8 PI- P.N XO   1/73
R28               . . . . . . . . . . .
R28 FIT        0.116    0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R29     ETA PRIME INTO (GAMMA 2MU)/(2GAMMA)(UNITS 10**-3)(P20)/(P4)          12/78
R29      33    4.9      1.2               VIKTOROV  80 CNTR     25,33 PI-P,2MU G  9/81*

R30     ETA PRIME INTO (ETA MU+ MU-)/TOTAL (UNITS 10**-5)(P21)                1/82*
R30         (1.5)  OR LESS  CL=.90        DZHELYAD  81 CNTR     30 PI-P,ETAP N   1/82*

R31     ETA PRIME INTO (PI0 MU+ MU-)/TOTAL (UNITS 10**-5)(P22)                1/82*
R31         (6.0)  OR LESS  CL=.90        DZHELYAD  81 CNTR     30 PI-P,ETAP N   1/82*
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                  2  ETA PRIME C-NONCONSERVING DECAY PARAMETER

      RELATED TEXT SECTION  VI C

A     DECAY ASYMMETRY PARAMETER FOR PI+ PI- GAMMA
A        152      .07      .08            RITTENBE  65 HBC      2.1-2.7 K-P      12/75
A        103      .00      .10            KALBFLEI  75 HBC      2.2 K-P          12/75
A        295    -.069     .078            GRIGORIA  75 STRC     2.1 PI-P         12/75
A                 . . . . . . . . . . .
A     AVG       -0.001    0.049   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR ETA PRIME


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DAUBER    64 PRL 13 449           DAUBER,SLATER,SMITH,STORK,TICHO         (UCLA)JP
    ALSO  64 DUBNA CONF 1 418     DAUBER,SLATER,L T SMITH,STORK,TICHO  (UCLA)
GOLDBERG  64 PRL 12 546           +GUNDZIK,LICHTMAN,CONNOLLY,HART,+(SYRA+BNL)
GOLDBERG  64 PRL 13 249           +GUNDZIK,LEITNER,CONNOLLY,HART,+ (SYRA+BNL)
KALBFLE1  64 PRL 12 527           KALBFLEISCH,ALVAREZ,BARBARO-GALTIERI,+(LRL)JP
KALBFLE2  64 PRL 13 349           G.R.KALBFLEISCH,O.DAHL,A.RITTENBERG   (LRL)JP

BADIER    65 PL 17 337            BADIER,DEMOULIN,BARLOUTAUD+(EPOL+SACL+AMST)
KIENZLE   65 PL 19 438            KIENZLE,MAGLIC,LEVRAT,LEFEBVRES +     (CERN)
RITTENBE  65 PRL 15 556           RITTENBERG,KALBFLEISCH              (LRL+BNL)
TRILLING  65 PL 19 427            +BROWN,GOLDHABERS,KADYK,SCANIO          (LRL)

COHN      66 PL 21 347            COHN,MCCULLOCH,BUGG,CONDO  (ORNL+TENN+UCND)
LONDON    66 PR 143 1034          LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)JP
MARTIN    66 PL 22,352            MARTIN,CRITTENDEN,SCHROEDER       (INDIANA U)

BARBARO-  68 PRL 20 349           BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)I=
BARLOUTA  68 PL 26 B  674         BARLOUTAUD+     (SACLAY+AMST+BGNA+REHO+EPOL)I=0
BOLLINI   68 NC 58 A  289         +BUHLER,DALPIAZ,MASSAM+      (CERN+BGNA+STRB)
DAVIS     68 PL 27 B 532          +AMMAR,MOTT,DAGAN,DERRICK,FIELDS (NWES+ANL)

DUFEY     69 PL 29 B 605          +GOBBI,POUCHON,CNOPS,+        (ETH+CERN+SACL)JP
MOTT      69 PR 177 1966          +AMMAR,DAVIS,KROPAC,SLATE,DAGAN+ (NWES+ANL)
RITTENBE  69  UCRL-18863          ALAN RITTENBERG (THESIS)              (LRL)I=0

AGUILAR   70 PRL 25 1635          AGUILAR-BENITEZ,BASSANO,SAMIOS,BARNES+(BNL)
BENSINGE  70 PL 33 B 505          BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)

BARDADIN  71 PR D4 2711           BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BASILE1   71 NC 3 A 371           +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
BASILE2   71 NP B 33 29           +BOLLINI,DALPIAZ,FRABETTI,+(CERN+BGNA+STRB)
HARVEY    71 PRL 27 885           +MARQUIT,PETERSON,RHOADES,+       (MINN+MICH)
OGIEVETS  71 PL 35 B 69           OGIEVETSKY,TYBOR,ZASLAVSKY             (DUBNA)

AGUILAR   72 PR D 6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
APEL      72 PL 40 B 680          +AUSLANDER,MULLER,BERTOLUCCI,+  (KARL+PISA)
BINNIE    72 PL 39 B 275          +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
BLOODWOR  72 NP B 39 525          BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DALPIAZ   72 PL 42 B 377          +FRABETTI,MASSAM,NAVARRIA,ZICHICHI    (CERN)
RADER     72 PR D 6 3059          +ABOLINS,DAHL,DANBURG,DAVIES,HOCH,+    (LBL)

DANBURG   73 PR D 8 3744          +KALBFLEISCH,BORENSTEIN,CHAPMAN,+(BNL+MICH)  JP
JACOBS    73 PR D 8 18            +CHANG,GAUTHIER,+        (BRAN+UMD+SYRA+TUFT)  JP
KALBFLEI  73 PRL 31 333           KALBFLEISCH,CHAPMAN,+          (BNL+MICH+LBL)  JP

BALTAY    74 PR D9 2959           +COHEN,CSORNA,HABIBI,KALELKAR,+ (COLU+BING)  JP
DUANE     74 PRL 32 425           +BINNIE,CAMILLERI,CARR,DEBENHAM+(LOIC+SHMP)
GAULT     74 NC 24 A 259          +JONES,SCADRON,THEWS        (DURH+LOIC+ARIZ)
KALBFLEI  74 PR D10 916           G.R.KALBFLEISCH                         (BNL)

GRIGORIA  75 NP B91 232           GRIGORIAN,LADAGE,MELLEMA,RUDNICK,+    (UCLA)
KALBFLEI  75 PR D11 987           KALBFLEISCH,STRAND,CHAPMAN        (BNL+MICH)

CERRADA   77 NP B 126 189         +WAGNER,BLOCKZIJL,+    (CERN+AMST+NIJM+OXF)  JP
DELAGUIL  77 PR D16 2833          F.DEL AGUILA AND M.G.DONCEL      (BARCELONA)  JP
GESSAROL  77 NP B 126 382         GESSAROLI,+  (BGNA+FIRZ+GENO+MILA+OXF+PAVI)
LEDNICKY  77  E2-10521,22,23      R.LEDNICKY                            (JINR)  JP
ROUSSARI  77  PREPRINT            +ERNWEIN,FELTESSE,BORGEAUD,ROUSSARIE+(SACL)  JP
    ALSO  77 BUDAPEST CONF.       HEMINGWAY REVIEW TALK                 (CERN)
ZANFINO   77 PRL 38 930           +BROCKMAN,DANKOWYCH,+ (CARL+MCGI+OHIO+TNTO)

ABRAMS    79  SLAC-PUB 2421       +ALAM,BLOCKER,BOYARSKI,+          (SLAC+LBL)
    ALSO  79 PRL 43 477           ABRAMS,ALAM,BLOCKER,BOYARSKI,+    (SLAC+LBL)
APEL      79 PL 83 B 131          +AUGENSTEIN,BERTOLUCCI(KARL+PISA+SERP+WIEN)
BINNIE    79 PL 83 B 141          +CARR,DEBENHAM,JONES,KARAMI,KEYNE+    (LOIC)
DZHELYAD  79 PL B 88 379          DZHELYADIN,GOLOVKIN,GRITZUK,KACHANOV+(SERP)

VIKTOROV  80 SJNP 32 520          +GOLOVKIN,DZHELYADIN,ZAITSEV,MUKHIN,+(NOVO)

DZHELYAD  81 PL 105 B 239         DZHELYADIN,GOLOVKIN,KONSTANTINOV,+    (SERP)

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S*(975)

3 S*(975,JPG=0++) I=0

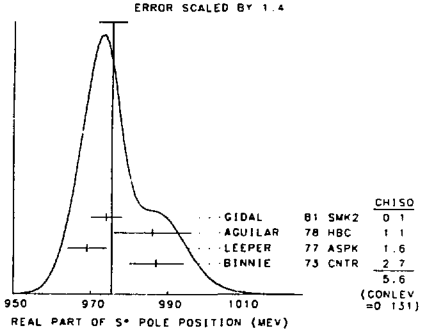
UNDER THIS ENTRY WE LIST PARAMETERS OF THE POLE IN THE ISOSCALAR S WAVE. FOR A MINI-REVIEW SEE UNDER EPSILON.

FOR EARLY WORK USING BREIT-WIGNER OR SCATTERIN' LENGTH PARAMETRIZATION IN FITS TO THE K KBAR SPECTRUM, SEE REFERENCE SECTION AND OUR 1972 EDITION.

3 REAL PART OF THE S* POLE POSITION (MEV)

M	R	(997.)	(6.)	PROTOPOPE 73 HBC	PI+ P	12/77
M	A	(997.)		ESTABROOK 73 ASPK	17 PI-P,PI+PI-N	12/75
M	R	(1012.)	(6.)	GRAYER 73 ASPK	17 PI-P,PI+PI-N	12/77
M	R	(1007.)	(20.)	HYAMS 73 ASPK	17 PI-P,N PI+PI-	12/77
M	A	(986.)	(5.)	FUJII 75 RVUE	17 PI-P,PI+PI-N	12/75
M	AD	(998.0)	(7.0)	BOHACIK 80 RVUE		9/81*
M	E	(988.)		IRVING 81 RVUE		3/82*
M	F	(966.)		IRVING 81 RVUE		3/82*
M		987.	7.	BINNIE 73 CNTR	PI- P,S* N	12/77
M		969.0	5.0	LEEPER 77 ASPK	2-2.4 PI-P	12/77
M	C	986.	10.	AGUILAR 78 HBC	.7 PBAR P, KS KS	12/77
M		(986.)		MARTIN 79 RVUE		9/81*
M	B	(975.)		ACHASOV 80 RVUE		9/81*
M		974.0	4.0	GIDAL 81 SMK2	J/PSI DECAY	1/82*
M	B	(985.)		TORNQVIS 82 RVUE		1/82*
M		. . . .				
M	AVG	975.4	3.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4) (SEE IDEOGRAM BELOW)		

WEIGHTED AVERAGE = 975.4 ± 3.8
ERROR SCALED BY 1.4



M A FROM SINGLE CHANNEL FIT TO HYAMS 73 DATA.
M B COUPLED CHANNEL ANALYSIS WITH FINITE WIDTH CORRECTIONS.SEE MINIREV.
M D POLE POSITIONS FROM ALMOST MODEL-INDEPENDENT PARAMETRIZATION
M C FROM COUPLED CHANNEL FIT TO HYAMS 73 AND PROTOPOPESCU 73 DATA.
M C WITH A SIMULTANEOUS FIT TO THE PI PI PHASE-SHIFTS.
M C INELASTICITY AND TO THE KS KS INVARIANT MASS.
M E FROM COUPLED CHANNEL ANALYSIS OF PI N --> PI PI N OR K KBAR N DATA
M E FROM GRAYER 73 AND COHEN 80
M F SIMILAR TO (E), BUT OMIT PI N --> PI PI N MOMENTS, AND INCLUDE
M F K- P --> PI+ PI- Y DATA
M R INCLUDED IN AGUILAR 78 FIT

3 NEGATIVE IMAG. PART OF THE S* POLE POSITION (MEV)
CORRESPONDS TO HALF-WIDTH, NOT FULL WIDTH.

W	R	(27.)	(8.)	PROTOPOPE 73 HBC	7. PI+ P	12/77
W	A	(5.)		ESTABROOK 73 ASPK	17 PI-P,PI+PI-N	12/75
W	R	(16.)	(5.)	GRAYER 73 ASPK	17 PI-P,PI+PI-N	12/77
W	R	(15.)	(5.)	HYAMS 73 ASPK	17 PI-P,N PI+PI-	12/77
W	A	(19.)	(3.)	FUJII 75 RVUE	17 PI-P,PI+PI-N	12/75
W	AD	(19.0)	(6.0)	BOHACIK 80 RVUE		9/81*
W	E	(8.)		IRVING 81 RVUE		3/82*
W	F	(24.)		IRVING 81 RVUE		3/82*
W		24.	7.	BINNIE 73 CNTR	PI- P,S* N	12/77
W		15.0	4.0	LEEPER 77 ASPK	2-2.4 PI-P	12/77
W	C	50.	40.	AGUILAR 78 HBC	.7 PBAR P, KS KS	12/77
W		(7.)		MARTIN 79 RVUE		9/81*
W	B	70 TO 300		ACHASOV 80 RVUE		9/81*
W		14.0	5.0	GIDAL 81 SMK2	J/PSI DECAY	1/82*
W	B	(260.)	APPROX.	TORNQVIS 82 RVUE		1/82*
W		. . . .				
W	AVG	16.3	2.8	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)		

W ACR SE NOTES UNDER REAL PART
W EF SEE NOTES UNDER REAL PART
W B COUPLED CHANNEL ANALYSIS WITH FINITE WIDTH CORRECTIONS.SEE MINIREV.
W D POLE POSITIONS FROM ALMOST MODEL-INDEPENDENT PARAMETRIZATION

3 S* PARTIAL DECAY MODES

		DECAY MASSES
P1	S* INTO K KBAR	497+ 497
P2	S* INTO PI PI	139+ 139
P3	S* INTO ETA ETA	548+ 548

3 S* BRANCHING RATIOS

R1	S* INTO (PI PI)/TOTAL						(P2)	
R1		(0.71)			HYAMS	75 ASPK	17.2 PI-P,PI+PI-	9/81*
R1		0.78	0.07		WETZEL	76 OSPK	8.9 PI-P,KS KS N	9/81*
R1		0.81	0.09	0.04	CASON	78 STRC	7. PI- P,KS KS N	9/81*
R1		0.67	0.09		LOVERRE	80 HBC	4. PI- P,K K N	9/81*
R1		. . . .						
R1	AVG	0.776	0.026	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

REFERENCES FOR S*

WANG	61 JETP 13 323	WANG TSU-TSENG,VEKSLER,VRANA,+	(JINR)
BIGI	62 CERN CONF 247	A BIGI,S BRANDT, R CARRARA +	(CERN)
BINGHAM	62 CERN CONF 240	H H BINGHAM,M BLOCH +	(EPOL+CERN)
ERWIN	62 PRL 9 34	ERWIN,HOYER,MARCH,WALKER,WANGLER	(WISC+BNL)
BALTAY	64 DUBNA CONF 1 409	BALTAY,LACH,CRENNELL,OREN,STUMP +(YALE+BNL)	
BARMIN	64 DUBNA CONF 1 433	BARMIN,DOLGOLENKO,YEROFEEV,KRESTNI+	(ITEP)
CRENNELL	66 PRL 16 1025	CRENNELL,KALBFLEISCH,LAI,SCARR,SCHU+	(BNL)
HESS	66 PRL 17 1109	+DAHL+HARDY+KIRZ+MILLER	(LRL)
BARLOW	67 NC 50A 701	+LILLESTOL+MONTANET+	(CERN+COEF+IRAD+LIVP)
BEUSCH	67 PL 25 B 357	+FISCHER,GOBBI,ASTBURY+	(ETH+CERN)
DAHL	67 PR 163 1377	+HARDY+HESS+KIRZ+MILLER	(LRL)
ALITTI	68 PRL 21 1705	+BARNES,CRENNELL,FLAMINIO,GOLDBERG,+	(BNL)
LAI	68 PHILAD.CONF.P.303	KWAN WU LAI	(BNL)
PHELAN	68 THESIS	JAMES J. PHELAN	(ANL+ST.LOUIS UNIV)
ALSO	68 PRL 21 316	HOANG,EARTLY,PHELAN,ROBERTS+	(ANL+CHIC+NDAM)
AGUILAR-	69 PL 29 B 241	M.AGUILAR-BENITEZ,J.BARLOW,+	(CERN+CDEF)
ALSO	69 NP B 14 195	M.AGUILAR-BENITEZ,J.BARLOW,+	(CERN+CDEF)
HOANG	69 NC 61 A 325	T.F.HOANG	(ANL)
HOANG	69 PR 184 1363	+EARTLY,PHELAN,ROBERTS,+	(ANL+ILLC)
BADIER	70 NP B 22 512	+BONNET,DREVILLON,BAUBILLIER,+	(EPOL+IPNP)
BATON	70 PL 33 B 528	+LAURENS,PFIGNIER	(SACLAY)
BEUSCH	70 PHILA.CONF.P.185	W.BEUSCH	(ETH+CERN)
HYAMS	PHILA.CONF.P.41	+KOCH,BEUSCH,+	(CERN+MPIM+ETH+LOIC+WAWA)
ALSO	70 NP B 22 189	HYAMS,KOCH,POTTER,VON LINDERN,+	(CERN+MPIM)
OH	70 PR D 1 2494	+GARFINKEL,MORSE,WALKER,PRENTICE	(WISC+TNTO)
ALSTON-G	71 PL 36 B 152	ALSTON-GARNJOST,BARBARO-GALTIERI,+	(LBL)
BASDEVAN	72 PL 41 B 178	BASDEVANT,FROGGATT,PETERSEN	(CERN)
DAMERI	72 NC 9 A 1	+BORZATTA,GOUSSU,+	(GENO+MILA+SACL)
DUBOC	72 NP B 46 429	+GOLDBERG,MAKOWSKI,DONALD,+	(LPNP+LIVP)
FLATTE	72 PL 38 B 232	+ALSTON-GARNJOST,BARBARO-GALTIERI,+	(LBL)
GRAYER	72 PHIL.CONF.PROC. 5	+HYAMS,JONES,SCHLEIN,BLUM,DIETL+	(CERN+MPIM)
WILLIAMS	72 PR D 6 3178	P.K.WILLIAMS	(FSU)
BINNIE	73 PRL 31 1534	+CARR,DEBENHAM,DUANE,GARBUTT,+	(LOIC+SHMP)
DIAMOND	73 PR D 7 1977	+BINKLEY,+	(WISC+DUKE+COLO+TNTO+OHIO)
ESTABROO	73 TALLAHASSEE	ESTABROOKS,MARTIN,GRAYER,HYAMS+	(CERN+MPIM)
FUJII	73 NC 13 A 311	Y.FUJII,M.KATO	(TOKYO)
GRAYER	73 TALLAHASSEE	+HYAMS,JONES,BLUM,DIETL,KOCH+	(CERN+MPIM)
HYAMS	73 NP B 64 134	+JONES,WEILHAMMER,BLUM,DIETL,+	(CERN+MPIM)
OCHS	73 THESIS	W.OCHS	(MPIM)
PROTOPOP	73 PR D 7 1290	PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+	(LBL)
GRAYER	74 NP B 75 189	+HYAMS,JONES,BLUM,DIETL,KOCH+	(CERN+MPIM)
GRAYER	74 NP B 76 375	+HYAMS,JONES,BLUM,DIETL	(CERN+MPIM)
MORGAN	74 PL 51B 71	D.MORGAN	(RHEL)
FUJII	75 NP B85 179	Y.FUJII,M.FUKUGITA	(TOKY)
HYAMS	75 NP B 100 205	+JONES,WEILHAMMER,BLUM,DIETL+	(CERN+MPIM)
MORGAN	75 ARGONNE CONF. 45	D. MORGAN	(RHEL)
PAWLICKI	75 PR D12 631	+AYRES,DIEBOLD,GREENE,KRAMER,WICKLUND	(ANL)
BRANDEB	76 NP B 104 413	+CARNEGIE,CASHMORE,DAVIER,LASINSKI,+	(SLAC)
BUTTRAM	76 PR D 13 1153	+CRAWLEY,DUKE,LAMB,LEEPER,PETERSON	(ISU)
CERRADA	76 PL 62 B 353	+GONZALEZ-ARROYO,RUBIO,YNDURAIN	(CERN+MADR)
FLATTE	76 PL 63 B 228	S.M.FLATTE	(CERN)
WETZEL	76 NP B 115 208	+FREUDENREICH,BEUSCH,+	(ETH+CERN+LOIC)
WILKINS	76 PR D 13 1831	+ALBRIGHT,S+V HAGOPIAN,+LANNUTTI	(FSU)
FROGATT	77 NP B 129 89	+PETERSEN	(GLASGOW+COPENHAGEN)
LEEPER	77 PR D 16 2054	+BUTTRAM,CRAWLEY,DUKE,LAMB,PETERSON	(ISU)
MARTIN	77 NP B 121 514	+OZMUTLU,SQUIRES	(DURHAM)
PAWLICKI	77 PR D 15 3196	+AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND	(ANL) J
AGUILAR	78 NP B 140 73	+CERRADA,+	(MADRID+BOMBAY+CERN+PARIS)
BALAND	78 NP B 140 220	+GRARD,JOHNSON,+	(MONS+BELG+CERN+LOIC+LALO)
CASON	78 PRL 41 271	+BAUMBAUGH,BISHOP,BISWAS,KENNEY,+	(NDAM+ANL)
ACHASOV	79 PL 88 B 367	+DEVYANIN,SHESTAKOV	(NOVO)
APEL	79 NP B 160 42	+AUSLANDER,MULLER,REHAK+	(KARL+PISA)
BECKER	79 NP B 151 46	+BLANAR,BLUM,CERRADA+	(MPIM+CERN+ZEEM+CRAC)
CORDEN	79 NP B 157 250	+DOWELL,GARVEY,JOBES,+	(BIRM+RHEL+TELA+LOWC) JP
ESTABROO	79 PR D 19 2678	P.ESTABROOKS	(CARL)
GREENHUT	79 PR D 20 2326	+INTEMANN	(SETO)
MARTIN	79 NP B 158 520	+OZMUTLU	(DURH) I.JP
POLYCHRO	79 PR D 19 1317	POLYCHRONAKOS,CASON,BISHOP+	(NDAM+ANL)
ACHASOV	80 SJNP 32 566	+DEVYANIN,SHESTAKOV	(NOVO)
BOHACIK	80 PR D 21 1342	J.BOHACIK,H.KUHNELT	(BRATISLAVA+WIEN)
COHEN	80 PR D 22 2595	+AYRES,DIEBOLD,KRAMER,PAWLICKI+	(ANL) I.JP
LOVERRE	80 ZPHY C 6 187	+ARMENTEROS,DIONISI+	(CERN+CDEF+MADR+STOH) I.JP
WICKLUND	80 PRL 45 1469	+AYRES,COHEN,DIEBOLD,PAWLICKI	(ANL)
ACHASOV	81 PL 102 B 196	+DEVYANIN,SHESTAKOV	(NOVO)
AGUILAR	81 ZPHY C 10 299	AGUILAR-BENITEZ,DONE,MARTIN	(MADR+DURH)
GIDAL	81 PL 107 B 153	+GOLDHABER,GUY,MILLIKAN,ABRAMS,+	(SLAC+LBL)
IRVING	81 ZPHY C 10 45	+MARTIN,DONE	(LIVP+DURH)
ROUSSARI	81 PL 105 B 394	ROUSSARIE,BURKE-ABRAMS,ALAM,+	(SLAC+LBL)
BARBER	82 ZPHY	+DAINTON,BRODBECK,BROOKES,+	(DARE+LANC+SHEF)
TORNQVIS	82 HU-TFT-82-1	N.A.TORNQVIST	(HELS)

δ(980)

36 DELTA(980,JPG=0+-) I=1

The quantum numbers of the δ(980) resonance are: $I^G = 1^-$ from its production in $D^0 \to \delta\pi$, from its $\eta\pi$ decay, and from the absence of a $\pi\pi$ decay; and $J^P = 0^+$ from the absence of a 3π or $\rho\pi$ decay (LIPKIN 69, GRASSLER 77) and from the decay distributions of the $\eta\pi$ decay. With these quantum numbers the δ(980) is expected to couple to the I=1 $K\bar{K}$ system, too, and to explain the nearby $K\bar{K}$ threshold enhancement (ASTIER 67).

In the scalar SU(3) nonet, the δ(980) has been a cause of problems. The near degeneracy with the $S^*(975)$ has been difficult to understand: if the S^* is mainly an $s\bar{s}$ system and the δ mainly a $u\bar{d}$ system, naive mass rules predict $m(S^*) - m(\delta) \simeq 200$ MeV. Similarly, naive mass rules predict $m(\kappa) - m(\delta) \simeq 100$ MeV, whereas the κ tends to appear near 1350 MeV.

Another problem has been the ratio of the widths: $\Gamma(\kappa)/\Gamma(\delta)$ is experimentally about 6, whereas SU(3) symmetry predicts 1.4. A solution to this problem came from coupled-channel analyses of the $\eta\pi$ and the $K\bar{K}$ channels (MORGAN 75, FLATTE 76). Above the $K\bar{K}$ threshold strong absorption makes the apparent width shrink, whereas below threshold strong analyticity effects reduce the apparent width.

Recent multi-channel analyses (ACHASOV 79,80, BRAMON 80, TORNQVIST 82) confirm this picture, taking also the $\eta'\pi$ channel into account. Moreover the most complete analysis (TORNQVIST 82) solves all the above problems at the same time.

Thus the picture of the δ(980) that emerges is a quark-antiquark state with large $q\bar{q}q\bar{q}$ components in the form of virtual two-meson states. The physical masses of all the scalar mesons are strongly influenced by the number of nearby 2-meson thresholds. Thus the δ(980) feels strongly the $\eta\pi$, $K\bar{K}$, and $\eta'\pi$ thresholds, whereas the κ(1350) is far away from the $K\pi$ and $K\eta'$ thresholds and couples very weakly to the $K\eta$ threshold. This is the reason for the observed large κ − δ mass difference. The small S^*−δ mass difference, on the other hand, is due to the isoscalar meson feeling the $K\bar{K}$ threshold a factor of 2 times stronger than the isovector meson does.

Thus the conventional $q\bar{q}$ model is sufficient, and no $q\bar{q}q\bar{q}$ multiplet is necessary to explain the observed scalar mesons (TORNQVIST 82). See also the mini-reviews under ε(1300) and κ(1350) and Appendix IIC.

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                    36  DELTA(980) MASS  (MEV)

M  ETA PI FINAL STATE ONLY.
M       10 (960.)     APPROX.          CHUNG S   68 HBC  -  3.2 PI-P           5/70
M       80 (975.0)                     DEFOIX    68 HBC +-  1.2 PB P,ETA PI 11/77
M       15 (980.0)   (10.0)            MILLER    69 HBC  -  4.5 K-N,ETA PI    7/69
M       21 (940.0)   (7.0)             BARDADIN  71 HBC +- 8 PI+P,P 00 PI   11/77
M   B      (982.)                      ACHASOV1  80 RVUE                      9/81*
M
M       30  980.0    10.0              AMMAR     68 HBC +-     ,5.5K-,ETA PI  2/73
M       20  970.0    15.0              BARNES    69 HBC  -  4-5 K-P,PI-ETA    9/69
M           980.     10.               CAMPBELL  69 DBC +- 2.7 PI+ D          1/73
M      150  972.     10.               DEFOIX    72 HBC +- 0.7 PBAR P,7 PI    1/73
M  C    70  989.0    10.0              WELLS     75 HBC  - 3.1-6 K-P,ETA PI 11/77
M       80  981.0     6.0              GAY       76 HBC  - 4.2 K-P,ETA PI    11/77
M           977.0     7.0              GRASSLER  77 HBC  - 16 PI-+P,ETA PI   11/77
M       47  980.     11.               CONFORTO  78 CSPK -  4.5 PI-P,P K-     4/78
M       50  978.0    16.0              CORDEN    78 OMEG +- 12-15PI-P,ETA PI  4/78
M    R 145  990.0     7.0              GURTU     79 HBC +- 4.2 K- P,ETA PI   12/79
M    R 500  986.      3.               EVANGELIS 81 OMEG    12 PI-P,ETA3PIP   1/82*
M          . . . . . . . . . . .
M   AVG     983.4     2.1    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M  C    SYSTEMATIC ERROR 6 MEV DUE TO ENERGY CALIBRATION ADDED
M   B   COUPLED CHANNEL ANALYSIS WITH FINITE WIDTH CORRECTIONS,SEE MINIREV.
M    R  FROM D(1285) DECAY

M  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
M      143(1103.3)      7.0+SYSTEMATIC ROSENFELD 65 RVUE +-                   8/66
M  A   100(1016.)     (10.)            ASTIER    67 HBC +-  0 PBAR P         12/77
M      316  976.        6.             DE BILLY  80 HBC +- 1.2-2 PB P,D OMG  6/81*

M  A    ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
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                    36  DELTA(980) WIDTH  (MEV)

W  ETA PI  FINAL STATE ONLY
W       80  (25.0)                     DEFOIX    68 HBC +-  1.2 PB P,ETA PI 11/77
W       20  (50.0)  OR LESS            BARNES    69 HBC  -  4-5 K-P,PI-ETA  11/77
W      150  (30.)     (5.)             DEFOIX    72 HBC +- 0.7 PBAR P,7 PI    2/74
W       70  (16.0)    (25.0)   (16.0)  WELLS     75 HBC  - 3.1-6 K-P,ETA PI

W       30   80.0     30.0             AMMAR     68 HBC +-     ,5.5K-,ETA PI  2/73
W            40.      15.              CAMPBELL  69 DBC +- 2.7 PI+ D          1/73
W       15   60.0     30.0             MILLER    69 HBC  -  4.5 K-N,ETA PI    2/74
W       21   31.0     28.0             BARDADIN  71 HBC +- 8 PI+P,P 00 PI     2/74
W   F        80 TO 300                 FLATTE    76 RVUE -  4.2 K-P,ETA PI   11/77
W   N        55.0     15.0             GAY       76 HBC  - 4.2 K-P  ETA PI   11/77
W            44.0     22.0             GRASSLER  77 HBC  - 16 PI-+P,ETA PI   11/77
W       47   60.      50.      30.     CONFORTO  78 DSPK -  4.5 PI-P,P X-     4/78
W   D   50   86.0     60.0     50.0    CORDEN    78 OMEG +- 12-15PI-P,ETA PI  4/78
W   R  145   60.0     20.0             GURTU     79 HBC +- 4.2 K- P,ETA PI   12/79
W   B        103 TO 262                ACHASOV1  80 RVUE                      9/81*
W   R  500   62.      15.              EVANGELIS 81 OMEG    12 PI-P,ETA3PIP   1/82*
W   B       (500.)   APPROX.           TORNQVIS  82 RVUE                      1/82*
W          . . . . . . . . . . .
W   AVG      53.7      6.7    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    B  COUPLED CHANNEL ANALYSIS WITH FINITE WIDTH CORRECTIONS,SEE MINIREV.
W   F   USING A TWO CHANNEL RESONANCE PARAMETRIZATION OF GAY 76 DATA.
W    N  THE ERROR IN THE PAPER IS WRONGLY QUOTED AT ONE POINT
W    R  FROM D(1285) DECAY

W  K KBAR ONLY, SEE THE TYPED NOTE ABOVE
W      143  (57.0)     13.0+SYSTEMATIC ROSENFELD 65 RVUE +-                   8/66
W  A   100  (25.) APPROX.              ASTIER    67 HBC +- SEE NOTE A ABOVE   9/67
W   M      (120.) APPROX.              MORGAN    75 RVUE    1.2 PBAR P       12/75

W  A    ASTIER 67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
W   M   FROM COUPLED CHANNEL FIT TO DUBOC 72 DATA
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                    36  DELTA(980) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      DELTA(980)    INTO ETA PI                    548+ 134
P2      DELTA(980)    INTO RHO PI                    769+ 134
P3      DELTA(980)    INTO K KBAR                    497+ 497
P4      DELTA(980)    INTO PI ETA PRIME              139+ 957
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                    36  DELTA(980) BRANCHING RATIOS

R1      DELTA(980)    INTO (RHO PI)/(ETA PI)                (P2)/(P1)
R1           (0.25) OR LESS  CL=.70   AMMAR      70 HBC  +- 4.1,5.5K-,ETA PI  5/70

R2      DELTA(980)    INTO (K KBAR)/(ETA PI)                (P3)/(P1)
R2  L        (0.25)    (0.08)         DEFOIX     72 HBC  +-  0.7 PBAR P      11/77
R2             SEEN                   GAY        76 HBC  - 4.2 K-P  ETA PI   11/77
R2   L       (0.7)     (0.3)          CORDEN     78 OMEG    12-15PI-P         4/78
R2  B        (0.75)TO 4.2             ACHASOV1   80 RVUE                      9/81*
R2  B   COUPLED CHANNEL ANALYSIS WITH FINITE WIDTH CORRECTIONS,SEE MINIREV.
R2  L   FROM THE DECAY OF D(1285).
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REFERENCES FOR DELTA(980)

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TURKOT   63 SIENNA CONF I 661 +COLLINS,FUJII,KEMP+         (BNL+PITTSBURGH)

ARMENTER 65 PL 17 344         ARMENTEROS,EDWARDS, JACOBSEN +  (CERN+CDEF)
BARASH   65 PR  139 B  1659   +FRANZINI,KIRSCH,MILLER,STEINBERGER+ (COLU)
KIENZLE  65 PL  19  438       + MAGLIC,LEVRAT,LEFEBVRES +          (CERN)
ROSENFEL 65 OXFORD CONF 58    A H ROSENFELD                   (LRL--RVUE)
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ALLEN D   66 PL 22  543          +GP FISHER,G GODDEN,L MARSHALL,SEARS (COLO)G=+
BALTAY    66 PR  142 B  932      +LACH,SANDWEISS,TAFT,YEH,STONEHILL+  (YALE)
FOCACCI   66 PRL  17  890        + KIENZLE,LEVRAT,MAGLIC,MARTIN       (CERN)
ODSTENS   66 PL  22  708         +CHAVANON,CROZON,TOCQUEVILLE  (SACLAY,COEF)I=1

ALLISON   67 PL 25B 619          +CRUZ+        (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
ASTIER    67 PL  25 B  294       +MONTANET,BAUBILLIER,DUBOC+(COEF+CERN+IRAD)
  ASTIER  67 INCLUDES DATA OF BARLOW 67,CONFORTO 67,ARMENTEROS 65.
BAILLON   67 NC 50A 393          +EDWARDS+O-ANDLAU+ASTIER+  (CERN+COEF+IRAD)
BANNER 1  67 PL  25 B  300       +FAYOUX,HAMEL,ZSEMBERY,CHEZE+ (SACLAY+CAEN)
BANNER 2  67 PL 25 B 569         +CHEZE,HAMEL,MAREL,TEIGER+       (COEF+SACL)
BARLOW    67 NC  50 A  701       +MONTANET,D-ANDLAU+    (CERN+COEF+IRAD+LIVP)
CONFORTO  67 NP B3 469           CONFORTO,MARECHAL+     (CERN+COEF+IPNP+LIVP)

AMMAR     68 PRL 21 1832         +DAVIS,KROPAC,DERRICK,FIELDS,+   (NWES+ANL)
CHUNG S   68 PR 165 1491          +O.DAHL, J. KIRZ, D.H.MILLER          (LRL)
DEFOIX    68 PL 28 B 253         +RIVET,SIAUD,CONFORTO+     (COEF+IPNP+CERN)
GALTIERI  68 PPL 20 349          BARBARO-GALTIERI,MATISON,RITTENBERG+  (LRL)
JUHALA    68 PL 27 B 257         +LEACOCK,RHODE,KOPELMAN,LIBBY+  (IOWA+COLO)
SABRE CO  68 PL 26 B 674         BARLOUTAUD+       (SACL+AMST+BGNA+REHO+EPOL)

BARNES    69 PRL 23 610          +CHUNG,EISNER,BASSANO,GOLDBERG+  (BNL+SYRA)
CAMPBELL  69 PRL 22 1204         J.H.CAMPBELL,LICHTMAN,LOEFFLER,+   (PURDUE)
CRENNELL  69 PRL 22 1398         +KARSHON,KWAN WU LAI,+              (BNL+NYU)
JUHALA    69 PR 184  1461        +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KRUSE     69 PR 177 1951         KRUSE,LOOS,GOLDWASSER            (ILLINOIS)
LIPKIN    69 PRL 22 212          +MESHKOV                        (REHO+NBS)  JP
MILLER    69 PL 29 B  255        D.H.MILLER,S.L.KRAMER,D.D.CARMONY,+(PURDUE)
    ALSO  69 PR 188 2011         YEN,AMMANN,CARMONY,ELSNER,+         (PURDUE)
SCHROEDE  69 PR 188  2081        SCHROEDER,KERNAN,FISHER,LIBBY,+  (ISU+COLO)

ABOLINS   70 PRL 25 469          +GRAVEN,MCCARTHY,G.SMITH,L.SMITH+ (LRL+UCD)
AMMAR     70 PR D 2 430          +KROPAC,DAVIS,DERRICK,+(KANS+NWES+ANL+WISC)
COOPER    70 NP B 23 605         +HANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
YIOU      70  THESIS. A 646      TCHIU-PUNG YIOU                     (ORSAY)

ANDERSON  71 PRL 26 108          +DIXIT,+    (CHIC+ANL+CARL+LASL+CNRC+NAGOYA)
BARDADIN  71 PR D4 2711          BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)

BINNIE    72 PL 39 B 275         +CAMILLERI,DUANE,GARBUTT,BURTON+(LOIC+SHMP)
CHESHIRE  72 PRL 28 520          +HOFFMAN,GARFINKEL,+        (IOWA+ANL+PURD)
DEFOIX    72 NP B 44 125         +NASCIMENTO,BIZZARRI,+          (COEF+CERN)
DUBOC     72 NP B 46 429         +GOLDBERG,MAKOWSKI,DONALD,+     (LPNP+LIVP)
HOLLOWAY  72 PHIL.CONF.PROC.133+HULD,KOETZ,KRUSE,BERNSTEIN,+    (ILL+ILLC)

ATHERTON  73 PL 43 B 249         +FRANEK,FRENCH,GHIDINI,HILPERT,+      (CERN)

BINNIE    74 PRL 32 392          +CAMILLERI,CARR,DEBENHAM,+      (LOIC+SHMP)
KALBFLEI  74 NP B65 279          KALBFLEISCH,VANDERBURG,+    (BNL+RUTG+IND)
MORGAN    74 PL 51B 71           D.MORGAN                              (RHEL)

BUTTRAM   75 PRL 35 970          +CRAWLEY,DUKE,LAMB,LEEPER,PETERSON     (ISU)
MORGAN    75 ARGONNE CONF. 45    D.MORGAN                              (RHEL)
WELLS     75 NP B 101 333        +RADOJICIC,ROSCOE,LYONS                (OXF)

GAY       76 PL 63 B 220         +CHALOUPKA,BLOKZIJL,HEINEN+(CERN+AMST+NIJM)  JP
FLATTE    76 PL 63 B 224         S.M.FLATTE                            (CERN)

GRASSLER  77 NP B 121 189        +        (AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
IRVING    77 PL 70 B 217         A.C.IRVING                       (LIVERPOOL)
MARTIN    77 NP B 121 514        +OZMUTLU,SQUIRES                    (DURHAM)
MAY       77 PR D 16 1983        +ABRAMSON,ANDREWS,BUSNELLO,+     (ROCH+CORN)

CONFORTO  78 LNC 23 419          B+G CONFORTO,KEY+(RHEL+TNTO+CHIC+FNAL+WISC)
CORDEN    78 NP B 144 253        +CORBETT,ALEXANDER,+  (BIRM+RHEL+TELA+LOWC)
MARTIN    78 ANP  114 1          A.D.MARTIN,M.R.PENNINGTON             (CERN)

ACHASOV   79 PL 88 B 367         +DEVYANIN,SHESTAKOV                   (NOVO)
ESTABROO  79 PR D 19 2678        P.ESTABROOKS                          (CARL)
GURTU     79 NP B 151 181        +GAVILLET,BLOKZIJL,+    (CERN+ZEEM+NIJM+OXF)
MARTIN    79 NP B 158 520        +OZMUTLU                              (DURH)

ACHASOV1  80 SJNP 32 566         +DEVYANIN,SHESTAKOV                   (NOVO)
ACHASOV2  80 PL 96 B 168         +DEVYANIN,SHESTAKOV                   (NOVO)
BRAMON    80 PL 93 B 65          +MASSO                                (BARC)
DE BILLY  80 NP B 176 1          +BRIAND,DUBOC,LEVY+    (CURI+LAUS+NEUC+GLAS)

EVANGELI  81 NP B 178 197        EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)

TORNQVIS  82  HU-TFT-82-1        N.A.TORNQVIST                         (HELS)

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ϕ(1020)

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4  PHI(1020,JPG=1-- ) I=0
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                   4  P I MASS (MEV)

M                     WE O   AVERAGE MASS AND WIDTH VALUES WHEN THE
M                     SYSTE  TIC ERRORS HAVE BEEN EVALUATED.

M       410 1019.9       0. )           STOTTLEMY 71 HBC    2.9 K-P,Y K KBAR 11/71
M     D 120 1019.6       0.5            AGUILAR   72 HBC    3.9,4.6 K- P     12/75
M     D 100 1019.9       0.5            AGUILAR   72 HBC    3.9,4.6 K- P     12/75
M       131 1020.4       0.5            COLLEY    72 HBC    10.K+ P,K+ P PHI 12/72
M       100 1020.3       0.4            BALLAM    73 HBC    2.8 - 9.3 G P     1/74
M           1019.4       0.7            BINNIE    73 CNTR   PI-P,PHI N        4/78
M    AR 500(1019.5)     (0.6)           AYRES     74 ASPK   3-6PI/K-P,K+K-   12/77
M       984 1019.4       0.8            BESCH     74 CNTR   2 GAMMA P,PK+K-  12/75
M    AR 170(1020.3)     (0.4)           DE GROOT  74 HBC    4.2 K-P,L K+K-   12/77
M       454 1019.7       0.5            KALBFLEIS 76 HBC    2.18 K-P,K KBAR   7/77
M    AR1300(1019.7)     (0.2)           AKERLOF   77 SPEC   400 P+A,K+K-     12/77
M    AR 905(1020.4)     (0.3)           BALDI     77 CNTR   10 K-P,K-PHI P   12/77
M    A  383(1020.0)     (1.0)           BALDI     77 CNTR   10 PI-P,PI-PHI P 12/77
M    AR2504(1020.0)     (0.2)           BALDI     77 CNTR   10 K+P,K+PHI P   12/77
M    AR 721(1022.0)     (1.0)           BALDI     77 CNTR   10 P P,P PHI P   12/77
M       800 1018.9       0.6            COHEN     77 ASPK   6 PI- PN,K+K-PN  12/77
M           1019.52      0.13           BUKIN 1   78 OLYA   E+E- COLL.BEAMS   9/81*
M       337 1019.4       0.5            COOPER    78 HBC    .7-.8 PB P,KS KO  4/78
M      1100 1019.54      0.12           BARKOV    79 EMUL   E+E- COLL.BEAMS   3/82*
M   R 6730(1019.7)      (0.1)           DAUM      81 SPEC   P BE,K+ K- X      9/81*
M  C    766 1019.8       0.7            IVANOV    81 OLYA   1-1.4 E+E-,K+K-   1/82*
M          (1019.3)     (0.1)           ARENTON   82 SPEC   11.8 POL.P P,KK   1/82*
M     25080 1019.67      0.17           PELLINEN  82 RVUE                     1/82*
M           . . . . . . . . . . .
M    AVG    1019.614     0.069   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   A   SYSTEMATIC ERRORS NOT EVALUATED.
M  C    SYSTEMATIC ERROR ADDED LINEARLY BY US.
M    D  MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N),SEE K* TYPED NOTE
M    P  INCLUDED IN PELLINEN 82 RVUE

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                   4  PHI WIDTH (MEV)

W                     WE ONLY AVERAGE MASS AND WIDTH VALUES WHEN THE
W                     SYSTEMATIC ERORRS HAVE BEEN EVALUATED.

W     D 150     4.2       1.4            AUGUSTIN  69 OSPK   E+ E- COLL.BEAMS 12/72
W               4.09      0.29           BIZOT     70 OSPK   E+ E- COLL.BEAMS 12/72
W     D 681     4.67      0.72           BALAKIN   71 OSPK    E+ E- COLL.BEAM 12/75
W     D 120     4.6       1.7            AGUILAR   72 HBC    3.9,4.6 K- P     12/75
W     D 100     4.7       1.9            AGUILAR   72 HBC    3.9,4.6 K- P     12/75
W     D 131     5.0       1.8            COLLEY    72 HBC    10.K+ P,K+ P PHI 12/75
W     D 454     3.8       0.7            BORENSTEI 72 HBC    2.18 K-P,K KBAR   7/77
W     D 100     3.8       1.5            BALLAM    73 HBC    2.8 - 9.3 G P    12/75
W               4.5       1.1            BINNIE    73 CNTR   PI-P,PHI N        4/76
W    AD 500    (4.5)     (0.8)           AYRES     74 ASPK   3-6PI/K-P,K+K-   12/75
W     D 984     4.4       0.6            BESCH     74 CNTR   2 GAMMA P,PK+K-  12/75
W               3.81      0.37           COSME 2   74 OSPK   E+E- COLL.BEAMS   2/74
W    AD 170    (4.2)     (1.3)           De GROOT  74 HBC    4.2 K-P,L K+K-   12/75
W   A D1300     4.5       0.50           AKERLOF   77 SPEC   400 P+A,K+K-     12/77
W   B D3681     4.36      0.29           BUKIN 1   78 OLYA   E+E- COLL.BEAMS   9/81*
W     D 337     3.6       0.8            COOPER    78 HBC    .7-.8 PB P,KS KO  4/78
W     D1100     4.58      0.55           BARKOV    79 EMUL   E+E- COLL.BEAMS   3/82*
W     D         4.3       0.6            CORDIER   80 WIRE   E+E-,PI+PI-PI0    9/81*
W     D 766     4.2       0.6            IVANOV    81 OLYA   1-1.4 E+E-,K+K-   1/82*
W           . . . . . . . . . . .
W    AVG        4.21      0.13   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   A   SYSTEMATIC ERRORS NOT EVALUATED.
W  B    NUMBER OF EVENTS INCLUDES A SMALL BACKGROUND CONTRIBUTION.
W    D  WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N), SEE K* TYPED NOTE

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                   4  PHI PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      PHI INTO K+ K-                                    493+ 493
P2      PHI INTO KL KS                                    497+ 497
P3      PHI INTO PI+ PI- PI0 (INCLUDING RHO PI)           139+ 139+ 134
P4      PHI INTO ETA GAMMA                                548+   0
P5      PHI INTO E+ E-                                     .5+  .5
P6      PHI INTO MU+ MU-                                  105+ 105
P7      PHI INTO PI0 GAMMA                                134+   0
P8      PHI INTO PI+ PI- (VIOLATES G)                     139+ 139
P9      PHI INTO PI+PI-GAMMA                              139+ 139+    0
P10     PHI INTO OMEGA GAMMA (VIOLATES C)                 782+   0
P11     PHI INTO ETA PI0 (VIOLATES C)                     548+ 134
P12     PHI INTO RHO GAMMA (VIOLATES C)                   769+   0
P13     PHI INTO ETA NEUTRALS
P14     PHI INTO 5PI                                      139+ 139+ 139+ 139+
P15     PHI INTO PI+ PI- PI+ PI- (VIOLATES G)             139+ 139+ 139+ 139
P16     PHI INTO RHO PI                                   769+ 139

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above, only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

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          P 1          P 2          P 3          P 4
P 1 .4908+-.0101
P 2   -.7157  .3461+-.0099
P 3   -.3787    -.3417  .1478+-.0073
P 4   -.1094    -.1038    -.0122  .0154+-.0022

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                   4  PHI BRANCHING RATIOS

R1      PHI INTO (K+ K-)/(K KBAR + PI+ PI- PI0)            (P1)/(P1+P2+P3)
R1      252    0.48     0.04          LINDSEY   66 HBC     2.7 K-P          10/66
R1             0.540    0.034         BALAKIN   71 OSPK    E+ E- COLL.BEAM  11/71
R1             0.486    0.044         CHATELUS  71 OSPK   E+ E- COLL.BEAMS  11/71
R1      270    0.49     0.06          DE GROOT  74 HBC     4.2 K-P,L PHI    12/75
R1      221    0.45     0.05          KALBFLEIS 76 HBC     2.18 K-P          7/77
R1           . . . . . . . . . . .
R1  AVG        0.497    0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT        0.498    0.010  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R2      PHI INTO (KL KS)/(K KBAR + PI+ PI- PI0)            (P2)/(P1+P2+P3)
R2      167    0.40     0.04          LINDSEY   66 HBC     2.7 K-P          10/66
R2             0.257    0.038         BALAKIN   71 OSPK   E+ E- COLL.BEAMS   1/73
R2      133    0.27     0.03          KALBFLEIS 76 HBC     2.18 K-P          7/77
R2  A   270   (0.37)   (0.05)         DE GROOT  74 HBC     4.2 K-P,L PHI    12/77
R2  A   SUPERSEDED BY LOSTY 78 UNDER R19.
R2           . . . . . . . . . . .
R2  AVG        0.300    0.042   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)
R2  FIT        0.351    0.010  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R3      PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/TOTAL      (P3)
R3 E           0.139    0.007         PARROUR2  76 OSPK    E+E- COLL.BEAMS   7/77
R3 E    USING TOTAL WIDTH 4.1 MEV. THE 3 PI MODE IS MORE THAN 80 PER CENT
R3 E    RHO PI AT THE 90 PER CENT C.L.
R3           . . . . . . . . . . .
R3  FIT        0.1478   0.0073 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R5      PHI INTO (KL KS)/(K KBAR)                          (P2)/(P1+P2)
R5       10    0.40     0.10          SCHLEIN   63 HBC     2.0 K-P          10/66
R5       52    0.48     0.07          BADIER    65 HBC     3.0 K-P          11/67
R5             0.44     0.07          LONDON    66 HBC     2.2 K-P          10/66
R5           . . . . . . . . . . .
R5  AVG        0.448    0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT        0.414    0.011  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R6      PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/(K KBAR)     (P3)/(P1+P2)
R6             0.30     0.15          LONDON    66 HBC     2.2 K-P          10/66
R6             0.237    0.039         CERRADA   77 HBC    4.2 K-P,LAM 3PI   12/77
R6           . . . . . . . . . . .
R6  AVG        0.241    0.038   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R6  FIT        0.177    0.010  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R7      PHI INTO (PI+ PI- PI0 (INCL.RHO PI))/(KL KS)      (P3)/(P2)
R7             0.47     0.06          COSME 1   74 OSPK    E+E- COLL.BEAMS   2/74
R7             0.56     0.13          BUKIN 1   78 OLYA    E+ E- COLL.BEAMS  9/81*
R7           . . . . . . . . . . .
R7  AVG        0.486    0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R7  FIT        0.427    0.028  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)
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R10      PHI INTO (MU+ MU-)/TOTAL (UNITS 10**-4)            (P6)
R10           2.34      1.01            MOY       69 CNTR   PHOTOPROD.          11/70
R10           2.17      0.60            EARLES    70 CNTR   6.0 BREMSSTR.       11/70
R10           2.69      0.46            HAYES     71 CNTR   PHOTOPROD.          11/71
R10          . . . . . . . . . . .
R10 AVG       2.48      0.34    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11      PHI INTO (ETA GAMMA)/TOTAL                         (P4)
R11A     25   0.026     0.007           BENAKSAS  72 OSPK   E+E- COLL.BEAMS      2/73
R11A     54   0.015     0.004           COSME     76 OSPK   E+E- COLL.BEAMS     12/75
R11B         (0.024)OR LESS  CL=0.95    COSME     76 OSPK   E+E- COLL.BEAMS      7/77
R11           0.0135    0.0029          ANDREWS   77 CNTR   6.7-10 GAMMA CU     12/77
R11A     FROM 2 GAMMA    DECAY MODE OF ETA                                       7/77
R11B     FROM PI+PI-PI0 DECAY MODE OF ETA                                        7/77
R11          . . . . . . . . . . .
R11 AVG       0.0152    0.0026  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R11 FIT       0.0154    0.0022 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12      PHI INTO (PI+ PI- GAMMA)/TOTAL                     (P9)
R12          (0.04) OR LESS             LINDSEY   65 HBC    2.7 K-P              2/74
R12          (0.007)OR LESS  CL=.90     COSME 1   74 OSPK   E+E- COLL.BEAMS      2/74
R12          (.06) OR LESS   CL=.90     KALBFLEI  75 HBC    2.2 K- P,GAMMA +    12/75

R13      PHI INTO (ETA NEUTRALS)/(K KBAR)                   (P13)/(P1+P2)
R13          (0.15) OR LESS             LINDSEY   66 HBC    2.7 K-P             10/66

R14      PHI INTO (OMEGA GAMMA) / TOTAL                     (P10)
R14          (0.05) OR LESS             LINDSEY   66 HBC    2.7 K-P             10/66

R15      PHI INTO (RHO GAMMA) / TOTAL                       (P12)
R15          (0.02) OR LESS             LINDSEY   66 HBC    2.7 K-P             10/66

R16      PHI INTO (E+ E-)/TOTAL (UNITS 10**-4)              (P5)
R16           2.81      0.25            BALAKIN   71 OSPK   E+ E- COLL.BEAMS 11/71
R16           3.50      0.27            CHATELUS  71 OSPK   E+ E- COLL.BEAMS 11/71
R16           3.3       0.3             COSME 1   74 OSPK   E+ E- COLL.BEAMS  2/74
R16   E       3.10      0.14            PARROUR1  76 OSPK   E+ E- COLL.BEAMS  7/77
R16           3.00      0.21            BUKIN 1   78 OLYA   E+ E- COLL.BEAMS  9/81*
R16          . . . . . . . . . . .
R16 AVG       3.107     0.096   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R16   E    USING TOTAL WIDTH 4.2 MEV. THEY DETECT 3 PI MODE AND OBSERVE
R16   E    SIGNIFICANT INTERFERENCE WITH OMEGA TAIL. THIS IS ACCOUNTED FOR
R16   E    IN THE RESULT QUOTED ABOVE

R17      PHI INTO (PI0 GAMMA)/(TOTAL)                       (P7)
R17       T  (0.0025) (0.0012)          BENAKSAS  72 OSPK   E+E- COLL. BEAMS  2/73
R17      32   0.0014    0.0005          COSME     76 OSPK   E+ E- COLL.BEAMS 12/77

R18      PHI INTO (PI+ PI-)/(TOTAL) (UNITS 10**-4)          (P8)
R18          (2.7)  OR LESS  CL=.95     ALVENSLE  72 OSPK   GAMMA+C              1/72
R18          (4.0)  OR LESS  CL=.95     JULLIAN   76 OSPK   E+ E- COLL.BEAMS     9/81*
R18          (6.6)  OR LESS  CL=.95     BUKIN 2   78 OLYA   E+ E- COLL.BEAMS     9/81*
R18A          1.94      1.03     0.81   VASSERMAN 81 OLYA   E+ E- COLL.BEAMS     9/81*
R18A    USING PHI INTO (E+ E-)/TOTAL = 3.1

R19      PHI INTO (KL KS)/(K+ K-)                           (P2)/(P1)
R19     144   0.89      0.10            AGUILAR   72 HBC    3.9,4.6 K- P        12/72
R19     125  (1.15)    (0.15)           COLLEY    72 HBC    10.K+ P,K+ P PHI    12/72
R19           0.71      0.05            LAVEN     77 HBC    10 K-P,K+K-LAMBD    12/77
R19           0.71      0.08            LYONS     77 HBC    3-4 K-P,LAMB PHI    12/77
R19           0.70      0.05            BUKIN 1   78 OLYA   E+ E- COLL.BEAMS     9/81*
R19           0.82      0.08            LOSTY     78 HBC    4.2 K-P,PHI HYP      4/78
R19          . . . . . . . . . . .
R19 AVG       0.736     0.030   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R19 FIT       0.705     0.032  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R20      PHI INTO (PI+ PI- PI0)(INCL.RHO PI)/(K+ K-)        (P3)/(P1)
R20      34   0.28      0.09            AGUILAR   72 HBC    3.9,4.6 K- P        12/72
R20          . . . . . . . . . . .
R20 FIT       0.301     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21      PHI INTO (2PI+ 2PI- PI0)/(K+ K-)                   (P14)/(P1)
R21          (0.02) OR LESS  CL=0.95  AGUILAR     72 HBC    3.9,4.6 K- P        12/72

R22      PHI INTO (PI+ PI- PI+ PI-)/TOTAL (UNITS 10**-4)  (P15)
R22          (8.7)  OR LESS  CL=.90   CORDIER     79 WIRE   E+ E-,4PI           12/79

R23      PHI INTO (RHO PI)/(PI+ PI- PI0)                    (P16)/(P3)
R23          (0.8)  OR MORE  CL=.90   JULLIAN     76 OSPK   E+ E- COLL.BEAM

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REFERENCES FOR PHI


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BERTANZA 62 PRL 9 180            BERTANZA,BRISSON,CONNOLLY,HART + (BNL+SYRA)

ARMENTER 63 SIENA CONF 2 70      ARMENTEROS,EDWARDS,ASTIER+       (CERN+CDEF)
GELFAND  63 PRL 11 438           GELFAND,MILLER,NUSSBAUM,KIRSCH+ (COLU+RUTG)
SCHLEIN  63 PRL 10 368           SCHLEIN,SLATER,SMITH,STORK,TICHO     (UCLA)

BADIER   65 PL 17 337            BADIER,DEMOULIN,BARLOUTAUD+      (SACL+AMST)
BERLEY   65 PR 139 B 1097        D BERLEY,N GELFAND            (BNL+COLUMBIA)
GALTIERI 65 PRL 14 279           A BARBARO GALTIERI,R D TRIPP          (LRL)
LINDSEY  65 PRL 15 221           JAMES S LINDSEY,GERALD A SMITH        (LRL)
    LINDSEY 65 DATA INCLUDED IN LINDSEY 66 BELOW
MILLER D 65 CU-237(NEVIS 131) DAVID C MILLER  (THESIS)            (COLUMBIA)

GRAY, L  66 PRL  17  501         +HAGERTY,BIZZARRI,CIAPETTI +  (SYRA+ROMA)JPG
LINDSEY  66 PR  147  913         JAMES S LINDSEY, GERALD A SMITH       (LRL)
LINDSEY1 66 PL 20 93             J.S.LINDSEY, G.A.SMITH                (LRL)
LONDON   66 PR 142 1034          LONDON,RAU,SAMIOS,GOLDBERG + (BNL+SYRACUSE)

ABRAMS   67 MD TECH REP 720      GERALD ABRAMS , THESIS           (MARYLAND)
BARLOW   67 NC 50A 701           +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
CHASE    67 PRL 18 710           R.C.CHASE,P.ROTHWELL,R.WEINSTEIN (CEA+NEAS)
DAHL     67 PR 163 1377          +HARDY+HESS+KIRZ+MILLER               (LRL)
HERTZBAC 67 PR 155  1461         HERTZBACH,KRAEMER,MADANSKI,ZOANIS+(JHU+BNL)
KHACHATU 67 PL 24B 349           KHACHATURYAN+AZIMOV+BALDIN+BELOUSOV+(DUBNA)

ABRAMS   68 PR 175 1697          [illegible]
ASTVACAT 68 PL 27 B  45          [illegible]
    ALSO 67 PRL 19 869           [illegible]
BECKER   68 PRL 21 1504          [illegible]
BINNIE   68 PL 27B 106           [illegible]
BOLLINI  68 NC 56 A 1171         [illegible]
MOSTEK   68 PRL 20 1057          [illegible]
WEHMANN  68 PRL 20 748           [illegible]

AUGUSTIN 69 PL 28 B 517          +BIZOT,BUON,DELCOURT,HAISSINSKI,+   (ORSAY)
MOY      69 THESIS               KEN MIN MOY      (NORTHEASTERN UNIVERSITY)
SCOTTER  69 NC 62 A 1057         +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)

BIZOT    70 PL 32 416            +BUON,CHATELUS,JEANJEAN,LALANNE,+    (ORSA)
    ALSO 69 PEREZ-Y-JORBA, LIVERPOOL SYMP.69
BIZOT2   70 LNC 4 1273           +DELCOURT,JEANJEAN,LALANNE,+        (ORSAY)
EARLES   70 PRL 25 1312          +FAISSLER,GETTNER,LUTZ,MOY,TANG,+    (NEAS)
HYAMS    70 NP B 22 189          +KOCH,POTTER,V.LINDERN,LORENZ,LUTJENS(CERN)

ALVENSLE 71 PRL 27 441           ALVENSLEBEN,BECKER,BUSZA,CHEN,+  (MIT+DESY)
BALAKIN  71 PL 34 B 328          +BUDKER,PAKHTUSOVA,SIDOROV,SKRINSKY,+(NOVO)
CHATELUS 71 LAL 1247(THESIS) Y.CHATELUS                        (STRASBOURG)
    ALSO 70 BIZOT
DIBIANCA 71 NP B 35 13           +EINSCHLAG,ENDORF,ENGLER,FISK,+      (CORN)
HAYES    71 PR D 4 899           +IMLAY,JOSEPH,KEIZER,STEIN           (CORN)
STOTTLEM 71 ORO 2504 170         A.R.STOTTLEMYER,THESIS           (MARYLAND)

AGUILAR  72 PR D 6 29            AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS  (BNL)
ALVENSLE 72 PRL 28 66            ALVENSLEBEN,BECKER,BIGGS,BINKLEY+(MIT+DESY)
BALAKIN  72 PL 40 B 431          +BOKIN,PAKHTUSOVA,SIDOROV,+   (NOVOSIBIRSK)
BASILE   72 NP B 44 605          +DALPIAZ,FRABETTI,ZICHICHI+(CERN+BGNA+STRB)
BENAKSAS 72 PL 42 B 511          +COSME,JEAN-MARIE,JULLIAN,LAPLANCHE+(ORSAY)
BORENSTE 72 PR D 5 1559          BORENSTEIN,DANBURG,KALBFLEISCH,+ (BNL+MICH)
COLLEY   72 NP B 50 1            +JOBES,RIDDIFORD,GRIFFITHS,+    (BIRM+GLAS)

BALLAM   73 PR D 7 3150          +CHADWICK,EISENBERG,BINGHAM,+    (SLAC+LBL)
BINNIE   73 PR D 8 2789          +CARR,DEBENHAM,DUANE,GARBUTT,+  (LOIC+SHMP)

AYRES    74 PRL 32 1463          +DIEBOLD,GREENE,KRAMER,LEVINE,+       (ANL)
BESCH    74 NP B70 257           +HARTMANN,KOSE,KRAUTSCHNEIDER,PAUL,+ (BONN)
BIZZARRI 74 NC 20A 393           +CIAPETTI,DIONISI,DORE,GASPERO+      (ROMA)
COSME 1  74 PL 48 B 155          +JEAN-MARIE,JULLIAN,LAPLANCHE,+     (ORSAY)
COSME 2  74 PL 48 B 159          +JEAN-MARIE,JULLIAN,LAPLANCHE,+     (ORSAY)
DE GROOT 74 NP B74 77            +HOOGLAND,JONGEJANS,METZGER+    (AMST+NIJM)

KALBFLEI 75 PR D11 987           KALBFLEISCH,STRAND,CHAPMAN       (BNL+MICH)

COSME    76 PL 63 B 352          +COURAU,DUDELZAK,GRELAUD,JEAN-MARIE+(ORSAY)
JULLIAN  76 TBLISI VOL.2 R19     S.JULLIAN                           (ORSAY)
KALBFLEI 76 PR D 13 22           KALBFLEISCH,STRAND,CHAPMAN       (BNL+MICH)
PARROUR1 76 PL 63 B 357          +GRELAUD,COSME,COURAU,DUDELZAK,+    (ORSAY)
PARROUR2 76 PL 63 B 362          +GRELAUD,COSME,COURAU,DUDELZAK,+    (ORSAY)

AKERLOF  77 PRL 39 861           +ALLEY,BINTINGER,DITZLER,+ (FNAL+MICH+PURD)
ANDREWS  77 PRL 38 198           +FUKUSHIMA,HARVEY,LOBKOWICZ,MAY,+    (ROCH)
BALDI    77 PL 68 B 391          +BOHRINGER,DORSAZ,HUNGERBUHLER,+   (GENEVA)
CERRADA  77 NP B 126 241         +BLOCKZIJL,HEINEN,+     (AMST+CERN+NIJM+OXF)
COHEN    77 PRL 38 269          +AYRES,DIEBOLD,KRAMER,PAWLICKI,WICKLUND(ANL)
COURANT  77 PR D 16 1            +MAKDISI,MARSHAK,PETERSON,RUDDICK,+  (MINN)
EVANGEL  77 NP B 127 384         EVANGELISTA,+    (BARI+BONN+CERN+DARE+GLAS+)
LAVEN    77 NP B 127 43          +OTTER,KLEIN,+    (AACH+BERL+CERN+LOIC+WIEN)
LYONS    77 NP B 125 207         +COOPER,CLARK                         (OXF)

BARTALUC 78 NC 44 A 587          BARTALUCCI,BASINI,BERTOLUCCI+   (DESY+FRAS)
BUKIN 1  78 SJNP 27 516          +KURDADZE,SEREDNYAKOV,SIDOROV+       (NOVO)
BUKIN 2  78 SJNP 27 521          +KURDADZE,SIDOROV,SKRINSKII+         (NOVO)
COOPER   78 NP B 146 1           +GURTU,MONTANET,+      (TIFR+CERN+CDEF+MADR)
LOSTY    78 NP B 133 38          +HOLMGREN,BLOKZIJL,+    (CERN+AMST+NIJM+OXF)

BARKOV   79 IYAF 79-93           +ZOLOTOREV,MAKARINA,MISHAKOVA,+      (NOVO)
CORDIER  79 PL B 81 389          +DELCOURT,ESCHSTRUTH,FULDA,+         (LALO)

CORDIER  80 NP B172 13           +DELCOURT,ESCHSTRUTH,FULDA+         (ORSAY)
ROOS     80 LNC 27 321           +PELLINEN                            (HELS)

DAUM     81 PL 100 B 439         +BARDSLEY+   (AMST+BRIS+CERN+CRAC+MPIM+RHEL)
IVANOV   81 PL 107 B 297         +KURDADZE,LELCHUK,SIDOROV,SKRINSKY,+ (NOVO)
    ALSO 82 PRIVATE COMM.        S.I.EIDELMAN                         (NOVO)
VASSERMA 81 PL 99 B 62           VASSERMAN,KURDADZE,SIDOROV,SKRINSKY+ (NOVO)

ARENTON  82  ANL-HEP-PR 81-22 +AYRES,DIEBOLD,MAY,SAUER,SWALLOW+(ANL+ELMT)
PELLINEN 82  HU-TFT-82-3         A.PELLINEN, M.ROOS                   (HELS)

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H(1190)

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30  H(1190,JPG=1+-1 I=0)
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                 30  H(1190) MASS (MEV)

M    C      1190.      60.               DANKOWYCH 81 SPEC   08 PI P,3 PI N    6/81*

M    C   USES THE MODEL OF BOWLER 75

------ --------- --------- --------- --------- --------- --------- --------

                 30  H(1190) WIDTH (MEV)

W    C      320.       50.               DANKOWYCH 81 SPEC   08 PI P,3 PI N    6/81*

W    C   USES THE MODEL OF BOWLER 75

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                 30  H(1190) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      H(1190) INTO RHO PI                                     769+ 134

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REFERENCES FOR H(1190)


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BOWLER   75 NP B97 227           +GAME,AITCHISON,DAINTON          (OXF+DARE)

DANKOWYC 81 PRL 46 580           +BROCKMAN,EDWARDS+(TNTO+BNL+CARL+MCGI+OHIO)

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B(1235)

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11  B(1235,JPG=1++) I=1
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                         11  B MASS (MEV)

M       376 1200.     20.            BALTAY     67 HBC  +- 0.0 PBAR P           2/67
M           1220.     20.            CHUNG      68 HBC   - 3.2,4.2 PI- P        9/67
M           1240.0    20.0           ANDERSON   70 CNTR   0 5-18 GAMMA P       11/70
M           1236.0    15.0           HOOGLAND   70 DBC   -  3.0 K- D            2/71
M           1200.0    15.0           MIYASHITA  70 HBC   -  6.7 PI-P,4PI       11/70
M    W     (1228.)   (5.)            FRENKIEL   72 HBC  +- 0. PBAR PI,5 PI     12/72
M  O  1163  1243.      6.            OTT        72 HBC  +  7.1 PI+ P,P B+       2/73
M           1235.     15.            AFZAL      73 HBC  +  11.7 PI+ P           2/73
M           1268.     16.            AFZAL      73 HBC  -  11.2 PI- P           2/73
M      1400 1222.      4.            CHALOUPKA  74 HBC   - 3.9 PI-P,P B-       12/75
M       600 1220.      7.            KARSHON    74 HBC  +  4.9 PI+P,P B+       12/75
M       890 1245.0    11.0           FLATTE     76 HBC   - 4.2 K-P,PI-OMEGA     7/77
M       450 1251.0     8.0           GESSAROLI  77 HBC   - 11 PI-P,PI- OME     12/77
M       225 1240.0    15.0           BALTAY     78 HBC  +  15 PI+P,P 4PI        4/78
M       360(1208.0)  (18.0)          GAVILLET   78 HBC  +  4.2 K-P,BACKWARD     4/78
M       105 1234.0    15.0           BLOODWORT  80 HBC   - 8.2 K- P,Y*+ B-     12/79
M           1239.      5.            EVANGELIS  81 OMEG  - 12 PI-P,OME PI P     1/82*
M           . . . . . . . . . .
M   AVG     1232.5     3.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                              (SEE IDEOGRAM BELOW )
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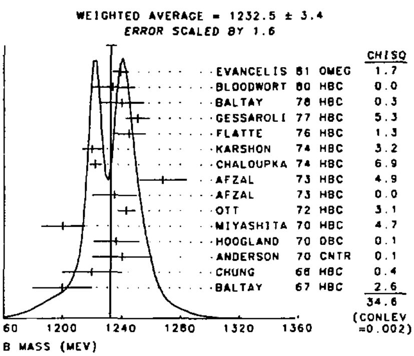


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M  O    FROM FIT OF THE MASS SPECTRUM
M   W   FIT REQUIRES AN ADDITIONAL JP=1- RESONANCE
M   W   AT 1256 MEV, WIDTH 129 MEV.
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                         11  B WIDTH (MEV)

W        60  100.0     20.0              ABOLINS   63 HBC  +   3.5 PI+P
W       376  100.      30.               BALTAY    67 HBC  +- 0.0 PBAR P           2/67
W            150.      20.               CHUNG     68 HBC   - 3.2,4.2 PI- P        9/67
W            100.0     20.0              EROFEEV   70 HBC   -  3.25 PI- P          1/71
W            132.0     20.0              HOOGLAND  70 DBC   -  3.0 K- D            2/71
W            113.0     44.0              MIYASHITA 70 HBC   -  6.7 PI-P,4PI       11/70
W    W      (126.)    (10.)              FRENKIEL  72 HBC  +- 0. PBAR PI,5 PI     12/72
W  O  1163   134.      23.        26.    OTT       72 HBC  +  7.1 PI+ P,P B+       2/73
W            120.      50.               AFZAL     73 HBC  +  11.7 PI+ P           2/73
W            130.      50.               AFZAL     73 HBC  -  11.2 PI- P           2/73
W      1400  135.      20.               CHALOUPKA 74 HBC   - 3.9 PI-P,P B-       12/75
W       600  156.      22.               KARSHON   74 HBC  +  4.9 PI+P,P B+       12/75
W       890  182.0     45.0              FLATTE    76 HBC   - 4.2 K-P,PI-OMEGA     7/77
W       450  155.0     32.0              GESSAROLI 77 HBC   - 11 PI-P,PI- OME     12/77
W       225  170.0     50.0              BALTAY    78 HBC  +  15 PI+P,P 4PI        4/78
W       360 (163.0)   (50.8)             GAVILLET  78 HBC  +  4.2 K-P,BACKWARD     4/78
W       105  150.0     50.0              BLOODWORT 80 HBC   - 8.2 K- P,Y*+ B-     12/79
W            170.      15.               EVANGELIS 81 OMEG  - 12 PI-P,OME PI P     1/82*
W            . . . . . . . . . .
W   AVG      137.2      6.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

W  O    FROM FIT OF THE MASS SPECTRUM
W   W   SEE NOTE UNDER THE MASS ABOVE.
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                         11  B PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      B INTO OMEGA+PI                                782+ 139
P2      B INTO 2PI+ 2PI-                               139+ 139+ 139+ 139
P3      B INTO K KBAR                                  493+ 493
P4      B INTO PI PI                                   139+ 139
P5      B INTO PI PHI                                  134+1019
P6      B INTO ETA PI (FORBIDDEN BY G)                 548+ 139
P7      B INTO K KBAR PI                               493+ 493+ 139
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                         11  B BRANCHING RATIOS

R10     D/S RATIO FOR B(1235) INTO OMEGA PI
R10
R10            0.3       0.1              CHALOUPKA 74 HBC  -  3.9-7.5 PI-P         1/74
R10     600    0.35      0.25             KARSHON   74 HBC  +  4.9 PI+P,P B+       12/75
R10            0.21      0.08             CHUNG     75 HBC  +  7.1 PI+P            12/75
R10            0.4       0.1       0.1    GESSAROLI 77 HBC  -  11 PI-P,PI- OME     12/77
R10            . . . . . . . . . .
R10 AVG        0.291     0.052    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R1      B INTO (4PI)/(OMEGA PI)                          (P2)/(P1)
R1             (0.5)  OR LESS             ABOLINS   63 HBC  +   3.5 PI+P

R2      B INTO (K KBAR)/(OMEGA PI)                       (P3)/(P1)
R2             (0.02) OR LESS             DAHL      67 HBC  -  1.6-4.2 PI- P      10/66
R2             (0.10) OR LESS  CL=.90     BALTAY    67 HBC  +- 0.0 PBAR P          2/67
R2             (0.08) OR LESS  CL=.95     BIZZARRI  69 HBC  +- 0 PBAR P            9/69

R3      B INTO (PI PI)/(PI OMEGA)                        (P4)/(P1)
R3             (0.3)  OR LESS             ADERHOLZ  64 HBC     4.0 PI+P            7/66
R3             (0.15) OR LESS  CL=.90     OTT       72 HBC  +  7.1 PI+ P          12/72

R4      B INTO (PI PHI) / (PI OMEGA)                     (P5)/(P1)
R4             (0.015)OR LESS             DAHL      67 HBC     1.6-4.2 PI- P      10/66
R4             (0.04) OR LESS  CL=.95     BIZZARRI  69 HBC  +- 0 PBAR P            9/69

R5      B INTO (ETA PI) / (PI OMEGA)                     (P6)/(P1)
R5             (0.25) OR LESS  CL=.90     BALTAY    67 HBC  +- 0.0 PBAR P          2/67

R6      B+- INTO ((K KBAR)+- PI0) / (PI OMEGA)
R6             (0.08) OR LESS  CL=.90     BALTAY    67 HBC  +- 0.0 PBAR P          2/67

R7      B+- INTO (KS KS PI+-) / (PI OMEGA)
R7             (0.02) OR LESS  CL=.90     BALTAY    67 HBC  +- 0.0 PBA- P          2/67

R8      B+- INTO (KS KL PI+-) / (PI OMEGA)
R8             (0.06) OR LESS  CL=.90     BALTAY    67 HBC  +- 0.0 PBAR P          2/67
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REFERENCES FOR B

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ABOLINS   63 PRL 11 381       ABOLINS,LANDER,MEHLHOP,XUONG,YAGER    (UCSD)
BONDAR    63 PL 5 209         BONDAR,DODD+    (AACHEN+BIRM+HAMB+LOIC+MPIM)

ADERHOLZ  64 PL 10 240        AACHEN+BERLIN+BIRM + BONN+HAMBUR+LOIC+MPIM
CARMONY   64 PRL 12 254       CARMONY,LANDER,RINDFLEISCH,XUONG,YAGER(UCB) JP

GOLDHABE  65 PRL 15 118       G GOLDHABER,S GOLDHABER,KADYK,SHEN     (LRL)

BALTAY    67 PRL 18 93        +SEVERIENS+YEH+ZANELLO              (COLU+BNL)
DAHL      67 PR 163 1377      +HARDY+HESS+KIRZ+MILLER                 (LRL)
LEE       67 PR 159 1156      +MOEBS,ROE,SINCLAIR,VANDERVELDE        (MICH)
SLATTERY  67 NC 50A 377       +KRAYBILL+FORMAN+FERBEL           (YALE+ROCH)

ASCOLI    68 PRL 20 1411      +CRAWLEY,MORTARA,SHAPIRO               (ILL)  JP
BOESEBEC  68 NP B 4 501       BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 983      +CONTE+CORDS+DIAZ+   (GENOVA+HAMB+MILA+SACL)
CHUNG     68 PR 165 1491      S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER      (LRL)

BIZZARRI  69 NP B 14 169      +FOSTER,GAVILLET,MONTANET,+       (CERN+CDEF)

ANDERSON  70 PR D 1 27        +GUSTAVSON,JOHNSON,+     (SLAC+CIT+UCSB+NEAS)
CASO      70 LNC 3 707        +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
CASON     70 PR D 1 851       +ANDREWS,BISWAS,GROVES,HARRINGTON,+    (NDAM)
EROFEEV   70 SJNP 11 450      +VETLITSKY,WLADIMIRSKY,GRIGOREV,+      (ITEP)
HONES     70 PR D 2 827       +CASON,BISWAS,HELLAND,KENNEY,MCGAHAN+(NDAM)
HOOGLAND  70 PL 33 B 631      SABRE COLLABOR.  (AMST+SACL+BGNA+REHO+EPOL)
MIYASHIT  70 PR D 1 771       MIYASHITA,VON KROGH,KOPELMAN,LIBBY     (COLO)
POLS      70 NP B 25 109      +BOECKMANN,CIRBA,+      (BONN+DURH+EPOL+TORI)
WERBROUC  70 LNC 4 1267       WERBROUCK,RINAUDO,+      (TORI+NIJM+BONN+LBL)JP

DEVONS    71 PRL 27 1614      +KOZLOWSKI,HORWITZ,+               (COLU+SYRA)

FRENKIEL  72 NP B 47 61       +GHESQUIERE,LILLESTOL,CHUNG,+    (CDEF+CERN)JP
OTT       72  LBL-1547        R.L.OTT  THESIS                          (LBL)JP
SISTERSO  72 NP B 48 493      SISTERSON,HARRISON,HEYDA,JOHNSON,+(HARVARD)

AFZAL     73 NCL 15 A 61      +BASSLER,+         (DURH+GENO+DESY+MILA+SACL)  JP
ARMENISE  73 NC 17 A 707      +FORINO,CARTACCI,+               (BARI+BGNA+FIRZ)
ARMENISE  73 LNC 8 425        +FORINO,CARTACCI,+               (BARI+BGNA+FIRZ)
ARNOLD    73 LNC 6 707        +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+    (STRB)
CASON     73 PR D 7 1971      +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1   73 NP B 64 14       +MADDEN,BISHOP,BISWAS,KENNEY,+         (NDAM)
CHUNG     73 PL 47 B 526      +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
COHEN     73 PR D 8 23        +FERBEL,SLATTERY                  (ROCHESTER)

BALLAM    74 NP B76 375       +CHADWICK,BINGHAM,FRETTER+   (SLAC+LBL+MPIM)
CHALOUPK  74 PL 51B 407       CHALOUPKA,FERRANDO,LOSTY,MONTANET    (CERN)  JP
KARSHON   74 PR D10 3608      +MIKENBERG,EISENBERG,PITLUCK,RONAT+  (REHO)  JP

CHUNG     75 PR D11 2426      +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)  JP
DUBOVIKO  75 SJNP 20 229      M.S.DUBOVIKOV,I.A.EROFEEV              (ITEP)  JP

FLATTE    76 PL 64 B 225      +GAY,BLOKZIJL,METZGER,+(CERN+AMST+NIJM+OXF)  JP

GESSAROL  77 NP B 126 382     GESSAROLI,+   (BGNA+FIRZ+GENO+MILA+OXF+PAVI)  JP

BALTAY    78 PR D 17 62       +CAUTIS,COHEN,CSORNA,SMITH,YEH,+(COLU+BING)
GAVILLET  78 PL 78 B 158      +DIONISI,GURTU,+          (CERN+AMST,NIJM+OXF)  JP

BLOODWOR  80 LNC 27 555       BLOODWORTH,+          (BIRM+CERN+GLAS+MSU+LPNP)

EVANGELI  81 NP B 178 197     EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
WONG      81 PRL 46 974       +KEY,FRISKEN,CLINE,DEBONTE+(TNTO+YORK+PURD)
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ρ′(1250)

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69  RHO PRIME(1250,JPG=1-+) I=1

EVIDENCE NOT COMPELLING. OMITTED FROM TABLE.
SEE ALSO THE RHO PRIME(1600) MINI-REVIEW.
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                   69  RHO PRIME(1250) MASS  (MEV)

M          1256.      10.              FRENKIEL  72 HBC  +- 0.PBARP,OMEGA PI 12/77
M          1266.0      5.0             BARTALUCC 79 MASP   0 7 GAM P,E+E- P   12/79
M    A    (1250.)                      ASTON     80 OMEG    20-70G P,OME PI0  9/81*
M    A    (1290.)    (40.)             BARBER    80 SPEC    3-5 G P,OMEG PI0  9/81*
M          . . . . . . . . . .
M   AVG    1264.0      4.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M    A   NOT SEPARATED FROM B(1235),NOT PURE JP=1- EFFECT
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                   69  RHO PRIME(1250) WIDTH  (MEV)

W           130.      20.              FRENKIEL  72 HBC  +- 0.PBARP,OMEGA PI 12/77
W           110.0     35.0             BARTALUCC 79 MASP   0 7 GAM P,E+E- P   12/79
W    A     (300.)                      ASTON     80 OMEG    20-70G P,OME PI0  9/81*
W    A     (320.)   (100.)             BARBER    80 SPEC    3-5 G P,OMEG PI0  9/81*
W           . . . . . . . . . .
W   AVG     125.1     17.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    A   NOT SEPARATED FROM B(1235),NOT PURE JP=1- EFFECT
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                          REFERENCES FOR RHO PRIME(1250)

ANDERSON 70 PR D 1 27           +GUSTAVSON,JOHNSON,+    (SLAC+CIT+UCSB+NEAS)

PODOLSKY 71  UCRL 20128         W.J.PODOLSKY,PH.D. THESIS               (LBL)

FRENKIEL 72 NP B 47 61          +GHESQUIERE,LILLESTOL,CHUNG,+   (CDEF+CERN)JP
WOLF     72 ITHACA N.Y. CONF.  G.WOLF,P.213                            (SLAC)

CHUNG    73 PL 47 B 526         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
BRAMON   73 LNC 8 659           A.BRAMON                           (FRASCATI)

BALLAM   74 NP B76 375          +CHADWICK,BINGHAM,FRETTER+   (SLAC+LBL+MPIM)
CHALOUPK 74 PL 51B 407          CHALOUPKA,FERRANDO,LOSTY,MONTANET     (CERN)
CONVERSI 74 PL 52B 493          +PAOLUZI,CERADINI,GRILLI+         (ROMA+FRAS)
ESTABROO 74 NP B79 301          P.ESTABROOKS,A.D.MARTIN                (DURH)
KARSHON  74 PR D10 3608         +MIKENBERG,EISENBERG,PITLUCK,RONAT+  (REHO)  JP

ALLES    75 NC 30A 136          ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
CHUNG    75 PR D11 2426         +PROTOPOPESCU,LYNCH,FLATTE,+ (BNL+LBL+UCSC)
ESTABROD 75 NP B95 322          P.ESTABROOKS,A.D.MARTIN                (DURH)
FROGGATT 75 NP B91 454          C.D.FROGGATT,J.L.PETERSEN         (GLAS+NORD)
HYAMS    75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+      (CERN+MPIM)

BASSOMPI 76 PL 65 B 397         BASSOMPIERRE,BINDER,+        (MULH+STRB+TORI)

BUDNEV   77 PL 70 B 365         N.M.BUDNEV,V.M.BUDNEV,V.V.SEREBRYAKOV(NOVO)
COSTA    77 PL 67 B 213         COSTA DE BEAUREGARD,PHAM,PIRE,TRUONG (EPOL)
GESSAROL 77 NP B 126 382        GESSAROLI,+  (BGNA+FIRZ+GENO+MILA+OXF+PAVI)

BUKIN    78 PL  73 B 226        +VASSERMAN,KOOP,KURDADZE,SIDOROV,+     (NOVO)

BACCI    79 PL B 86 234         +DE ZORZI,PENSO,STELLA,+     (ROMA+BGNA+FRAS)
BARTALUC 79 NC 49 A 207         BARTALUCCI,BASINI,BERTOLUCCI+     (DESY+FRAS)

ASTON    80 PL 92 B 211         (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+)
BARBER   80 ZPHY C 4 169        +DAINTON,BRODBECK,BROOKES,+(DARE+LANC+SHEF)
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f(1270)

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                     5  F(1270,JPG=2++) I=0

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                     5  F MASS (MEV)

M            1276.      11.              RABIN     67 HBC     8.5 PI+ P          9/67
M  T  1960   1261.       5.              ARMENISE  68 DBC     5.1 PI+N,P PI+ -   1/73
M  T   360   1270.      10.              ARMENISE  68 DBC     5.1 PI+N,P PI0 0   1/73
M            1265.       8.              BOESEBECK 68 HBC     8 PI+ P            6/68
M   J        1268.0      6.0             JOHNSON   68 HBC      3.7-4.2 PI- P     7/69
M            1275.0     13.0             ARMENISE  70 HBC      9 PI+ N -- F P    1/71
M            1273.0      7.0             ARMENISE  70 HBC      9 PI+ N -- MM P   1/71
M      600   1275.0     10.0             OH        70 HBC     1.26 PI- P,P F     1/71
M   E       (1273.0)    (6.0)            STUNTEBEC 70 HBC     8.PI-P,5.4 PI+D   11/71
M     5300   1277.0      4.0             FLATTE    71 HBC      7.0 PI+ P         6/71
M     2000   1261.0     10.0             JACOBS    72 HBC      2.8 PI- P         1/73
M      600   1258.0     10.0             TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73
M     4600   1272.       4.              ENGLER    74 DBC      6. PI+N,PI+PI-P  12/75
M  IH       (1269.)     (4.)             ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75
M  IG       (1275.)     (4.)             HYAMS     75 ASPK     17 PI-P,PI+PI-N  12/75
M    16000   1284.0     10.0             DEUTSCHMA 76 HBC     16 PI+P            4/78
M            1273.8      2.8      2.7    BECKER    79 ASPK    17 PI- P POLARIZ  12/79
M            1282.0      5.0             CORDEN    79 OMEG    12-15PI-P, N 2PI  12/79
M            1281.0      7.0             GIDAL     81 SMK2    J/PSI DECAY        1/82*
M            . . . . . . . . . . .
M   AVG      1272.9      1.6      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

M   G   INCLUDED IN BECKER 79 ANALYSIS
M   H   USES SAME DATA AS HYAMS 75
M  I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
M    J  JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
M  T    MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N),SEE K* TYPED NOTE

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                     5  F WIDTH (MEV)

W             155.      17.              RABIN     67 HBC     8.5 PI+ P          9/67
W  T  1960    216.      20.              ARMENISE  68 DBC     5.1 PI+N,P PI+ -   1/73
W             128.      23.              BOESEBECK 68 HBC     8 PI+ P            6/68
W   J         176.0     13.0             JOHNSON   68 HBC      3.7-4.2 PI- P     7/69
W             131.0     25.0             ARMENISE  70 HBC      9 PI+ N -- MM P   1/71
W  T          173.0     25.0             ARMENISE  70 HBC      9 PI+ N -- F P    2/74
W  T   600    120.0     20.0             OH        70 HBC     1.26 PI- P,P F     2/74
W             196.0     18.0             STUNTEBEC 70 HBC     8.PI-P,5.4 PI+D   11/71
W     5300    183.0     15.0             FLATTE    71 HBC     7.PI+P,DELTA++F    1/71
W     2000    130.0     25.0             JACOBS    72 HBC      2.8 PI- P         1/73
W  T   600    166.0     28.0             TAKAHASHI 72 HBC     8. PI- P,N 2PI     1/73
W     4600    192.      16.              ENGLER    74 DBC      6. PI+N,PI+PI-P  12/75
W  IH        (209.)    (10.)             ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75
W  IG        (188.)    (4.)              HYAMS     75 ASPK     17 PI-P,PI+PI-N  12/75
W    16000    225.0     38.0             DEUTSCHMA 76 HBC     16 PI+P            4/78
W  T   650    187.0     30.0             ANTIPOV   77 CIBS  0 25 PI-P,P 3PI      1/82*
W             183.2      8.3      7.9    BECKER    79 ASPK    17 PI- P POLARIZ  12/79
W             216.0     13.0             CORDEN    79 OMEG    12-15PI-P, N 2PI  12/79
W             186.0     27.0             GIDAL     81 SMK2    J/PSI DECAY        1/82*
W             . . . . . . . . . . .
W   AVG       179.4      6.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
                                  (SEE IDEOGRAM BELOW )

W   G   INCLUDED IN BECKER 79 ANALYSIS
W   H   USES SAME DATA AS HYAMS 75
W  I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
W    J  JOHNSON 68 INCLUDES BONDAR 63, LEE 64, DERADO 65, EISNER 67.
W  T    WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE
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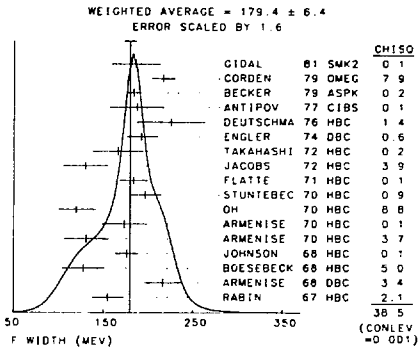


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                     5  F PARTIAL DECAY MODES

                                                            DECAY MASSES
P1       F INTO PI PI                                       139+ 139
P2       F INTO 2PI+ 2PI-                                   139+ 139+ 139+ 139
P3       F INTO PI+ PI- 2PI0                                139+ 139+ 134+ 134
P4       F INTO K KBAR                                      497+ 497
P5       F INTO K KBAR PI                                   497+ 497+ 139
P6       F INTO ETA PI PI                                   548+ 139+ 139
P7       F INTO ETA ETA                                     548+ 548
P8       F INTO GAMMA GAMMA                                   0+   0

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                     5  F PARTIAL WIDTHS

W1       F INTO GAMMA GAMMA (KEV)                           (G8)                 12/78
W1   A         2.3       0.8               BERGER    80 PLUT    E+ E-              9/81*
W1 D           3.2       0.8               BRANDELIK 81 TASS    GAM GAM,2PI        1/82*
W1 D           3.6       0.8               ROUSSARIE 81 SMK2    GAM GAM,2PI        1/82*
W1 D           2.7       0.8               EDWARDS   82 CBAL    GAM GAM,2PI0       2/82*
W1 DH         (2.9)     (1.2)     (1.0)    EDWARDS   82 CBAL    GAM GAM,2PI0       2/82*
W1             . . . . . . . . . . .
W1  AVG        2.95      0.40    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W1   A  USING MASS, WIDTH AND BR(F TO 2PI) FROM PDG 1978
W1 D    SYSTEMATIC ERROR ADDED LINEARLY BY US.
W1   H  IF HELICITY=2 ASSUMPTION IS NOT MADE

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                     5  F BRANCHING RATIOS

R1       F INTO (2PI+ 2PI-)/(PI PI)                         (P2)/(P1)
R1             0.047     0.013             OH        70 HBC     1.26 PI- P,P F      2/73
R1      154    0.037     0.007             ANDERSON  73 DBC     6. PI+N,P F0        1/74
R1            (0.033)OR LESS  C.L.=.90     BUGG      73 DBC     8. PI+N,P F0        1/74
R1       70    0.051     0.025             EISENBERG 74 HBC     4.9 PI+P,DEL++F0  11/75
R1      285    0.043     0.007     .011    LOUIE     74 HBC     3.9 PI- P,N F0     11/75
R1      160    0.024     0.006             EMMS      75 DBC     4.  PI+N,P F0      11/75
R1             . . . . . . . . . . .
R1  AVG        0.0340    0.0045  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

R2       F INTO (PI+ PI- 2PI0)/(PI PI)                      (P3)/(P1)
R2    SHOULD BE TWICE R1 IF DECAY IS RHO-RHO (SEE ASCOLI 68)
R2      600    0.15      0.06              EISENBERG 74 HBC     4.9 PI+P,DEL++F0  11/75
R2            (0.07)                       EMMS      75 DBC     4.  PI+N,P F0      11/75

R3       F INTO (K KBAR)/(PI PI)                            (P4)/(P1)
R3           WE ONLY AVERAGE EXPERIMENTS WHICH EITHER TAKE INTO ACCOUNT F-A2
R3           INTERFERENCE EXPLICITLY OR DEMONSTRATE THAT A2 PRODUCTION IS
R3           NEGLIGIBLE.
R3            (0.047)   (0.012 + SYST.     BEUSCH    67 OSPK    5,7,12 PI-P         9/67
R3       20    0.031     0.012             ADERHOLZ  69 HBC      8 PI+ P,K+K-PI-  12/75
R3             0.025     0.015             EMMS      75 DBC     4.  PI+N,P F0      11/75
R3  W         (0.029)   (0.006)            WETZEL    76 OSPK    8.9 PI-P,KS KS      7/77
R3   C         0.047     0.005             PAWLICKI  77 SPEC    6. PI N,K+ K- N    12/77
R3   N         0.028     0.005             CASON     78 STRC    7. PI-P,KS KS N    12/78
R3             0.030     0.005             MARTIN    79 RVUE                       12/79
R3   M         0.027     0.009             POLYCHRON 79 STRC    7. PI-P,KS KS N    12/79
R3             0.036     0.003             COSTA     80 OMEG    1-2.2 PI-P,K+K-N    9/81*
R3             0.069     0.023    0.031    GORLICH   80 ASPK    17,18 PI-P POLAR   12/79
R3             0.039     0.008             LOVERRE   80 HBC     4. PI-P,K K N      12/79
R3            (0.03) OR LESS  CL=.95       AGUILAR   81 HBC     4.2 K-P,LAM 2K      1/82*
R3             . . . . . . . . . . .
R3  AVG        0.0352    0.0023  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                 (SEE IDEOGRAM BELOW )

R3   C  THIS DETERMINATION HAS QUANTITATIVELY ACCOUNTED FOR BOTH F-PRIME
R3   C  AND A2 INTERFERENCE EFFECTS.
R3   N  TAKES INTO ACCOUNT THE F-F' INTERFERENCE
R3   N  BY EXTRAPOLATION TO THE PION POLE
R3  W   USING F PRIME WIDTH = 40 MEV
```
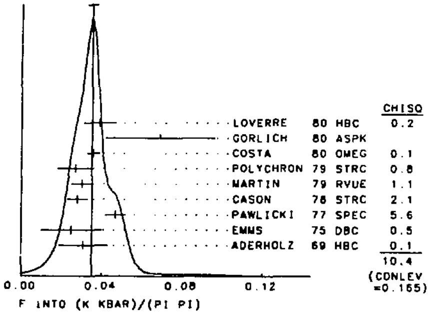

WEIGHTED AVERAGE = 0.0352 ± 0.0023
ERROR SCALED BY 1.2

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R4     F INTO (KO K- PI+ AND C.C.)/(PI PI)                    (P5)/(P1)
R4           (.004)OR LESS  CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75

R5     F INTO (ETA PI PI)/(PI PI)                             (P6)/(P1)
R5           (.010)OR LESS  CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75

R6     F INTO (ETA ETA)/(PI PI)                               (P7)/(P1)
R6           (.09) OR LESS  CL=.95   EISENBERG 74 HBC     4.9 PI+P,DEL++FO  11/75
R6           (.016)OR LESS  CL=.95   EMMS      75 DBC     4.  PI+N,P FO      11/75
R6           (.05) OR LESS  CL=.95   EDWARDS   82 CBAL    GAM GAM,AGAMMA     2/82*

R10    F INTO (PI PI)/TOTAL                                   (P1)
R10    600   0.8       0.04          OH        70 HBC    01.26 PI- P,P F     1/71
R10    250   0.85      0.05          BEAUPRE   71 HBC    05 PI+ P,DELTA++F   1/71
R10EH        (0.82)    (0.01)        ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75
R10EG        (0.803)   (0.003)       HYAMS     75 ASPK    17 PI-P,PI+PI-N   12/75
R10          0.847     0.016         BECKER    79 ASPK    17 PI- P POLARIZ  12/79
R10          0.75      0.04          CORDEN    79 OMEG    12-15PI-P, N 2PI  12/79
R10        . . . . . . . . . .
R10 AVG      0.831     0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                               (SEE IDEOGRAM BELOW )

R10 G   INCLUDED IN BECKER 79 ANALYSIS
R10 H   USES SAME DATA AS HYAMS 75
R10I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
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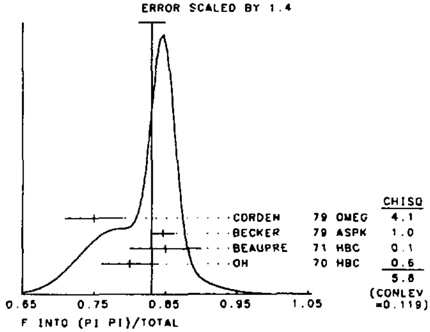
WEIGHTED AVERAGE = 0.831 ± 0.019
ERROR SCALED BY 1.4



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REFERENCES FOR F


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SELOVE   62 PRL 9 272          SELOVE,HAGOPIAN,BRODY,BAKER,LEBOY     (PENN)
BONDAR   63 PL 5 153           BONDAR+   (AACHEN+BIRM+BONN+DESY+LOIC+MPIM)
GUIRAGOS 63 PRL 11 85          Z.G.T. GUIRAGOSSIAN                    (LRL)
HAGOPIAN 63 PRL 10 533         V HAGOPIAN,W SELOVE                   (PENN)
VEILLET  63 PRL 10 29          VEILLET,HENNESSY,BINGHAM,BLOCH+(EPOL+MILAN)

ADERHOLZ 64 PL 10 240          AACHEN+BERLIN+BERLIN+BONN+HAMBURG+LOIC+MPI  IJ
BRUYANT  64 PL 10 232          BRUYANT,GOLDBERG,HOLDER,FLEURY+ (CERN+EPOL) I
LEE      64 PRL 12 342         LEE,ROE,SINCLAIR,VANDERVELDE          (MICH)
SODICKSO 64 PRL 12 485         SODICKSON,WAHLIG,MANNELLI,FRISCH+      (MIT) I

BARMIN   65 SJNP 1 230         +DOLGOLENKO,ELENSKY,EROFEEV+  (ITEP MOSCOW) JP
BARMIN   65 SJNP 1 623         +DOLGOLENKO+EROFEEV+KRESTNIKOV+ (ITEP MOSC)
CHUNG    65 PRL 15 325         CHUNG,DAHL,HARDY,HESS,JACOBS,KIRZ      (LRL)
DERADO   65 PRL 14 872         DERADO,KENNEY,POIRIER,SHEPHARD (NOTRE DAME)
GUIRAGOS 65 PRL 11 85          Z G T GUIRAGOSSIAN                     (LRL)
WANGLER  65 PR 137 B 414       T P WANGLER,A R ERWIN,W WALKER  (WISCONSIN)

ACCENSI  66 PL 20 557          ACCENSI,ALLES-BORELLI,FRENCH,FRISK+  (CERN)
JACOBS   66 UCRL-16877         L.D.JACOBS,THESIS                      (LRL)
WAHLIG   66 PR 147 941         +SHIBATA,GORDON,FRISCH,MANNELLI  (MIT+PISA) J

BARLOW   67 NC 50A 701         +LILLESTOL+MONTANET+  (CERN+CDEF+IRAD+LIVP)
BEUSCH   67 PL 25 B 357        +FISCHER,GOBBI,ASTBURY+             (ETH+CERN)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
EISNER   67 PR 164 1699        +JOHNSON+KLEIN+PETERS+SAHNI+YEN+   (PURDUE)
POIRIER  67 PR 163 1462        +BISWAS,CASON,DERADO,KENNEY+     (NDAM+PENN)
RABIN    67 THESIS             M. RABIN                           (RUTGERS)

ARMENISE 68 NC 54 A 999        [illegible]
ASCOLI   68 PRL 21 1712        [illegible]
BOESEBEC 68 NP B 4 501         [illegible]
FOSTER   68 NP B 6 107         [illegible]
JOHNSON  68 PR 176 1651        [illegible]
LAMSA    68 PR 166 1395        [illegible]
WHITEHEA 68 NC 53A 817         [illegible]

ADERHOLZ 69 NP B 11 259        +BARTSCH,+         (AACH+BERL+CERN+JAGL+WARS)
AGUILAR  69 PL 29 B 241        M.AGUILAR-BENITEZ,J.BARLOW,+     (CERN+CDEF)
ARMENISE 69 LNC 2 501          +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CASO     69 NC 62 A 755        +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)

AGUILAR  70 PRL 25 58          AGUILAR-BENITEZ,BARNES,BASSANO,+ (BNL+SYRA)
ARMENISE 70 LNC 4 199          +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BADIER   70 NP B 22 512        +BONNET,DREVILLON,BAUBILLIER,+  (EPOL+IPNP)
OH       70 PR D 1 2494        +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
STUNTEBE 70 PL 32 B 391        STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,+          (WARS)
BEAUPRE  71 NP B 28 77         +DEUTSCHMANN,GRAESSLER,+    (AACH+BERL+CERN)
FARBER   71 NP B 29 237        +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NDAM)
FLATTE   71 PL 34 B 551        +ALSTON-GARNJOST,BARBARO-GALTIERI,+    (LBL)

AGUILAR  72 PR D 6 29          AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
BISWAS   72 PR D 5 1564        +CASON,HARRINGTON,KENNEY,SHEPHARD     (NDAM)
FOGLI    72 NC 8 A 670         FOGLI-MUCIACCIA,PICCIARELLI           (BARI)
GRAYER   72 PHIL.CONF.PROC. 5  +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
JACOBS   72 PR D 6 1291        L.D.JACOBS                          (SACLAY)
KEMP     72 NC 8 A 611         +MAJOR,CONTRI,+  (DURH+GENO+MILA+EPOL+LPNP)
SCARROTT 72 LNC 3 271          SCARROTT,KEMP                       (DURHAM)
TAKAHASH 72 PR D 6 1266        TAKAHASHI,BARISH,+      (TOHO+PENN+NDAM+ANL)
WHITEHEA 72 NP B 48 365        WHITEHEAD,AULD,+        (AERE+RHEL+SHMP+LOUC)

ANDERSON 73 PRL 31 562         +ENGLER,KRAEMER,TOAF,DIAZ,+      (CARN+CASE)
BUGG     73 PR D 7 3264        +CONDO,HART,COHN,ENDORF,+   (TENN+ORNL+CINC)
CHARLESW 73 NP B 65 253        CHARLESWORTH,EMMS,BELL,+    (RHEL+BIRM+DURH)
HYAMS    73 NP B 64 134        +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
TOET     73 NP B 63 248        +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

EISENBER 74 PL 52B 239         EISENBERG,ENGLER,HABER,KARSHON+       (REHO)
ENGLER   74 PR D10 2070        +KRAEMER,TOAFF,WEISSER,DIAZ+     (CARN+CASE)
GRAYER   74 NP B 75 189        G.GRAYER,HYAMS,BLUM,DIETL,+      (CERN+MPIM)
HOLLOWAY 74 PR D9 1161         +HULD,JORDAN,KOETZ,BERNSTEIN+     (ILL+ILLC)
LOUIE    74 PL 48B 385         +ALITTI,GANDOIS,CHALDUPKA+       (SACL+CERN)

EMMS     75 NP B96 155         +KINSON,STACEY,VOTRUBA+     (BIRM+DURH+RHEL)
ESTABROO 75 NP B95 322         P.ESTABROOKS,A.D.MARTIN                (DURH)
HYAMS    75 NP B100 205        +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
PAWLICKI 75 PR D12 631         +AYRES,DIEBOLD,GREENE,KRAMER,WICKLUND (ANL)

DEUTSCHM 76 NP B 103 426       +KIRK,+(AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
WETZEL   76 NP B 115 208       +FREUDENREICH,BEUSCH,+        (ETH+CERN+LOIC)

ALEXANDE 77 NP B 131 365       ALEXANDER,CORDEN,+      (TELA+BIRM+RHEL+LOWC)
ANTIPOV  77 NP B 119 45        +BUSNELLO,DAMGAARD,KIENZLE,+     (SERP+GEVA)
PAWLICKI 77 PR D 15 3196       +AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND   (ANL)

BALTAY   78 PR D 17 62         +CAUTIS,COHEN,CSORNA,SMITH,YEH,+(COLU+BING)
CASON    78 PRL 41 271         +BAUMBAUGH,BISHOP,BISWAS,KENNEY,+(NDAM+ANL)

BECKER   79 NP B 151 46        +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
CORDEN   79 NP B 157 250       +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TELA+LOWC)
MARTIN   79 NP B 158 520       +OZMUTLU                               (DURH)
POLYCHRO 79 PR D 19 1317       POLYCHRONAKOS,CASON,BISHOP+        (NDAM+ANL)

BERGER   80 DESY 80/34         +GENZER+(AACH+BERG+DESY+HAMB+LUND+SIEG+WUPG)
COSTA    80 NP B 175 402       +        (BARI+BONN+CERN+GLAS+LIVP+MILA+WIEN)
GORLICH  80 NP B 174 16        +NICZYPORUK,ROZANSKA+ (CRAC+MPIM+CERN+ZEEM)
LOVERRE  80 ZPHY C 6 187       +ARMENTEROS,DIONISI+  (CERN+CDEF+MADR+STOH)

AGUILAR  81 ZPHY C 8 313       +ALBAJAR,ARMENTEROS,+ (CERN+CDEF+MADR+STOH)
BRANDELI 81 ZPHY C 10 117      BRANDELIK,BOERNER,+    (TASSO COLLABORATION)
GIDAL    81 PL 107 B 153       +GOLDHABER,GUY,MILLIKAN,ABRAMS,+ (SLAC+LBL)
ROUSSARI 81 PL 105 B 304       ROUSSARIE,BURKE,ABRAMS,ALAM,+     (SLAC+LBL)

EDWARDS  82 PL 110 B 82        +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
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A_1(1270)

10 A1(1270,JPG=1+-) I=1

The long-standing question concerning the resonance interpretation of the A_1 has been considerably clarified since the last edition of this Review. The results of the partial-wave analyses obtained in two recent high-statistics experiments dealing with the diffractive (DAUM 80,81) and charge-exchange (DANKOWYCH 81) production of the 3π system in πp interactions, clearly show that the behavior of the 1^+S0^+ intensity with the 3π mass and the phase variation of the 1^+S0^+ ($\rho\pi$) amplitude with respect to other waves [already reported in a study of diffractive production from nuclei (PERNEGR 78)] require the presence of both Deck background and a resonance.

The resonance parameters of the A_1 resonance are obtained by fitting the data (intensity and relative phases) to a phenomenological amplitude containing direct resonance production and a coherent Deck background which is rescattered through the resonance (BOWLER 75, BASDEVANT 77). In the context of this model-dependent analysis, the Deck background is responsible for making the peak of the 1^+S0^+ intensity occur some 110 MeV below the most likely resonance mass.

We take the mass values for the A_1 from these reactions (1240 ± 80 MeV, DANKOWYCH 81; 1280 ± 30 MeV, DAUM 81). Note, however, the result reported in a study of a backwardly produced 3π system in the reaction $K^-p \to \Sigma^-\pi^+\pi^+\pi^-$ (1041 ± 13 MeV, GAVILLET 77). Based on a rather small statistical sample, GAVILLET 77 fitted the 1^+S partial-wave intensity in terms of a single Breit-Wigner function disregarding a possible background component in the 1^+S wave.

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                    10  A1 MASS (MEV)

M   A     1270. TO 1350.            BOWLER    75 RVUE +- 7-40 PI+- P      6/81*
M    B    (1382.)                   BASDEVANT 77 RVUE  - 25,40 PI- P      6/81*
M   F     (1041.0)   (13.0)         GAVILLET  77 HBC  +  4.2 K- P,S 3PI  12/77
M   E     (1230.0)   (30.0)         AARON     81 RVUE                     1/82*
M    D     1240.0     80.0          DANKOWYCH 81 SPEC   08.45 PI-P,3PI N  6/81*
M    D     1280.0     30.0          DAUM      81 CNTR    63,94 PI- P     12/79
M          . . . . . . . . . . .
M   AVG    1275.1     28.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   A   USES DATA OF ANTIPOV 73,ASCOLI 74,OTTER 74,TABAK 74,THOMPSON 74.
M    B  USES ANTIPOV 73 DATA. WE SELECT SOLUTION B OF BASDEVANT 77.
M    D  USES THE MODEL OF BOWLER 75.
M   E   USES MULTICHANNEL AITCHISON-BOWLER MODEL.
M   E   USES DATA FROM DAUM 80 AND DANKOWYCH 81.
M   F   PRODUCED IN K- BACKWARD SCATTERING.

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                    10  A1 WIDTH (MEV)

W   A      240. TO  280.            BOWLER    75 RVUE +- 7-40 PI+- P      6/81*
W    B    (470.)                    BASDEVANT 77 RVUE  - 25,40 PI- P      6/81*
W   F     (230.0)    (50.0)         GAVILLET  77 HBC  +  4.2 K- P,S 3PI  12/77
W   E     (350.0)    (60.0)         AARON     81 RVUE                     1/82*
W    D     380.0     100.0          DANKOWYCH 81 SPEC   08.45 PI-P,3PI N  6/81*
W    D     300.0      50.0          DAUM      81 CNTR    63,94 PI- P      1/82*
W          . . . . . . . . . . .
W   AVG    316.0      44.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   A   USES DATA OF ANTIPOV 73,ASCOLI 74,OTTER 74,TABAK 74,THOMPSON 74.
W    B  USES ANTIPOV 73 DATA. WE SELECT SOLUTION B OF BASDEVANT 77.
W    D  USES THE MODEL OF BOWLER 75.
W   E   USES MULTICHANNEL AITCHISON-BOWLER MODEL.
W   E   USES DATA FROM DAUM 80 AND DANKOWYCH 81.
W   F   PRODUCED IN K- BACKWARD SCATTERING.

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                    10  A1 PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      A1 INTO RHO PI                                   769+ 139
P2      A1 INTO KBAR K                                   493+ 497
P3      A1 INTO PI (PI PI) S WAVE                        139+ 139+ 139

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                    10  A1 BRANCHING RATIOS

R4      A1 INTO (PI (PI PI) S WAVE)/(RHO PI)          (P3)/(P1)
R4 E          (0.042)                 AARON     81 RVUE                   3/82*
R4 E    USES MULTICHANNEL AITCHISON-BOWLER MODEL.
R4 E    USES DATA FROM DAUM 80 AND DANKOWYCH 81.

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                         REFERENCES FOR A1

BELLINI   63 NC 29 896          BELLIN.,FIORINI,HERZ,NEGRI,RATTI     (MILAN)

ADERHOLZ 64 PL 10 226          AACH+BERL+BIRM+BONN+DESY+HAMBURG+LOIC+MPIM
GOLDHABE 64 PRL 12 336         GOLDHABER,BROWN,KADYK,SHEN+         (LRL+UCB)
LANDER   64 PRL 13 346 A       LANDER,ABOLINS,CARMONY,HENDRICKS +     (UCSD)  JP

ABOLINS  65 ATHENS(OHIO)CONF.  +CARMONY,LANDER,XUONG,YAGER       (LA JOLLA)I=1
ALITTI   65 PL 15 69           ALITTI,BATON,DELER,CRUSSARD+      (SACL+BGNA)

ALLARD   66 NC 46A 737         +DRIJARD+HENNESSY+    (ORSAY+MILAN+SACL+UCB)
DEUTSCHM 66 PL 20 82           DEUTSCHMANN,STEINBERG +  (AACH+BERLIN+CERN)
HESS     66 UCRL-16832         R I HESS (THESIS, BERKELEY)                (LRL)

ALLISON  67 PL 25B 619         +CHUZ+        (OXF+MPIM+BIRM+RHEL+GLAS+LOIC)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                     (LRL)
DANYSZ   67 NC 51 A 801        DANYSZ+FRENCH+SIMAK                       (CERN)
JUHALA   67 PRL 19 1355        +LEACOCK+RHODE+KOPELMAN+             (IOWA+COLO)
SLATTERY 67 NC 50A 377         +KRAYBILL+FORMAN+FERBEL              (YALE+ROCH)  JP

ARMENISE 68 PL 26 B  336       +FORINO+CARTACCI+        (BARI+BGNA+FIRZ+ORSAY)
ASCOLI   68 PRL 21 113         +CRAWLEY,KRUSE,MORTARA,SCHAFER,+ (ILLINOIS)
BALLAM   68 PRL 21 934         +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+    (SLAC)JP
BOESEBEC 68 NP B 4 501         BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983        +CONTE+CORDS+DIAZ+   (GENOVA+HAMB+MILA+SACL)
CHUNG    68 PR 165 1491        S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER        (LRL)
CHOPS    68 PRL 21 1609        +HOUGH,COHN,BUGG+ (BNL+ORNL+UCND+TENN+PENN)
FRIDMAN  68 PR 167 1268        +MAURER,MICHALON,OUDET+      (HEID+STRASBOURG)
JUNKMANN 68 NP B8 471          +COCCONI+            (AACH+BERL+BONN+CERN+WARS)
KEY      68 PR 166 1430        +PRENTICE+COOPER+MANNER+        (TNTO+ANL+WISC)

ALEXANDE 69 PR 183 1168        G.ALEXANDER,A.FIRESTONE,G.GOLDHABER     (LRL)
ALLABY   69 PL 29B 198         +BINON+DIDDENS+DUTEIL+KLOVNING+...      (CERN)
ANDERSON 69 PRL 22 1390        +COLLINS,+                            (BNL+CARN)
BERLINGH 69 PRL 23 42          BERLINGHIERI,FARBER,+                     (ROCH)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+     (LIVP+OSLO+PADO)
FAYOLLE  69 NP B 13 40         +DE MONTAIGNAC,MORAND,STRACHMAN+       (PARIS)
JUHALA   69 PR 184  1461       +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
KENYON   69 PRL 23 146         +KINSON,SCARR,+                (BNL+UCND+ORNL)

ARMENISE 70 LNC 4  199         +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
ASCOLI   70 PRL 25 562         +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+  (ILL)  JP
BRANDENB 70 NP B16 369         +BRENNER,IOFFREDO,JOHNSON,KIM+      (HARVARD)
CASO     70 LNC 3  707         +CORDS,COSTA+      (GENO+DESY+HAMB+MILA+SACL)
CRENNELL 70 PRL 24 781         +KARSHON,LAI,SCARR,SIMS                   (BNL)
GARELICK 70 PHILAD.CONF.P.205 D.A.GARELICK,REVIEW              (NORTHEASTERN)
RABIN    70 PRL 24 .25         +GALTIERI,DERENZO,FLATTE,FRIEDMAN+        (LRL)

ASCOLI   71 PRL 26 929         ILLINOIS+GENO+HAMB+MIL+SACL+HARV+TNTO+WISC
BEMPORAD 71 NP B 33 397        +BEUSCH,MELISSINOS,+    (CERN+ETH+LOIC+MILA)
BERGER   71 PHENOMENOLOGY  IN PARTICLE PHYSICS. CALTECH 1971          (LRL)
RINAUDO  71 NC 5 A 239         +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

BERENYI  72 NP B 37 621        +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR 72 NP B 46 402        BLOODWORTH,JACKSON,PRENTICE,YOON  (TORONTO)
DIEBOLD  72 BATAV.CONF.3P.17 R.DIEBOLD  RAPPORTEUR TALK                 (ANL)
LAMSA    72 NP B 41 388        +EZELL,GAIDOS,WILLMANN                (PURDUE)
MORSE    72 NP B 43 77         +OH,WALKER,JOHNSTON,YOON            (WISC+TNTO)

ANTIPOV1 73 NP B 63 153        +ASCOLI,BUSNELLO,FOCACCI,+        (CERN+SERP)  JP
ANTIPOV2 73 NP B 63 141        +ASCOLI,BUSNELLO,FOCACCI,+        (CERN+SERP)  JP
ARNOLD   73 NC 17 A 393        +ENGEL,ESCOUBES,GEMESY,JANOSSY,+(STRB+BUDA)
ASCOLI 1 73 PR D 8 3894        +JONES,WEINSTEIN,WYLD                      (ILL)
ASCOLI 2 73 PRL 31 795         +CHAPIN,CUTLER,HOLLOWAY,KOESTER,KRUSE+(ILL)  JP
ATHERTON 73 PL 43 B 249        +FRANEK,FRENCH,GHIDINI,HILPERT,+         (CERN)
READ     73 NP B 64 511        B.J.READ                                  (DESY)

ASCOLI   74 PR D9 1963         +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
BOWLER   74 NP B74 493         +DAINTON,KADDOURA,AITCHISON                (OXF)
KRUSE    74 PRL 32 1328        +ROBERTS,EDELSTEIN+     (ILL+CARN+NWES+ROCH)  JP
LICHTMAN 74 NP B81 31          +BISWAS,CASON,KENNEY,MCGAHAN,+            (NDAM)  JP
OTTER    74 NP B80 1           +RUDOLPH+           (AACH+BERL+BONN+CERN+HEID)  JP
TABAK    74 BOSTON CONF. P.46  +DONAT,ROSENFELD,LASINSKI+         (LBL+SLAC)  JP
THOMPSO1 74 PR D9 560          THOMPSON,GAIDOS,MCILWAIN,WILLMANN      (PURD)  JP
THOMPSO2 74 NP B69 381         THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+     (PURD)  JP

ABASHIAN 75 PRL 34 691         +BEAMER,BROSS,EISENSTEIN,+       (ILL+ANL+ISU)
AITCHISO 75 PL 59 B 288        I.J.R.AITCHISON, R.J.GOLDING            (OXFORD)
ASCOLI   75 PR D 12 43         G.ASCOLI, H.W.WYLD                    (ILLINOIS)
BEUSCH   75 PL 55B 97          +POLGAR,FREUDENREICH+    (CERN+ETH+LOIC+MILA)
BOSETTI  75 NP B 101 304       +OTTER+(AACH+BERL+BONN+CERN+HEID+LOIC+WIEN)
BOWLER   75 NP B97 227         +GAME,AITCHISON,DAINTON               (OXF+DARE)
DIAZ     75 PR 12 D 1272       +DIBIANCA,FICKINGER,DADO,ENGLER+(CASE+CARN)  JP
EMMS 1   75 NP B93 1           +JONES,KINSON,BELL,DALE+     (BIRM+DURH+RHEL)  JP
EMMS 2   75 PL 60 B 109        +JONES,KINSON,BELL,DALE+     (BIRM+DURH+RHEL)  JP
HORNE    75 PR D11 996         +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KANE     75  TENTH RENCONTRE DE MORIOND                                  (MICH)
WAGNER   75 PL 58B 201         +TABAK,CHEW                                (LBL)  JP

BAUBILLI 76 NP B 115 237       BAUBILLIER,RIVOAL,ARMENISE +      (BARI+LPNP)  JP
BENZ     76 NP B 115 385       +BRAUN +(AACHEN+BONN+HAMBURG+HEIDBERG+MPIM)
BRAYSHAW 76 PRL 36 73          D.BRAYSHAW                                (SLAC)

BALTAY   77 PRL 39 591         +CAUTIS,KALELKAR                      (COLUMBIA)  JP
BASDEVAN 77 PR D 16 657        BASDEVANT,BERGER                       (FNAL+ANL)  JP
CAUTIS   77  THESIS NEVIS 221  C.V.CAUTIS                            (COLUMBIA)  JP
CERRADA  77 NP B 126 241       +BLOCKZIJL,HEINEN+         (AMST+CERN+NIJM+OXF)  JP
FERRER   77  THESIS,LAL 1295   A.FERRER SORIA                           (ORSAY)
GAVILLET 77 PL 69 B 119        +BLOCKZIJL,ENGELEN+        (AMST+CERN+NIJM+OXF)  JP
HABER    77 NP B 129 429       H.E.HABER,G.L.KANE           (UNIV. OF MICHIGAN)
LONGACRE 77 PRL 38 1509        +AARON                   (NORTHEASTERN,BOSTON)  JP
SCHULT   77 PR D 16 62         + WYLD                                (ILLINOIS)  JP

ALEXANDE 78 PL 73 B 99         ALEXANDER,KNIES,+(DESY+AACH+HAMB+SIEG+WUPG)
BALTAY   78 PR D 17 62         +CAUTIS,COHEN,CSORNA,KALELKAR+  (COLU+BING)
BASDEVAN 78 PRL 40 994         BASDEVANT,BERGER                       (FNAL+ANL)  JP
CORDEN   78 NP B 136 77        DOWELL,GARVEY,JOBES+  (BIRM+RHEL+TELA+LOWC)  JP
FERRER 1 78 PL 74 B 287        +TREILLE,RIVET +       (ORSAY+CERN+CDEF+LPNP)
FERRER 2 78 NPB 142 77         +TREILLE,RIVET +       (ORSAY+CERN+CDEF+LPNP)
JAROS    78 PRL 40 1120        +ABRAMS,ALAM+               (SLAC+LBL+NWES+HAWA)
PERNEGR  78 NP B 134 436       +AEBISCHER+                 (ETH+CERN+LOIC+MILA)  JP
ROBERTS  78 PR D 18 59         +KRUSE,EDELSTEIN+           (ILL+CARN+NWES+ROCH)  JP

CORDIER  79 PL B 81 389        +DELCOURT,ESCHSTRUTH,FULDA,+              (LALO)
KASPER   79 NP B 156 207       +CHAPMAN,DEROACH,GOLD,KLEIN,MARTIN+  (MELB)
MAZZUCAT 79 NP B 156 532       MAZZUCATO,PENNINGTON+  (CERN+ZEEM+NIJM+OXF)

DAUM     80 PL 89 B 281        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)  JP
WAGNER   80 ZPHY C 3 193       +ALEXANDER+          (AACH+DESY+HAMB+SIEG+WUPP)

AARON    81 PR D 24 1207       +LONGACRE                              (NEAS+BNL)
BELLINI  81 PRL                +DI CORATO,FRABETTI,+          (MILA+JINR+BGNA)
DANKOWYC 81 PRL 46 580         +BROCKMAN,EDWARDS+(TNTO+BNL+CARL+MCGI+OHIO)
DAUM     81 NP B 182 269       +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
FOSTER   81 NP B 187 231       +BLOKZIJL,ARMENTEROS,+ (OXF+ZEEM+CERN+NIJM)

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η(1275)

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37  ETA(1275.JPG=0-+) 1=0

SEEN IN PHASE SHIFTS ANALYSIS OF THE ETA PI+ PI-
SYSTEM WITH PI+ PI- IN AN S-WAVE  (STANTON 79).
WAIT CONFIRMATION. OMITTED FROM TABLE.
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                      37  ETA(1275) MASS (MEV)

M         (1275.)    APPROX.          STANTON   79 CNTR  0 8.4PI-P,ETA 2PI  12/79
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                      37  ETA(1275) WIDTH (MEV)

M          (70.)    APPROX.          STANTON   79 CNTR  0 8.4PI-P,ETA 2PI  12/79
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                      37  ETA(1275) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     ETA(1275) INTO DELTA PI                              983+ 139
P2     ETA(1275) INTO ETA PI+ PI-                           548+ 139+ 139
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                      37  ETA(1275) BRANCHING RATIOS.

R1     ETA(1275) INTO DELTA PI                         (P1)
R1          LARGE                    STANTON   79 CNTR  0 8.4PI-P,ETA 2PI  12/79
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                          REFERENCES FOR ETA(1275)

STANTON   79 PRL 42 346        +BROCKMAN,DANKOWYCH,+  (OSU+CARL+MCGI+TNTO)  JP
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D(1285)

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8  D(1285.JPG=1++) 1=0
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                      8  D MASS (MEV)

M   S  500(1280.)     (3.)                THUN       72 MMS     13.4 PI- P        12/72
M        34(1271.0)   (10.0)              CORDEN     78 OMEG    12-15PI-P,K+K-PI   4/78
M   P    46(1275.0)  APPROX.              STANTON    79 CNTR    8.5PI-P,2GAM 2PI  12/79

M           1283.0      5.0               DAHL       67 HBC      1.6-4.2 PI- P    10/66
M           1290.       7.                D-ANDLAU   68 HBC  1.2 PBAR P, 5-6 PFS   6/68
M           1270.0     10.0               CAMPBELL   69 DBC      2.7 PI+ D         8/69
M           1285.       7.                LORSTAD    69 HBC  0.7 PB P, 4,5-BODY    9/69
M           1303.0      8.0               BAROADIN   71 HBC     8 PI+ P, P+6PI     9/69
M           1283.0      6.0               BOESEBECK  71 HBC     16.0 PI P,5 PI     6/71
M       150 1292.      10.                DEFOIX     72 HBC     0.7 PBAR P,7 PI    1/73
M       180 1286.       3.                DUBOC      72 HBC     1.2 PBAR P,2K4PI  12/72
M       210 1279.0      5.0               GRASSLER   77 HBC     16. PI-+ P        11/77
M        85 1295.0     12.0               CORDEN     78 OMEG    12-15PI-P, N 5PI   4/78
M       320 1282.0      2.0               NACASCH    78 HBC     .7+.76 PB P,KKBP   4/78
M       200 1288.0      9.0               GURTU      79 HBC     4.2 K- P,ETA 2PI  12/79
M        31 1275.0      6.0               BROMBERG   80 SPEC    100 PI-P,2KPIX     1/82*
M       103 1283.0      3.0               DIONISI    80 HBC     4. PI- P,K KB PI  12/79
M           1278.       4.                EVANGELIS  81 OMEG    12 PI-P,ETA3PIP    1/82*
M           . . . . . . . . . . .
M   AVG     1283.0      1.2       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

M   P   FROM PHASE SHIFT ANALYSIS OF ETA PI+PI- SYSTEM.
M   S   SEEN IN THE MISSING MASS SPECTRUM
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```
                      8  D WIDTH (MEV)

M   R        (35.0)   (10.0)              DAHL       67 HBC      1.6-4.2 PI- P    11/71
M   R        (60.)    (15.)               LORSTAD    69 HBC  0.7 PB P, 4,5-BODY   11/71
M   R        (44.0)   (24.0)              BAROADIN   71 HBC     8 PI+ P, P+6PI    11/71
M   R  150   (28.)     (5.)               DEFOIX     72 HBC     0.7 PBAR P,7 P9    1/73
M   R  180   (46.)     (9.)               DUBOC      72 HBC     1.2 PBAR P,2K4PI  12/72
M   S  500   (37.)     (5.)               THUN       72 MMS     13.4 PI- P        12/72
M    D  34   (55.0)   (38.0)              CORDEN     78 OMEG    12-15PI-P,K+K-PI   4/78
M   P        (10.0)  APPROX.              STANTON    79 CNTR    8.5PI-P,2GAM 2PI  12/79

M  U          46.      20.                D-ANDLAU   68 HBC  1.2 PBAR P, 5-6 PFS   2/72
M             30.0     15.0               CAMPBELL   69 DBC      2.7 PI+ D         8/69
M             10.0     10.0               BOESEBECK  71 HBC     16.0 PI P,5 PI     6/71
M      210    24.0     18.0               GRASSLER   77 HBC     16. PI-+ P        12/77
M    D  85    70.0     30.0               CORDEN     78 OMEG    12-15PI-P, N 5PI   4/78
M      320    28.3      6.7               NACASCH    78 HBC     .7+.76 PB P,KKBP   4/78
M      200    25.0     15.0               GURTU      79 HBC     4.2 K- P,ETA 2PI  12/79
M       31    22.0     21.0               BROMBERG   80 SPEC    100 PI-P,2KPIX     1/82*
M      103    29.0     10.0               DIONISI    80 HBC     4. PI- P,K KB PI  12/79
M             26.      12.                EVANGELIS  81 OMEG    12 PI-P,ETA3PIP    1/82*
M           . . . . . . . . . . .
M   AVG       26.3      3.9       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M    D   WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE
M   P    FROM PHASE SHIFT ANALYSIS OF ETA PI+PI- SYSTEM.
M   R    RESOLUTION NOT UNFOLDED
M   S    SEEN IN THE MISSING MASS SPECTRUM
M  U     UNFOLDED BY DOBRZYNSKI 71
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                      8  D PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     D INTO K KBAR PI                                     497+ 497+ 134
P2     D INTO PI PI RHO                                     134+ 134+ 769
P3     D INTO ETA PI PI                                     548+ 134+ 134
P4     D INTO DELTA PI                                      983+ 134
P5     D INTO 2PI+ 2PI-                                     139+ 139+ 139+ 139
P6     D INTO K* KBAR                                       891+ 497
P7     D INTO 4PI                                           139+ 139+ 139+ 139
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle\delta P_i \delta P_i\rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle\delta P_i \delta P_j\rangle/(\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the *fit to be nonzero* and are thus constrained to add to 1.

```
        P 1          P 3          P 7
P 1  .1117+-.0266
P 3    .2931   .4883+-.0586
P 7   -.6152    -.9341   .4000+-.0711
```

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                      8  D BRANCHING RATIOS

        THE D BRANCHING RATIOS FIT IS MADE WITH THE ASSUMPTION THAT
        THE D INTO 4PI DECAY IS ALWAYS VIA DECAY INTO I=1 PI PI
        PAIRS (E.G., RHO PI PI).

R1      D INTO (PI PI RHO) / (K KBAR PI)                    (P2)/(P3)
R1           (2.0)  OR LESS              DAHL       67 HBC      CHARGED PI ONLY 10/66
R1  D        (4.0)  OR LESS              DONALD     69 HBC      1.2 PBAR P,5P+
R1  D         THIS IS FOR (RHO0 PI+ PI-)/(K KBAR PI0)

R2      D INTO (K KBAR PI)/(ETA PI PI)                      (P1)/(P3)
R2              0.16      0.08           CAMPBELL   69 DBC      2.7 PI+ D          1/73
R2 K            0.20      0.08           DEFOIX     72 HBC      0.7 PBAR P,7 PI    1/73
R2              0.5       0.2            CORDEN     78 OMEG     12-15PI-P          4/78
R2              0.42      0.15           GURTU      79 HBC      4.2 K- P          12/79
R2 K     K KBAR SYSTEM CHARACTERIZED BY THE I=1 THRESHOLD
R2 K     ENHANCEMENT (SEE UNDER DELTA(980)).
R2           . . . . . . . . . . .
R2  AVG         0.279     0.061   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
R2  FIT         0.229     0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      D INTO (DELTA PI)/(ETA PI PI)                       (P4)/(P3)
R3          SEEN                         DEFOIX     68 HBC      PBAR P             1/80
R3              1.0       0.3            GRASSLER   77 HBC    0 16. PI-+ P        11/77
R3              0.6       0.3      0.2   CORDEN     78 OMEG     12-15PI-P          4/78
R3              0.72      0.15           GURTU      79 HBC      4.2 K- P          12/79
R3           . . . . . . . . . . .
R3  AVG         0.74      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      D INTO (2PI+ 2PI- (INCL. RHO PI PI))/(ETA PI+PI-)(P5)/(2/3P3)
R4              0.46      0.15           GRASSLER   77 HBC      16. PI-+ P        11/77
R4              0.32      0.20           GURTU      79 HBC      4.2 K- P          12/79
R4           . . . . . . . . . . .
R4  AVG         0.41      0.12    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5      D INTO (K* KBAR)/TOTAL                              (P6)
R5          NOT SEEN                     NACASCH    77 HBC      .7+.76 PB P,KKBP  12/77

R6      D INTO (RHO0 PI+ PI-)/(2PI+ 2PI-)                   (1/3P2/P5)
R6              1.0       0.4            GRASSLER   77 HBC      16 GEV PI+- P     11/77

R7      D INTO (RHO PI PI)/(ETA PI PI)                      (P2)/(P3)
R7 C         (0.4)  OR LESS  CL=.95      CORDEN     78 OMEG     12-15PI-P          4/78
R7 C     NOTE THAT CORDEN 78 AND GRASSLER 77 ARE IN DISAGREEMENT.
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                          REFERENCES FOR D

D-ANDLAU 65 PL 17 347          +BARLOW,ADAMSON,+       (CDEF+CERN+IRAD+LIVP)
MILLER   65 PRL 14 1074        +CHUNG,DAHL,HESS,HARDY,KIRZ,+       (LRL+UCB)

BARLOW   67 NC  50 A  701      +MONTANET,D-ANDLAU+    (CERN+CDEF+IRAD+LIVP)
DAHL     67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)I JP

D-ANDLAU 68 NP  B 5  693       +ASTIER,BARLOW+        (CDEF+CERN+IRAD+LIVP)I JP
DEFOIX   68 PL 28 B 353        +RIVET,STAUD,CONFORTO+       (CDEF+IPNP+CERN)

CAMPBELL 69 PRL 22 1204        +LICHTMAN,+                            (PURD)
DONALD   69 NP B 11 551        +EDWARDS,BURAN,BETTINI,+    (LIVP+OSLO+PADO)
LORSTAD  69 NP B 14 63         B.LORSTAD,D-ANDLAU,ASTIER,+      (CDEF+CERN)  JP
OTWINOWS 69 PL 29 B 529        S.OTWINOWSKI                          (WARSAW)

AMMAR    70 PR D2 430          +KROPAC,DAVIS,DERRICK+ (KANS+NWES+ANL+WISC)

BARDADIN 71 PR D4 2711         BARDADIN-OTWINOWSKA,HOFMOKL,MICHEJDA+(WARS)
BOESEBEC 71 PL 34 B 659              (AACH+BERL+BONN+CERN+CRAC+HEID+WARS)
GOLDBERG 71 LNC 1 627          +MAKOWSKI,YOUCHARD,DONALD,+      (IPN+LIVP)  JP

BERENYI  72 NP B 37 621        +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
CHAPMAN  72 NP B 42 1          +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX   72 NP B 44 125        +NASCIMENTO,BIZZARRI,+           (CDEF+CERN)
DUBOC    72 NP B 46 429        +GOLDBERG,MAKOWSKI,DONALD,+      (LPNP+LIVP)
THUN     72 PRL 28 1733        +BLIEDEN,FINOCCHIARO,BOWEN,+     (STON+NEAS)

VUILLEMI 75 LNC 14 165         VUILLEMIN,+         (LAUS+NEUC+LPNP+LIVP+GLAS)  JP
WELLS    75 NP B 101 333       +RADOJICIC,ROSCOE,LYONS,+               (OXF)

HANDLER  76 NP B 110 173       +PLAND,BRUCKER,KOLLER+         (RUTG+STEV+SETO)
VUILLEMI 76 NC 33A 133         VUILLEMIN+          (LAUS+NEUC+LPNP+LIVP+GLAS)

GRASSLER 77 NP B 121 189       +(AACHEN+BERLIN+BONN+CERN+CRACOW+HEID+WARS)

CORDEN   78 NP B 144 253       +CORBETT,ALEXANDER,+  (BIRM+RHEL+TELA+LOWC)  JP
IRVING   78 NP B 139 327       A.C.IRVING,H.R.SEPANGI                 (LIVP)
NACASCH  78 NP B 135 203       +DEFOIX,DOBRZYNSKI,+     (PARIS+MADRID+CERN)

GURTU    79 NP B 151 181       +GAVILLET,BLOKZIJL,+    (CERN+ZEEM+NIJM+OXF)
STANTON  79 PRL 42 346         +BROCKMAN,DANKOWYCH,+  (OSU+CARL+MCGI+TNTO)  JP

BROMBERG 80 PR D 22 1513       +HAGGERTY,ABRAMS,DZIERBA(CIT+FNAL+ILLC+IND)
DE BILLY 80 NP B 176 1         +BRIAND,DUBOC,LEVY+  (CURI+LAUS+NEUC+GLAS)  JP
DIONISI  80 NP B 169 1         +GAVILLET,ARMENTEROS+ (CERN+MADR+CDEF+STOH)

EVANGELI 81 NP B 178 197       EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
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$\epsilon(1300)$

14 EPSILON(1300,JPG=0++) I=0

S-Wave $\pi\pi$ and $K\bar{K}$ Interactions

In this note we discuss information on the non-strange $I^G J^{PC} = 0^+0^{++}$ partial wave (S wave) coupled to the $\pi\pi$ and $K\bar{K}$ systems.

Near the $\pi\pi$ threshold the S wave shows no resonant behavior. For a discussion of the relevant scattering lengths and various resonance-like kinematic effects, see our 1978 edition.

Up to the ρ meson mass region, the phase shift δ_0^0 is (qualitatively) uniquely determined: it rises monotonically and reaches 60° to 70° near 700 MeV (SONDEREGGER 69, BATON 70, BAILLON 72, CARROL 72, FRENKIEL 72, GAIDOS 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73, ENGLER 74, ESTABROOKS 74,75. GRAYER 74).

In the early phase-shift analyses two solutions for δ_0^0 were found (the "up-down ambiguity") in the 700 to 900 MeV region. The "up" solution corresponds to an ϵ resonance under the ρ meson with mass and width similar to the ρ meson, the $\epsilon(800)$. The "down" solution is characterized by an approximately energy-independent phase shift of almost 90°, showing no resonant behavior. This ambiguity was considered resolved in favor of the "down" solution by the observation of a very rapid decrease in the modulus of the S-wave amplitude between 900 MeV and the $K\bar{K}$ threshold, followed by a sharp drop in the elasticity. δ_0^0 is $\sim 90^\circ$ at about 900 MeV and reaches $\sim 180^\circ$ around 990 MeV (FLATTE 72, GAIDOS 72, HYAMS 73, BINNIE 73, ENGLER 74). However, the region is complicated by the simultaneous presence of the S^* resonance and the opening of the $K\bar{K}$ channel, permitting almost discontinuous jumps from one solution to another.

Without polarization information, the reaction $\pi N \to \pi\pi N$ cannot be analyzed unambiguously due to the fact that there are more helicity amplitudes than observables (see, e.g., DONOHUE 75). Thus one is obliged to make some supplementary assumptions.

An amplitude analysis (ESTABROOKS 74) of the largest $\pi^- p$ (unpolarized) $\to \pi^+\pi^- n$ experiment (HYAMS 73, GRAYER 74) still finds both the "up" and "down" solutions. This analysis assumes both spin coherence (the unnatural-parity-exchange, s-channel helicity amplitudes are nucleon spin-flip, i.e., no A_1-like exchange) and phase coherence (the S-wave amplitude and the unnatural-parity-exchange, meson helicity-zero P-wave amplitude have the same phase). These assumptions may tend to bias the results (MORGAN 74, DONOHUE 75,79).

The advent of $\pi^- p$ (polarized) $\to \pi^+\pi^- n$ data (BECKER 79) has made both the spin coherence and phase coherence assumptions unnecessary. Analyzing their data in a model-independent way, BECKER2 79 also find both the "up" and the "down" solutions.

The reaction $\pi^+ p \to \pi^+\pi^-\Delta^{++}$ has been analyzed in the region 660 to 860 MeV (OWENS 76, DONOHUE 79) and in the region 600 to 920 MeV (GELFAND 78), using all the information carried by the Δ^{++} decay. The conclusion from both analyses is that the $\epsilon(800)$ of the "up" solution cannot be ruled out.

The only way to rule out a narrow ϵ under the ρ meson (the "up" solution) is to study the $\pi^0\pi^0$ system. With the exception of one experiment (BISWAS 81), all the $\pi^0\pi^0$ experiments agree that no such narrow resonance is present and that the "down" solution describes the data well (DEINET 69, SONDEREGGER 69, SHIBATA 70, BENSINGER 71, APEL 72,79, BRAUN 73, SKUJA 73, RIESTER 75, GRIVAZ 76, DAVID 77, BORREANI 79,81). The phase shifts of BISWAS 81 lie much lower than all others in the 300-700 MeV region, thus requiring a sudden phase motion in the ρ region to match the "down" solution above the ρ.

The region of elastic $\pi\pi$ scattering is known to extend to about 990 MeV, near the $K\bar{K}$ threshold (BATON 70, CARROLL 72, PROTOPOPESCU 73, HYAMS 73, OCHS 73). Beyond 1 GeV we therefore have to consider the two channels $\pi\pi$ and $K\bar{K}$, and beyond 1100 MeV the $\eta\eta$ channel also opens up. In addition, the solutions have inherent ambiguities related to the Barrelet zeros of the amplitudes. Thus HYAMS 75 find four solutions in the region 1.0 to 1.8 GeV, ESTABROOKS 74 find eight solutions, and CORDEN 79, extending the $\pi\pi$ analysis to 2.08 GeV, find another eight solutions.

In the past many of these solutions have been ruled out by imposing continuity in various ways, as well as analyticity and unitarity (FROGGATT 75,77, COMMON 76, MARTIN 78).

Unfortunately, the polarization information (BECKER 79) has not yet been fully analyzed. One notes that a model-independent partial-wave analysis (BECKER2 79) agrees qualitatively with solutions β and β' (of MARTIN 78).

The β and β' amplitudes describe the experimental moments in each bin without any explicit smoothing; they are analytic in s and approximately analytic in cosθ. They take into account all waves up to $\ell = 4$. The β solution has a highly elastic S wave, whereas the S wave of solution β' is somewhat inelastic (MARTIN 78). The unique solution of FROGGATT 77, which has explicit smoothness built in and which takes account only of $\ell \leq 3$ waves, is rather similar to β. However, it has problems with unitarity, apparently because of the neglected G wave (MARTIN 78).

The S wave is clearly resonant in the data of BECKER2 79. In the 1150 to 1400 MeV region both the S-P and S-D phase differences show the presence of a broad resonance, and the intensity of the S wave confirms this by exhibiting a peak at about 1300 MeV with a width of about 300 MeV; see Fig. 1(a).

The amplitude analysis of the $\pi^-p \to \pi^+\pi^-n$ experiment of CORDEN 79 has two preferred solutions which are close to β and β', giving some support for an ε(1300). Also the S wave in the $\pi^0\pi^0$ system tends to confirm the ε(1300) by staying near its unitarity limit around 1200 MeV (APEL 79).

Independent evidence for the ε(1300) comes from studies of the $K\bar{K}$ systems. In the reaction $\pi^-p \to K^0_SK^0_Sn$, the S wave exhibits a large intensity in the 1300 MeV region (WETZEL 76, LOVERRE 80), with some evidence for a bump. Moreover, the Y^2_0 moment shows a large negative excursion indicating S-D interference (CASON 76, WETZEL 76, POLYCHRONAKOS 79, GOTTESMAN 80, LOVERRE 80). The main problem is the isospin of the bump: if OPE were the only mechanism, I=0 would be assured. However, an I=1 non-OPE contribution in the same region cannot be excluded. Moreover, the I=1 K^-K^0 system does show some peaking (MARTIN 79), so one will possibly have to disentangle two resonances in the $K^0_SK^0_S$ bump.

In agreement with this, the K^+K^- system produced in π^-p, π^+n, and π^-p (polarized) scattering clearly shows the S wave peaking at 1300 MeV [see Fig. 1(b), (c)]; again, both I=0 and I=1 may be present (PAWLICKI 77, MARTIN 79, COHEN 80, COSTA 80, GORLICH 80, WICKLUND 80).

To get from phase shifts to resonance parameters and $q\bar{q}$-composition one has to make coupled-channel analyses. It has become evident that it is not enough to consider the channels ππ and $K\bar{K}$ only; ηη must also be included. Two such fully unitarized analyses (ACHASOV 79,80,81, TORNQVIST 82) finally appear to bring order to the scalar SU(3) nonet. TORNQVIST 82 is more general in considering simultaneously all the pseudoscalar-pseudoscalar meson pairs coupling to the full scalar multiplet, but confirms well the earlier results of ACHASOV 79,80.

The picture emerging (TORNQVIST 82) is that of a dominantly $q\bar{q}$-system with large $q\bar{q}q\bar{q}$ components in the form of virtual two-meson bound

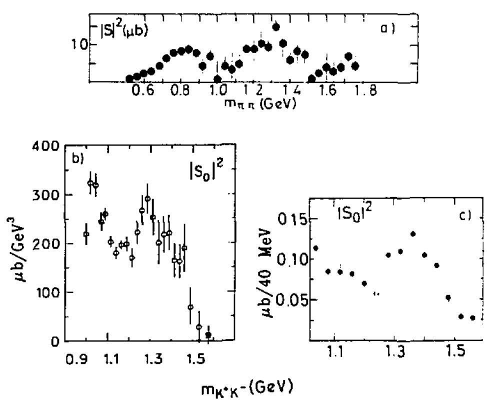

Fig. 1. (a) The absolute intensity (in μb) of the $\pi^+\pi^-$ S wave in 40 MeV bins (without dividing by the bin size), as given by the "down" solution of BECKER2 79. (b) Absolute intensity (in μb/GeV^3) of the K^+K^- S wave, as given by the favored solution of COHEN 80, for $|t| < 0.08$ GeV^2. (c) The absolute intensity (in μb/40 MeV bin) of the K^+K^- S wave, as given by the favored solution of GORLICH 80.

states. At the SU(3) level, two isoscalar resonances are needed, a narrow S^* superimposed on a broad ε. The position and width of the S^* are well determined by its interference with the ε, visible as a dip in the $\pi\pi \to \pi\pi$ cross section. The S^* appears particularly clearly as a $\pi^+\pi^-$ peak in J/ψ decay (GIDAL 81) and as a 2-prong peak in γγ interactions (BRANDELIK 81).

The mass and width of the ε, however, are difficult to define in any simple way, its Breit-Wigner shape being completely distorted by hadronic mass renormalization effects (cusps) from the ππ, $K\bar{K}$, and ηη channels (MORGAN 74, ACHASOV 79,80,81, IRVING 81, TORNQVIST 82).

The long-standing contradiction between the small coupling of the S^* to ππ - evidence for a pure $s\bar{s}$ system - and the Gell-Mann-Okubo mass formula prediction of the S^* being an SU(3) singlet, is also now resolved. The mixing angle turns out to be a very strong function of energy, nearly ideal below the $K\bar{K}$ threshold, but rapidly approaching the configuration S^*-octet/ε-singlet at about 1400 MeV (TORNQVIST 82). This also lends support to the simpler analyses which find an average $K\bar{K}$ branching ratio in the 1300-1400 MeV region of the order of 10% (MARTIN 78, ESTABROOKS 79, GREENHUT 79, COSTA 80, GORLICH 80, LOVERRE 80).

For further discussion of the scalar nonet, see the mini-reviews under δ(980) and κ(1350) and Appendix IIC.

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                   14  EPSILON MASS (MEV)

M          (1256.0)                     FROGGATT  77 RVUE   PI+PI- CHANNEL     12/77
M          (1270.)  APPROX.             MARTIN    78 RVUE   PI+PI- CHANNEL     12/77
M          (1300.)  APPROX.             POLYCHRON 79 STRC   7. PI-P,KS KS N    12/79
M           1425.      15.              WICKLUND  80 SPEC   6. PI N,K+ K- N     9/81*
M          (1394.)                      IRVING    81 RVUE   PI+PI-,K KBAR CH    3/82*
M          (1390.)   APPROX.            TORNQVIS  82 RVUE                       1/82*

                   14  EPSILON WIDTH (MEV)

W   E       (400.)  APPROX.             FROGGATT  77 RVUE   PI+PI- CHANNEL     12/77
W           (150.)  APPROX.             POLYCHRON 79 STRC   7. PI-P,KS KS N    12/79
W            160.      30.              WICKLUND  80 SPEC   6. PI N,K+ K- N     9/81*
W P         (220.)                      IRVING    81 RVUE   PI+PI-,K KBAR CH    3/82*
W          (1400.)   APPROX.            TORNQVIS  82 RVUE                       1/82*

W   E  WIDTH DEFINED AS DISTANCE BETWEEN 45 AND 135 DEGREES PHASE SHIFT.       12/77
W P     FROM POLE POSITION

                   14  EPSILON PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      EPSILON INTO PI PI                               139+ 139
P2      EPSILON INTO K KBAR                              497+ 497
P3      EPSILON INTO ETA ETA                             548+ 548

                   14  EPSILON BRANCHING RATIOS

R1      EPSILON INTO (PI PI)/TOTAL                                    (P1)
R1            (0.73)                      HYAMS     75 ASPK   17.2 PI-P,PI+PI-   9/81*
R1             0.936     0.019     0.015 GORLICH   80 ASPK   17.18 PI-P POLAR   9/81*
R1            (0.93)                      LOVERRE   80 HBC    4. PI- P,K K N     9/81*
R1            (0.93) APPROX.              TORNQVIS  82 RVUE                      1/82*

R2      EPSILON INTO (K KBAR)/(PI PI )                                (P2)/(P1)
R2             0.08      0.01             COSTA     80 OMEG  0 10 PI-P,K+ K- N   1/82*

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REFERENCES FOR EPSILON


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SAMIOS   62 PRL 9 139              +BACHMAN,LEA+              (BNL+CUNY+COLU+KNTY)

BLOKHINT 63 JETP 17 80             BLOKHINTSEVA,GREIBINNIK,ZHUKCV +     (DUBNA)
BOOTH    63 PR 132 2314            + ADASHIAN                             (LRL)
KIRZ     63 PR 130 2481            +SCHWARTZ + TRIPP                      (LRL)

BARISH   64 PR 135 B 416           BARISH,KURZ,PEREZ-MENDEZ,SOLCMON       (LRL)
CRAWFORD 64 PRL 13 421             +GROSSMAN,LLOYD,PRICE,FCWLER           (LRL)
DEL FABR 64 PRL 12 674             DEL FABRO,DE PRETIS,JONES+       (FRASCATI)
KALMUS   64 PRL 13  99             +KERNAN,PU,POWELL,DOWD      (LRL+WISCONSIN)

BATON    65 NC 36 1149             J.P.BATON, J.REGNIER                (SACLAY)
BIRGE    65 PR 139 B 1600          +ELY+GIDAL+KALMUS+CAMERINI+       (LRL+WISC)
BROWN    65 CORAL GABLES 219       BROWN+FAIER                   (NORTHWESTERN)
DURAND   65 PRL 14 329             L. DURAND AND Y.T. CHIU               (YALE)

BETTINI  66 NC 42A 695             +CRESTI,LIMENTANI,LORIA,PERUZZO+(PADO+PISA)
JACOBS   66 PRL 16 669             +SELOVE                                (LRL)
KOPELMAN 66 PL  22  118            +ALLEN,GOODEN,MARSHALL +     (COLORADO+IOWA)
LOVELACE 66 PL  22  232            LOVELACE,HEINZ,DONNACHIE              (CERN)

ANDERSON 67 PRL 18 89              +FUKUI+KESSLER+ (CHIC+ANL+CNRC+MCGILL+LOQM)
BEUSCH   67 PL 25 B 357            +FISCHER,GOBBI,ASTBURY+          (ETH+CERN)
CLEGG    67 PR 163 1664            A.B.CLEGG                        (LANCASTER)
CORBETT  67 PR 156 1451            +DAMERELL+MIDDLEMAS+NEWTON       (OXF+RHEL)
GUTAY    67 PRL 18 142             +JOHNSON+LOEFFLER+MCILWAIN+     (PURDUE+LRL)
JOHNSON  67 PR 163 1497            +GUTAY,EISNER,KLEIN,PETERS,SAHNI,YEN+(PURD)
MALAMUD  67 PRL 19 1056            E.MALAMUD + P.E.SCHLEIN               (UCLA)
WALKER   67 RMP 39 695             W.D.WALKER                       (WISCONSIN)
WALKER   67 PRL 18 630             +CARROLL,GARFINKEL,OH            (WISCONSIN)

BANDER   68 PR 168 1679            +SHAW,FULCO           (UC IRVINE+S.BARBARA)
BISWAS   68 PL 27 B 513            +CASON,JOHNSON,KENNEY,POIRIER+        (NDAM)
BRAUN    68 PRL 21 1275            BRAUN,CLINE,SCHERER              (WISCONSIN)
DUTTA-RO 68 PR 169 1357            B. DUTTA-ROY, I.R. LAPIDUS            (STEV)
EISENHAN 68 PRL 20 758             EISENHANDLER,MISTRY,MOSTEK +       (CORNELL)
FOSTER   68 NP B 6 107             +GAVILLET+LABROSSE+MONTANET+     (CERN+CDEF)
HYAMS    68 NP 87 1                +KOCH,POTTER,..VON LINDERN,LORENICERN+MPIM)
JONES    68 PR 166 1405            +CALDWELL+ZACHAROV+MARTING+BLEULER+   (CERN)
JOHNSON  68 PR 176 1651            +POIRIER,BISWAS,GUTAY+      (NDAM+PURD+SLAC)
LOVELACE 68 PL 26 B 264            C.LOVELACE                            (CERN)
MARATECK 68 PRL 21 1613            +HAGOPIAN,+  (PENN+LRL+COLO+PURD+TNTO+WISC)

BIZZARRI 69 NP B14 169(SEE P.190)+FOSTER,GAVILLET,GHESQUIERE+ (CERN+CDEF)
DAVISON  69 PR 180 1333            +BACASTOW,BARKAS,+                 (UCR+UCB)
DEINET   69 PL 30 B 359            +MENZIONE,MULLER,STAUDENMAIER,+ (KARL+CERN)
ELY      69 PR 180 1319            +GIDAL,HAGOPIAN,+            (UCB+LOUC+WISC)
FELDMAN  69 PRL 22 316             +FRATI,GLEESON,HALPERN,NUSSBAUM,+     (PENN)
GUTAY    69 NP B 12 31             +CARMONY,CSONKA,LOEFFLER,MEIERE     (PURDUE)
HALL     69 NP B 12 573            +MURRAY,RIDDIFORD                (BIRMINGHAM)
HOPKINSO 69 NC 59 A 181            J.HOPKINSON,R.G.ROBERTS               (CERN)
MALAMUD  69 ARGONNE CONF.P.93 E.MALAMUD, P.SCHLEIN                       (UCLA)
MORGAN   69 NP B 10 261            D.MORGAN,G.SHAW                       (RHEL)
ROBERTS  69 PL 29 B 368            R.G. ROBERTS, F. WAGNER               (CERN)
SCHAREN1 69 ARGONNE CONF.306       SCHARENGUIVEL                       (PURDUE)
SCHAREN2 69 PR 186 1287            SCHARENGUIVEL(PURD+LRL+CERN+COLO+PENN+TNTO)
SMITH    69 PRL 23 335             G.A.SMITH, R.J.MANNING             (MSU+LRL)
SONDEREG 69  SEE BASDEVANT 72 SONDEREGGER,BONAMY                         (SACL)
STRUGALS 69 PL 29 B 518            +CHUVILO,FENYVES,+          (WARS+JINR+BUDA)
    ALSO 70 NP B 24 358            STRUGALSKI,CHUVILO,FENYVES,GEMESY,+ (DUBNA)
WAGNER   69 NC 64 A 189            F.WAGNER                              (CERN)

BARTSCH  70 NP B 22 1              +KEPPEL,GENSCH,MORRISON,+  (AACH+BERL+CERN)
BATON    70 PL 33 B 528            +LAURENS,REIGNIER                   (SACLAY)
BRODY    70 PRL 24 948             +GROVES,VANBERG,MAGLIC+(PENN+RUTG+UPNJ+ANL)
DIAZ     70 NP B 16 239            +GAVILLET,LABROSSE,MONTANET+     (CERN+COFF)
HYAMS    70 PHILAD.CONF.P.41  +SCHLEIN,BEUSCH,+ (CERN+MPIM+ETH+LOIC+HAWA)
MAUNG    70 PL 33 B 521            +MASEK,MILLER,RUDERMAN,VERNON,+  (UCSD+LRL)
MORGAN 1 70 SPRINGER TRACTS MOD.PHYS.,VOL.55,P.1. MORGAN,PISUT(RHEL+CERN)
MORGAN 2 70 PR D 2 520             D.MORGAN,G.SHAW                       (RHEL)
NIELSEN  70 NP B 22 525            +LYNG-PETERSEN,PIETARINEN          (NORDITA)
OH       70 PR D 1 2494            +GARFINKEL,MORSE,WALKER,PRENTICE(WISC+TNTO)
SCHARENG 70 NP B 22 16             SCHARENGUIVEL,GUTAY,MILLER,+     (PURD+PENN)
SHIBATA  70 PRL 25 1227            +FRISCH,WAHLIG                         (MIT)

ALSTON-G 71 PL 36 B 152            ALSTON-GARNJOST,BARBARO-GALTIERI,+     (LBL)
BANAIGS  71 NP B 28 509            +BERGER,DUFLO,GOLDZAHL,COTTEREA+(SACL+CAEN)
BEAUPRE  71 NP B 28 77             +DEUTSCHMANN,GRAESSLER,+   (AACH+BERL+CERN)
BENSINGE 71 PL 36 B 134            BENSINGER,ERWIN,THOMPSON,W.D.WALKER  (WISC)
DUBAL    71 NP B 32 535            L.DUBAL,D.J.BROWN                (CNRC+CARL)
GUILLOU  71 NC 5 A 659             LE GUILLOU,MOREL,NAVELET              (CERN)
GUTAY    71 NP B 27 486            +SCHARENGUIVEL,FUCHS,GAIDOS,MILLER,+ (PURD)
HAMILTON 71 SPRINGER TRACTS MOD.PHYS.,VOL. 57,P.41 J.HAMILTON      (NORDITA)
KIM      71 PR D 4 265             +BANDER                                (UCI)
LYNG PET 71 PHYS.REPRTS 2 155 J.LYNG PETERSEN (REVIEW)                   (CERN)

APEL     72 PL 41 B 542            +AUSLANDER,MULLER,BERTOLUCCI,+   (KARL+PISA)
BAILLON  72 PL 38 B 555            +CARNEGIE,KLUGE,LEITH,LYNCH,RATCLIFF+(SLAC)
BASDEVAN 72 PL 41 B 178            BASDEVANT,FROGGATT,PETERSEN           (CERN)
BRODY 1  72 PRL 28 1215            +GROVES,MAGLICH,NOREN,+    (PENN+RUTG+UPNJ)
BRODY 2  72 PRL 28 1217            H.BRODY                       (PENNSYLVANIA)
CARROLL  72 PRL 28 318             +DIAMOND,FIREBAUGH,MATTHEWS,+    (WISC+TNTO)
ELVEKJAE 72 NP B 43 445            F.ELVEKJAER                         (AARHUS)
FLATTE   72 PL 38 B 232            +ALSTON-GARNJOST,BARBARO-GALTIERI,     (LBL)
FRENKIEL 72 NP B 47 61             +GHESQUIERE,LILLESTOL,CHUNG,+    (CDEF+CERN)
GAIDOS   72 NP B 46 449            +MCILWAIN,THOMPSON,WILLMANN         (PURDUE)
PRASAD   72 PR D 6 3216            +BREHM           (UNIV.OF MASSACHUSETTS)
NIELSEN  72 NP B 49 586            H.NIELSEN,G.OADES               (NORD+AARHUS)
WHITEHEA 72 NP B 48 365            WHITEHEAD,AULD,+         (AERE+RHEL+SHMP+LOUC)
WILLIAMS 72 PR D 6 3178            P.K.WILLIAMS                           (FSU)
ZYLBERSZ 72 PL 38 B 457            ZYLBERSZTEJN,BASILE,BOURQUIN,+   (GEVA+SACL)

ANJOS    73 NP B 67 37             +D.LEVY,A.SANTORO                   (SACLAY)
BANAIGS1 73 PL 43 B 535            +COTTEREAU,FABBRI,+         (SACL+CAEN+FRAS)
BANAIGS2 73 NP B 67 1              +BERGER,GOLDZAHL,COTTEREAU,+     (SACL+CAEN)
BASDEVAN 73 AIX CONF.P.220         J.L.BASDEVANT RAPPORTEUR TALK    (PARIS VI)
BEIER    73 PRL 30 399             +BUCHHOLZ,MANN,PARKER,ROBERTS         (PENN)
BINNIE   73 PRL 31 1534            +CARR,DEBENHAM,DUANE,GARBUTT,+   (LOIC+SHMP)
BRAUN    73 PR D 8 3794            +D.CLINE                              (WISC)
HYAMS    73 NP B 64 134            +JONES,WEILHAMMER,BLUM,DIETL,+   (CERN+MPIM)
    FOR OTHER RESULTS ON SAME EXPERIMENT SEE GRAYER 74
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OCHS      73 THESIS              THESIS                                  (MPIM)
PILKUHN   73 NP B 65 460         +SCHMIDT,MARTIN,+        (KARL+CERN+LOUC+NIJM)
PROTOPOP  73 PR D 7 1280         PROTOPOPESCU,GARNJOST,GALTIERI,FLATTE+(LBL)
RISSER    73 PL 43 B 68          T.RISSER,M.O.SHUSTER                    (SACL)
SKUJA     73 PRL 31 653          +WAHLIG,RISSER,PRIPSTEIN,NELSON,+        (LBL)

BASDEVAN  74 NP B 72 413         BASDEVANT,FROGGATT,PETERSEN        (LPTP+NORD)
BONNIER   74 NP B 83 440         B.BONNIER,N.JOHANNESSON                 (CERN)
CARROLL   74 PR D 10 1430        +MATTHEWS,WALKER+        (SLAC+DUKE+WISC+TNTO)
ENGLER    74 PR D 10 2070        +KRAEMER,TOAFF,WEISSER,DIAZ+       (CARN+CASE)
ESTABROO  74 NP B 79 301         P.ESTABROOKS,A.D.MARTIN                 (DURH)
GRAYER    74 NP B 76 375         +HYAMS,JONES,BLUM,DIETL            (CERN+MPIM)
JONES     74 NP B 83 93          +ALLISON,SAXON                           (OXF)
MORGAN    74 PL 51 B 71          D.MORGAN                                (RHEL)
ORITO     74 PL 48 B 380         +FERRER,PAOLUZI,SANTONICO          (FRAS+ROMA)
PASCUAL   74 NP B 83 362         P.PASCUAL,F.J.YNDURAIN             (BARC+MADU)

BAR-NIR   75 NP B 87 109         +RISSER,SHUSTER               (CERN+UCSB+TELA)
BARRY     75 NP B 85 239         G.W.BARRY                               (PURD)
BASDEVAN  75 NP B 98 285         BASDEVANT,CHAPELLE,LOPEZ,SIGELLE        (LPTP)
DONOHUE   75 NC 25 A 409         J.T.DONOHUE,Y.LEROYER                   (BORD)
ESTABROO  75 NP B 95 322         P.ESTABROOKS,A.D.MARTIN                 (DURH)
FROGGATT  75 NP B 91 454         C.D.FROGGATT,J.L.PETERSEN          (GLAS+NORD)
FUJII     75 NP B 85 179         Y.FUJII,M.FUKUGITA                      (TOKY)
HYAMS     75 NP B 100 205        +JONES,WEILHAMMER,BLUM,DIETL+      (CERN+MPIM)
MORGAN    75 ARGONNE CONF. 45    D.MORGAN                                (RHEL)
RIESTER   75 NP B 96 407         +ARNOLD,ENGEL,PATY                      (STRB)
SHIMADA   75 NP B 100 225        T.SHIMADA                               (TOKY)
SRINIVAS  75 PR D 12 681         SRINIVASAN,HELLAND,LENNOX,KLEM+    (NDAM+ANL)

BANAIGS   76 NP B 105 52         +BERGER,GOLDZAHL,COTTEREAU+(SACL+CAEN+FRAS)I,JP
CASON     76 PRL 36 1485         +POLYCHRONAKOS,BISHOP,BISWAS,+    (NDAM+ANL)I J
CERRADA   76 PL 62 B 353         +GONZALEZ-ARROYO,RUBIO,YNDURAIN (CERN+MADR)
COMMON    76 NP B 103 109        A.K.COMMON                              (KENT)  JP
FLATTE    76 PL 63 B 228         S.M.FLATTE                              (CERN)
GRIVAZ    76 PL 61 B 400         +DAVIS,HALSTEINSLID,IRWIN,+(LALO+BERG+EPOL)
OWENS     76 NP B 112 514        +EISNER,CHUNG,PROTOPOPESCU         (CASE+BNL)
PAWLICKI  76 PRL 37 1666         +AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND  (ANL)I,JP
WETZEL    76 NP B 115 208        +FREUDENREICH,BEUSCH,+        (ETH+CERN+LOIC)

FROGGATT  77 NP B 129 89         +PETERSEN                  (GLASGOW+COPENHAGEN)
DAVID     77 PR D 16 2027        +VILLET,AYED,BAREYRE,BORGEAUD,+         (SACL)
MARTIN    77 NP B 121 514        +OZMUTLU,SQUIRES                      (DURHAM)
PAWLICKI  77 PR D 15 3196        +AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND  (ANL)I J
ROSSELET  77 PR D 15 574         +EXTERMANN,FISHER,BERGER,BLOCH,+(GEVA+SACL)

AGUILAR   78 NP B 140 73         +CERRADA,+           (MADRID+BOMBAY+CERN+PARIS)
GELFAND   78 NP B 138 365        +DAGAN,LISSAUER,OREN,ABRAMS+       (TELA+UCB)
HOLMGREN  78 PL 77 B 304         +PENNINGTON                        (STOH+CERN)
MARTIN    78 ANP  114 1          A.D.MARTIN,M.R.PENNINGTON               (CERN)

ACHASOV   79 PL B 88 367         +DEVYANIN,SHESTAKOV                     (NOVO)
APEL      79 NP B 160 42         +AUSLANDER,MULLER,REHAK+           (KARL+PISA)
BECKER 1  79 NP B 150 301        +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
BECKER 2  79 NP B 151  46        +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
BORREANI  79 NP B 147 28         +FISHER,GUY,ELY,LEUTZ,+(TORI+RHEL+LBL+CERN)
CORDEN    79 NP B 157 250        +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TELA+LOWC)  JP
DONOHUE   79 NP B 159 123        +LEROYER                      (BORD+ANL+OXF)
ESTABROO  79 PR D 19 2678        P.ESTABROOKS                            (CARL)
GREENHUT  79 PR D 20 2326        +INTEMANN                               (SETO)
MARTIN    79 NP B 158 520        +OZMUTLU                              (DURH)I,JP
POLYCHRO  79 PR D 19 1317        POLYCHRONAKOS,CASON,BISHOP+       (NDAM+ANL)I,JP

ACHASOV   80 SJNP 32 566         +DEVYANIN,SHESTAKOV                     (NOVO)
BOHACIK   80 PR D 21 1342        J.BOHACIK,H.KUHNELT              (BRATISLAVA+WIEN)
COHEN     80 PR D 22 2595        +AYRES,DIEBOLD,KRAMER,PAWLICKI+       (ANL)I,JP
COSTA     80 NP B 175 402        +      (BARI+BONN+CERN+GLAS+LIVP+MILA+WIEN)
DE BILLY  80 NP B 176 1          +BRIAND,DUBOC,LEVY+    (CURI+LAUS+NEUC+GLAS)  JP
GORLICH   80 NP B 174 16         +NICZYPORUK,ROZANSKA+ (CRAC+MPIM+CERN+ZEEM)
GOTTESMA  80 PR D 22 1503        GOTTESMAN,JACOBS,+       (SYRA+BRAN+BNL+CINC)
LOVERRE   80 ZPHY C 6 187        +ARMENTEROS,DIONISI+  (CERN+CDEF+MADR+STOH)I,JP
WICKLUND  80 PRL 45 1469         +AYRES,COHEN,DIEBOLD,PAWLICKI            (ANL)

ACHASOV   81 PL 102 B 196        +DEVYAHIN,SHESTAKOV                     (NOVO)
AGUILAR   81 ZPHY C 10 299       AGUILAR-BENITEZ,DONE,MARTIN        (MADR+DURH)
AGUILAR2  81 ZPHY C 8 313        +ALBAJAR,ARMENTEROS,+ (CERN+CDEF+MADR+STOH)
BOREANI   81 NP B 187 42         +GUY,MARCHETTO,MAURIZIO,+  (TORI+RHEL+CERN)
BISWAS    81 PRL 47 1378         +CASON,BAUMBAUGH,BISHOP,CANNATA,+(NDAM+ANL)
BRANDELI  81 ZPHY C 10 117       BRANDELIK+  (AACH+BONN+DESY+HAMB+LOIC+OXF+)
GIDAL     81 PL 107 B 153        +GOLDHABER,GUY,MILLIKAN,ABRAMS,+ (SLAC+LBL)
IRVING    81 ZPHY C 10 45        +MARTIN,DONE                       (LIVP+DURH)

TORNQVIS  82  HU-TFT-82-1        N.A.TORNQVIST                           (HELS)
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π(1300)

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58  PI(1300,JPG=0--) I=1

    SEEN IN PARTIAL WAVE ANALYSIS OF THE
    DIFFRACTIVELY PRODUCED 3 PI SYSTEM.

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                 58  PI(1300) MASS (MEV)

M   E     1273.0    50.0          AARON     81 RVUE                 1/82*
M  P      1209.     30.           BELLINI2  81 SPEC   40 PI-A,3PI A  1/82*
M  P      1342.     20.           BONESINI  81 OMEG   12 PI-P,3PI P  1/82*
M        (1400.)   APPROX.        DAUM      81 SPEC   63.94 PI- P    1/82*
M         . . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

M   E  USES MULTICHANNEL AITCHISON-BOWLER MODEL.
M   E  USES DATA FROM DAUM 80 AND DANKOWYCH 81.
M  P   FROM A FIT TO JP=0- EPSILON PI PARTIAL WAVE.

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                 58  PI(1300) WIDTH (MEV)

M   E      580.0   100.0          AARON     81 RVUE                 1/82*
M  P       330.     40.           BELLINI2  81 SPEC   40 PI-A,3PI A  1/82*
M  P       220.     70.           BONESINI  81 OMEG   12 PI-P,3PI P  1/82*
M         (600.)   APPROX.        DAUM      81 SPEC   63.94 PI- P    1/82*
M         . . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 2.1)

M   E  USES MULTICHANNEL AITCHISON-BOWLER MODEL.
M   E  USES DATA FROM DAUM 80 AND DANKOWYCH 81.
M  P   FROM A FIT TO JP=0- EPSILON PI PARTIAL WAVE.

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                 58  PI(1300) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1    PI(1300) INTO RHO PI                                769+ 139
P2    PI(1300) INTO EPSILON PI                            1300+ 139
P3    PI(1300) INTO PI (PI PI) S WAVE                     139+ 139+ 139

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                 58  PI(1300) BRANCHING RATIOS

R1    PI(1300) INTO (PI (PI PI) S WAVE/(RHO PI)          (P3)/(P1)
R1 E     (2.12)                        AARON       81 RVUE              3/82*
R1 E  USES MULTICHANNEL AITCHISON-BOWLER MODEL.
R1 E  USES DATA FROM DAUM 80 AND DANKOWYCH 81.

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                 REFERENCES FOR PI(1300)

DAUM      80 PL 80 B 281         +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)

AARON     81 PR D 24 1207        +LONGACRE                      (NEAS+BNL)
BELLINI1  81 LISBON CONF.        +IVANSHIN,FRABETTI,+      (MILA+JINR+BGNA)
BELLINI2  81 CERN-EP/81-98       +IVANSHIN,FRABETTI,+      (MILA+JINR+BGNA)
BONESINI  81 PL 103 B 75         +DONALD,+    (MILA+LIVP+DARE+CERN+BARI+BONN)
DANKOWYC  81 PRL 46 580          +BROCKMAN,EDWARDS+(TNTO+BNL+CARL+MCGI+OHIO)
DAUM      81 NP B 182 269        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
EVANGELI  81 NP B 178 197        EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
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A_2(1320)

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12  A2(1320,JPG=2+-) I=1

    ONLY EXPERIMENTS GIVING MASS ERROR LESS THAN 15 MEV
    ARE KEPT FOR AVERAGING.

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                 12  A2 MASS (MEV),  3PI MODE

M        260  1311.0      6.0      ARMENISE   68 DBC    0 5.1 PI+D         9/67
M        120  1320.      10.       BOESEBECK  68 HBC    0 8 PI+ P          6/68
M             1310.0     14.0      EISENBERG  69 HBC  + 4.3,5.3 GAMMA P   12/69
M        941  1306.0      4.0      ALSTON     70 HBC  + 7.0 PI+P,3PI P     1/71
M        280  1313.0      7.0      BOCKMANN   70 HBC    05. PI+P           5/70
M        360  1304.0      4.5      BARNHAM    71 HBC  + 3.7 PI+ P,(3PI)+  11/71
M      10000  1307.       5.       BINNIE1    71 MMS  - PI-P NEAR A2 THR  11/71
M       5000  1309.       5.       BINNIE1    71 MMS  - PI-P NEAR A2 THR  11/71
M      28000  1299.0      6.0      BOWEN      71 MMS  - 5. PI- P          11/71
M      24000  1300.       6.0      BOWEN      71 MMS  + 5. PI+ P          11/71
M      17000  1309.0      4.0      BOWEN      71 MMS  - 7. PI- P          11/71
M        160  1307.       7.       BLOODWORT  72 HBC  + 5.45 PI+ P,P 3PI   1/73
M  P          1315.       5.       ANTIPOV1   73 CNTR - 25.,40. PI- P      1/74
M       1580  1306.       9.       CHALOUPKA  73 HBC  - 3.9 PI- P,P A2     2/73
M  P    1600  1318.       7.       EMMS       75 DBC    04.  PI+N,P A20   11/75
M  P    1200  1298.       8.       WAGNER     75 HBC    07.  PI+P,DEL++A2 11/75
M       1097  1320.0     10.0      BALTAY 1   78 HBC  +0 15 PI+P,P 4PI     4/78
M  P    490 (1343.0)    (11.0)     BALTAY 1   78 HBC    0 15 PI+P,DEL 3PI  4/78
M             1285.0      9.0      CORDEN 2   78 OMEG  - 12-15 PI-P,3PI N  4/78
M             1306.0      8.0      FERRER     78 OMEG  - 9 PI-P,P 3PI      4/78
M  P   25000  1317.0      2.0      DAUM       80 SPEC  - 63.94 PI- P= 3PI 12/79
M  P          1310.       2.       EVANGELIS  81 OMEG  - 12 PI-P,3PI P     1/82*
M             . . . . . . . . . .
M     AVG     1310.4      1.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                                   (SEE IDEOGRAM BELOW )

M  P   FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
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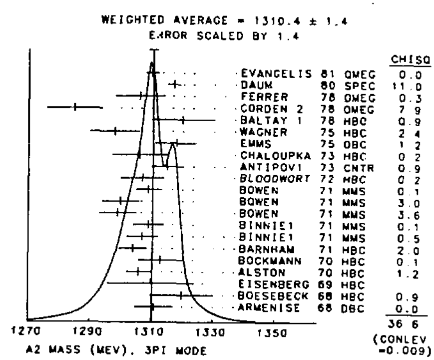


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                 12  A2 MASS (MEV),  CHARGED K KBAR MODE

MK S   1500  1319.0       3.0      GRAYER     71 ASPK  - 17.2 PI-P,K-KS P   2/72
MK      730  1313.0       4.0      FOLEY      72 CNTR  - 20.3 PI- P,K- KS  12/72
MK     2724  1320.0       2.0      MARGULIES  76 SPEC  - 23. PI-P,K-KS     12/77
MK    11000  1312.0       4.0      CHABAUD    78 SPEC  -9.8 PI-P,K- KS P    4/78
MK     4730  1316.0       2.0      CHABAUD    78 SPEC  - 18.8PI-P,K- KS P   4/78
MK      350  1324.0       5.0      HYAMS      78 ASPK + 12.7 PI+P,K+KS P    4/78
MK P S       1318.        1.       MARTIN 1   78 SPEC  -10 PI P,KS K- P     4/78
MK     4000  1320.0       2.0      CHABAUD    80 SPEC  - 17PI-NUCLEI,KSK- 12/79
MK           . . . . . . . . . .
MK    AVG    1318.08      0.77     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

MK S   SYSTEMATIC ERROR IN MASS SCALE SUBTRACTED
MK  P  FROM A FIT TO JP=2+ PARTIAL WAVE

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Data Card Listings
For notation, see key at front of Listings.


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                    12  A2 MASS (MEV), ETA PI MODE

M  E  1000 1323.        8.             KEY        73 CSPK -  6.PI-P,P PI-ETA   1/74
M  EM 62001 1324.1     (8.)            CONFORTO   73 DSPK -  6.PI-P,P MMS-     1/74
M     2561 1336.2       1.7            DELFOSSE   81 SPEC +  PI+-P,PI+-ETA P   1/82*
M     1653 1330.7       2.4            DELFOSSE   81 SPEC -  PI+-P,PI+-ETA P   1/82*
M               . . . . . . . . . .
M   AVG    1334.0       2.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)

M  E    ERROR INCLUDES 5 MEV SYSTEMATIC MASS-SCALE ERROR
M   M   MISSING MASS WITH ENRICHED MMS=ETA PI-, ETA = 2 GAMMA

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                    12  A2 WIDTH (MEV), 3PI MODE

W       260   96.0      16.0           ARMENISE   68 DBC    C 5.1 PI+D          9/67
W       941   79.0      12.0           ALSTON     70 HBC +   7.0 PI+P,3PI P     1/71
W       360  111.4      13.0           BARNHAM    71 HBC +   3.7 PI+ P,(3PI)+  11/71
W     10000 (100.)                     BINNIE1    71 MMS   - PI-P NEAR A2 THR  11/71
W      5000   72.       16.            BINNIE1    71 MMS   - PI-P NEAR A2 THR  11/71
W     26000  105.0       5.0           BOWEN      71 MMS   - 5. PI- P          11/71
W     24000   99.0       5.0           BOWEN      71 MMS +   5. PI+ P          11/71
W     17000  103.0       5.0           BOWEN      71 MMS   - 7. PI- P          11/71
W  P         115.       15.            ANTIPOV1   73 CNTR -  25.,40. PI- P      1/74
W      1580   99.       15.            CHALOUPKA  73 HBC  -  3.9 PI- P,P A2     2/73
W  P   1600  112.       18.            EMMS       75 DBC    04.  PI+N,P A20    11/75
W  P  51200  122.       14.            WAGNER     75 HBC    07.  PI+P,DEL++A2  11/75
W      1097  110.0      15.0           BALTAY 1   78 HBC +D 15 PI+P,P 4PI       4/78
W   P   490 (115.0)    (14.0)          BALTAY 1   78 HBC  0 15 PI+P,DEL 3PI     4/78
W            150.0      20.0           CORDEN 2   78 OMEG  - 12-15 PI-P,3PI N   4/78
W  P  25000   96.0       9.0           DAUM       80 SPEC  - 63,94 PI- P= 3PI  12/79
W  P          97.        5.            EVANGELIS  81 OMEG  - 12 PI-P,3PI P      1/82*
W               . . . . . . . . . .
W   AVG      101.2       2.5    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
                                (SEE IDEOGRAM BELOW )

W   D   ONLY EXPERIMENTS GIVING MASS ERROR LT. 15 MEV KEPT FOR AVERAGING
W   E   BACKGROUND SUBTRACTION MODEL-DEPENDENT.
W   D   MAY BE DIFFERENT OBJECT, ALTHOUGH JPC=2++. COMPARE CRENNELL 69.
W   A   ANALYSIS COMPLICATED BY NEARBY PEAK (A1.5) AND/OR A1
W    S  WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE
W   P   FROM A FIT TO JP=2+ RHO PI PARTIAL WAVE
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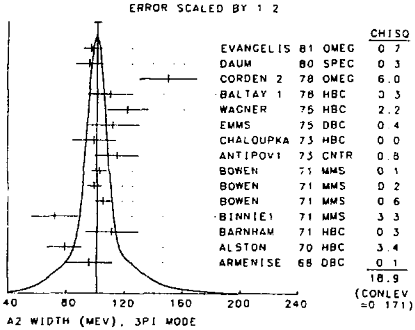
WEIGHTED AVERAGE = 101.2 ± 2.5
ERROR SCALED BY 1 2

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                    12  A2 WIDTH (MEV), CHARGED K KBAR MODE

WK    51500  123.0      13.0           GRAYER     71 ASPK - 17.2 PI-P,K-KS P 11/71
WK      730  113.0      19.0           FOLEY      72 CNTR - 20.3 PI- P,K- KS 12/72
WK    52724  105.0       8.0           MARGULIES  76 CPEC - 23.PI-P,K-KS     12/77
WK      350  110.0      18.0           HYAMS      78 ASPK + 12.7 PI+P,K+KS P  4/78
WK    11000  126.0      11.0           CHABAUD    78 SPEC  -9.8 PI-P,K- KS P  4/78
WK     4730  101.0       8.0           CHABAUD    78 SPEC - 18.8PI-P,K- KS P  4/78
WK P S       113.        4.            MARTIN 1   78 SPEC  -10 PI P,KS K- P   4/78
WK     4000  106.0       4.0           CHABAUD    80 SPEC - 17PI-NUCLEI,KSK- 12/79
WK              . . . . . . . . . .
WK  AVG      109.6       2.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

WK  P    FROM A FIT TO JP=2+ PARTIAL WAVE.
WK   S  WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE

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                    12  A2 WIDTH (MEV), ETA PI MODE

W      1000  108.        9.            KEY        73 DSPK -  6.PI-P,P PI-ETA   1/74
W    M 6200 (104.)      (9.)           CONFORTO   73 DSPK -  6.PI-P,P MMS-     1/74
W      2561  112.2       5.7           DELFOSSE   81 SPEC +  PI+-P,PI+-ETA P   1/82*
W      1653  116.6       7.7           DELFOSSE   81 SPEC -  PI+-P,PI+-ETA P   1/82*
W               . . . . . . . . . .
W   AVG      112.6       4.1    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   M   MISSING MASS WITH ENRICHED MMS=ETA PI-, ETA = 2 GAMMA
W   T   WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE

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                    12  A2 PARTIAL DECAY MODES

                                                          DECAY MASSES
P1       A2 INTO RHO PI                                  769+ 139
P2       A2 INTO K KBAR                                  493+ 497
P3       A2 INTO ETA PI                                  548+ 139
P4       A2 INTO OMEGA PI PI                             139+ 139+ 782
P5 S     A2 INTO PI+ PI- PI0 EXCL.RHO PI                 139+ 139+ 134
P6 S     A2 INTO PI+ PI- PI- EXCL.RHO PI                 139+ 139+ 139
P7 S     A2 INTO PI GAMMA                                139+   0
P8 S     A2 INTO ETA PRIME PI                            957+ 139
P9 S     A2 INTO GAMMA GAMMA                               0+   0

P   S    SMALL, NOT USED IN THE FIT

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1        P 2        P 3        P 4
P 1  .7213+-.0219
P 2   .1200   .0478+-.0050
P 3  -.0755   -.0422   .1449+-.0117
P 4  -.8653   -.2841   -.3948   .1060+-.0250


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                    12  A2 PARTIAL WIDTHS

W1       A2 INTO GAMMA GAMMA (KEV)                            (G9)
W1 F         (2.5)  OR LESS CL=0.95   ABRAMS     79 SMAG   E+ E-           12/79
W1 F     FROM RHO PI DECAY MODE
W1 D        (17.0)  OR LESS CL=0.95   ABRAMS     79 SMAG   E+ E-           12/79
W1 D     FROM K+ K- DECAY MODE
W1 E     22    0.77     0.45          EDWARDS    82 CBAL   E+ E-,PI0 ETA    2/82*
W1 E     SYSTEMATIC ERROR ADDED LINEARLY BY US


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                    12  A2 BRANCHING RATIOS

R1       A2 (CHARGED ONLY) INTO (K KBAR)/(RHO PI)             (P2)/(P1)
R1            0.054     0.022          CHUNG      68 HBC  -  3.2 PI-P          1/67
R1            0.06      0.03           ABRAMOVIC  70 HBC  -  3.93 PI- P        1/71
R1            0.07      0.03           NEF        70 MMS  -  7.0 PI- P         6/70
R1       113  0.097     0.018          ALSTON     71 HBC  +  7.0 PI+ P         1/71
R1        50  0.056     0.014          CHALOUPKA  73 HBC  -  3.9 PI- P,P A2    2/73
R1   F        0.078     0.017          CHABAUD    78 SPEC - 10,19 PI-P,KS K- 12/78
R1   F  FROM A FIT TO ALL AVAILABLE CROSS SECTIONS AT DIFFERENT ENERGIES.
R1             . . . . . . . . . .
R1  AVG       0.0697    0.0079  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT       0.0682    0.0071 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2       A2 INTO (ETA PI)/(RHO PI + K KBAR + ETA PI)          (P3)/(P1+P2+P3)
R2        34  0.15      0.04           BARNHAM    71 HBC  +  3.7 PI+ P        11/71
R2            0.13      0.04           ESPIGAT    72 HBC  +- 0.PBAR P,        11/71
R2             . . . . . . . . . .
R2  AVG       0.140     0.028   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT       0.162     0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3       A2 INTO (ETA PI) / (RHO PI)                          (P3)/(P1)
R3            0.22      0.09           CONTE      67 HBC  -  11.0 PI-P         8/67
R3        22  0.23      0.08           ASCOLI     68 HBC  -  5 PI-P            6/68
R3            0.12      0.08           CHUNG      68 HBC  -  3.2 PI-P         12/66
R3        15  0.25      0.09           BOCKMANN   70 HBC  +  5.0 PI+P          9/69
R3       167  0.246     0.042          ALSTON     71 HBC  +  7.0 PI+ P         1/71
R3       149  0.211     0.044          CHALOUPKA  73 HBC  -  3.9 PI- P,P A2    2/73
R3        52  0.22      0.05           ANTIPOV    73 CNTR -  40. PI-P,P A2-    1/74
R3            0.18      0.05           FORINO     76 HBC     11 PI- P,ETA PI  12/77
R3             . . . . . . . . . .
R3  AVG       0.213     0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT       0.207     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4       A2 INTO (ETA PRIME PI) / TOTAL                       (P8)
R4           (0.021 OR LESS  CL=.97    BARNHAM    71 HBC  +  3.7 PI+ P         2/72

R5       A2 INTO (ETA PRIME PI)/(RHO PI)                      (P8)/(P1)
R5            0.04      0.03     0.04  BOCKMANN   70 HBC    0 5.0 PI+ P        9/69
R5           (0.04) OR LESS            ALSTON     71 HBC  +  7.0 PI+ P         1/71
R5           (0.011)OR LESS  CL=.90    EISENSTEI  73 HBC  -  5.PI- P,P 6PI     1/74

R8       A2 INTO (K KBAR)/(RHO PI + K KBAR + ETA PI)          (P2)/(P1+P2+P3)
R8        17  0.06      0.03           BARNHAM    71 HBC  +  3.7 PI+ P,KSK+P  11/71
R8   A       (0.020)   (0.004)         ESPIGAT    72 HBC  +- 0.PBAR P,         2/72
R8         8  0.03      0.02           DAMERI     72 HBC  -  11. PI- P        12/72
R8            0.05      0.02           TOET       73 HBC  +  5. PI+ P,P K+ K0 12/75
R8            0.09      0.04           TOET       73 HBC    0 5.PI+P,PI+P K KB 12/75
R8   A  NOT AVERAGED BECAUSE OF DISCREPANCY BETWEEN MASSES
R8   A  FROM  (K KBAR)  AND  (RHO PI)  MODES
R8             . . . . . . . . . .
R8  AVG       0.048     0.012   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT       0.0535    0.0053 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9       A2 INTO (PI+ PI- PI-)/(RHO0 PI-)                     (P6C)/(P1C)
R9           (0.23) OR LESS  CL=.90    ABRAMOVIC  70 HBC  -  3.93 PI- P        1/71

R11      A2 INTO (PI GAMMA)/TOTAL                             (P7)
R11R          0.005     0.005    0.003 EISENBERG  72 HBC     PHOTOPRODUCTION  11/71
R11R M        0.0045    0.0011         MAY        77 SPEC +- 9.7 GAM N,A2 X   12/77
R11R    PION EXCHANGE MODEL USED IN THIS ESTIMATION
R11  M  MAY 77 GIVE PARTIAL WIDTH 460+/-110 KEV.
R11            . . . . . . . . . .
R11 AVG       0.0045    0.0011  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12      A2 INTO (OMEGA PI PI)/(RHO PI)                       (P4)/(P1)
R12          (0.19)    (0.08)          DEFOIX     73 HBC    0 0.7 PBAR P,7 PI 12/77
R12      279  0.10      0.05           CHALOUPKA  73 HBC  -  3.9 PI- P,P A2    2/73
R12       60  0.28      0.09           DIAZ       74 DBC    0 6.PI+N,P(5PI)0   1/74
R12    K 140 (0.29)    (0.08)          KARSHON    74 HBC    0 4.9 PI+P,DEL++A2 12/77
R12    K  60 (0.10)    (0.04)          KARSHON    74 HBC  +  4.9 PI+P,P A2+   12/77
R12    K      0.18      0.08           KARSHON    74 HBC     AVG OF ABOVE TWO  12/77
R12    K  KARSHON 74 SUGGESTS AN ADDITIONAL I=0 STATE, STRONGLY COUPLED
R12    K  TO OMEGA PI PI  COULD EXPLAIN DISCREPANCIES IN BRANCHING RATIOS
R12    K  AND MASSES. WE USE A CENTRAL VALUE AND A SYST. SPREAD.
R12            . . . . . . . . . .
R12 AVG       0.151     0.049   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R12 FIT       0.151     0.040  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR A2


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ADERHOLZ 64 PL 10 226                (AACHEN+BERLIN+BIRM+BONN+HAMBURG+LOIC+MPIM)
CHUNG    64 PRL 12 621               +DAHL,HARDY,HESS,KALBFLEISCH,KIRZ      (LRL)
GOLDHABE 64 DUBNA CONF    1 480 G GOLDHABER,S GOLDHABER,OHALLORAN,SHEN(LRL)
    ALSO 64 PRL 12 336               G+S.GOLDHABER,BROWN,KADYK,TRILLING,+  (LBL)
LANDER   64 PRL 13 346               +ABOLINS,CARMONY,HENDRIKS,XUONG+ (LA JOLLA)
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ABOLINS   65 ATHENS(OHIO)CONF. +CARMONY,LANDER,XUONG,YAGER      (LA JOLLA)I=1
ADERHOLZ  65 PR 138 B 897          (AACHEN+BERL+BIRM+BONN+HAMB+LOIC+MPIM)
ALITTI    65 PL 15 69          ALITTI,BATON,DELER,CRUSSARD+  (SACLAY+OGNA)  JP
CHUNG     65 PRL  15  325      +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER     (LRL)
FORINO    65 PL 19 69          +GESSAROLI+        (BGNA+BARI+FIRZ+ORSA+SACL)
LEFEBVRE  65 PL 19 434         CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEIDLITZ  65 PRL 15 217        L SEIDLITZ,O I DAHL,D H MILLER           (LRL)

BARNES    66 PRL 16 41         BARNES,FOWLER,LAI,ORENSTEIN +     (BNL+CUNY)
BENSON    66 MICH COO-1112-4   G.C.BENSON, THESIS                      (MICH)
   ALSO   66 PRL 16 1177       G BENSON,LOVELL,MARQUIT,ROE  +          (MICH)
EHRLICH   66 PR 152 1194       R. EHRLICH,W.SELOVE,H.YUTA              (PENN)
FERBEL    66 PL 21 111         FERBEL                             (ROCHESTER)
LEVRAT    66 PL  22  714       CERN MISSING MASS SPECTROMETER GROUP (CERN)

ARMENISE  67 PL 25B 53         ARMENISE,FORINO,+       (BARI+BGNA+FIRZ+ORSAY)
BALTAY    67 PL 25B 160        +KIRSCH+KUNG+YEH+RABIN    (COLU+BNL+RUTGERS)
BARLOW    67 NC 50A 701        +LILLESTOL+MONTANET+   (CERN+CDEF+IRAD+LIVP)
BARTSCH   67 PL 25B 48         +DEUTSCHMANN+GROTE+COCCONI+ (AACH+BERL+CERN)
BEUSCH    67 PL 25 B 357       +FISCHER,GOBBI,ASTBURY+              (ETH+CERN)
CASON     67 PRL 18 880        +LAMSA,BISWAS,DERADO,GROVES,+    (NOTREDAME)
CHIKOVAN  67 PL 25B 44         CERN MISSING MASS SPECTROMETER GROUP (CERN)
CHUNG     67 PRL 18 100        +DAHL,HARDY,HESS,KIRZ,MILLER             (LRL)
   ALSO   66 UCRL-16832        RICHARD I HESS--THESIS,BERKELEY          (LRL)
COHN      67 NP 81 57          +MCCULLOCH+BUGG+CONDO     (ORNL+UNIV.TENN.)
CONFORTO  67 NP 83 46          +MARECHAL,MONTANET+     (CERN+CDEF+IPN+LIVP)
CONTE     67 NC  51 A          +TOMASINI,CORDS+(GENOVA+HAMB+MILANO+SACLAY)
DAHL      67 PR 163 137        +HARDY+HESS+KIRZ+MILLER                  (LRL)
DANYSZ    67 NC 51 A 901       DANYSZ+FRENCH+SIMAK                     (CERN)
SLATTERY  67 NC 50A 377        +KRAYBILL+FORMAN+FERBEL          (YALE+ROCH)  JP

ARMENISE  68 PL 26B 336        ARMENISE,FORINO,+       (BARI+BGNA+FIRZ+ORSAY)
ASCOLI    68 PRL 20  1321      +CRAWLEY,MORTARA,SHAPIRO,BRIDGES+(ILLINOIS)  JP
BALLAM    68 PRL 21 934        +BRODY,CHADWICK,FRIES,GUIRAGOSSIAN+   (SLAC)
BENZ      68 PL 28 B 233       CERN MISSING MASS SPECTROMETER GROUP (CERN)
BOESEBEC  68 NP B 4 501        BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO      68 NC 54 A 583       +CONTE+COROS+DIAZ+ (GENOVA+HAMB+MILAN+SACL)
CHUNG     68 PR 165 1491       S.U.CHUNG,O.DAHL,J.KIRZ,D.H.MILLER       (LRL)
CRENNELL  68 PRL 20 1318       +KARSHON+KWAN LAI,SCARR,SKILLICORN       (BNL)
DONALD    68 PL 26 B  327      +FRODESEN+BETTINI+   (LIVERPOOL+OSLO+PADUA)
FOSTER    68 NP B 8 174        +GAVILLET,LABROSSE,MONTANET,+    (CERN+CDEF)
FRIDMAN   68 PR 167 1268       +MAURER,MICHALON,OUDET+(HEID    +STRASBOURG)
JUNKMANN  68 NP B8 471         +COCCONI,+         (AACH+BERL+BONN+CERN+WARS)
KEY       68 PR 166 1430       +PRENTICE+COOPER+MANNER+      (TNTO+ANL+WISC)
LAMSA     68 PR 166 1395       +CASON+BISWAS+DERADO+GROVES+      (NOTREDAME)
VON KROG  68 PL 27 B 253       +MIYASHITA,KOPELMAN,MARSHALL LIBBY     (COLO)

ADERHOLZ  69 NP B 11 259       +BARTSCH,+        (AACH+BERL+CERN+JAGL+WARS)
AGUILAR  169 PL 29 B  62       +BARLOW,JACOBS,DELLA NEGRA+(CERN+CDEF+LIVP)
AGUILAR  269 PL 29 B  241      M.AGUILAR-BENITEZ,J.BARLOW,+      (CERN+CDEF)
ANDERSON  69 PRL 22 1390       +COLLINS,+                          (BNL+CARN)
ARMENISE  69 LNC 2 501         +GHIDINI,FORINO,CARTACCI+  (BARI+BGNA+FIRZ)
CHIKOVAN  69 PL 28 B  526      CERN MISSING MASS SPECTROMETER GROUP (CERN) JP
CRENNELL  69 PRL 22 1327       +KARSHON,KWAN WU LAI,+                 (BNL)IJP
DONALD    69 NP B 12 325       +EDWARDS,FOSTER,MOORE              (LIVERPOOL)
EISENBER  69 PRL 23 1322       EISENBERG,HABER,BALLAM,CHADWICK+(REHO+SLAC)
VETLITSK  69 SJNP 9 596        VETLITSKY,GRIGOREYEV,GRISHIN,+          (ITEP)

ABRAMOVI  70 NP B 29 466       ABRAMOVICH,BLUMENFELD,BRUYANT,+       (CERN)  JP
ALSTON    70 PL 33 B 607       +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
ASCOLI    70 PRL 25 962        +BROCKWAY,CRAWLEY,EISENSTEIN,HANFT,+   (ILL)
BASILE    70 LNC 4 838         +DALPIAZ,FRABETTI,MASSAM,+ (CERN+BGNA+STRB)
BAUD1     70 PL 31B  397       CERN BOSON SPECTROMETER GROUP           (CERN)
BAUD2     70 PHILAD.CONF.P.311 CERN BOSON SPECTROMETER GROUP           (CERN)
BAUD3     70 PL 31 B 401       CERN BOSON SPECTROMETER GROUP           (CERN)
BOCKMANN  70 NP B 16 221       +MAJOR,POLS,+     (BONN+DURH+NIJM+EPOL+TORI)
BUTLER    70  UCRL 19845       THESIS                                   (LRL)
CAROLL    70 PRL 25 1393       +FIREBAUGH,GARFINKEL,MORSE,OH,+ (WISC+TNTO)
CASO      70 LNC 3 707         +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
DIAZ      70 NP B 16 239       +GAVILLET,LABROSSE,MONTANET+     (CERN+CDEF)JP
DZIERBA   70 PR D 2 2544       +SHEPHARD,BISWAS,CASON,JOHNSON,KENNEY(NDAM)
GARFINKE  70 PL 33 B 536       GARFINKEL,AMMANN,CARMONY,YEN        (PURD)JPC
JOHNSTON  70 NP B 24 253       +KEY,PRENTICE,YOON,GARFINKEL,+  (TNTO+WISC)
KRUSE     70 PHILAD.CONF.P.359 U.KRUSE, PARTIAL WAVE ANALYSIS          (ILL)  JP
NEF       70  THESIS+PRIV.COMM.CERN BOSON SPECTROMETER GROUP          (CERN)
SUTHERLA  70 PHILAD.CONF.P.369 G.SUTHERLAND,INTERFERING RESONANC (GLASGOW)

AGUILAR   71 PR D 4 2583       AGUILAR-BENITEZ,EISNER,KINSON            (BNL)
ALSTON    71 PL 34 B 156       +BARBARO,BUHL,DERENZO,EPPERSON,FLATTE+(LRL)
BARNHAM   71 PRL 26 1494       +ABRAMS,BUTLER,COYNE,GOLDHABER,HALL,+ (LBL)
BEKETOV   71 SJNP 4 765        +SOMMKOWSKY,KONOWALOV,KRUTSCHININ,+   (ITEP)  JP
BINNIE1   71 PL 36 B 257       +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BINNIE2   71 PL 36 B 537       +CAMILLERI,DUANE,FARUQI,BURTON,+(LOIC+SHMP)
BOWEN     71 PRL 26 1663       +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
CRENNEL   71 PL 35 B 185       +GORDON,KWAN-WU LAI,SCARR                (BNL)
FARBER    71 NP B 29 237       +DE PINTO,BISWAS,CASON,DEERY,KENNEY,+(NDAM)
FOLEY     71 PRL 26 413        +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
GRAYER    71 PL 34 B 333       +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
LYNCH     71 UCRL 20022 AND 71 AMSTERDAM CONF.  G.LYNCH                 (LBL)
RINAUDO   71 NC 5 A 239        +BOECKMANN,MAJOR+(TORI+BONN+DURH+NIJM+EPOL) JP

ANKENBRA  72 PRL 29 1698       ANKENBRANDT,BRABSON,CRITTENDEN,HEINZ,+(IND)
BERENYI   72 NP B 37 621       +PRENTICE,STEENBERG,YOON,WALKER (TNTO+WISC)
BLOODWOR  72 NP B 37 203       BLOODWORTH,JACKSON,PRENTICE,YOON        (TNTO)
DAMERI    72 NC 9 A 1          +BORZATTA,GOUSSU,+          (GENO+MILA+SACL)
DIEBOLD   72  BATAV.CONF.      P.DIEBOLD  RAPPORTEUR TALK               (ANL)
EISENBER  72 PR D 5 15         EISENBERG,BALLAM,DAGAN,+   (REHO+SLAC+TELA)
ESPIGAT   72 NP B 36 93        +GHESQUIERE,LILLESTOL,MONTANET  (CERN+CDEF)
FOLEY     72 PR D 6 747        +LOVE,OZAKI,PLATNER,LINDENBAUM,+ (BNL+CUNY)
LASSILA   72 PRL 28 1491       LASSILA,YOUNG                           (IOWA)
MORSE     72 NP B 43 77        +OH,WALKER,JOHNSTON,YOON           (WISC+TNTO)

AMMANN    73 PR D 7 1345       +CARMONY,GARFINKEL,GUTAY,MILLER+(PURD+PURU)
ANKEBRAN  73 PR D 8 2785       ANKENBRANDT,BRABSON,CRITTENDEN,HEINZ,+ (IND)
ANTIPOV   73 NP B 63 175       +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
ANTIPOV1  73 NP B 63 153       +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
ANTIPOV2  73 NP B 63 141       +ASCOLI,BUSNELLO,FOCACCI,+      (CERN+SERP)  JP
CASON     73 NP B 64 14        +MADDEN,BISHOP,BISWAS,KENNEY,+          (NDAM)
CHALOUPK  73 PL 44 B 211       CHALOUPKA,DOBRZYNSKI,FERRANDO,LOSTY,+(CERN)
CONFORTO  73 PL 45 B 154       +MOBLEY,KEY,PERPOST,+  (EFI+FNAL+TNTO+WISC)
DEFOIX    73 PL 43 B 141       +DOBRZYNSKI,ESPIGAT,NASCIMENTO,+       (CDEF)
EISENSTE  73 PR D 7 278        EISENSTEIN,SCHULTZ,ASCOLI,TOFFREDO,+   (ILL)
KEY       73 PRL 30 503        +CONFORTO,MOBLEY,+     (TNTO+EFI+FNAL+WISC)
TOET      73 NP B 63 248       +THUAN,MAJOR,RINAUDO,+(NIJM+BONN+DURH+TORI)

DIAZ      74 PRL 32 260        +DIBIANCA,FICKINGER,ANDERSON,+  (CASE+CARN)
KARSHON   74 PRL 32 852        +MIKENBERG,PITLUCK,EISENBERG,RONAT+  (REHO)
OTTER     74 NP B80 1          +RUDOLPH+        (AACH+BERL+BONN+CERN+HEID)  JP
TABAK     74  BOSTON P. 46     +RONAT,ROSENFELD,LASINSKI+       (LBL+SLAC)  JP
THOMPSO1  74 PR D9 560         THOMPSON,GAIDOS,MCILWAIN,WILLMANN      (PURD)  JP
THOMPSO2  74 NP B69 381        THOMPSON,BADENITZ,GAIDOS,MCILWAIN+    (PURD)  JP

ABASHIAN  75 PRL 34 691        +BEAMER,BROSS,EISENSTEIN,+     (ILL+ANL+ISU)
EMMS      75 PL 58B 117        +JONES,KINSON,STACEY,BELL+ (BIRM+DURH+RHEL)  JP
LOSTY     75 PL 56B 96         +CHALOUPKA,MONTANET,GANDO,+     (CERN+SACL)  JP
UNDERWOO  75 PR D11 2345       UNDERWOOD,CONFORTO,KEY+(EFI +NAL+TNTO+WISC)
   ALSO   73 CONFORTO. 73 KEY
WAGNER    75 PL 58B 291        +TABAK,CHEW                              (LBL)  JP

FORINO    76 NC A 35 465       +GESSAROLI,+  BGNA+FIRZ+GENO+MILA+OXF+PAV
HANDLER   76 NP B 110 173      +PLANO,BRUCKNER,KOLLER,,+   (RUTG,STEV,SETO)
MARGULIE  76 PR D 14 667       +KRAMER,FOLEY,LOVE,LINDENBAUM,+  (BNL+CUNY)

CERRADA   77 NP B 126 241      +BLOCKZIJL,HEINEN,+     (AMST+CERN+NIJM+OXF)
MAY       77 PR D 16 1983      +ABRAMSON,ANDREWS,BUSNELLO,+      (ROCH+CORN)
PAWLICKI  77 PR D 15 3196      +AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND  (ANL)I J

BALTAY 1  78 PR D 17 62        +CAUTIS,COHEN,CSORNA,SMITH,YEH,+(COLU+BING)
BALTAY 2  78 PRL 40 97         +CAUTIS,KALELKAR                        (COLU)  JP
CHABAUD   78 NP B 145 349      +HYAMS,JONES,WEILHAMMER,BLUM,+  (CERN+MPIM)
CORDEN 1  78 NP B 136 77       DOWELL,GARVEY,JOBES+  (BIRM+RHEL+TELA+LOWC)  JP
CORDEN 2  78 NP B 138 235      +CORBETT,ALEXANDER,+  (BIRM+RHEL+TELA+LOWC)
FERRER    78 PL 74 B 287       +TREILLE,RIVET +       (ORSAY+CERN+CDEF+LPNP)
HYAMS     78 NP B 146 303      +JONES,WEILHAMMER,BLUM,+   (CERN+MPIM+ATEN)
MARTIN 1  78 PL 74 B 417       +OZMUTLU+BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)  JP
MARTIN 2  78 NP B 140 158      +OZMUTLU,BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)

ABRAMS    79  SLAC-PUB 2421    +ALAM,BLOCKER,BOYARSKI,+            (SLAC+LBL)

CHABAUD   80 NP B 175 189      +HYAMS,PAPADOPOULOU,+         (CERN+MPIM+AMST)
DAUM      80 PL 89 B 276       +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)  JP

DAUM      81 NP B 182 269      +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
DELFOSSE  81 NP B 183 349      +GUISAN,MARTIN,MUHLEMANN,WEILL,+(GEVA+LAUS)
EVANGELI  81 NP B 178 197      EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)

EDWARDS   82 PL 110 B 82       +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
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E(1420)

+ E(1420,JPG=1++) I=0

The E(1420) has $J^{PC} = 1^{++}$ (DIONISI 80) just like the isoscalar companion D(1285). Thus the D and E normally both appear in the same experiments.

Recently a new resonance, the ι(1440), has been claimed in the decay $J/\psi \to \gamma K^+K^-\pi^0$ (SCHARRE 80,81), on top of the E. It differs from the E in three respects:

(a) No D(1285) is produced.

(b) It has $J^{PC} = 0^{-+}$.

(c) Its decay is dominantly $\delta(980)\pi$, unlike the E(1420).

We note that the early $\bar{p}p$ annihilation experiment at rest (BAILLON 67) agrees with (a) and (b).

We do not open a new entry for the ι(1440) for this edition, but we group BAILLON 67 and SCHARRE 80,81 separately under the E(1420).

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                    E MASS (MEV)

M   NO D(1285) MESON SEEN IN EXPERIMENTS BELOW  (SEE MINIREVIEW)
M         1425.      7.                BAILLON   67 HBC    0. PBAR P          11/66
M         1440.0     10.0      15.0    SCHARRE   80 SWAG   E+E-,J/PSI,E GAM   6/81*
M         . . . . . . . . . . .
M   AVG   1428.6     6.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   D(1285) MESON SEEN IN EXPERIMENTS BELOW  (SEE MINIREVIEW)
M         1420.      20.               DAHL      67 HBC    1.6-4.2 PI- P      9/66
M         1423.0     10.0              FRENCH    67 HBC    3-4 PBAR P         6/67
M     310 1420.      7.                LORSTAD   69 HBC    .7PB P,4,5-BODY    9/69
M     170 1398.      10.               DEFOIX    72 HBC    0.7 PBAR P,7 PI    1/73
M     280 1406.      7.                DUBOC     72 HBC    1.2 PBAR P,2K4PI  12/72
M     36(1397.0)    (10.0)             CORDEN    78 OMEG   12-15PI-P,K+K-PI   4/78
M         1417.      4.                NACASCH   78 HBC    .7,.76 PBAR P      4/78
M  A      1440.0     10.0              BROMBERG  80 SPEC   100 PI-P,2KPIX     1/82*
M  A    MASS ERROR INCREASED TO ACCOUNT FOR DELTA MASS CUT UNCERTAINTIES
M     221 1426.0     6.0               DIONISI   80 HBC    4. PI-P,K K PI N  12/79
M         . . . . . . . . . . .
M   AVG   1418.4     3.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                              (SEE IDEOGRAM BELOW )
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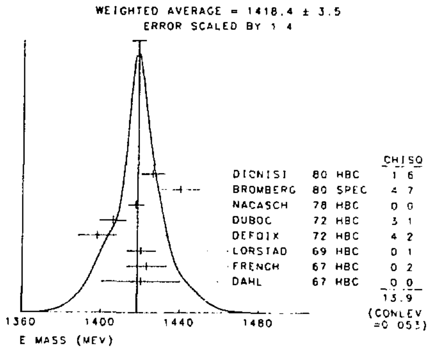


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                    6  E WIDTH (MEV)

W   NC D(1285) MESON SEEN IN EXPERIMENTS BELOW
W           80.      10.              BAILLON   67 HBC    0. PBAR P         11/66
W           50.0     30.0     20.0    SCHARRE   80 SMAG   E+E-,J/PSI,E GAM  2/81*
W           . . . . . . . . . .
W   AVG     75.9     10.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

W   D(1285) MESON SEEN IN EXPERIMENTS BELOW
W           60.0     20.0             DAHL      67 HBC    1.6-4.2 PI- P     10/66
W           45.      20.              FRENCH    67 HBC    3-4 PBAR P         6/67
W     310   60.      20.              LORSTAD   69 HBC    .7PB P,4,5-BODY    9/69
W     170   53.      10.              DEFOIX    72 HBC    0.7 PBAR P.7 PI    1/73
W     280   50.      12.              DUBOC     72 HBC    1.2 PBAR P,2K4PI  12/72
W      36  (45.0)   (30.0)            CORDEN    78 OMEG   12-15PI-P,K+K-PI   4/78
W           53.      20.0             NACASCH   78 HBC    .7,.76 PBAR P      4/78
W           62.0     14.0             BROMBERG  80 SPEC   100 PI-P,2KPIX     1/82*
W     221   40.0     15.0             DIONISI   80 HBC    4. PI-P,K K PI N  12/79
W           . . . . . . . . . .
W   AVG     51.7      5.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                    6  E PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      E INTO K K*(892)                                     497+ 891
P2      E INTO K KBAR PI                                     497+ 497+ 139
P3      E INTO PI PI RHO                                     139+ 139+ 769
P4      E INTO DELTA PI                                      983+ 139
P5      E INTO ETA PI PI                                     548+ 139+ 139
P6      E INTO 4 PI                                          139+ 139+ 139+ 139
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                    6  E BRANCHING RATIOS

R1      E INTO (KBAR K*(892) + C.C.)/(K KBAR PI)           (P1)/(P2)
R1  MD        (.50)     (.10)         BAILLON   67 HBC    0.0 PBAR P        12/78
R1            0.76      0.06          BROMBERG  80 SPEC   100 PI-P,2KPIX     1/82*
R1   N        0.86      0.12          DIONISI   80 HBC    4. PI-P,K K PI N  12/79
R1  D   NO D(1285) MESON SEEN
R1  M   FROM JP=0- SOLUTION
R1   N  FROM JP=1+ SOLUTION
R1            . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      E INTO (PI PI RHO) / (K KBAR PI)                   (P3)/(P2)
R2            (2.0)  OR LESS          DAHL      67 HBC    0  1.6-4.2 PI- P  10/66
R2            (0.3)  OR LESS  CL=.95  CORDEN    78 OMEG   12-15PI-P          4/78

R3      E INTO (ETA 2 PI)/(K KBAR PI)                      (P5)/(P2)
R3            (1.5)  OR LESS  CL=.95  FOSTER    68 HBC    - 0.0 PBAR P       9/69
R3            1.5       0.8           DEFOIX    72 HBC    0.7 PBAR P         1/73
R3            (0.5)  OR LESS  CL=.95  CORDEN    78 OMEG   12-15PI-P          4/78
R3  D         (1.1)  OR LESS  CL=.90  SCHARRE   80 SMAG   E+E-,J/PSI,E GAM   2/81*
R3  D   NO D(1285) MESON SEEN

R4      E INTO (DELTA PI)/(ETA PI PI)                      (P4)/(P5)
R4            0.4       0.2           DEFOIX    72 HBC    0.7 PBAR P.7 PI    1/73
R4            NOT SEEN IN EITHER MODE CORDEN    78 OMEG   12-15PI-P          4/78

R5      E INTO (4PI)/(KBAR K*(892) +C.C.)                  (P6)/(P1)
R5            (0.90)OR LESS CL=.95    DIONISI   80 HBC    4. PI-P,K K PI N  12/79

R6      E INTO (K KBAR PI)/(DELTA PI + KBAR K*(892) +C.C)(P2)/(P1+P4)
R6  C         0.65      0.27          DIONISI   80 HBC    4. PI-P            2/81*
R6  C   CALCULATED USING (DELTA INTO K KB)/(DELTA INTO ETA PI)=0.24+-0.07

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                    REFERENCES FOR E

BAILLON   67 NC 50A  393       +EDWARDS+D-ANDLAU+ASTIER+   (CERN+CDEF+IRAD)
BARASH    67 PR 156  1399      BARASH,KIRSCH,MILLER,TAN           (COLUMBIA)
DAHL      67 PR 163 1377       +HARDY+HESS+KIRZ+MILLER               (LRL)I JP
    ALSO  65 PRL 14 1074       MILLER,CHUNG,DAHL,HESS,HARDY,KIRZ+(LRL+UCB)
FRENCH    67 NC 52A 438        +KINSON+MCDONALD+RIDDIFORD+       (CERN+BIRM)

FOSTER    68 NP B 8 174        +GAVILLET,LABROSSE,MONTANET,+     (CERN+CDEF)

BETTINI   69 NC 62 A 1038      +CRESTI,LIMENTANI,BERTANZA,BIGI+(PADO+PISA)IC
LORSTAD   69 NP B 14 63        B.LORSTAD,D-ANDLAU,ASTIER,+      (CDEF+CERN)  JP

DEVONS    71 PRL 27 1614       +KOZLOWSKI,HORWITZ,+              (COLU+SYRA)

CHAPMAN   72 NP B 42 1         +CHURCH,LYS,MURPHY,RING,VANDER VELDE (MICH)
DEFOIX    72 NP B 44 125       +NASCIMENTO,BIZZARRI,+            (CDEF+CERN)
DUBOC     72 NP B 46 429       +GOLDBERG,MAKOWSKI,DONALD,+       (LPNP+LIVP)

VUILLEMI  75 LNC 14 165        VUILLEMIN,+       (LAUS+NEUC+LPNP+LIVP+GLAS)  JP
HANDLER   76 NP B 110 173      +PLAND,BRUCKER,KOLLER+      (RUTG+STEV+SETO)
VUILLEMI  76 NC 33A 133        +VUILLEMIN,+       (LAUS+NEUC+LPNP+LIVP+GLAS)

GRASSLER  77 NP B 121 189      +(AACHEN+BERLIN+BONN+CERN+CRACOW+HEID+WARS)

CORDEN    78 NP B 144 253      +CORBETT,ALEXANDER,+  (BIRM+RHEL+TELA+LOWC)
IRVING    78 NP B 139 327      A.C.IRVING,H.R.SEPANGI                (LIVP)
NACASCH   78 NP B 135 203      +DEFOIX,DOBRZYNSKI,+     (PARIS+MADRID+CERN)

STANTON   79 PRL 42 346        +BROCKMAN,DANKOWYCH,+  (OSU+CARL+MCGI+TNTO)  JP

BROMBERG  80 PR D 22 1513      +HAGGERTY,ABRAMS,DZIERBA(CIT+FNAL+ILLC+IND)
    ALSO  82 PRIVATE COMM.     C.BROMBERG                             (MSU)
DIONISI   80 NP B 169 1        +GAVILLET,ARMENTEROS+ (CERN+MADR+CDEF+STOH)I,JP
SCHARRE   80 PL 97 B 329       +TRILLING,ABRAMS,ALAM,BLOCKER+    (SLAC+LBL)

CHANOWIT  81 PRL 46 981        CHANOWITZ                              (LBL)
LACAZE    81 NP B 186 247      +NAVELET                             (SACL)
LIPKIN    81 PL 106 B 114      LIPKIN                               (FNAL)
SCHARRE   81 BONN CONF. 163    D.L.SCHARRE                          (SLAC)
    ALSO  81 SANTA CRUZ CONF.  COYNE,EDWARDS,+     (PRIN+CIT+HARV+STAN+SLAC)
    ALSO  80 MORIOND II 83     ASCHMAN,PARTRIDGE+(PRIN+CIT+HARV+STAN+SLAC)

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f′(1515)

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13  F PRIME(1515,JPG=2++) I=0
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                    13  F PRIME MASS (MEV)

M   P       (1515.0)    (7.0)           AMMAR     67 HBC    5.5 K-P,K KBAR     9/67
M   P   100(1519.)      (7.)            AGUILAR   72 HBC    3.9,4.6 K-,K KB   12/72
M   P    46(1514.)      (4.)            COLLEY    72 HBC    10.K+ P,K+ K-     12/72
M   P    47(1521.)      (7.)            VIDEAU    72 HBC    4.K- P,K KBAR     12/72
M   P   120(1527.0)     (3.0)           BRANDENBU 76 ASPK   13.K-P,K+K-        7/77
M    N      (1502.0)   (25.0)           CORDEN    79 OMEG   12-15PI-P, N 2PI  12/79
M
M      123  1522.0      6.0             BARREIRO  77 HBC    4.15 K-P,KS KS     7/77
M      166  1528.       7.              EVANGELIS 77 OMEG   10 K- P           12/77
M    C      1506.0      7.5             PAWLICKI  77 SPEC   6.PI N,K+K-       12/77
M           1492.0     29.0             GORLICH   80 ASPK   17 PI- P,POLARIZ  12/79
M      650  1521.0      5.0             AGUILAR   81 HBC    4.2 K-P,LAM 2K     1/82*
M      572  1521.0      3.0             ALHARRAN  81 OMEG   8.25 K-P,LAM 2K    1/82*
M           . . . . . . . . . .
M   AVG     1520.4      2.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

M    C  WITH A PHASE SHIFT ANALYSIS
M    C  MASS ERRORS ENLARGED BY US BY FACTOR 1.5.
M    N  FROM AN AMPLITUDE ANALYSIS WHERE THE F PRIME WIDTH AND
M    N  ELASTICITY ARE IN COMPLETE DISAGREEMENT WITH VALUES
M    N  OBTAINED FROM KKBAR CHANNEL MAKING THE SOLUTION DUBIOUS.
M   P   F-A2-F PRIME INTERFERENCE IN K+K- FINAL STATE NOT ACCOUNTED FOR.
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                    13  F PRIME WIDTH (MEV)

W   P        (35.0)    (25.0)             AMMAR     67 HBC    5.5 K-P, K KBAR   9/67
W   P   100  (69.)     (22.)              AGUILAR   72 HBC    3.9,4.6 K-P,K KB 12/72
W   P    46  (28.)     (15.)              COLLEY    72 HBC    10.K+ P,K+ K-    12/72
W   P    47  (40.)     (10.)              VIDEAU    72 HBC    4.K- P,K KBAR    12/72
W   P   120  (61.0)     (8.0)             BRANDENBU 76 ASPK   13.K-P,K+K-       7/77
W    N      (165.0)    (42.0)             CORDEN    79 OMEG   12-15PI-P, N 2PI 12/79
W           (150.0)    (83.0)    (50.0)   GORLICH   80 ASPK   17 PI- P,POLARIZ 12/79
W
W       123   62.0      19.0      14.0    BARREIRO  77 HBC    4.15 K-P,KS KS    7/77
W       166   72.0      25.0              EVANGELIS 77 OMEG   10 K- P          12/77
W    C        66.0      15.0              PAWLICKI  77 SPEC   6.PI N,K+K-      12/77
W    M        92.0      39.0      22.0    POLYCHRON 79 STRC   7. PI-P,KS KS N  12/79
W       650   85.0      16.0              AGUILAR   81 HBC    4.2 K-P,LAM 2K    1/82*
W       572   80.0      14.0      11.0    ALHARRAN  81 OMEG   8.25 K-P,LAM 2K   1/82*
W             . . . . . . . . . .
W   AVG       74.8       6.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    C  WITH A PHASE SHIFT ANALYSIS
W    C  WIDTH ERRORS ENLARGED BY US BY FACTOR 1.5.
W    M  FROM A FIT TO THE D WAVE WITH F-F PRIME INTERFERENCE. MASS FIXED
W    M  AT 1516 MEV.
W    N  SEE NOTE N UNDER MASS.
W   P   F-A2-F PRIME INTERFERENCE IN K+K- FINAL STATE NOT ACCOUNTED FOR.
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                    13  F PRIME PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      F PRIME INTO PI  PI                                  139+ 139
P2      F PRIME INTO K KBAR                                  497+ 497
P3      F PRIME INTO K K*(892)                               493+ 891
P4      F PRIME INTO ETA ETA                                 548+ 548
P5      F PRIME INTO PI PI ETA                               139+ 139+ 548
P6      F PRIME INTO PI K KBAR                               139+ 497+ 497
P7      F PRIME INTO PI+ PI+ PI- PI-                         139+ 139+ 139+ 139
P8      F PRIME INTO GAMMA GAMMA                               0+   0
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                    13  F PRIME PARTIAL WIDTHS                           12/78

W1      F PRIME INTO GAMMA GAMMA (KEV)                 (G8)              12/78

W1 B        (1.2)  OR LESS CL=0.95   ABRAMS    79 SMAG   E+ E-           12/79
W1 B    USING BRANCHING RATIO F PRIME INTO K KBAR = 1.                   12/78
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                    13  F PRIME BRANCHING RATIOS

R1      F PRIME INTO (PI PI)/TOTAL                          (P1)
R1 C        (0.0086) OR LESS            BEUSCH    75 OSPK   8.9 PI-P,K0 K0 N 12/77
R1          (0.063)OR LESS  CL=0.90     BRANDENBU 76 ASPK   13.K-P,K+K-       7/77
R1          (0.045)OR LESS  CL=0.95     BARREIRO  77 HBC    4.15 K-P,KS KS    7/77
R1 C         0.012     0.004            PAWLICKI  77 SPEC   6.PI N,K+K-      12/77
R1   N      (0.19)    (0.03)            CORDEN    79 OMEG   12-15PI-P, N 2PI 12/79
R1 C D       0.0075    0.0025           MARTIN    79 RVUE                    12/79
R1           0.007     0.002            COSTA     80 OMEG   10 PI-P,K+ K- N   1/82*
R1 C        (0.027)   (0.071)  (0.013)GORLICH   80 ASPK   17,18 PI-P POLAR 12/79
R1          (0   5) OR LESS  CL=.95     AGUILAR   81 HBC    4.2 K-P,LAM 2K    1/82*
R1 C    ASSUMING THAT THE F PRIME IS PRODUCED BY AN OPE
R1      PRODUCTION MECHANISM.
R1   D  MARTIN 79 USES THE PAWLICKI 77 DATA WITH DIFFERENT INPUT
R1      VALUE OF THE F INTO K KBAR BRANCHING RATIO.
R1   N  SEE NOTE N UNDER MASS.
R1           . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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R3     F PRIME INTO (ETA ETA)/(K KBAR)                        (P4)/(P2)
R3          (0.50) OR LESS              BARNES    67 HBC        4.6, 5.0 K- P   10/67

R4     F PRIME INTO (PI PI ETA)/(K KBAR)                      (P5)/(P2)
R4          (0.3)  OR LESS  CL=.67   AMMAR     67 HBC                           10/67
R4          (0.41) OR LESS  CL=.95   AGUILAR   72 HBC       3.9,4.6 K- P        12/72

R5     F PRIME INTO (PI K KBAR + K K*(892))/(K KBAR)          (P6+P3)/(P2)
R5          (0.4)  OR LESS  CL=.67   AMMAR     67 HBC                           10/67
R5          (0.35) OR LESS  CL=.95   AGUILAR   72 HBC       3.9,4.6 K- P        12/72

R6     F PRIME INTO (PI+ PI+ PI- PI-)/(K KBAR)                (P7)/(P2)
R6          (0.32) OR LESS  CL=.95   AGUILAR   72 HBC       3.9,4.6 K- P        12/72

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REFERENCES FOR F PRIME


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BARNES    65 PRL 15 322          +CULWICK,GUIDONI,KALBFLEISCH,GOZ+(BNL+SYRA)

CRENNELL 66 PRL  16  1025        + KALBFLEISCH,LAI,SCARR,SCHUMANN +     (BNL)I

ABRAMS    67 PRL 18 620          +KEHOE,GLASSER,SECHI-ZORN,WOLSKY (MARYLAND)
AMMAR     67 PRL  19  1071       +DAVIS,HWANG,DAGAN,DERRICK +      (NWES+ANL)  JP
BARNES    67 PRL  19  964        +DORNAN,GOLDBERG,LEITNER +    (BNL+SYRACUSE)ICJP

ALITTI    68 PRL 21 1705         +BARNES,CRENNELL,FLAMINIO,GOLDBERG,+  (BNL)

LORSTAD   69 NP B 14 63          B.LORSTAD,O-ANDLAU,ASTIER,+       (CDEF+CERN)
SCOTTER   69 NC 62 A 1057        +ERSKINE,PALER,+  (BIRM+GLAS+LOIC+MPIM+OXF)

AGUILAR   72 PR D 6 29           AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS    (BNL)
COLLEY    72 NP B 50 1           +JOBES,RIDDIFORD,GRIFFITHS,+      (BIRM+GLAS)
VIDEAU    72 PL 41 B 213         +VIDEAU,ROUGE,BARRELET,DEBRION,+(EPOL+SACL)

BEUSCH    75 PL 60 B 101         +BIRMAN,WEBSDALE,WETZEL            (CERN+ETH)

BRANDENB 76 NP B 104 413         BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)

BARREIRO 77 NP B 121 237         +DIAZ,GAY,HEMINGWAY,+   (CERN+AMST+NIJM+OXF)
EVANGELI 77 NP B 127 384         EVANGELISTA,+    (BARI+BONN+CERN+DARF+GLAS+)
LAVEN     77 NP B 127 43         +OTTER,KLEIN,+    (AACH+BERL+CERN+LOIC+WIEN)
PAWLICKI 77 PR D 15 3196         +AYRES,COHEN,DIEBOLD,KRAMER,WICKLUND  (ANL)I JP

ABRAMS    79  SLAC-PUB 2421      +ALAM,BLOCKER,BOYARSKI,+           (SLAC+LBL)
BECKER    79 NP B 151  46        +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
CORDEN    79 NP B 157 250        +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TELA+LOWC)  JP
MARTIN    79 NP B 158 520        +OZMUTLU                              (DURH)
POLYCHRO 79 PR D 19 1317         POLYCHRONAKOS,CASON,BISHOP+        (NDAM+ANL)

COSTA     80 NP B 175 402        +      (BARI+BONN+CERN+GLAS+LIVP+MILA+WIEN)
GORLICH   80 NP B 174 16         +NICZYPORUK,ROZANSKA+ (CRAC+MPIM+CERN+ZEEM)

AGUILAR   81 ZPHY C 8 313        +ALBAJAR,ARMENTEROS,+ (CERN+CDEF+MADR+STOH)
ALHARRAN 81 NP B 191 26          +BAUBILLIER,+     (BIRM+CERN+GLAS+MICH+LPNP)
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ρ′(1600)

65 RHO PRIME(1600,JPG=1-+) I=1

The ρ′(1600) has been seen in the $\rho^0\pi^+\pi^-$ final state, in photoproduction (BINGHAM 72, DAVIER 73, SCHACHT 74, ALEXANDER 75, LEE 75, ATIYA 79, RICHARD 79, BARBER 80, ASTON 81), in e^+e^- annihilation (BARBARINO 72, CONVERSI 74, CORDIER 79, COSME 79, BACCI 80, DELCOURT 81), in electroproduction (KILLIAN 80), and in a π^+d experiment (DIBIANCA 81). If the $\pi^+\pi^-$ subsystem were in an S wave, as has often been assumed, one would also expect to see the ρ′ decaying into $\rho^0\pi^0\pi^0$. This has, however, not been seen (ATKINSON 82). Thus the most likely decay chain is $\rho' \to A_1\pi \to \rho\pi\pi \to 4\pi$.

For the determination of the ρ′(1600) parameters we turn to its relatively rare $\pi^+\pi^-$ decays, which do not have the problems of the above decay chain. The $\pi^+\pi^-$ final state has been produced in π^-p interactions (HYAMS 73, BECKER 79), in photoproduction (ATIYA 79, ASTON 80), and with weaker evidence in e^+e^- annihilation (reviewed by GENSINI 78, HEYN 80). The mass and width in these experiments are consistently 1600 MeV and 300 MeV, respectively. Note, however, that these parameters are the results of very simplified analyses which are not adequate for such a broad resonance. An attempt to determine the ρ′ pole position in a more model-independent way (LANG 79) from the HYAMS 73 data yields a mass at 1660 MeV.

The elusive ρ′(1250) has recently been reclaimed in the diffractively photoproduced $\omega\pi^0$ system (ASTON 80, BARBER 80). However, the J^P determinations are complicated by the simultaneously present B(1235) resonance. In addition, other dynamical effects obscure the interpretation of the ρ′(1250) as a resonance.

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                    65  RHO PRIME MASS (MEV)

M   PI+ PI- MODE
M    H      (1590.)     (20.)              HYAMS     73 ASPK  0 17 PI-P,N PI+PI-   1/74
M   P        1610.       30.               FROGGATT  77 RVUE  0 17 PI-P,PI+PI-N  12/77
M   P       (1575.)                        MARTIN    78 RVUE  0 17 PI-P,PI+PI-N  12/77
M     R      1600.0      10.0              ATIYA     79 SPEC    50 GAM C,2PI     12/79
M            1558.0      24.0      22.0    BECKER    79 ASPK  0 17 PI- P POLARIZ 12/79
M    P      (1659.)     (25.)              LANG      79 RVUE  0                   1/82*
M     M      1590.       20.               ASTON     80 OMEG    20-70GAM P,2 PI   9/81*
M            . . . . . . . . . .
M   AVG      1599.9      8.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   2(PI+ PI-) MODE
M       400 1430.        50.               BINGHAM   72 HBC   0 9.3 GAM P,P 4PI  12/72
M     M      1550.       60.               CONVERSI  74 OSPK  0 E+ E-,2(PI+PI-)  12/75
M       160 1550.        50.               SCHACHT   74 STRC  0 5.5-9 G P,P 4PI  12/75
M       340 1450.       100.               SCHACHT   74 STRC  0 9-18 G P,P 4PI   12/75
M    D   65(1570.)      (160.)             ALEXANDER 75 HBC   0 7.5 GAM P,P 4PI  12/75
M    C     (1500.)                         ATIYA     79 SPEC    50 GAM C,4 PI+-   9/81*
M    AX    (1666.)      (39.)              BACCI     80 FRAG    E+ E-, 2(PI+PI-)  9/81*
M        34(1780.)                         KILLIAN   80 SPEC    11 E-P,2(PI+PI-)  9/81*
M    B     (1500.)                         PENSO     80 RVUE    E+ E-, 2(PI+PI-)  9/81*
M      M     1520.       30.               ASTON     81 OMEG    20-70GAM P,4 PI   9/81*
M   A X      1570.       60.               DELCOUR2  81 DM1     E+ E-,2(PI+PI-)   9/81*
M   O        1654.       25.               DIBIANCA  81 DBC   0 PI+D,PP2(PI+PI-)  1/82*
M            . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

M    A    SIMPLE RELATIV. BREITWIGNER FIT WITH MODEL DEPENDENT WIDTH
M    B    ASSUMING RHO+EPSILON DECAY MODE INTERFERES WITH A1+PI BACKGROUND
M    C    PARAMETERS ROUGHLY ESTIMATED,NOT FROM A FIT
M    D    SKEW MASS DISTRIBUTION COMPENSATED BY ROSS-STODOLSKY FACTOR
M    H    INCLUDED IN BECKER 79 ANALYSIS
M     M   SIMPLE RELATIV. BREIT WIGNER FIT WITH CONSTANT WIDTH
M   O     ONE PEAK FIT RESULT.
M   P     FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
M     R   AN ADDITIONAL 40 MEV UNCERTAINTY IN BOTH THE MASS AND WIDTH
M     R   IS PRESENT DUE TO THE CHOICE OF THE BACKGROUND SHAPE.
M     X   THE VEPP2M-OLYA AND DCI-DM1 DATA HAVE A SYSTEMAT.CALIBR.DIFFERENCE

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                    65  RHO PRIME WIDTH (MEV)

W   PI+ PI- MODE
W    H      (180.)      (50.)              HYAMS     73 ASPK  0 17 PI-P,N PI+PI- 12/75
W   P        300.       100.               FROGGATT  77 RVUE  0 17 PI-P,PI+PI-N  12/77
W   P       (340.)                         MARTIN    78 RVUE  0 17 PI-P,PI+PI-N  12/77
W     R      283.0       14.0              ATIYA     79 SPEC    50 GAM C,2PI     12/79
W            175.0       98.0      53.0    BECKER    79 ASPK  0 17 PI- P POLARIZ 12/79
W    P      (232.)      (34.)              LANG      79 RVUE  0                   1/82*
W     M      230.0       80.0              ASTON     80 OMEG    20-70 GAM P,2PI   9/81*
W            . . . . . . . . . .
W   AVG      278.4       14.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

W   2(PI+ PI-) MODE
W       400  650.       100.               BINGHAM   72 HBC   0 9.3 GAM P,P 4PI  12/72
W     M      360.       100.               CONVERSI  74 OSPK  0 E+ E-,2(PI+PI-)  12/75
W   E   160  400.       120.               SCHACHT   74 STRC  0 5.5-9 G P,P 4PI  12/75
W   E   340  850.       200.               SCHACHT   74 STRC  0 9-18 G P,P 4PI   12/75
W    D   65 (340.)      (160.)             ALEXANDER 75 HBC   0 7.5 GAM P,P 4PI  12/75
W    C      (600.)                         ATIYA     79 SPEC    50 GAM C,4 PI+-   9/81*
W    A      (700.)      (160.)             BACCI     80 FRAG    E+ E-, 2(PI+PI-)  9/81*
W        34 (107.)                         KILLIAN   80 SPEC    11 E-P,2(PI+PI-)  9/81*
W    B      (230.)                         PENSO     80 RVUE    E+ E-, 2(PI+PI-)  9/81*
W     M      400.        5 .               ASTON     81 OMEG    20-70GAM P,4 PI   9/81*
W   A        510.        50.               DELCOUR2  81 DM1     E+ E-,2(PI+PI-)   9/81*
W   O        400.       146.               DIBIANCA  81 DBC   0 PI+D,PP2(PI+PI-)  1/82*
W            . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

W    A    SIMPLE RELATIV. BREITWIGNER FIT WITH MODEL DEPENDENT WIDTH
W    B    ASSUMING RHO+EPSILON DECAY MODE INTERFERES WITH A1+PI BACKGROUND
W    C    PARAMETERS ROUGHLY ESTIMATED,NOT FROM A FIT
W    D    SKEW MASS DISTRIBUTION COMPENSATED BY ROSS-STODOLSKY FACTOR
W   E     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE
W    H    INCLUDED IN BECKER 79 ANALYSIS
W     M   SIMPLE RELATIV. BREIT WIGNER FIT WITH CONSTANT WIDTH
W   O     ONE PEAK FIT RESULT.
W   P     FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
W     R   AN ADDITIONAL 40 MEV UNCERTAINTY IN BOTH THE MASS AND WIDTH
W     R   IS PRESENT DUE TO THE CHOICE OF THE BACKGROUND SHAPE.

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                    65  RHO PRIME PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      RHO PRIME  INTO RHO PI+ PI-                       769+ 139+ 139
P2      RHO PRIME  INTO ALL 4 CHARGED PI                  139+ 139+ 139+ 139
P3      RHO PRIME  INTC RHO RHO                           769+ 769
P4      RHO PRIME  INTC PI PI                             139+ 139
P5      RHO PRIME  INTO KBAR K                            493+ 493
P6      RHO PRIME  INTO PI OMEGA                          139+ 782
P7      RHO PRIME  INTC RHOO PIO PIO                      769+ 134+ 134
P8      RHO PRIME  INTO E+ E-                              .5+  .5
P9      RHO PRIME  INTO RHO+- PI-+ PIO                    769+ 139+ 134
P10     RHO PRIME  INTO KBAR K*(892) + C.C.               493+ 891
P11     RHO PRIME  INTO PI PI ETA                         139+ 139+ 548
P12     RHO PRIME  INTC RHO PI PI                         769+ 139+ 139

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                    65  RHO PRIME PARTIAL WIDTHS (KEV)

W1      RHO PRIME INTC E+ E-                          (G8)

W1  D         (7.5)     (1.5)          DELCOUR2  81 DM1    E+ E-, 2(PI+PI-)  9/81*

W1  D   MODEL DEPENDENT, NOT INDEPENDENT OF DELCOUR2 81 WIDTH TIMES E+E-
W1  D   BRANCHING RATIO BELOW

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                    65  RHO PRIME BRANCHING RATIOS

R1      RHO PRIME INTO (RHO PI+ PI-)/(4 PI, ALL CHARGED) (P1)/(P2)
R1 S          (0.80)                   BINGHAM   72  HBC    9.3 GAM P,P 4PI   1/73
R1      500    0.7      0.1            SCHACHT   74 STRC    5.5-18 G P,P 4PI 12/75
R1            (1.0)  APPROX.           DELCOUR2  81 DM1     E+E-,2(PI+PI-)   1/82*
R1 S     THE PI PI SYSTEM IS IN S WAVE                                        1/73

R3      RHO PRIME INTC (PI+ PI-)/(4 PI, ALL CHARGED)        (P4)/(P2)
R3            (0.2)  OR LESS  2 SIGMA  BINGHAM   72  HBC  0 9.3 GAM P,P 2PI   1/73
R3            (0.16) OR LESS  ESTIMATE DAVIER    73 STRC  0 6-18 G P,P 4PI    1/74
R3             0.13     0.05           ASTON     80 OMEG    20-70 GAM P,2PI   9/81*

R4      RHO PRIME INTC (KBAR K)/(4 PI, ALL CHARGED)         (P5)/(P2)
R4            (0.04) OR LESS  CL=0.95  BINGHAM   72  HBC  0 9.3 GAM P         1/73
R4   D         0.015    0.010          DELCOUR2  81 DM1     E+E-,KBAR K       1/82*
R4   D  ASSUMING RHO PRIME AND OMEGA PRIME TO BE DEGENERATE IN MASS.

R5      RHO PRIME INTO (PI+PI-)/TOTAL                       (P4)
R5  E         (0.15) OP LESS           EISENBERG 73 HBC     5 PI+ P,DEL++2PI  1/74
R5  H         (0.25)   (0.05)          HYAMS     73 ASPK    17 PI-P,N PI+PI-  1/74
R5             0.20     0.05           MONTANET  73 HBC     PBAR P AT REST   12/77
R5 C          (0.20) OR LESS           COSTA 2   77 RVUE    E+E-,2 PI + 4 PI 12/77
R5  P         (0.30)   (0.05)          FROGGATT  77 RVUE    17 PI-P,PI+PI-N  12/77
R5 P          (0.15)TO 0.30            MARTIN    78 RVUE    17 PI-P,PI+PI-N  12/77
R5             0.287    0.043    0.042 BECKER    79 ASPK  0 17 PI- P POLARIZ 12/79
R5 C    ESTIMATE USING UNITARITY,TIME REVERSAL INVARIANCE,BREIT WIGNER
R5  F   ESTIMATED USING OPE MODEL.
R5  H   INCLUDED IN BECKER 79 ANALYSIS
R5 P    FROM PHASE SHIFT ANALYSIS OF HYAMS 73 DATA
R5          . . . . . . . . . .
R5  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

R6      RHO PRIME INTO (RHOO PIO PIO)/(RHO+- PI-+ PIO)   (P7)/(P9)
R6                                                       (P7)/(P2)
R6            (0.15) OR LESS           ATKINSON  82 OMEG  0 20-70GAM P,4PI P  1/82*

R7      RHO PRIME INTO (PI+ PI- + NEUTRALS)/(4PI,ALL CHARGED)
R7                                                       (P7+....)/(P2)
R7  U         (2.6)    (0.4)           BALLAM    74 HBC     9.3 GAMMA P      12/75
R7  U   UPPER LIMIT. BACKGROUND NOT SUBTRACTED

R8      RHO PRIME INTO (PI PI ETA)/(4 PI, ALL CHARGED)   (P11)/P2
R8            (0.1)  APPROX.           ASTON     80 OMEG    20-70 GAM P       1/82*
R8             0.13     0.03           DELCOUR2  81 DM1     E+E-,PI+PI-MM     1/82*

R9      RHO PRIME INTO (KBAR K*(892)+C.C.)/(4PI, ALL CHG)(P10)/(P2)
R9   D         0.15     0.03           DELCOUR2  81 DM1     E+E-,KBAR K PI    1/82*
R9   D  ASSUMING RHO PRIME AND OMEGA PRIME TO BE DEGENERATE IN MASS.

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                    65  RHO PRIME     G(I)*G(E+E-)/G(TOTAL)     (KEV)

        THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH INTO
        E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE CROSS-SECTION
        INTO CHANNEL(I) IN E+E- ANNIHILATION.

G2      G(4 PI, ALL CHARGED)*G(E+E-)/G(TOTAL)
G2             2.87     0.42           BACCI     80 FRAG  0 E+ E-, 2(PI+PI-)  3/82*
G2 P          (0.4)                    PENSO     80 RVUE  0 E+ E-, 2(PI+PI-)  3/82*
G2 P    ASSUMING RHO+EPSILON DECAY MODE INTERFERES WITH A1+PI BACKGROUND
G2             2.6      0.2            DELCOUR2  81 DM1   0 E+ E-, 2(PI+PI-)  3/82*
G2          . . . . . . . . . .
G2  AVG        2.64     0.18     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

G5      G(KBAR K)*G(E+E-)/G(TOTAL)
G5  M         (0.035)  (0.029)         BIZOT     80 DM1   0 E+ E-                 3/82*

G10     G(KBAR K*(892) + C.C.)*G(E+E-)/G(TOTAL)
G10 M         (0.305)  (0.071)         BIZOT     80 DM1   0 E+ E-                 3/82*

G12     G(RHO PI PI)*G(E+E-)/G(TOTAL)
G12 M         (3.510)  (0.090)         BIZOT     80 DM1   0 E+ E-                 3/82*

G   M   MODEL DEPENDENT

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REFERENCES FOR RHO PRIME


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ALVENSLE 71 PRL 26 273        ALVENSLEBEN,BECKER,BERTRAM,CHEN,+(DESY+MIT) G
BRAUN    71 NP B30 213        +FRIDMAN, GERBER, GIVERNAUD,+  (STRASBOURG) G
BULOS    71 PRL 26 149        +BUSZA,KEHDE,BENISTON,+  (SLAC+UMD+IBM+LBL) G
BACCI    72 PL 38B 551        +PENSO,SALVINI,STELLA,BALDINI-CE(ROMA+FRAS) JPG
BARBARIN 72 LNC 3 689         BARBARINO,CERADINI,+    (FRAS+ROMA+PADO+UMD)IGJP
BARTOLI  72 PR D 6 2374       +FELICETTI,OGREN,+            (FRAS+ROMA+NAPL)IGJP
BINGHAM  72 PL 41B 635        +RABIN,ROSENFELD,SMADJA,YOST+(LBL,UCR,SLAC)IGJP
BRAMON   72 LNC 3 693         +GRECO (THEORETICAL PAPER)       (FRASCATI)
DIEBOLD  72  BATAV.CONF.      P.DIEBOLD  RAPPORTEUR TALK              (ANL)
EISENBER 72 PR D 5 15         EISENBERG,BALLAM,DAGAN,+    (REHO+SLAC+TELA)
LAYSSAC  72 NC 10A 467        J.LAYSSAC,F.M.RENARD                   (MONP)
SMADJA   72 PHIL.CONF.PROC349 +BINGHAM,FRETTER,BALLAM,CHADWICK+(LBL+SLAC)

CERADINI 73 PL 43 B 341       +CONVERSI,EKSTRAND,GRILLI,+(ROMA+FRAS+PADO)IGJP
CHUNG    73 PL 47 B 526       +PROTOPOPESCU,LYNCH,FLATTE+    (BNL+LBL+USC)
DAVIER   73 NP B 58 31        +DERADO,FRIES,LIU,MOZLEY,ODIAN,PARK,+(SLAC)
EISENBER 73 PL 43 B 149       EISENBERG,KARSHON,MIKENBERG,PITLUCK,+(REHO)
HYAMS    73 NP B 64 134       +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
KREUZER  73 PR D 8 1431       H.J.KREUZER,A.N.KAMAL     (UNIV. OF ALBERTA)
OCHS     73 THESIS            THESIS                                 (MPIM)
MONTANET 73 ERICE SCHOOL 518  L.MONTANET                             (CERN)
PARK     73 NP B 58 45        J.C.H.PARK                             (MPIM)   JP

BALLAM   74 NP B76 375        +CHADWICK,BINGHAM,FRETTER+  (SLAC+LBL+MPIM)
BERNABEI 74 LNC 11 261        +D.ANGELO,SPILLANTINI,VALENTE    (ROMA+FRAS)
CHALOUPK 74 PL 51 B 407       CHALOUPKA,FERRANDO,LOSTY,MONTANET      (CERN)
CONVERSI 74 PL 52B 493        +PAOLUZI,CERADINI,GRILLI+        (ROMA+FRAS)
ESTABROO 74 NP B79 301        P.ESTABROOKS,A.D.MARTIN                (DURH)
FERBEL   74 PR D9 824         T.FERBEL AND P.SLATTERY                (ROCH)
GRAYER   74 NP B 75 189       G.GRAYER,HYAMS,BLUM,DIETL,+       (CERN+MPIM)
HIRSHFEL 74 NP B74 211        A.C.HIRSHFELD,G.KRAMER                 (HAMB)
SCHACHT  74 NP B81 205        +DERADO,FRIES,PARK,YOUNT               (MPIM)

ALEXANDE 75 PL 57B 487        ALEXANDER,BENARY,GANDSMAN,LISSAUER+    (TELA)
ALLES    75 NC 30A 136        ALLES-BORELLI,BERNARDINI+  (CERN+BGNA+FRAS)
CHUNG    75 PR D 11 2436      +PROTOPOPESCU,LYNCH,FLATTE+    (BNL+LBL+USC)
ESTABROO 75 NP B95 322        P.ESTABROOKS,A.D.MARTIN                (DURH)
FROGGATT 75 NP B91 454        C.D.FROGGATT,J.L.PETERSEN         (GLAS+NORD)
HYAMS    75 NP B100 205       +JONES,WEILHAMMER,BLUM,DIETL+     (CERN+MPIM)
LANG     75 PL 58B 450        C.B.LANG,I.S.STEFANESCU                (KARL)
LANGACKE 75 PR D 13 657       P.LANGACKER,G.SEGRE                    (PENN)
LEE      75 STANFORD CONF.213 WONYONG LEE                            (COLU)
ROOS     75 NP B 97 165       M.ROOS                                 (HELS)

BASSOMPI 76 PL 65 B 397       BASSOMPIERRE,BINDER,+        (MULH+STRB+TORI)
COMMON   76 NP B 103 109      A.K.COMMON                             (KENT)   JP
JOHNSON  76 PL 63 B 95        +MARTIN,PENNINGTON                (DURH+CERN)   JP

BUDNEV   77 PL 70 B 365       N.M.BUDNEV,V.M.BUDNEV,V.V.SEREBRYAKOV(NOVO)
COSTA 1  77 PL 67 B 213       COSTA DE BEAUREGARD,PHAM,PIRE,TRUONG (EPOL)
COSTA 2  77 PL 71 B 345       COSTA DE BEAUREGARD,PIRE,T.N.TRUONG  (EPOL)
FROGGATT 77 NP B 129 89       C.D.FROGGATT,J.L.PETERSEN         (GLAS+BOHR)
GESSAROL 77 NP B 126 382      GESSAROLI+    (BGNA+FIRZ+GENO+MILA+OXF+PAVI)

GENSINI  78 PR D 17 1368      PAOLO M GENSINI                        (SLAC)
MARTIN   78 ANP  114 1        A.D.MARTIN,M.R.PENNINGTON              (CERN)

ATIYA    79 PRL 43 1691       +HOLMES,KNAPP,LEE,SETO,+      (COLU+ILL+FNAL)
BACCI    79 PL B 86 234       +DE ZORZI,PENSO,STELLA,+      (ROMA+BGNA+FRAS)
BECKER   79 NP B 151  46      +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
CORDEN   79 NP B 157 250      +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TFLA+LOWC)   JP
CORDIER  79 PL 81 B 389       +DELCOURT,ESCHSTRUTH,FULDA+            (LALO)
COSME    79 NP B 152 215      +DUDELZAK,GRELAUD,JEAN-MARIE,JULLIAN+ (IPN)
LANG     79 PR D 19 956       C.B.LANG,A.MAS-PARAREDA                (GRAZ)
RICHARD  79 FERMILAB SYMP.469 F.RICHARD                              (LALO)

ASTON    80 PL 92 B 215       (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+I
BARBER   80 ZPHY C 4 169      +DAINTON,BRODBECK,BROOKES,+(DARE+LANC+SHEF)
BACCI    80 PL 95 B 139       +DE ZORZI,PENSO,BALDINI-CELIO,+ (ROMA+FRAS)
BIZOT    80 MADISON CONF. 546 +BISELLO,BUON,CORDIER,DELCOURT,+(LALO+USTL)
HEYN     80 ZPHY C 7 169      M.F.HEYN,C.B.LANG                      (GRAZ)
KILLIAN  80 PR D 21 3005      +TREADWELL,AHRENS,BERKELMAN,CASSEL,+ (CORN)
O-DONNEL 80 PR D 22 711       P.J.O-DONNELL                       (TORONTO)
PENSO    80 PL 95 B 143       G.PENSO,TRAN N.TRUONG            (ROMA+EPOL)
    ALSO 82 NC    (TO BE PUB.) G.PENSO,TRAN N.TRUONG           (ROMA+EPOL)

ASTON    81  CERN/EP/81-13    (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+I
DELCOURT 81 PL 99 B 257       +BISELLO,BIZOT,BUON,CORDIER,MANE      (ORSAY)
DELCOUR2 81 BONN CONF. 205    B.DELCOURT                            (ORSAY)
    ALSO 82 PL 109B 129       CORDIER,+                             (ORSAY)
DIBIANCA 81 PR D 23 595       +FICKINGER,MALKO,DADO,ENGELER,+ (CASE+CARN)

ATKINSON 82 PL 108 B 55       + (BONN+CERN+GLAS+LANC+MCHS+CURI+RHEL+SHEF)
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$\theta(1640)$ →

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        68  THETA(1640,JPG=2++) I=0

        SEEN IN J/PSI INTO GAMMA THETA. THEREFORE C=+.
        THETA DECAYS INTO 2 ETA, THEREFORE IG=0+.
        JP=2+ IS PREFERRED OVER 0+, HIGHER SPINS NOT
        STUDIED. NEEDS CONFIRMATION. OMITTED FROM TABLE.

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                    68  THETA(1640) MASS (MEV)

M           1640.      50.                 EDWARDS   82 CBAL  0 J/PSI,GAM 2ETA    1/82*

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                    68  THETA(1640) WIDTH (MEV)

W            220.     100.       70.       EDWARDS   82 CBAL  0 J/PSI,GAM 2ETA    1/82*

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                    68  THETA(1640) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      THETA(1640) INTO ETA ETA                          548+ 548

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REFERENCES FOR THETA(1640)


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EDWARDS  82 PRL 48 458        +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
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ω(1670)

45 OMEGA(1670,JPG=3--) I=0.

45 OMEGA(1670) MASS (MEV)

M			1636.	20.	ARMENISE	68 DBC		5.1 PI+N,P(3PI)0	9/68
M	Q		1695.0	20.0	BARNES	69 HBC	0	4.6 K-P,OMEG2PI	2/74
M			1670.	20.	KENYON	69 DBC		8. PI+N,P(3PI)0	8/69
M		200	1679.	17.	MATTHEWS	71 DBC		7.0 PI+N,P(3PI)0	1/71
M		500	1678.	14.	DIAZ	74 DBC		6. PI+N,P(3PI)0	1/74
M	Q	200	1660.	13.	DIAZ	74 DBC		6. PI+N,P(5PI)0	1/74
M	P	600	1669.	11.	WAGNER	75 HBC		7. PI+P,DEL++3PI	11/75
M	E	110	(1700.0)	APPROX.	CERRADA	77 HBC		4.2 K-P,LAM 3PI	12/77
M	P E	430	1673.0	12.0	BALTAY	78 HBC		15 PI+P,DEL 3PI	4/78
M			1650.0	12.0	CORDEN	78 OMEG		8-12 PI- P,N 3PI	12/77
M		60	1685.0	20.0	BAUBILLIE	79 HBC		8.2K- P,BACKWARD	12/79
M	AVG		1667.9	4.6	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)				

M E PHASE ROTATICN SEEN FOR JP 3- (RHO PI) WAVE.
M P FROM A FIT TO I=0. JP=3- RHO PI PARTIAL WAVE
M Q FROM (OMEGA PI PI) MODE

45 OMEGA(1670) WIDTH (MEV)

W			112.	60.	ARMENISE	68 DBC		5.1 PI+N,P(3PI)0	9/68
W	Q		190.)	(20.)	BARNES	69 HBC	0	4.6 K-P,OMEG2PI	1/73
W			100.	40.	KENYON	69 DBC		8. PI+N,P(3PI)0	8/69
W	S	200	155.	40.	MATTHEWS	71 DBC		7.0 PI+N,P(3PI)0	11/75
W		500	167.	40.	DIAZ	74 DBC		6. PI+N,P(3PI)0	1/74
W	Q	200	122.	39.	DIAZ	74 DBC		6. PI+N,P(5PI)0	1/74
W	P S	600	173.	28.	WAGNER	75 HBC		7. PI+P,DEL++3PI	11/75
W	P E	430	173.0	16.0	BALTAY	78 HBC		15 PI+P,DEL 3PI	4/78
W			253.0	39.0	CORDEN	78 OMEG		8-12 PI- P,N 3PI	12/77
W	S	60	160.0	80.0	BAUBILLIE	79 HBC		8.2K- P,BACKWARD	12/79
W	AVG		166.1	12.0	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)				

W E PHASE ROTATICN SEEN FOR JP 3- (RHO PI) WAVE.
W P FROM A FIT TO I=0, JP=3- RHO PI PARTIAL WAVE
W S WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE
W Q FROM (OMEGA PI PI) MODE

45 OMEGA(1670) PARTIAL DECAY MODES

		DECAY MASSES
P1	OMEGA(1670) INTO 3 PI (INCL. RHO PI)	134+ 134+ 134
P2	OMEGA(1670) INTO 5 PI (INCL. OMEGA PI+PI-)	134+ 134+ 134+ 134+
P3	OMEGA(1670) INTO RHO PI	769+ 134
P4	OMEGA(1670) INTO OMEGA 2 PI	782+ 134+ 134
P5	OMEGA(1670) INTO B(1235) PI	1233+ 134

45 OMEGA(1670) BRANCHING RATIOS

R1 OMEGA(1670) INTO (5 PI)/(3 PI) (P2)/(P1)
R1 200 0.97 0.28 DIAZ 74 DBC 6. PI+N,P(5PI)0 1/74

R2 OMEGA(1670) INTO (RHO PI)/(3 PI) (P3)/(P1)
R2 200 (0.70) OR MORE MATTHEWS 71 DBC 7.0 PI+N,P(3PI)0 11/71

R3 OMEGA(1670) INTO (OMEGA 2 PI)/(RHO PI) (P4)/(P3)
R3 100 0.71 0.27 DIAZ 74 DBC 6. PI+N,P(5PI)0 12/78

R4 OMEGA(1670) INTO (B(1235) PI)/(RHO PI) (P5)/(P3)
R4 POSSIBLY SEEN DIAZ 74 DBC 6. PI+N,P(5PI)0 1/74

R5 OMEGA(1670) INTO (B(1235)PI)/(OMEGA PI PI) (P5)/(P4)
R5 1.0 0.0 0.25 BAUBILLIE 79 HBC 8.2K- P,BACKWARD 12/79

REFERENCES FOR OMEGA(1670)

ARMENISE 68 PL 26B 336 +GHIDINI,FORINO+ (BARI+BGNA +FIRZ +ORSAY)

BARNES 69 PRL 23 142 +CHUNG,EISNER,FLAMINIO,+ (BNL)
KENYON 69 PRL 23 146 +KINSON,SCARR,+ (BNL+UCND+ORNL)

ARMENISE 70 LNC 4 199 +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)

MATTHEWS 71 PR D 3 2561 +PRENTICE,YOON,CARROLL,+ (TNTO+WISC)
MATTHEWI 71 LNC 1 361 +PRENTICE,YOON,CARROLL,+ (TNTO+WISC)

DIAZ 74 PRL 32 260 +DIBIANCA,FICKINGER,ANDERSON,+ (CASE+CARN)

WAGNER 75 PL 58B 201 +TABAK,CHEW (LBL) JP

CERRADA 77 NP B 126 241 +BLOCKZIJL,HEINEN,+ (AMST+CERN+NIJM+OXF) JP

BALTAY 78 PRL 40 87 +CAUTIS,KALELKAR (COLU) JP
CORDEN 78 NP B 138 235 +CORBETT,ALEXANDER,+ (BIRM+RHEL+TELA+LOWC)

BAUBILLI 79 PL B 89 131 BAUBILLIER+ (BIRM+CERN+GLAS+MSU+LPNP)

A_3(1680)

44 A3(1680,JPG=2--) I = 1

Evidence for the existence of the A_3 meson was previously confused due to its appearance near the $f\pi$ threshold in the diffractive-like process $\pi N \to \pi\pi\pi N$, much like the A_1 meson. While everybody agreed that there was a ~300 MeV wide $f\pi$ enhancement in the $J^P LM = 2^- S0$ partial wave at about 1650 MeV, some claimed non-resonant states (ANTIPOV1 73, ASCOLI1 73, BALTAY 77), while others saw evidence for a resonance in the phase variation with respect to other partial waves (OTTER 74, THOMPSON 74).

In the non-diffractive charge-exchange reaction $\pi^+ p \to \pi^+\pi^-\pi^0\Delta^{++}$ (WAGNER 75, BALTAY 77, CAUTIS 77) and in the hypercharge-exchanged reaction $K^- p \to \pi^+\pi^-\pi^0\Lambda$ at 4.2 GeV/c (CERRADA 77), there is no evidence for A_3 production.

Definitive proof for the resonant nature of the A_3 has been given by PERNEGR 78 (3π system diffractively produced on nuclei) and DAUM 80,81 and EVANGELISTA 81 (3π diffraction on proton target). In all these experiments the $2^- S0^+ (f\pi)$ partial-wave amplitude exhibits resonance-like phase variation.

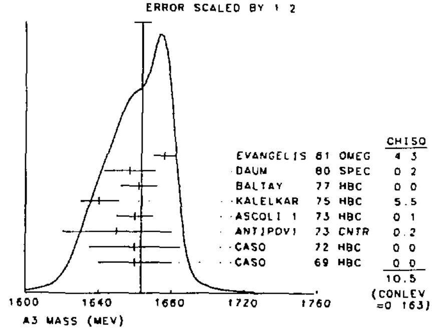
In a simultaneous fit to the four 2^- waves ($\varepsilon\pi$, $\rho\pi$, twice $f\pi$), DAUM 81 needs a heavier companion to the A_3 in addition to the Deck background. This fit probably gives the most reliable estimates of the A_3 and its heavier companion, which we name $\pi(2100)$.

34 A3 MASS (MEV)

M			1660.0	20.0	CASO	69 HBC	-	11 PI-P, PI-F	12/75
M		260	1660.	25.	CASO	72 HBC	+	11.7 PI+ P	12/75
M	P		1650.	30.	ANTIPOV1	73 CNTR	-	25.+40. PI- P	12/75
M	P		1660.	10.	ASCOLI 1	73 HBC	-	5.-25.PI- P,P A3	12/75
M	P E		(1600.)	(10.)	THOMPSON	74 HBC	+	13. PI+ P,P A3+	12/75
M		575	1640.	10.	KALELKAR	75 HBC	+	15 PI+P,P PI+F	12/75
M	P	2M	1662.0	10.0	BALTAY	77 HBC	0	15 PI+ P,P 3PI	12/77
M	R		(1650.0)		PERNEGR	78 CNTR	-	9+13+15,PI- NUC.	4/78
M	P D		1657.0	14.0	DAUM	80 SPEC	-	63-94 PI- P. 3PI	12/79
M	L		(1710.0)	(20.0)	DAUM	81 SPEC	-	63+94 PI- P	1/82*
M	P		1676.	6.	EVANGELIS	81 OMEG	-	12 PI-P,3PI P	1/82*
M	AVG		1663.5	4.7	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2) (SEE IDEOGRAM BELOW)				

M D CLEAR PHASE ROTATION SEEN IN (2-S),(2-P),(2-D) WAVES.
M D WE QUOTE CENTRAL VALUE AND SPREAD OF SINGLE-RESONANCE
M D FITS TO THREE CHANNELS.
M E EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
M L FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES. THIS SHOULD NOT BE
M L AVERAGED WITH ALL THE SINGLE RESONANCE FITS. SEE MINIREVIEW.
M P FROM A FIT TO JP=2-S (F PI) PARTIAL WAVE
M R CLEAR PHASE ROTATION SEEN IN (2-S) AND (2-P) WAVES

WEIGHTED AVERAGE = 1663.5 ± 4.7
ERROR SCALED BY 1.2



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                    34  A3 WIDTH (MEV)

W        297  240.0      50.0           ARMENISE  69 DBC  +   5.1 PI+D,3PI++-  5/70
W             (130.)                    CASO      69 HBC  -  11 PI- P          6/68
W             (150.0)                   CASO      69 HBC  - 11.0 PI-P,PI- F    6/68
W  P           200. TO 400.             CASO      72 HBC  +  11.7 PI+ P        1/72
W        260  190.      100.            CASO      72 HBC  +  11.7 PI+ P       12/75
W  P           300.      50.            ANTIPOV1  73 CNTR -  25.,40. PI- P    12/75
W  P           270.      60.            ASCOLI 1  73 HBC  -  5.-25.PI- P,P A3 12/75
W  P E        (310.)    (40.)           THOMPSON  74 HBC  +  13. PI+ P,P A3+  12/75
W        575  240.       30.            KALELKAR  75 HBC  +  15 PI+P,P PI+F   12/75
W  P    2000  285.0      60.0           BALTAY    77 HBC  0 15 PI+ P,P 3PI    12/77
    R        (400.0)                    PERNEGR   78 CNTR -  9+13+15,PI- NUC.  4/78
W  P D        219.0      20.0           DAUM      80 SPEC -  63-94 PI- P, 3PI 12/79
W   L         312.0      50.0           DAUM      81 SPEC -  63,94 PI- P       1/82*
W  P          260.       20.            EVANGELIS 81 OMEG -  12 PI-P,3PI P     1/82*
W             . . . . . . . . . . .
W   AVG       248.3      11.2   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   D     SEE NOTE D UNDER MASS.
W   E  EVIDENCE FOR A ROTATION OF THE PHASE CLAIMED.
W   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES. THIS SHOULD NOT BE
W   L  AVERAGED WITH ALL THE SINGLE RESONANCE FITS. SEE MINIREVIEW.
W  P   FROM A FIT TO JP=2- F PI PARTIAL WAVE
W   R  CLEAR PHASE ROTATION SEEN IN (2-S) AND (2-P) WAVES

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                    34  A3 PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      A3 INTO 3 PI                                          134+ 134+ 134
P2      A3 INTO RHO PI                                        134+ 769
P3      A3 INTO ETA PI                                        134+ 548
P4      A3 INTO 5 PI                                          139+ 139+ 139+ 139+
P5      A3 INTO K K*(892)                                     497+ 891
P6      A3 INTO K KBAR PI                                     497+ 497+ 134
P7      A3 INTO K KBAR                                        497+ 497
P8      A3 INTO F PI                                         1273+ 134
P9      A3 INTO OMEGA PI PI                                   782+ 134+ 134
P10     A3 INTO 3 PI                                          139+ 139+ 139
P11     A3 INTO EPSILON PI                                   1300+ 139

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                    34  A3 BRANCHING RATIOS

R2      A3+- INTO (PI+- RHO0)/(ALL PI+- PI+ PI-)          (P2C)/(P1C)
R2           (0.3) OR LESS            BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R2           (0.4) OR LESS            FERBEL    68 RVUE +-                   9/68
R2   L        0.29      0.05          DAUM      81 SPEC    63,94 PI- P       1/82*
P2   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

R3      A3+- INTO (PI+- F)/(ALL PI+- PI+ PI-)             (P8)/(P1C)
R3                  (WITH F INTO PI+ PI-)
R3           (0.59)                   BARTSCH   68 HBC  +  8. PI+ P,3PI P    8/69
R3            0.35      0.20          BALTAY    68 HBC  +  7-8.5 PI+P        5/68
R3            0.76      0.24    0.34  ARMENISE  69 DBC  +  5.1 PI+D,3PI++-   5/70
R3   L        0.61      0.04          DAUM      81 SPEC    63,94 PI- P       1/82*
R3   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.
R3            . . . . . . . . . .
R3  AVG       0.603     0.050   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R5      A3+- INTO (PI+- ETA)/(ALL PI+- PI+ PI-)           (P3)/(P1C)
R5                   (ALL ETA DECAYS)
R5           (0.09) OR LESS           BALTAY    68 HBC  +  7-8.5 PI+P        5/68
R5           (0.10) OR LESS           CRENNELL  70 HBC  -  6. PI- P,F PI     5/70

R6      A3+- INTO (PI+- 2PI+ 2PI-)/(ALL PI+- PI+ PI-)     (P4C)/(P1C)
R6           (0.1)  OR LESS           BALTAY    68 HBC  +  7,8.5 PI+ P       6/68
R6           (0.10) OR LESS           CRENNELL  70 HBC  -  6. P+- P,F P+     5/70

R11     A3+-  INTO  (PI+- EPSILON)/(ALL PI+- PI+ PI-)     (P11)/(P1C)
R11                 (WITH EPSILON INTO PI+ PI-)
R11  L        0.10      0.05          DAUM      81 SPEC    63,94 PI- P       1/82*
R11  L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

R12     D/S RATIO FOR A3 INTO F PI
R12  L        0.22      0.10          DAUM      81 SPEC    63,94 PI- P       1/82*
R12  L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

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REFERENCES FOR A3


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FORINO    65 PL 19 68            +GESSAROLI+          (BGNA+BARI+FIRZ+ORSA+SACL)

FOCACCI   66 PRL  17  890        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT    66 PL   22  714        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LUBATTI   66 THESIS BERKELEY     H.J.LUBATTI                          (LRL)1-2-
VETLITSK  66 PL   21  579        VETLITSKY,GUSZAVIN,KLIGER,ZOLGANOV+  (ITEP)

DANYSZ    67 NC 51 A 801         DANYSZ+FRENCH+SIMAK                  (CERN)
DUBAL     67 NP B3 435           CERN MISSING MASS SPECTROMETER GROUP (CERN)
   ALSO   68 THESIS 1456         L.DUBAL                             (GENEVE)

BALTAY    68 PRL 20 887          +KUNG+YEH+FERBEL+     (COLU+ROCH+RUTG+YALE)I=1
BARTSCH   68 NP B 7 345          +KEPPEL,KRAUS,+            (AACH+BERL+CERN) JP
CASO      68 NC 54 A 583         +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
FERBEL    68 PHILA.CONF.335      T.FERBEL                          (ROCHESTER)
IOFFREDO  68 PRL 21 1212         +BRANDENBURG,BRENNER,EISENSTEIN+  (HARVARD)
LANSA     68 PR 166 1395         +CASON+BISWAS+DERADO+GROVES+      (NOTREDAME)

ARMENISE  69 LNC 2 501           +GHIDINI,FORINO,CARTACCI+   (BARI+BGNA+FIRZ)
BARNES    69 PRL 23 142          +CHUNG,EISNER,FLAMINIO,+               (BNL)
CASO      69 LNC 2 437           +CONTE,TOMASINI,CANTORE+    (GENO+MILA+SACL)

BRANDENB  70 NP B16 369          +BRENNER,IOFFREDO,JOHNSON,KIM+      (HARVARD)
CRENNELL  70 PRL 24 781          +KARSHON,LAI,SCARR,SIMS                (BNL)
CHIEN     70 PHILAD.CONF.P.275 C.Y.CHIEN, REVIEW            (JOHNS HOPKINS)
MIYASHIT  70 PR D 1 771          MIYASHITA,VON KROGH,KOPELMAN,LIBBY    (COLO)

BEKETOV   71 SJNP 4 765          +SOMBKOWSKY,KONOWALOV,KRUTSCHININ,+ (ITEP)  JP
PALER     71 PRL 26 1675         +BADEWITZ,BARTON,MILLER,PALFREY,TEBES(PURD)

ALEXANDE  72 NP B 45 29          ALEXANDER,BAR-NIR,BENARY,DAGAN,+      (TELA)
ARMENISE  72 LNC 4 201           +FORINO,CARTACCI,+          (BARI+BGNA+FIRZ)
CASO      72 NP B 36 349         +MADDOCK,BASSLER+(DURH+GENO+DESY+MILA+SACL)
HARRISON  72 PRL 28 775          +HEYDA,JOHNSON,KIM,LAW,MUELLER,+      (HARV)
SALZBERG  72 NP B 41 397         +HARRISON,HEYDA,JOHNSON,KIM,LAW,+     (HARV)

ANTIPOV1  73 NP B 63 153         +ASCOLI,BUSNELLO,FOCACCI,+     (CERN+SERP)  JP
ANTIPOV2  73 NP B 63 141         +ASCOLI,BUSNELLO,FOCACCI,+     (CERN+SERP)  JP
ASCOLI 1  73 PR D 7 669          INTERNAT. COLLABORATION             (ILL+)  JP
ASCOLI 2  73 PR D 8 3894         +JONES,WEINSTEIN,WYLO               (ILL)   JP

ASCOLI    74 PR D9 1963          +CUTLER,JONES,KRUSE,ROBERTS,WEINSTEIN+(ILL)
LICHTMAN  74 NP B81 31           +BISWAS,CASON,KENNEY,MCGAHAN,+        (NDAM)
OTTER     74 NP B80 1            +RUDOLPH+         (AACH+BERL+BONN+CERN+HEID) JP
TABAK     74 BOSTON CONF.        +RONAT,ROSENFELD,LASINSKI+       (LBL+SLAC) JP
THOMPSON  74 PRL 32 331          +BADEWITZ,GAIDOS,MCILWAIN,PALER,+    (PURD) JP
    ALSO  74 NP B69 381          THOMPSON,BADEWITZ,GAIDOS,MCILWAIN+   (PURD) JP

BEKETOV   75 SJNP 20 379         +ZOMBKOVSKII,KAIDALON,KONOVALOV+     (ITEP)
EMMS      75 PL 60 B 109         +JONES,KINSON,BELL,DALE+    (BIRM+DURH+RHEL) JP
HORNE     75 PR D11 996          +S.HAGOPIAN,V.HAGOPIAN,BENSINGER+(FSU+BRAN)
KALELKAR  75 THESIS(NEVIS 207) M.S.KALELKAR                           (COLU)
WAGNER    75 PL 58B 201          +TABAK,CHEW                           (LBL) JP

BALTAY    77 PRL 39 591          +CAUTIS,KALELKAR                 (COLUMBIA) JP
CAUTIS    77  THESIS NEVIS 221 C.V.CAUTIS                         (COLUMBIA) JP
CERRADA   77 NP B 126 241        +BLOCKZIJL,HEINEN,+     (AMST+CERN+NIJM+OXF) JP

BALTAY    78 PR D 17 52          +CAUTIS,COHEN,CSORNA,KALELKAR+  (COLU+BING)
CORDEN    78 NP B 136 77         DOWELL,GARVEY,JOBES+   (BIRM+RHEL+TELA+LOWC) JP
PERNEGR   78 NP B 134 436        +AEBISCHER+             (ETH+CERN+LOIC+MILA)
ROBERTS   78 PR D 18 59          +KRUSE,EDELSTEIN+      (ILL+CARN+NWES+ROCH)

DAUM      80 PL 89 B 285         +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL) JP

DAUM      81 NP B 182 269        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
EVANGELI  81 NP B 178 197        EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
    ALSO  81 NP B 186 594        (ERRATUM)
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$\phi'(1680)$

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67  PHI PRIME(1680,JPG=1--) I=0

FIRST IDENTIFIED USING DALITZ PLOT ANALYSIS OF
E+E- INTO K K* (BIZOT 80, DELCOURT 81)

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                    67  PHI PRIME MASS (MEV)

M            (1652.0)   (17.0)        COSME     79 OSPK  0 E+ E-,3PI         12/79
M    AB      (1700.)                  ASTON 1   80 OMEG    25-70 GAM,OM 2PI   6/81*
M            (1647.)    (10.)         BIZOT     80 DM1   0 E+ E-, ALL MODES   3/82*
M    C       (1657.)    (13.)         CORDIER   81 DM1     E+E-,OMEGA 2 PI    9/81*
M            (1670.)                  MANE      81 DM1     E+E-,K+K-,KL KS    9/81*

M        21  1679.       34.          ESPOSITO  80 MEA     E+E-,3 PI          6/81*
M     B      1690.       10.          ASTON     81 OMEG    25-70 GAM P,K+K-   9/81*
M            1660.       20.          DELCOUR2  81 DM1     E+E-,ALL MODES     9/81*
M            . . . . . . . . . . .
M    AVG     1683.7       9.6   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M    A   RESONANCE NOT DISTINGUISHED FROM THRESHOLD ENHANCEMENT
M     B  JP NOT UNAMBIGUOSLY 1-
M    C   FIT TO ONE CHANNEL ONLY,NEGLECT INTERFERENCE WITH OMEGA,RHO PRIME

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                    67  PHI PRIME WIDTH (MEV)

W             (42.0)    (17.0)        COSME     79 OSPK  0 E+ E-,3PI         12/79
W    AB      (500.)                   ASTON 1   80 OMEG    25-70 GAM,OM 2PI   6/81*
W            (152.)     (19.)         BIZOT     80 DM1   0 E+ E-, ALL MODES   3/82*
W    C       (136.)     (46.)         CORDIER   81 DM1     E+E-,OMEGA 2 PI    9/81*
W            (130.)                   MANE      81 DM1     E+E-,K+K-,KL KS    9/81*

W        21    99.       49.          ESPOSITO  80 MEA     E+E-,3 PI          6/81*
W     B       100.       40.          ASTON     81 OMEG    25-70 GAM P,K+K-   9/81*
W             150.       30.          DELCOUR2  81 DM1     E+E-,ALL MODES     9/81*
W             . . . . . . . . . . .
W    AVG      125.6      21.6   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    A   RESONANCE NOT DISTINGUISHED FROM THRESHOLD ENHANCEMENT
W     B  JP NOT UNAMBIGUOSLY 1-
W    C   FIT TO ONE CHANNEL ONLY,NEGLECT INTERFERENCE WITH OMEGA,RHO PRIME

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                    67  PHI PRIME PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      PHI PRIME INTO OMEGA 2 PI                             782+ 139+ 139
P2      PHI PRIME INTO 3 PI                                   139+ 139+ 134
P3      PHI PRIME INTO K KBAR                                 493+ 493
P4      PHI PRIME INTO K*(892) KBAR + C.C.                    782+ 493

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                    67  PHI PRIME BRANCHING RATIOS

R1      PHI PRIME INTO (OMEGA PI+PI-)/(K*(892) KBAR+C.C.)(P1)/(P4)
R1           (0.25) OR LESS           DELCOUR2  81 DM1     E+E-               1/82*

R2      PHI PRIME INTO (K KBAR)/(K*(892) KBAR+C.C.)        (P3)/(P4)
R2            0.15      0.08          DELCOUR2  81 DM1     E+E-               1/82*

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                    67  PHI PRIME    G(I)*G(E+E-)/G(TOTAL)    (KEV)

        THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH INTO
        E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
        CROSS SECTION INTO CHANNEL(I) IN E+E- ANNIHILATION.
        WE ONLY LIST DATA NOT HAVING BEEN USED TO DETERMINE THE PARTIAL
        WIDTH G(I) OR THE BRANCHING RATIO G(I)/TOTAL.

G1      G(OMEGA 2PI)*G(E+E-)/G(TOTAL)
G1   M       (0.017)APPROX            BIZOT     80 DM1   0 E+ E-              3/82*

G3      G(K KBAR)*G(E+E-)/G(TOTAL)
G3   M       (0.053)  (0.035)         BIZOT     80 DM1   0 E+ E-              3/82*

G4      G(K*(892) KBAR + C.C.)*G(E+E-)/G(TOTAL)
G4   M       (0.413)  (0.033)         BIZOT     80 DM1   0 E+ E-              3/82*

G    M   MODEL DEPENDENT

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                              REFERENCES FOR PHI PRIME

COSME     79 NP 9 152 215          +DUDELZAK,GRELAUD,JEAN-MARIE,JULLIAN+ (IPNI

ASTON 1   80 NP B 174 269          (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+)
ASTON 2   80 PL 92 B 219           (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+)
BIZOT     80 MADISON CONF. 546     +BISELLO,BUON,CORDIER,DELCOURT,+(LALO+USTL)
ESPOSITO  80 LNC 28 195            +MARINI,PATTERI,NIGRO+(FRAS+NAPL+PADO+ROMA)

ASTON     81 PL 104 B 231          (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+)
CORDIER   81 PL 106 B 155          +BISELLO,BIZOT,BUON,DELCOURT,MANE   (ORSAY)
DELCOURT  81 PL 99 B 257           +BISELLO,BIZOT,BUON,CORDIER,MANE    (ORSAY)
DELCOUR2  81 BONN CONF. 205        B.DELCOURT                          (ORSAY)
MANE      81 PL 99 B 261           +BISELLO,BIZOT,BUON,CORDIER,DELCOURT(ORSAY)
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g(1690)

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15  G(1690,JPG = 3-+) I=1
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                        15  G MASS (MEV)

M         WE AVERAGE ONLY THE 2PI AND KKBAR MODES WHICH HAVE LARGE STATISTICS

M     2 PI MODE
M
M            1670.0      30.0              GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M           (1683.)     (13.)              ARMENISE  68 DBC    0 5.1 PI+ D          6/68
M           (1737.0)    (23.0)             ARMENISE  70 DBC    0 9 PI+ N            1/71
M        122 1650.0      35.0              BARTSCH   70 HBC  +  8 PI+ P,2 PI        5/70
M            1687.       21.               STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D    2/72
M            1678.       12.               MATTHEWS  71 DBC   0  7. PI+ N           2/72
M   E    600 1690.        7.               ENGLER    74 DBC   0 6. PI+N,PI+PI-P   12/75
M   G        1693.        8.               GRAYER    74 ASPK  0 17 PI-P,PI+PI-N    2/74
M   GI      (1692.)     (12.)              ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75
M    I      (1722.)      (3.)              HYAMS     75 ASPK  0 17 PI-P,PI+PI-N   12/75
M   E    175 1678.0      12.0              ANTIPOV   77 CIBS  0 25 PI-P,P 3PI      1/82*
M        476 1679.0      11.0              BALTAY    78 HBC   0 15 PI+P,PI+PI-     4/78
M     M     (1734.0)    (10.0)             CORDEN    79 OMEG    12-15PI-P, N 2PI  12/79
M            1677.       14.               EVANGELIS 81 OMEG  - 12 PI-P,2PI P      1/82*
M
M   E     MASS ERRORS ENLARGED BY US TO WIDTH/SQRT(N).SEE K* TYPED NOTE
M   G     USES SAME DATA AS HYAMS 75
M    I    FROM PHASE-SHIFT ANALYSIS
M    I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
M     M   FROM A PHASE SHIFT SOLUTION CONTAINING A F PRIME WIDTH
M     M   TWO TIMES LARGER THAN THE K KBAR RESULT.
M
M     K KBAR + K KBAR PI MODE
M
M            1690.0      16.0              ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI   8/69
M            1692.        6.               BLUM      75 ASPK   018.4 PI-P,N K+K-  11/75
M   P S   6K 1698.       12.               MARTIN 1  78 SPEC    10 PI P,KS K- P    4/78
M            1699.0       5.0              ALPER     80 CNTR  0 62 PI-P,K+ K- N    1/82*
M     L     (1694.0)    (8.0)              COSTA     80 OMEG    10. PI-P,K+ K- N   1/82*
M
M     L   THEY CANNOT DISTINGUISH BETWEEN G AND OMEGA(1670).
M   P     FROM A FIT TO JP=3- PARTIAL WAVE.
M     S   SYSTEMATIC ERROR ON MASS SCALE SUBTRACTED
M
M            . . . . . . . . . . .
M   AVG      1690.9       2.6       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M     (4PI)+- MODE
M
M            1720.       15.               BALTAY    68 HBC  +   7, 8.5 PI+ P       6/68
M        144 1680.0      40.0              BARTSCH   70 HBC  +  8 PI+ P,4 PI        4/71
M   F    102(1689.0)    (20.0)             BARTSCH   70 HBC  +  8 PI+ P,2 RHO       4/71
M            1705.0      21.0              CASO      70 HBC   - 11.2PI-P,RHO 2PI    5/70
M            1630.       15.               HOLMES    72 HBC  +  10.-12. K+ P        1/73
M            1687.       20.               CASON     73 HBC  -  8.,18.5 PI- P       1/74
M   F       (1685.)     (14.)              CASON     73 HBC  -  8.,18.5 PI- P       1/74
M   F     66(1733.)      (9.)              KLIGER    74 HBC   - 4.5 PI-P,P 4PI     12/75
M            1670.       10.               THOMPSON  74 HBC  +  13 PI+ P           12/75
M        177 1665.0      15.0              BALTAY    78 HBC  +  15 PI+P,P 4PI       4/78
M   A       (1694.)      (6.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M   B       (1718.)     (10.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M   C       (1673.)      (9.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M
M            . . . . . . . . . . .
M   AVG      1675.2      11.1       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
                               (SEE IDEOGRAM BELOW )

M   A     FROM RHO- RHO0 MODE, NOT INDEPENDENT OF (B), (C)
M   B     FROM (A2)- PI0 MODE, NOT INDEPENDENT OF (A), (C)
M   C     FROM (A2)0 PI- MODE, NOT INDEPENDENT OF (A), (B)
M   F     FROM (RHO+- RHO0) MODE
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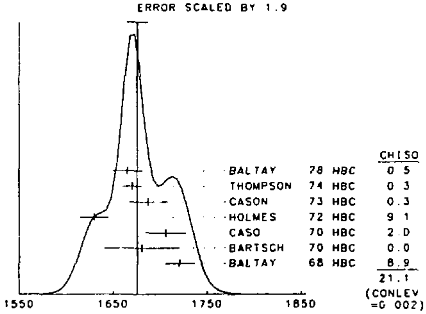
WEIGHTED AVERAGE = 1675.2 ± 11.1
ERROR SCALED BY 1.9



G MASS (MEV), (4PI)+- MODE

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M     OMEGA PI  MODE
M
M            1654.       24.               BARNHAM   70 HBC  +  10 K+ P,OMEGA PI   6/70
M            1686.        9.               THOMPSON  74 HBC  +  13 PI+ P           12/75
M            1666.0      14.0              GESSAROLI 77 HBC     11 PI-P,OMEGA PI 12/77
M            1690.       15.               EVANGELIS 81 OMEG  - 12 PI-P,OME PI P  1/82*
M
M            . . . . . . . . . . .
M   AVG      1680.1       6.6       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                        15  G WIDTH (MEV)

M         WE AVERAGE ONLY THE 2PI AND KKBAR MODES WHICH HAVE LARGE STATISTICS

M     2 PI MODE
M
M             180.0      40.0              GOLDBERG  65 HBC    0 6 PI+D, 8 PI-P
M             188.       49.               ARMENISE  68 DBC    0 5.1 PI+ D          6/68
M             171.0      65.0              ARMENISE  70 DBC    0 9 PI+ D            1/71
M        122  180.0      30.0              BARTSCH   70 HBC  +  8 PI+ P,2 PI        5/70
M             267.       72.       46.     STUNTEBEC 70 HDBC  0 8. PI-P,5.4 PI+D    2/72
M             156.       36.               MATTHEWS  71 DBC   0  7. PI+ N           2/72
M        600  167.       40.               ENGLER    74 DBC   0 6. PI+N,PI+PI-P   12/75
M   G         200.       18.               GRAYER    74 ASPK  0 17 PI-P,PI+PI-N    2/74
M   GI       (240.)     (30.)              ESTABROOK 75 RVUE    17 PI-P,PI+PI-N   12/75
M    I       (267.)     (30.)              HYAMS     75 ASPK  0 17 PI-P,PI+PI-N   12/75
M   T    175  162.0      50.0              ANTIPOV   77 CIBS  0 25 PI-P,P 3PI      1/82*
M        476  116.0      30.0              BALTAY    78 HBC   0 15 PI+P,PI+PI-     4/78
M            (206.0)   OR MORE  CL=.84     BECKER    79 ASPK  0 17 PI- P POLARIZ  12/79
M     M      (322.0)    (35.0)             CORDEN    79 OMEG    12-15PI-P, N 2PI  12/79
M             246.       37.               EVANGELIS 81 OMEG  - 12 PI-P,2PI P      1/82*
M
M    I    FROM PHASE-SHIFT ANALYSIS
M    I    ERROR TAKES ACCOUNT OF SPREAD OF DIFFERENT PHASE-SHIFT SOLUTIONS
M   G     USES SAME DATA AS HYAMS 75 AND BECKER 79
M     M   FROM A PHASE SHIFT SOLUTION CONTAINING A F PRIME WIDTH
M     M   TWO TIMES LARGER THAN THE K KBAR RESULT.
M   T     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N).SEE K* TYPED NOTE
M
M     K KBAR + K KBAR PI MODE
M
M             112.0      60.0              ADERHOLZ  69 HBC  +   8 PI+ P,KKBARPI   8/69
M             205.       20.               BLUM      75 ASPK   018.4 PI-P,N K+K-  11/75
M   P  6000   199.       40.               MARTIN 1  78 SPEC    10 PI P,KS K- P    4/78
M             219.0       4.0              ALPER     80 CNTR  0 62 PI-P,K+ K- N    1/82*
M     L      (186.0)    (11.0)             COSTA     80 OMEG    10. PI-P,K+ K- N   1/82*
M
M     L   THEY CANNOT DISTINGUISH BETWEEN G AND OMEGA(1670).
M   P         FROM A FIT TO JP=3- PARTIAL WAVE.
M
M            . . . . . . . . . . .
M   AVG       213.5       5.4       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                               (SEE IDEOGRAM BELOW )
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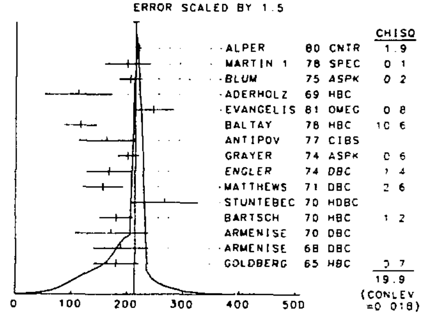
WEIGHTED AVERAGE = 213.5 ± 5.4
ERROR SCALED BY 1.5



G WIDTH (MEV), PI PI + K KBAR MODES

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M     (4PI)+- MODE
M
M             100.       35.               BALTAY    68 HBC  +   7, 8.5 PI+ P       6/68
M        144  135.0      30.0              BARTSCH   70 HBC  +  8 PI+ P,4 PI        4/71
M         90 (180.0)    (30.0)             BARTSCH   70 HBC  +  8 PI+ P,A2 PI       4/71
M   F    102 (160.0)    (30.0)             BARTSCH   70 HBC  +  8 PI+ P,2 RHO
M             130.       30.               HOLMES    72 HBC  +  10.-12. K+ P        1/73
M             169.       70.       48.     CASON     73 HBC  -  8.,18.5 PI- P       1/74
M   F        (125.)     (83.)     (35.)    CASON     73 HBC  -  8.,18.5 PI- P       1/74
M   F     66 (150.)                        KLIGER    74 HBC   - 4.5 PI-P,P 4PI     12/75
M             106.       25.               THOMPSON  74 HBC  +  13 PI+ P           12/75
M        177  105.0      30.0              BALTAY    78 HBC  +  15 PI+P,P 4PI       4/78
M   A        (123.)     (13.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M   B        (230.)     (28.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M   C        (184.)     (33.)              EVANGELI  81 OMEG  - 12 PI-P,(4PI)-P    3/82*
M
M            . . . . . . . . . . .
M   AVG       117.8      12.9       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   A     FROM RHO- RHO0 MODE, NOT INDEPENDENT OF (B), (C)
M   B     FROM (A2)- PI0 MODE, NOT INDEPENDENT OF (A), (C)
M   C     FROM (A2)0 PI- MODE, NOT INDEPENDENT OF (A), (B)
M   F     FROM (RHO+- RHO0) MODE

M     OMEGA PI  MODE
M
M             130.       73.       43.     BARNHAM   70 HBC  +  10 K+ P,OMEGA PI   6/70
M              89.       25.               THOMPSON  74 HBC  +  13 PI+ P           12/75
M             160.0      56.0              GESSAROLI 77 HBC     11 PI-P,OMEGA PI 12/77
M             190.       65.               EVANGELIS 81 OMEG  - 12 PI-P,OME PI P  1/82*
M
M            . . . . . . . . . . .
M   AVG       112.9      20.6       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                  15   G PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      G INTO PI PI                                       139+ 139
P2      G INTO 4PI(INCL. PI0'S)                            139+ 139+ 139+ 139
P3      G INTO K KBAR PI                                   497+ 497+ 139
P4      G INTO K KBAR                                      497+ 497
P5      G INTO PI PI RHO (EXCLUDING 2RHO+A2 PI)            139+ 139+ 769
P6      G INTO A2 PI                                      1318+ 139
P7      G INTO OMEGA PI                                    139+ 782
P8      G INTO 2 RHO                                       769+ 769
P9      G INTO PHI PI                                     1019+ 139
P10     G INTO ETA PI                                      548+ 139
P11     G+- INTO  3 PI CHARGED AND 1 PI0                   139+ 139+ 139+ 139
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4
P 1 .2380+-.0129
P 2   -.7561   .7090+-.0189
P 3    .1510    -.7415   .0378+-.0122
P 4   -.1452    -.0478    -.0230  .0151+-.0031

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                  15   G BRANCHING RATIOS

R1      G INTO (2PI)/TOTAL                                  (P1)
R1   P        0.22      0.04          MATTHEWS  71 HOBC  0  7. PI+N,PI-P     2/72
R1  G        (0.245)   (0.006)        ESTABROOK 75 RVUE    17 PI-P,PI+PI-N  12/75
R1            0.259     0.018   0.019 BECKER    79 ASPK  0 17 PI- P POLARIZ 12/79
R1            0.23      0.02          CORDEN    79 OMEG    12-15PI-P, N 2PI 12/79
R1  G   FROM PHASE-SHIFT ANALYSIS OF HYAMS 75 DATA
R1  H   INCLUDED IN BECKER 79 ANALYSIS
R1  P   OPE MODEL USED IN THIS ESTIMATION
R1            . . . . . . . . . .
R1  AVG       0.243     0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R1  FIT       0.238     0.013  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      G INTO(2 PI)/(4 PI) CHARGED                         (P1)/(P11)
R2            (0.12) OR LESS          BALLAM    71 HBC  -  16. PI- P          2/72
R2            (0.21  OR LESS          HOLMES    72 HBC  +  10.-12. K+ P       1/73
R2             0.35     0.11          CASON     73 HBC  -  8.,18.5 PI- P      1/74

R3      G0 INTO(2 PI)/(4 PI) ALL                            (P1)/(P2)
R3             0.30     0.10          BALTAY    78 HBC   0 15 PI+P,P 4PI      4/78
R3            . . . . . . . . . .
R3  FIT        0.336    0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      G+- INTO (K KBAR)/(2PI)                             (P4)/(P1)
R4             0.191    0.040   0.037 GORLICH   80 ASPK  0 17,18 PI-P POLAR 12/79
R4            . . . . . . . . . .
R4  FIT        0.063    0.014  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R5      G+- INTO (K KBAR PI)/(2PI)                          (P3)/(P1)
R5 A           0.16     0.05          BARTSCH   70 HBC  +  8. PI+ P           2/72
R5 A    INCREASED BY US TO CORRESPOND TO G INTO (2PI)=.24
R5            . . . . . . . . . .
R5  FIT        0.159    0.051  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      G+- INTO (RHO 2PI)/(4 PI) CHARGED                   (P5+P6+P8)/(P11)
R6             CONSISTENT WITH 1.     CASO      68 HBC  -  11 PI- P           6/68
R6            (1.1      (0.15)        BARTSCH   70 HBC  +  8. PI+ P           2/72
R6             0.88     0.15          BALLAM    71 HBC  -  16. PI- P          2/72
R6             0.96     0.21          BALTAY    78 HBC  +  15 PI+P,P 4PI      4/78
R6            . . . . . . . . . .
R6  AVG        0.91     0.12   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      G+- INTO (2RHO)/(4 PI) CHARGED                      (P8)/(P11)
R7            (0.7)     (0.15)        BARTSCH   70 HBC  +  8. PI+ P           2/72
R7       66   (0.56)                  KLIGER    74 HBC  -  4.5 PI-P,P 4PI    12/75
R7  T         (0.13)    (0.09)        THOMPSON  74 HBC  +  13 PI+ P          12/75
R7             0.12     0.11          BALTAY    78 HBC  +  15 PI+P,P 4PI      4/78
R7  T   RHO RHO AND A2 PI MODES ARE INDISTINGUISHABLE

R8      G+- INTO (2 RHO)/(ALL RHO 2PI)                      (P8)/(P5+P6+P8)
R8             0.48     0.16          CASO      68 HBC  -  11 PI- P           6/68

R9      G+- INTO (PI A2)/(4 PI) CHARGED                     (P6)/(P11)
R9            (0.6)                   BALTAY    68 HBC  +  7,8.5 PI+P         6/68
R9            (0.6)     (0.15)        BARTSCH   70 HBC  +  8. PI+ P           2/72
R9             NOT SEEN               CASON     73 HBC     8.,18.5 PI- P      1/74
R9  T         (0.36)    (0.14)        THOMPSON  74 HBC  +  13 PI+P            4/78
R9             0.66     0.08          BALTAY    78 HBC  +  15 PI+P,P 4PI      4/78
R9  T   RHO RHO AND A2 PI MODES ARE INDISTINGUISHABLE

R10     G+- INTO (PI OMEGA)/(4 PI) CHARGED                  (P7)/(P11)
R10            0.25     0.10          BALTAY    68 HBC  +  7-8.5 PI+P         5/68
R10            0.25     0.10          JOHNSTON  68 HBC  -  7.0 PI- P          6/68
R10            0.12     0.07          BALLAM    71 HBC  -  16. PI- P          2/72
R10           (0.09) OR LESS          KLIGER    74 HBC  -  4.5 PI-P,P 4PI    12/75
R10            0.33     0.07          THOMPSON  74 HBC  +  13 PI+ P          12/75
R10           (0.11) OR LESS  CL=0.95 BALTAY    78 HBC  +  15 PI+P,P 4PI      4/78
R10           . . . . . . . . . .
R10 AVG        0.233    0.050  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

R11     G+- INTO (PI PHI)/(4 PI) CHARGED                    (P9)/(P11)
R11           (0.11) OR LESS          BALTAY    68 HBC  +  7,8.5 PI+P         6/68

R12     G+- INTO (PI+- 2PI+ 2PI- PI0)/(4 PI) CH.
R12           (0.15) OR LESS          BALTAY    68 HBC  +  7,8.5 PI+ P        6/68

R13     G+- INTO (PI ETA)/(4 PI) CHARGED                    (P10)/(P11)
R13           (0.02) OR LESS          THOMPSON  74 HBC  +  13 PI+ P          12/75

R14     G+- INTO (K KBAR)/TOTAL                             (P4)
R14  B         0.013    0.004         MARTIN 2  78 SPEC  -10 PI P,KS K- P     4/78
R14            0.013    0.003         COSTA     80 OMEG  0 10 PI-P,K+ K- N    1/82*
R14  B  FROM SQRT(P1*P4)=0.056+-0.034 ASSUMING (2PI)/TOTAL=P1=0.24
R14           . . . . . . . . . .
R14 AVG        0.0130   0.0024  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R14 FIT        0.0151   0.0031 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R16     G+- INTO (PI OMEGA)/(PI OMEGA+ 2 RHO)                (P7)/(P7+P8)
R16            0.22     0.08          CASON     73 HBC  -  8.,18.5 PI- P      1/74

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                          REFERENCES FOR G

BELLINI  65 NC 40 A 948         BELLINI,DI CORATO,DUIMIC,FIORINI    (MILANO)
DEUTSCHM 65 PL 18 351           M.DEUTSCHMANN ET AL     (AACHEN+BERLIN+CERN)
FORINO   65 PL 19 65            FORINO,GESSAROLI +   (BOLOGNA+ORSAY+SACLAY)
GOLDBERG 65 PL 17 354           GOLDBERG+ (CERN+EPOL+ORSAY+MILANO+CEA-SACL)

EHRLICH  66 PR 152 1194         R. EHRLICH,W.SELOVE,H.YUTA     (PENNSYLVANIA)
FOCACCI  66 PRL  17  890        CERN MISSING MASS SPECTROMETER GROUP (CERN)
LEVRAT   66 PL   22  714        CERN MISSING MASS SPECTROMETER GROUP (CERN)
SEGUINOT 66 PL 19 712           CERN MISSING MASS SPECTROMETER GROUP (CERN)

ABRAMS   67 PRL 18 620          +KEHOE+GLASSER+SECHI-ZORN+WOLSKY (MARYLAND)
DANYSZ   67 PL 24B 309          +FRENCH+KINSON+SIMAK+        (CERN+LIVERPOOL)
DUBAL    67 NP B3 435           +FOCACCI+KIENZLE+LECHANOINE+LEVRAT+  (CERN)
   ALSO  68 THESIS 1456         L.DUBAL                             (GENEVE)
FRENCH   67 NC 52A 442          +KINSON+MCDONALD+RIDDIFORD+      (CERN+BIRM)

ARMENISE 68 NC 54 A 599         +FORINO+CARTACCI+(BARI+BGNA +FIRENZE+ORSAY)I
BALTAY   68 PRL 20 887          +KUNG+YEH+FERBEL+       (COLU+ROCH+RUTG+YALE)I=1
BISWAS   68 PRL 21 50           +CASON,DZIERBA,GROVES,KENNEY,+        (NDAM)
BOESEBEC 68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)
CASO     68 NC 54 A 983         +CONTE+CORDS+DIAZ+  (GENOVA+HAMB+MILA+SACL)
CRENNELL 68 PL 28 B 136         +KARSHON,LAI,SCARR,SKILLICORN          (BNL)
JOHNSTON 68 PRL 20 1414         +PRENTICE,STEENBERG,YOON       (TORONTO+WISC)JP

ADERHOLZ 69 NP B 11 259         +BARTSCH,+          (AACH+BERL+CERN+JAGL+WARS)
ANDERSON 69 PRL 22 1390         +COLLINS,BLIEDEN+                  (BNL+CARN)
BARISH   69 P  184  1375        +SELOVE,BISWAS,CASON,+        (PENN+NDAM+ROCH)
CASO     69 NC 62 A 755         +CONTE,BENZ,+     (GENO+DESY+HAMB+MILA+SACL)
VETLITSK 69 SJNP 9 461          +GUZHAVIN,KLIGER,KOLGANOV,LEBEDEV+     (ITEP)

ARMENISE 70 LNC 4  199          +GHIDINI,FORINO,CARTACCI,+ (BARI+BGNA+FIRZ)
BARNHAM  70 PRL 24 1083         +COLLEY,JOBES,KENYON,PATHAK,RIDDIFORD(BIRM)
BARTSCH  70 NP B 22 109         +KRAUS,TSANOS,GROTE,KOTZAN+(AACH+BERL+CERN)
CASO     70 LNC 3 707           +CONTE,TOMASINI,CORDS+(GENO+HAMB+MILA+SACL)
KRAMER   70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+     (PURDUE)
MAURER   70  THESIS NO.588      G.MAURER                        (STRASBOURG)
STUNTEBE 70 PL 32 B 391         STUNTEBECK,KENNEY,DEERY,BISWAS,CASON+(NDAM)

BALLAM   71 PR D 3 2606         +CHADWICK,GUIRAGOSSIAN,JOHNSON,+      (SLAC)
BRAUN    71 NP B 30 213         +FRIDMAN,GERBER,GIVERNAUD,KAHN,+      (STRB)
GRAYER   71 PL 35 B 610         +HYAMS,JONES,SCHLEIN,BLUM,+      (CERN+MPIM)JP3-
MATTHEWS 71 NP B 331            +PRENTICE,YOON,CARROLL,+         (TNTO+WISC)JP3-

ARMENISE 72 LNC 4 205           +FORINO,CARTACCI,+           (BARI+BGNA+FIRZ)
   ALSO  75 LNC 14 177          +FOGLI-MUCIACCIA,FORINO+     (BARI+BGNA+FIRZ)  JP
BOWEN    72 PRL 29 890          +EARLES,FAISSLER,BLIEDEN,+          (NEAS+STON)
CLAYTON  72 NP B 47 81          +MASON,MUIRHEAD,RIGOPOULOS,+        (LIVP+PATR)
GRAYER   72 PHIL.CONF.PROC. 5   +HYAMS,JONES,SCHLEIN,BLUM,DIETL+(CERN+MPIM)
HOLMES   72 PR D 6 3336         +FERBEL,SLATTERY,WERNER                 (ROCH)

ARNOLD   73 LNC 6 707           +ENGEL,ESCOUBES,KURTZ,LLORET,PATY,+   (STRB)
CASON    73 PR D 7 1971         +BISWAS,KENNEY,MADDEN,SANDER,SHEPHARD(NDAM)
CASON 1  73 NP B 64 14          +MADDEN,BISHOP,BISWAS,KENNEY,+         (NDAM)
HYAMS    73 NP B 64 134         +JONES,WEILHAMMER,BLUM,DIETL,+  (CERN+MPIM)
ROBERTSO 73 PR D 7 2554         ROBERTSON,WALKER,DAVIS               (DUKE+WISC)

DUBOVIKO 74 SJNP 19 568         DUBOVIKOV,MATSYUK,NILOV,SOKOLOV        (ITEP)
ENGLER   74 PR D10 2070         +KRAEMER,TOAFF,WEISSER,DIAZ+      (CARN+CASE)
GRAYER   74 NP B 75 189         G.GRAYER,HYAMS,BLUM,DIETL,+       (CERN+MPIM)
KLIGER   74 SJNP 19 428         +BEKETOV,GRECHKO,GUZHAVIN,DUBOVIKOV+ (ITEP)
OREN     74 NP B71 189          +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)
THOMPSON 74 NP B69 220          +GAIDOS,MCILWAIN,MILLER,MULERA,+     (PURD)

BLUM     75 PL 57B 403          +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM) JP
ESTABROO 75 NP B95 322          P.ESTABROOKS,A.D.MARTIN                (DURH)
HYAMS    75 NP B100 205         +JONES,WEILHAMMER,BLUM,DIETL+    (CERN+MPIM)
KALELKAR 75 THESISINEVIS 2071   M.S.KALELKAR                         (COLU)I=I

ANTIPOV  77 NP B 119 45         +BUSNELLO,DAMGAARD,KIENZLE+       (CERN+SERP)
GESSAROL 77 NP B 126 382        GESSAROLI,+   (BGNA+FIRZ+GENO+MILA+OXF+PAVI)

BALTAY   78 PR D 17 62          +CAUTIS,COHEN,CSORNA,SMITH,YEH,+(COLU+BING)
FORINO   78 NP B 139 413        +CARTACCI,+ (BGNA+FIRZ+GENO+MILA+OXF+PAVI)  JP
MARTIN 1 78 PL 74 B 417         +DZMUTLU+BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)
MARTIN 2 78 NP B 140 158        +DZMUTLU,BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)
MARTIN 3 78 ANP  114 1          A.D.MARTIN,M.R.PENNINGTON             (CERN)

BECKER   79 NP B 151  46        +BLANAR,BLUM,CERRADA+ (MPIM+CERN+ZEEM+CRAC)
CORDEN   79 NP B 157 250        +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TELA+LOWC)  JP
EVANGELI 79 NP B 154 381        + (BARI+BONN+CERN+DARE+GLAS+LIVP+MILA+WIEN)

ALPER    80 PL 94 B 422         +BECKER,+     (AMST+CERN+CRAC+MPIM+OXF+RHEL)
COSTA    80 NP B 175 402        +        (BARI+BONN+CERN+GLAS+LIVP+MILA+WIEN)
GORLICH  80 NP B 174 16         +NICZYPORUK,ROZANSKA+ (CRAC+MPIM+CERN+ZEEM)

EVANGELI 81 NP B 178 197        EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
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ϕ(1850) →

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54  PHI(1850,JPG=   ) 1*0

SEEN IN THE K KBAR AND K KBAR PI MASS
DISTRIBUTIONS.
NEEDS CONFIRMATION. OMITTED FROM TABLE.

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                  54  PHI(1850) MASS (MEV)

M      123 1850.0      10.0              ALHARRAN  81 OMEG    8.25 K-P,LAM 2K    1/82*

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                  54  PHI(1850) WIDTH (MEV)

W      123   80.0      40.0      30.0    ALHARRAN  81 OMEG    8.25 K-P,LAM 2K    1/82*

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                  54  PHI(1850) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      PHI(1850) INTO K KBAR                              493+ 493
P2      PHI(1850) INTC K*(892) K + C.C.                    891+ 493

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                    54  PHI(1850) BRANCHING RATIOS

R1     PHI(1850) INTO (K*(892) K+C.C.)/(K KBAR)          (P2)/(P1)
R1          0.8       0.4              ALHARRAN  81 OMEG    8.25 K-P,LAM 2K   1/82*

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                         REFERENCES FOR PHI(1850)

ASTON    80 PL 92 B 219        (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+)

ALHARRAN 81 PL 101 B 357       +AMIRZADEH,+      (BIRM+CERN+CLAS+MICH+LPNP)
DELCOURT 81 BONN CONF. 205     B.DELCOURT                           (ORSAY)
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X(1850)

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38  X(1850,JPG=2+ ) I=

FROM AN AMPLITUDE ANALYSIS OF THE K+K- SYSTEM SEEN IN
PI- P INTO K+ K- N AT 10 GEV/C.
NEEDS CONFIRMATION. OMITTED FROM TABLE.

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                    38  X(1850) MASS (MEV)

M    A     1857.0     35.0     24.0   COSTA     80 OMEG  0 10 PI-P,K+ K- N   1/82*
M    A  ERROR INCREASED BY SPREAD OF TWO SOLUTIONS.

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                    38  X(1850) WIDTH (MEV)

W    A      185.0     102.0    139.0   COSTA     80 OMEG  0 10 PI-P,K+ K- N   1/82*
W    A  ERROR INCREASED BY SPREAD OF TWO SOLUTIONS.

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                    38  X(1850) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     X(1850) INTO K+ K-                                  493+ 493

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                    38  X(1850) BRANCHING RATIOS

R1     X(1850) INTO ( K+ K- )/TOTAL                      (P1)
R1          SEEN                     COSTA     80 OMEG  0 10 PI-P,K+ K- N   1/82*

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                         REFERENCES FOR X(1850)

COSTA    80 NP B 175 402      +      (BARI+BONN+CERN+GLAS+LIVP+MILA+WIEN)
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S(1935)

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31  S(1935,JPG= )
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A narrow enhancement called the S(1935) has been observed in the antiproton-proton total cross section (CARROLL 74, CHALOUPKA 76, BRUCKNER 77, SAKAMOTO 79).

This observation is not confirmed by more recent experiments (ALLEN 80, KAMAE 80, JASTRZEMBSKI 81, LOWENSTEIN 81), or the effect is found to be smaller in magnitude and larger in width (HAMILTON 80).

No significant signal is observed for a narrow S(1935) in backward antiproton-proton elastic scattering (GARNJOST 79), nor in the charge-exchange cross section (GARNJOST 75, CHALOUPKA 76, HAMILTON 80).

The first positive observations of the S(1935) in hadro-production experiments (DAUM 80) are not confirmed by more recent ones (DAUM 81). In view of this situation, the only observation which remains unchallenged is the one of RICHARD 79 in a photoproduction experiment. One should wait for confirmation before taking the S(1935) as a well-established narrow resonance.

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                    31  S MASS (MEV)

M        S CHANNEL NBAR N
M   C     (1940.)      (8.)                   CLINE     70 HBC   0  .25-.74 PBAR P   2/72
M   B     (1968.)                             BENVENUTI 71 HBC   0  .1 - .8 PBAR P   2/72
M  S       1932.        2.                    CARROLL   74 CNTR    S CHAN,PBAR P,D  12/75
M   C     (1942.)      (5.)                   D-ANDLAU  75 HBC   0 .175-.750 PBAR P 12/75
M   Z     (1934.4)     (2.6)      (1.4)       KALOGERO  75 DBC   - PBAR N ANNIH     12/75
M  S       1935.9       1.0                   CHALOUPKA 76 HBC   0 PBAR P TOT.ELAS  12/75
M          1939.0       3.0                   BRUCKNER  77 SPEC  0 .4-.85 PBAR P     7/77
M          1935.5       1.0                   SAKAMOTO  79 HBC   0 .37-.73 PB P     12/79
M          1930.0       2.0                   ASTON     80 OMEG    GAM P,P PBAR X    1/82*
M   A     (1949.1      (10.)                  DEFOIX    80 HBC   0 PBAR P,SPI        1/80
M    M     1939.0       2.0                   HAMILTO2  80 CNTR  0 S CHAN,PBAR P    12/79
M
M        PRODUCTION EXPERIMENTS
M        36(1940.0)    (1.0)                  DAUM      80 CNTR  0 93 P P,PB P + X  12/79
M          . . . . . . . . . .
M  AVG     1935.3       1.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
                               (SEE IDEOGRAM BELOW )

M   A   FROM ENERGY DEPENDENCE OF SPI CROSS-SECTION.IG=1- FROM OBSERVATION
M   A   OF OMEGA RHO DECAY. P=+ AND J>1. A2 PI PI ALSO SEEN.
M   B   SEEN AS A BUMP IN THE PBAR P - KS KL  CROSS SECTION WITH JPC=1--.
M       NOT SEEN BY CARSON 72 WITH EQUAL STATISTICS.
M   C   FROM ENERGY DEPENDENCE OF FAR BACKWARD ELASTIC SCATTERING.
M       SOME INDICATION OF ADDITIONAL STRUCTURE.
M    M  I=0 FAVORED,J=0 OR 1,SEEN IN TOTAL PBAR P TOTAL CROSS-SECTION.
M    M  PRIMARLY FROM ANNIH. REACTIONS.  NOT SEEN IN PBAR D TOTAL AND
M    M  ANNIH. CROSS SECTIONS.
M   N   SEEN IN 3 CHARGED MODE. NOT SEEN BY BOWEN 73 WITH 6X STATISTICS.
M   S   NARROW BUMP SEEN IN TOTAL PBAR P,D CROSS-SECTIONS.ISOSPIN UNCERTAIN
M       NOT SEEN IN PBAR P CEX BY GARNJOST 75,CHALOUPKA 76. INTEGRATED
M       CROSS-SECTION 3X LARGER THAN BRUCKNER 77.
M   Z   NOT SEEN BY ALBERI 79 WITH COMPARABLE STATISTICS.
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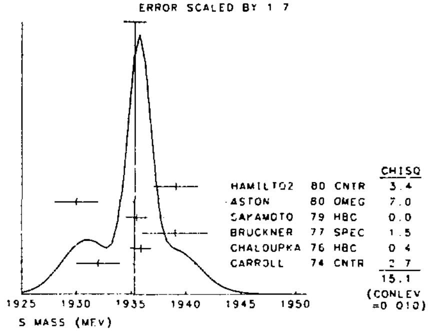
WEIGHTED AVERAGE = 1935 3 ± 1.0
ERROR SCALED BY 1 7

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                    31  S WIDTH (MEV)

W        S CHANNEL NBAR N
W   C      (49.)       (9.)                   CLINE     70 HBC   0  .25-.74 PBAR P   2/72
W   B      (35.)                              BENVENUTI 71 HBC   0  .1 - .8 PBAR P   2/72
W  S         9.         4.         3.         CARROLL   74 CNTR    S CHAN,PBAR P,D  12/75
W   C     (57.5)       (5.)                   D-ANDLAU  75 HBC   0 .175-.750 PBAR P 12/75
W   Z      (11.)      (11.)       (4.)        KALOGERO  75 DBC   - PBAR N ANNIH     12/75
W  S        8.8        4.3        3.2         CHALOUPKA 76 HBC   0 PBAR P TOT.ELAS  12/75
W          (4.0)   OR LESS                    BRUCKNER  77 SPEC  0 .4-.85 PBAR P     7/77
W           2.8        1.4                    SAKAMOTO  79 HBC   0 .37-.73 PB P     12/79
W          12.0        7.0                    ASTON     80 OMEG    GAM P,P PBAR X    1/82*
W   A      (80.)      (20.)                   DEFOIX    80 HBC   0 PBAR P,SPI        1/80
W    M     22.0        6.0                    HAMILTO2  80 CNTR  0 S CHAN,PBAR P    12/79
W
W        PRODUCTION EXPERIMENTS
W          (6.0)   APPROX.                    DAUM      80 CNTR    93 P P,PB P + X  12/79
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

W   SEE FOOTNOTES UNDER S MASS ABOVE

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                    31  S PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     S INTO PBAR P                                       938+ 938

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                         REFERENCES FOR S(1935)

CLINE    68 PRL 21 1268        +ENGLISH,REEDER,TERRELL,TWITTY  (WISCONSIN)

CLINE    70  PREPRINT          D.CLINE,J.ENGLISH,D.D.REEDER          (WISC)J
   ALSO  70  KIEV CONF.        ASTIER RAPPORTEUR TALK

BENVENUT 71 PRL 27 283         BENVENUTI,CLINE,RUTZ,REEDER,SCHERER  (WISC)
PINSKI   71 PRL 27 1548        STEPHEN S. PINSKY             (UTAH+ARGONNE)

BIZZARRI 72 PR D 6 160         +GUIDONI,MARZANO,CASTELLI,+       (ROMA+TRST)
BOWEN 1  72 PRL 29 890         +EARLES,FAISSLER,BLIEDEN,+        (NEAS+STON)

BOWEN    73 PRL 30 332         +EARLES,FAISSLER,BLIEDEN,+        (NEAS+STON)
BURNS    73 PR D 8 1286        +CONDON,DONAHUE,MANDELKERN,PRICE,+     (UCI)
KIENZLE  73 PR D 7 3520        W.KIENZLE                             (CERN)

BURNS    74 NC 20A 463         +CONDON,MANDELKERN,PRICE,SCHULTZ       (UCI)
CARROLL  74 PRL 32 247         +CHIANG,KYCIA,LI,MAZUR,MICHAEL,+       (BNL)
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ABASHIAN 75 PRL 34 691        +BEAMER,BROSS,EISENSTEIN,+      (ILL+ANL+ISU)
D-ANDLAU 75 PL 58B 223        +COHEN-GANDUNA,LALOUM,LUTZ,PETRI(CDEF+PISA)  JP
DEFOIX   75 PALERMO  CONF.    B.FRENCH, RAPPORTEURS TALK              (CDEF)
DONNACHI 75 NC 26 A 317       A.DONNACHIE,P.R.THOMAS            (MANCHESTER)
GARNJOST 75 PRL 35 1685       +KENNEY,POLLARD,ROSS,TRIPP,+      (LBL+MHCO)
KALOGERO 75 PRL 34 1047       KALOGEROPOULOS,TZANAKOS                 (SYRA)
WEINGART 75 PRL 34 1701       WEINGARTEN,OKUBO                        (ROCH)

ABASHIAN 76 PR D 13 5         +WATSON,GELFAND,BUTTRAM,+(ILL+ANL+CHIC+ISU)
DEFOIX   76 STOCK-SYMP.NBAR-N +LADRON OF GUEVARA,ANGELINI,+   (CDEF+PISA)
DOVER    76 PL 62 B 293       +KAHANA                                  (BNL)
CHALOUPK 76 PL 61 B 487       CHALOUPKA,+ (CERN+LIVP+MONS+PADO+ROMA+TRST)

BENKHEIR 77 PL B 68 483       BENKHEIRI,BOUCROT,+    (CERN+CDEF+EPOL+LALO)
BRUCKNER 77 PL 67 B 222       +GRANZ,INGHAM,KILIAN,LYNEN+(MPIH+HEID+CERN)
MONTANET 77 BOSTON CONF. 260  L.MONTANET                              (CERN)
ROSSI    77 PL 70 B 255       G.C.ROSSI,G.VENEZIANO                   (CERN)

CARTER   78 NP B 132 176      A.A.CARTER                              (LOQM)  JP
CUTTS    78 PR D 17 16        +GOOD,GRANNIS,GREEN,LEE,PITTMAN+(STON+WISC)
PENNINGT 78 NP B 137 77       M.R. PENNINGTON                         (CERN)

ALBERI   79 PL 83 B 247       +ALVEAR,CASTELLI,POROPAT+   (TRST+CERN+IFRJ)
ALSTON-G 79 PRL 43 1901       ALSTON-GARNJOST,HAMILTON+       (LBL+MTHO+BNL)
CARROLL  79 PR D 19 1950      +CHIANG,KYCIA,LI,LITTENBERG,+     (BNL+ROCH)
DELCOURT 79 PL B 86 395       +DERADO,BERTRAND,BISELLO,BIZOT,BUON,+(LALO)
GIBBARD  79 PRL 42 1593       +AHRENS,BERKELMAN,CASSEL,DAY,HARDING+(CORN)
KLUYVER  79 ZPHY C 2 351      J.C. KLUYVER                            (AMST)
RICHARD  79 BATAVIA CONF. 469 F. RICHARD                              (LALO)
SAKAMOTO 79 NP B 158 410      +HASHIMOTO,SAI,YAMAMOTO+                (TOKY)

ALLEN    80 BRESSANONE 175    5TH EUROPEAN SYMPOSIUM ON N-NBAR INTS.
ASTON    80 PL 93 B 517       (BONN+CERN+EPOL+GLAS+LANC+MCHS+ORSA+PARIS+I
BIONTA   80 PRL 46 970        +CARROLL,EDELSTEIN,+    (BNL+CARN+FNAL+SMAS)
CHUNG    80 PRL 45 1611       +ETKIN,BENSINGER,+(BNL+BRAN+CUNY+SMAS+MASA)
DAUM     80 PL 90 B 475       +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
DEFOIX   80 NP B 162 12       +DOBRZYNSKI,ANGELINI,BIGI,+     (CDEF+PISA)
    ALSO 80 NP B 162 41       ESPIGAT,DEFOIX,DOBRZYNSKI+      (CDEF+PISA)
HAMILTO1 80 PRL 44 1179       HAMILTON,PUN,TRIPP,LAZARUS,+ (LBL+BNL+MTHO)
HAMILTO2 80 PRL 44 1182       HAMILTON,PUN,TRIPP,LAZARUS,+ (LBL+BNL+MTHO)
KAMAE    80 PRL 44 1439       +AIHARA,CHIBA,FUJII,IWASAKI,+   (TOKY+HIRO)

DAUM     81 PL 100 B 439      +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
GANGULI  81 NP B 183 295      +CERRADA,DEFOIX,+(TIFR+CERN+CDEF+MADR+PISA)
JASTRZEM 81 PR D 23 2784      JASTRZEMBSKI,MANDELKERN,+      (TEMP+UCI+UNM)
LOWENSTE 81 PR D 23 2788      LOWENSTEIN,PEASLEE,+     (BNL+DOE+HSJ+SYRA)
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δ(2030)

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17 DELTA(2030,JPG=4+-) I=1

SEEN IN PARTIAL WAVE ANALYSIS OF THE K KBAR AND
PI+PI-PIO SYSTEMS.
NEEDS CONFIRMATION. OMITTED FROM TABLE.

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                    17  DELTA(2030) MASS (MEV)

M   Y    (1903.0)   (10.0)           BALDI     78 SPEC -  10 PI-P,P KS K-    12/77
M   M    2030.0     50.0             CORDEN    78 OMEG  0 15 PI- P,3 PI N    12/78
M   C    2035.0     20.0             CLELAND   80 SPEC +- 50 PI P,KS K+-P     6/81*
M        . . . . . . . . . .
M   AVG  2034.3     18.6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   M  JP=4+ IS FAVORED , THOUGH 2+ CAN NOT BE EXCLUDED.                    12/78
M   Y   FROM A FIT TO THE Y(8,0) MOMENT. LIMITED BY PHASE SPACE.
M   C   FROM AN AMPLITUDE ANALYSIS
M

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                    17  DELTA(2030) WIDTH (MEV)

W   Y    (166.0)    (43.0)           BALDI     78 SPEC -  10PI-P,P KS K-     12/77
W   M    510.0      200.0            CORDEN    78 OMEG  0 15 PI- P,3 PI N    12/78
W   C    600.0      100.0            CLELAND   80 SPEC +- 50 PI P,KS K+-P     6/81*
W        . . . . . . . . . .
W   AVG  582.9      89.4    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   M  JP=4+ IS FAVORED , THOUGH 2+ CAN NOT BE EXCLUDED.                    12/78
W   Y   FROM A FIT TO THE Y(8,0) MOMENT. LIMITED BY PHASE SPACE.
W   C   FROM AN AMPLITUDE ANALYSIS
W

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                    17  DELTA(2030) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      DELTA(2030) INTO K KBAR                       493+ 493
P2      DELTA(2030) INTO PI+ PI- PIO                  139+ 139+ 134

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                    17  DELTA(2030) BRANCHING RATIOS

R1      DELTA(2030) INTO (K KBAR)/TOTAL                 (P1)
R1         SEEN                      CLELAND   80 SPEC +- 50 PI P,KS K+-P     6/81*

R2      DELTA(2030) INTO (PI+ PI- PIO)/TOTAL            (P2)
R2         SEEN                      CORDEN    78 OMEG  0 15 PI- P,3 PI N     6/81*

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REFERENCES FOR DELTA(2030)


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BALDI    78 PL 74 B 413       +BOHRINGER,DORSAZ,HUNGERBULER,+  (GENEVA)  JP
CORDEN   78 NP B 136 77       DOWELL,GARVEY,JOBES+ (BIRM+RHEL+TELA+LOWC)  JP

CLELAND  80 UGVA-DPNC/07-101  +GLOOR,MARTIN,NEF,+       (PITT+GEVA+LAUS)

DELFOSSE 81 NP B 183 349      +DORSAZ,EXTERMANN,GLOOR,WEILL,+ (GEVA+LAUS)
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h(2040)

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16 H(2040,JPG=4++) I=0

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                    16  H MASS (MEV)

M        700 2030.     30.              APEL       75 CNTR    40. PI-P,N 2PIO 11/75
M            2050.     25.              BLUM       75 ASPK    18.4 PI-P,N K+K- 11/75
M   T        1922.0    14.0             ANTIPOV    77 CIBS  0 25 PI-P,P 3PI     1/82*
M            1935.0    13.0             CORDEN     79 OMEG    12-15PI-P, N 2PI 12/79
M            1988.0     7.0             EVANGELIS  79 OMEG    10. PI-P,K+ K- N 12/79
M     M     (2040.0)   (10.0)           ROZANSKA   80 SPRK    18.PI-P,P PB N   12/79
M            1978.0     5.0             ALPER      80 CNTR    62 PI-P,K+ K- N   1/82*
M            . . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)

M     M  I=0,JP=4+ FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE       12/78
M   T     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE

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                    16  H WIDTH (MEV)

W        700  190.     60.              APEL       75 CNTR    40. PI-P,N 2PIO 11/75
W             225.     120.     70.     BLUM       75 ASPK    18.4 PI-P,N K+K- 11/75
W   T         107.0    56.0             ANTIPOV    77 CIBS  0 25 PI-P,P 3PI     1/82*
W             263.0    57.0             CORDEN     79 OMEG    12-15PI-P, N 2PI 12/79
W             100.0    28.0             EVANGELIS  79 OMEG    10. PI-P,K+ K- N 12/79
W     M      (140.0)   (15.0)           ROZANSKA   80 SPRK    18.PI-P,P PB N   12/79
W             243.0    16.0             ALPER      80 CNTR    62 PI-P,K+ K- N   1/82*
W            . . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

W     M  I=0,JP=4+ FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE       12/78
W   T     WIDTH ERRORS ENLARGED BY US TO 4*WIDTH/SQRT(N),SEE K* TYPED NOTE

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                    16  H PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      H INTO PI PI                                  139+ 139
P2      H INTO K KBAR                                 497+ 497

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                    16  H BRANCHING RATIOS

R1      H INTO (PI PI)/TOTAL                            (P1)
R1           0.17      0.02          CORDEN     79 OMEG    12-15PI-P, N 2PI 12/79

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REFERENCES FOR H(2040)


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WAGNER   74 LONDON CONF.      F. WAGNER, RAPPORTEURS TALK             (MPIM)

APEL     75 PL 57B 399        +AUGENSTEIN+      (KARL+PISA+SERP+WIEN+CERN)  JP
BLUM     75 PL 57B 403        +CHABAUD,DIETL,GARELICK,GRAYER+ (CERN+MPIM)  JP

ANTIPOV  77 NP B 119 45       +BUSNELLO,DAMGAARD,KIENZLE+      (CERN+SERP)

CORDEN   79 NP B 157 250      +DOWELL,GARVEY,JOBES,+(BIRM+RHEL+TELA+LOWC)  JP
EVANGELI 79 NP B 154 381      + (BARI+BONN+CERN+DARE+GLAS+LIVP+MILA+WIEN)

ALPER    80 PL 94 B 422       +BECKER,+     (AMST+CERN+CRAC+MPIM+OXF+RHEL)

GOTTESMA 81 PR D 22 1503      GOTTESMAN,JACOBS,+      (SYRA+BRAN+BNL+CINC)
ROZANSKA 80 NP B 162 505      +BLUM,DIETL,GRAYER,LORENZ+       (MPIM+CERN)
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π(2050)

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43 PI(2050,JPG=3+-) I=1

PREVIOUSLY CALLED A4.
NEEDS CONFIRMATION. OMITTED FROM TABLE.

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                    43  PI(2050) MASS (MEV)

M   B   40(1960.)    (30.)            BASTIEN    73 DBC  -  15.PI-D,D 3PI       2/74
M      208 2080.     40.              KALELKAR   75 HBC  +  15 PI+P,P PI+G     12/75
M         (2100.)    APPROX           ANTIPOV    77 CIBS -  25PI-P,P PI-G      12/77
M         (2214.)    (15.)            BALTAY     77 HBC   0 15PI-P,DEL++3PI    12/77

M   B   MARGINAL STATISTICAL SIGNIFICANCE.

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                    43  PI(2050) WIDTH (MEV)

W   B   40 (200.)                     BASTIEN    73 DBC  -  15.PI-D,D 3PI       2/74
W      208  340.     80.              KALELKAR   75 HBC  +  15 PI+P,P PI+G     12/75
W          (500.)    APPROX.          ANTIPOV    77 CIBS -  25PI-P,P PI- G     12/77
W          (355.)    (21.)            BALTAY     77 HBC   0 15PI-P,DEL++3PI    12/77

W   B   MARGINAL STATISTICAL SIGNIFICANCE.

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                    43  PI(2050) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1      PI(2050) INTO 3PI                             139+ 139+ 139
P2      PI(2050) INTO G PI                            1691+ 139

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                    43  PI(2050) BRANCHING RATIOS

R1      PI(2050) INTO (G PI)/(ALL 3PI)                  (P2)/(P1)
R1         DOMINANT                  KALELKAR   75 HBC  +  15 PI+P,P 3PI       12/75

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                               REFERENCES FOR PI(2050)

HUSON    68 PL 28 B 208         +LUBATTI,BELLINI,BINGHAM,+  (ORSA+MILA+LBL)
BEMPORAD 71 NP B 33 357         +DUFEY,COULING,+         (CERN+ETH+LOIC+MILA)
CLAYTON  72 NP B 47 81          +MASON,MUIRHEAD,RIGOPOULOS,+     (LIVP+PATR)
BASTIEN  73 UPPSALA CONF. 73    +DUNN,HARRIS,LUBATTI,BINGHAM,+   (SEAT+UCB)
OREN     74 NP B71 159          +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)
DEUTSCHM 75 NP B99 397          DEUTSCHMANN,+        (ABBCCHW COLLABORATION)
KALELKAR 75 THESIS(NEVIS 207)   M.S.KALELKAR                          (COLU)
ANTIPOV  77 NP B 119 45         +BUSNELLO,DAMGAARD,KIENZLE+      (CERN+SERP)
BALTAY   77 PRL 39 591          +CAUTIS,KALELKAR                 (COLUMBIA)  JP
CAUTIS   77  THESIS NEVIS 221   C.V.CAUTIS                       (COLUMBIA)  JP
BALTAY   78 PR D 17 52          +CAUTIS,COHEN,CSORNA,KALELKAR+   (COLU+BING)
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π(2100)

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           20  PI(2100,JPG=2--) I=1

           SEEN IN THE (RHO PI), (EPSILON PI) AND (F PI)
           JP = 2- WAVES OF THE DIFFRACTIVELY PRODUCED 3 PI
           SYSTEM. NEEDS CONFIRMATION. OMITTED FROM TABLE.

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           20  PI(2100) MASS (MEV)

M   L     2100.      150.            DAUM      81 CNTR    63,94 PI- P,3PI   1/82*

M   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

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           20  PI(2100) WIDTH (MEV)

W   L      651.       50.            DAUM      81 CNTR    63,94 PI- P,3PI   1/82*

W   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

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           20  PI(2100) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     PI(2100) INTO 3PI                               139+ 139+ 139
P2     PI(2100) INTO RHO PI                            769+ 139
P3     PI(2100) INTO F PI                             1273+ 139
P4     PI(2100) INTO EPSILON PI                       1300+ 139

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           20  PI(2100) BRANCHING RATIOS

R1     PI(2100) INTO (RHO PI)/(ALL 3PI)                (P2)/(P1)
R1  L       0.19      0.05           DAUM      81 CNTR    63,94 PI- P       1/82*

R2     PI(2100) INTO (F PI)/(ALL 3PI)                  (P3)/(P1)
R2  L       0.36      0.09           DAUM      81 CNTR    63,94 PI- P       1/82*

R3     PI(2100) INTO (EPSILON PI)/(ALL 3PI)            (P4)/(P1)
R3  L       0.45      0.07           DAUM      81 CNTR    63,94 PI- P       1/82*

R4     D/S RATIO FOR PI(2100) INTO F PI
R4  L       0.39      0.23           DAUM      81 CNTR    63,94 PI- P       1/82*

R   L  FROM A TWO RESONANCE FIT TO FOUR 2-0+ WAVES.

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                               REFERENCES FOR PI(2100)

DAUM     81 NP B 182 269        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
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Note on T and U Regions

The observation of broad enhancements at 2190 and 2350 MeV comes from $\bar{p}p$ total cross-section measurements (ABRAMS 67), $\bar{p}p$ annihilation measurements (ALSPECTOR 73), $\bar{p}p$ elastic cross-section measurements (COUPLAND 77), and $\bar{p}p$ charge-exchange cross-section measurements (CUTTS 78). The mass regions centered around 2190 MeV and 2350 MeV have been called T and U regions, respectively.

Searches for resonances in exclusive $\bar{p}p$ annihilation channels which could be coupled to the enhancements observed in the $\bar{p}p$ total cross section and in $\bar{p}p$ elastic scattering have been unsuccessful, except for the two-body annihilation channels $\pi^+\pi^-$ and $\pi^0\pi^0$, where partial-wave analyses have shown that resonances are formed in the 2100-2500 MeV mass region (CARTER 77, DULUDE 78, MARTIN A 80, MARTIN B 80). We have listed the results on these analyses under the headings $\varepsilon(2150)/T_0(2150)$ for the I=0, JP=2+ wave; $\rho(2150)/T_1(2190)$ for the I=1, JP=1- wave; $\rho(2250)$ for the I=1, JP=3- wave; $\varepsilon(2300)/U_0(2300)$ for the I=0, JP=4+ wave; and $\rho(2350)/U_1(2400)$ for the I=1, JP=5- wave.

Various structures coupled to $\bar{p}p$ and observed in production experiments are listed under the heading $\bar{N}N(1400-3600)$.

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ρ(2150)

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           32  RHO(2150,JPG=1-+) I=1

           THIS ENTRY WAS PREVIOUSLY CALLED T1(2190).
           CONTAINS ONLY RESULTS FROM FORMATION EXPERIMENTS. FOR
           PRODUCTION EXPERIMENTS SEE THE NBAR N(1400-3600) ENTRY.
           SEE ALSO S,T,U MINI-REVIEWS.
           OMITTED FROM TABLE.

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           32  RHO(2150) MASS (MEV)

M       PBAR P INTO PI PI
M
M    P    (2100.0)  APPROX.          MARTIN A  80 RVUE                        1/82*
M    P    (2170.0)  APPROX.          MARTIN B  80 RVUE                        1/82*

M    P  I=1,JP=1- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PI0 PI0

M       S CHANNEL NUCLEON ANTINUCLEON
M
M  B       2190.      10.            ABRAMS    70 CNTR    S CHANNEL PBAR N  1/73
M    I     2193.       2.            ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  E I     2155.0     15.0           COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M    I    (2190.0)  APPROX.          CUTTS     78 CNTR    .97-3. PB P,NB N 12/78
M           . . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M  B    SEEN AS BUMP IN I=1 STATE. SEE ALSO COOPER 68.
M  B    PEASLEE 75 CONFIRM PBAR P RESULTS OF ABRAMS 70,NO NARROW STRUCTURE
M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED

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           32  RHO(2150) WIDTH (MEV)

W       PBAR P INTO PI PI
W
W    P    (200.0)   APPROX.          MARTIN A  80 RVUE                        1/82*
W    P    (250.0)   APPROX.          MARTIN B  80 RVUE                        1/82*

W    P  I=1,JP=1- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PI0 PI0

W       S CHANNEL NUCLEON ANTINUCLEON
W
W  B       (85.)    APPROX.          ABRAMS    70 CNTR    S CHANNEL PBAR N  7/67
W    I      98.        8.            ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W  E I     135.0      75.0           COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
W           . . . . . . . . . .
W  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

W  B    SEE NOTE B ABOVE.
W  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
W    I  ISOSPINS 0 AND 1 NOT SEPARATED

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                               REFERENCES FOR RHO(2150)

ABRAMS   67 PRL 18 1209         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+     (BNL)
COOPER   68 PRL 20 1059         +HYMAN,MANNER,MUSGRAVE,VOYVODIC         (ANL)
BRICMAN  69 PL 29 B 451         +FERRO-LUZZI,BIZARD,+        (CERN+CAEN+SACL)
ABRAMS   70 PR D 1 1917         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+     (BNL)
BACON    71 NP B 32 66          +BUTTERWORTH,MILLER,PHELAN,+      (RHEL+LIVP)
FIELDS   71 PRL 27 1749         +COOPER,RHINES,ALLISON               (ANL+OXF)
YOH      71 PRL 26 922          +BARISH,CAROLL,LOBKOVICZ+      (CIT+BNL+ROCH)
ALEXANDE 72 NP B 45 29          ALEXANDER,BAR-NIR,BEVARY,DAGAN,+       (TELA)
DONALD   72 PL 40 B 586         +GALLETLY,EDWARDS,DE BILLY,+      (LIVP+LPNP)
ALSPECTO 73 PRL 30 511          ALSPECTOR,COHEN,CVIJANOVICH,+     (RUTG+UPNJ)
BACON    73 PR D 7 577          +BUTTERWORTH,                     (RHEL+LIVP)
BETTINI  73 NC 15 A 563         +GARNJOST,BIGI,+         (PADO+LBL+PISA+TORI)
DONALD   73 NP B 61 333         +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
NICHOLSO 73 PR D 7 2572         NICHOLSON,DELORME,CARROLL,+   (CIT+ROCH+BNL)
BERTANZA 74 NC 23A 209          +BIGI,CASALI,LARICCIA,+       (PISA+PADO+TORI)
HYAMS    74 NP B 73 202         +JONES,WEILHAMMER,BLUM,+          (CERN+MPIM)
DONNACHI 75 NC 26 A 317         A.DONNACHIE,P.R.THOMAS            (MANCHESTER)
EISENHAN 75 NP B 96 109         EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)
HAYDLER  75 NP B101 35          +JACQUES,JONES,PANOOULAS + (RUTG+STEV+ALBA)
HUESMAN  75 NC 25A  91          +GARNJOST,ROSS,+          (LBL+PADO+PISA+TORI)
PEASLEE  75 PL 57B 189          +DEMARZO,GUERRIERO,+     (CANB+BARI+BROW+MIT)
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GAY       76 NC 31 A 593          +JEANNERET,BOGDANSKI,+(NEUC+LAUS+LIVP+LPNP)
ZEMANY    76 NP B 103 537         +MING MA,MOUNTZ,SMITH                  (MSU)

CARTER 1  77 PL 67 B 117          +COUPLAND,EISENHANDLER,ASTBURY,+(LOQM+RHEL)  JP
CARTER 2  77 PL 67 B 122          A.A.CARTER                            (LOQM)  JP
CARTER 3  77 NP B 127 202         +COUPLAND,ATKINSON,ARNISON+(LOQM+DARE+RHEL)
COUPLAND  77 PL 71 B 460          +EISENHANDLER,GIBSON,ASTBURY,+  (LOQM+RHEL)
JONES     77 NP B 119 476         M.D.JONES,R.J.PLANO                   (RUTG)
MONTANET  77 BOSTON CONF. 260     L.MONTANET                            (CERN)

CARTER 1  78 NP B 132 176         A.A.CARTER                            (LOQM)  JP
CARTER 2  78 NP B 141 467         A.A.CARTER                            (LOQM)
CUTTS     78 PR D 17 16           +GOOD,GRANNIS,GREEN,LEE,PITTMAN+(STON+WISC)

MARTIN    79 PL 86 B 93           A.D. MARTIN,M.R. PENNINGTON           (DURH)

MARTIN A  80 NP B 169 216         A.D. MARTIN,M.R. PENNINGTON           (DURH)  JP
MARTIN B  80 NP B 176 355         B.R.MARTIN,D.MORGAN              (LOUC+RHEL)  JP
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ε(2150)

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42   EPSILON(2150,JPG=2++) I=0

THIS ENTRY WAS PREVIOUSLY CALLED TO(2150).
CONTAINS ONLY RESULTS FROM FORMATION EXPERIMENTS, FOR
PRODUCTION EXPERIMENTS SEE THE NBAR N(1400-3600) ENTRY.
SEE ALSO S,T,U MINI-REVIEWS.
OMITTED FROM TABLE.
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              42   EPSILON(2150) MASS (MEV)

M        PBAR P INTO PI PI
M
M    L    (2150.0)  APPROX.        DULUDE2   78 DSPK    1.-2.PB P,PIOPIO 12/78
M    P    (2150.0)  APPROX.        MARTIN A  80 RVUE                      1/82*
M    P    (2170.0)  APPROX.        MARTIN B  80 RVUE                      1/82*

M    L  IG=0+,JP=2+ FROM PARTIAL WAVE AMPLITUDE ANALYSIS
M    P  I=0,JP=2+ FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL PBAR P OR NBAR N
M
M    I     2193.       2.          ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  E I     2155.0     15.0         COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M    I    (2190.0)  APPROX.        CUTTS     78 CNTR    .97-3. PB P,NB N 12/78
M            . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED
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              42   EPSILON(2150) WIDTH (MEV)

M        PBAR P INTO PI PI
M
M    L    (250.0)  APPROX.         DULUDE2   78 DSPK    1.-2.PB P,PIOPIO 12/78
M    P    (250.0)  APPROX.         MARTIN A  80 RVUE                      1/82*
M    P    (250.0)  APPROX.         MARTIN B  80 RVUE                      1/82*

M    L  IG=0+,JP=2+ FROM PARTIAL WAVE AMPLITUDE ANALYSIS
M    P  I=0,JP=2+ FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL PBAR P OR NBAR N
M
M    I      98.        8.          ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  E I     135.0      75.0         COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M            . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED
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REFERENCES FOR EPSILON(2150)

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FIELDS    71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH       71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

DONALD    72 PL 40 B 586          +GALLETLY,EDWARDS,DE BILLY,+    (LIVP+LPNP)

ALSPECTO  73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BACON     73 PR D 7 577           +BUTTERWORTH,                   (RHEL+LIVP)
DONALD    73 NP B 61 333          +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
NICHOLSO  73 PR D 7 2572          NICHOLSON,DELORME,CARROLL,+  (CIT+ROCH+BNL)

GAY       76 NC 31 A 593          +JEANNERET,BOGDANSKI,+(NEUC+LAUS+LIVP+LPNP)

COUPLAND  77 PL 71 B 460          +EISENHANDLER,GIBSON,ASTBURY,+  (LOQM+RHEL)

CUTTS     78 PR D 17 16           +GOOD,GRANNIS,GREEN,LEE,PITTMAN+(STON+WISC)
DULUDE1   78 PL 79 B 329          +LANOU,MASSIMO,PEASLEE+       (BROW+MIT+BARI)  JP
DULUDE2   78 PL 79 B 335          +LANOU,MASSIMO,PEASLEE+       (BROW+MIT+BARI)  JP

MARTIN    79 PL 86 B 93           A.D. MARTIN,M.R. PENNINGTON           (DURH)

BOWCOCK   80 LNC 28 21            J.E.BOWCOCK,D.C.HODGSON               (BIRM)
MARTIN A  80 NP B 169 216         A.D. MARTIN,M.R. PENNINGTON           (DURH)  JP
MARTIN B  80 NP B 176 355         B.R.MARTIN,D.MORGAN              (LOUC+RHEL)  JP
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ρ(2250)

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44   RHO(2250,JPG=3-+) I=1

CONTAINS ONLY RESULTS FROM FORMATION EXPERIMENTS, FOR
PRODUCTION EXPERIMENTS SEE THE NBAR N(1400-3600) ENTRY.
SEE ALSO S,T,U MINI-RF.IEWS.
OMITTED FROM TABLE.
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```
              44   RHO(2250) MASS (MEV)

M        PBAR P INTO PI PI OR K KB
M
M  J      (2150.0)  APPROX.        CARTER 1  77 CNTR  0 .7-2.4PB P,PIPI  12/77
M    K    (2140.0)  APPROX.        CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
M    P    (2300.0)  APPROX.        MARTIN A  80 RVUE                      1/82*
M    P    (2250.0)  APPROX.        MARTIN B  80 RVUE                      1/82*

M  J    I=1,JP=3- FROM AMPLITUDE ANALYSIS.
M    K  I=0,1,JP=3- FROM BARRELET ZERO'S ANALYSIS.
M    P  I=1,JP=3- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL NUCLEON ANTINUCLEON
M
M  B       2190.      10.          ABRAMS    70 CNTR    S CHANNEL PBAR N  1/73
M    I     2193.       2.          ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  E I     2155.0     15.0         COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M    I    (2190.0)  APPROX.        CUTTS     78 CNTR    .97-3. PB P,NB N 12/78
M            . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M  B    SEEN AS BUMP IN I=1 STATE. SEE ALSO COOPER 68.
M  B    PEASLEE 75 CONFIRM PBAR P RESULTS OF ABRAMS 70,NO NARROW STRUCTURE
M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED
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              44   RHO(2250) WIDTH (MEV)

M        PBAR P INTO PI PI OR K KB
M
M  J      (200.0)  APPROX.         CARTER 1  77 CNTR  0 .7-2.4PB P,PIPI  12/77
M    K    (150.0)  APPROX.         CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
M    P    (200.0)  APPROX.         MARTIN A  80 RVUE                      1/82*
M    P    (250.0)  APPROX.         MARTIN B  80 RVUE                      1/82*

M  J    I=1,JP=3- FROM AMPLITUDE ANALYSIS.
M    K  I=0,1,JP=3- FROM BARRELET ZERO'S ANALYSIS.
M    P  I=1,JP=3- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL NUCLEON ANTINUCLEON
M
M  B       (85.)   APPROX.         ABRAMS    70 CNTR    S CHANNEL PBAR N  7/67
M    I      98.        8.          ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  E I     135.0      75.0         COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M            . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M  B    SEE NOTE B ABOVE.
M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED
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REFERENCES FOR RHO(2250)

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ABRAMS    67 PRL 18 1209          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)

COOPER    68 PRL 20 1059          +HYMAN,MANNER,MUSGRAVE,VOYVODIC        (ANL)

ABRAMS    70 PR D 1 1917          +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)

FIELDS    71 PRL 27 1749          +COOPER,RHINES,ALLISON            (ANL+OXF)
YOH       71 PRL 26 922           +BARISH,CAROLL,LOBKOVICZ+    (CIT+BNL+ROCH)

ALSPECTO  73 PRL 30 511           ALSPECTOR,COHEN,CVIJANOVICH,+   (RUTG+UPNJ)
BETTINI   73 NC 15 A 563          +GARNJOST,BIGI,+        (PADO+LBL+PISA+TORI)
DONNACHI  73 LNC 7 285            A.DONNACHIE,P.R.THOMAS          (MANCHESTER)
NICHOLSO  73 PR D 7 2572          NICHOLSON,DELORME,CARROLL,+  (CIT+ROCH+BNL)

BERTANZA  74 NC 23A 209           +BIGI,CASALI,LARICCIA,+     (PISA+PADO+TORI)

ZEMANY    76 NP B 103 537         +MING MA,MOUNTZ,SMITH                  (MSU)

CARTER 1  77 PL 67 B 117          +COUPLAND,EISENHANDLER,ASTBURY,+(LOQM+RHEL)  JP
CARTER 2  77 PL 67 B 122          A.A.CARTER                            (LOQM)  JP
CARTER 3  77 NP B 127 202         +COUPLAND,ATKINSON,ARNISON+(LOQM+DARE+RHEL)
COUPLAND  77 PL 71 B 460          +EISENHANDLER,GIBSON,ASTBURY,+  (LOQM+RHEL)
MONTANET  77 BOSTON CONF. 260     L.MONTANET                            (CERN)

CARTER 1  78 NP B 132 176         A.A.CARTER                            (LOQM)  JP
CARTER 2  78 NP B 141 467         A.A.CARTER                            (LOQM)
CUTTS     78 PR D 17 16           +GOOD,GRANNIS,GREEN,LEE,PITTMAN+(STON+WISC)

MARTIN    79 PL 86 B 93           A.D. MARTIN,M.R. PENNINGTON           (DURH)

MARTIN A  80 NP B 169 216         A.D. MARTIN,M.R. PENNINGTON           (DURH)  JP
MARTIN B  80 NP B 176 355         B.R.MARTIN,D.MORGAN              (LOUC+RHEL)  JP
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ε(2300)

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41   EPSILON(2300,JPG=4++) I=0

THIS ENTRY WAS PREVIOUSLY CALLED UO(2350).
CONTAINS ONLY RESULTS FROM FORMATION EXPERIMENTS, FOR
PRODUCTION EXPERIMENTS SEE THE NBAR N(1400-3600) ENTRY.
SEE ALSO S,T,U MINI-REVIEWS.
OMITTED FROM TABLE.
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              41   EPSILON(2300) MASS (MEV)

M        PBAR P INTO PI PI OR KB K
M
M  J      (2310.0)  APPROX.        CARTER :  77 CNTR  0 .7-2.4PB P,PIPI  12/77
M    K    (2340.0)  APPROX.        CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
M         (2330.0)  APPROX.        DULUDE2   78 DSPK    1.-2.PB P,PIOPIO  1/82*
M    P    (2300.0)  APPROX.        MARTIN A  80 RVUE                      1/82*
M    P    (2300.0)  APPROX.        MARTIN B  90 RVUE                      1/82*

M  J    I=0,JP=4+ FROM AMPLITUDE ANALYSIS.
M    K  I=0,JP=4+ FROM BARRELET ZERO'S ANALYSIS
M    P  I=0,JP=4+ FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL PBAR P OR NBAR N
M
M          2375.      10.          ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
M    I    (2359.)    (2.)          ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  EI     (2345)    (15.0)         COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M    I    (2380.0)  APPROX.        CUTTS     78 CNTR    .97-3. PB P,NB N 12/78

M  E    FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M    I  ISOSPINS 0 AND 1 NOT SEPARATED
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Mesons

Data Card Listings

ε(2300), ρ(2350), δ(2450), e^+e^-(1100–2200)

For notation, see key at front of Listings.

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                    41  EPSILON(2300) WIDTH (MEV)

W        PBAR P INTO PI PI OR KB K
W
W  J        (210.0)  APPROX.              CARTER 1  77 CNTR  0 .7-2.4PB P,PIPI  12/77
W    K      (150.0)  APPROX.              CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
W    P      (200.)   APPROX.              MARTIN A  80 RVUE                      3/82*

W  J     I=0,JP=4+ FROM AMPLITUDE ANALYSIS.
W    K   I=0,JP=4+ FROM BARRELET ZERO'S ANALYSIS
W    P   I=0,JP=4+ FROM SIMULTANEOUS ANAL. OF P PBAP --> PI-PI+ AND PIO PIO

W        S CHANNEL PBAR P OR NBAR N
W
W           (190.)    APPROX.             ABRAMS    70 CNTR    S CHANNEL NBAR N  1/71
W   I       (165.)    (18.)      (8.)     ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W  EI       (135.0)   (150.0)    (65.0)   COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77

W  E     FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
W   I    ISOSPINS 0 AND 1 NOT SEPARATED

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                      REFERENCES FOR EPSILON(2300)

BRICMAN   69 PL 29 B 451        +FERRO-LUZZI,BIZARD,+        (CERN+CAEN+SACL)

ABRAMS    70 PR D 1 1917        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)

FIELDS    71 PRL 27 1749        +COOPER,RHINES,ALLISON             (ANL+OXF)
YOH       71 PRL 26 922         +BARISH,CAROLL,LOBKOVICZ+     (CIT+BNL+ROCH)

EASTMAN   72 NP B 51 29         +MING MA,OH,PARKER,SMITH,SPRAFKA       (MSU)

ALSPECTO  73 PRL 30 511         ALSPECTOR,COHEN,CVIJANOVICH,+    (RUTG+UPNJ)
DONNACHI  73 LNC 7 285          A.DONNACHIE,P.R.THOMAS          (MANCHESTER)
NICHOLSO  73 PR D 7 2572        NICHOLSON,DELORME,CARROLL,+   (CIT+ROCH+BNL)

HYAMS     74 NP B 73 202        +JONES,WEILHAMMER,BLUM,+         (CERN+MPIM)
MING MA   74 NP B68 214         +MOUNTZ,ZEMANY,SMITH                  (MICH)

DONNACHI  75 NC 26 A 317        A.DONNACHIE,P.R.THOMAS          (MANCHESTER)
EISENHAN  75 NP B 96 109        EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)

CARTER 1  77 PL 67 B 117        +COUPLAND,EISENHANDLER,ASTBURY,+(LOQM+RHEL)  JP
CARTER 2  77 PL 67 B 122        A.A.CARTER                           (LOQM)  JP
CARTER 3  77 NP B 127 202       +COUPLAND,ATKINSON,ARNISON+(LOQM+DARE+RHEL)
COUPLAND  77 PL 71 B 460        +EISENHANDLER,GIBSON,ASTBURY,+  (LOQM+RHEL)
MONTANET  77 BOSTON CONF. 260   L.MONTANET                           (CERN)

CARTER 1  78 NP B 132 176       A.A.CARTER                           (LOQM)  JP
CARTER 2  78 NP B 141 467       A.A.CARTER                           (LOQM)
CUTTS     78 PR D 17 16         +GOOD,GRANNIS,GREEN,LEE,PITTMAN+(STON+WISC)
DULUDE1   78 PL 79 B 329        +LANOU,MASSIMO,PEASLEE+      (BROW+MIT+BARI)  JP
DULUDE2   78 PL 79 B 335        +LANOU,MASSIMO,PEASLEE+      (BROW+MIT+BARI)  JP

MARTIN    79 PL 86 B 53         A.D. MARTIN,M.R. PENNINGTON          (DURH)

BOWCOCK   80 LNC 28 21          J.E.BOWCOCK,D.C.HODGSON              (BIRM)
MARTIN A  80 NP B 169 216       A.D. MARTIN,M.R. PENNINGTON          (DURH)  JP
MARTIN B  80 NP B 176 355       B.R.MARTIN,D.MORGAN             (LOUC+RHEL)  JP

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ρ(2350)

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33  RHO(2350,JPG=5-+) I=1

THIS ENTRY WAS PREVIOUSLY CALLED U1(2400).
CONTAINS ONLY RESULTS FROM FORMATION EXPERIMENTS. FOR
PRODUCTION EXPERIMENTS SEE THE NBAR N(1400-3600) ENTRY.
SEE ALSO S,T,U MINI-REVIEWS.
OMITTED FROM TABLE.
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                    33  RHO(2350) MASS (MEV)

M        PBAR P INTO PI PI OR KB K
M  J       (2480.0)  APPROX.              CARTER 1  77 CNTR  0 .7-2.4PB P,PIPI  12/77
M    K     (2500.0)  APPROX.              CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
M    P     (2250.0)  APPROX.              MARTIN A  80 RVUE                      1/82*
M    P     (2300.0)  APPROX.              MARTIN B  80 RVUE                      1/82*

M  J     I=1,JP=5- FROM AMPLITUDE ANALYSIS.
M    K   I=0,1,JP=5- FROM BARRELET ZERO'S ANALYSIS.
M    P   I=1,JP=5- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

M        S CHANNEL NUCLEON ANTINUCLEON
M
M  A        2350.      10.                ABRAMS    70 CNTR    S CHANNEL NBAR N  1/73
M   N      (2360.0)   (25.0)              OH        70 HOBC  -OPBAR(P,N),K*K2PI  1/73
M   I      (2359.)    (2.)                ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
M  EI      (2345.0)   (15.0)              COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77
M   I      (2380.0)  APPROX.              CUTTS     78 CNTR    .97-3. PB P,NB N 12/78

M  A     FOR I=1 NBAR N
M  E     FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
M   I    ISOSPINS 0 AND 1 NOT SEPARATED
M   N    NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71
M   N    NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.

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                    33  RHO(2350) WIDTH (MEV)

W        PBAR P INTO PI PI OR KB K
W  J        (210.0)  APPROX.              CARTER 1  77 CNTR  0 .7-2.4PB P,PIPI  12/77
W    K      (150.0)  APPROX.              CARTER 2  78 CNTR  0 .7-2.4PB P,K-K+  12/78
W    P      (300.0)  APPROX.              MARTIN A  80 RVUE                      1/82*
W    P      (250.0)  APPROX.              MARTIN B  80 RVUE                      1/82*

W  J     I=1,JP=5- FROM AMPLITUDE ANALYSIS.
W    K   I=0,1,JP=5- FROM BARRELET ZERO'S ANALYSIS.
W    P   I=1,JP=5- FROM SIMULTANEOUS ANALYSIS OF P PB --> PI-PI+ AND PIO PIO

W        S CHANNEL NUCLEON ANTINUCLEON
W
W           (140.)    APPROX.             ABRAMS    67 CNTR    S CHANNEL PBAR N  1/73
W   N        (60.0)   OR LESS             OH        70 HOBC  -OPBAR(P,N),K*K2PI 11/71
W   I       (165.)    (18.)      (8.)     ALSPECTOR 73 CNTR    S CHANNEL PBAR P  1/74
W  EI       (135.0)   (150.0)    (65.0)   COUPLAND  77 CNTR  0 .7-2.4PB-P,PB-P  12/77

W  E     FROM A FIT TO THE TOTAL ELASTIC CROSS SECTION.
W   I    ISOSPINS 0 AND 1 NOT SEPARATED
W   N    NO EVIDENCE FOR THIS BUMP SEEN IN THE PBAR P DATA OF CHAPMAN 71
W   N    NARROW STATE NOT CONFIRMED BY OH 73 WITH MORE DATA.

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                      REFERENCES FOR RHO(2350)

ABRAMS    67 PRL 18 1209        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)

BRICMAN   69 PL 29 B 451        +FERRO-LUZZI,BIZARD,+        (CERN+CAEN+SACL)
CASO      69 LNC 3 707          +CONTE,BENZ,+    (GENO+DESY+HAMB+MILA+SACL)

ABRAMS    70 PR D 1 1917        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI,+    (BNL)
OH        70 PRL 24 1257        +PARKER,EASTMAN,SMITH,SPRAFKA,MA       (MSU)

CHAPMAN   71 PR D4 1275         +GREEN,LYS,MURPHY,RING,+              (MICH)
FIELDS    71 PRL 27 1749        +COOPER,RHINES,ALLISON             (ANL+OXF)
YOH       71 PRL 26 922         +BARISH,CAROLL,LOBKOVICZ+     (CIT+BNL+ROCH)

EASTMAN   72 NP B 51 29         +MING MA,OH,PARKER,SMITH,SPRAFKA       (MSU)
MING MA   72 NP B 51 77         +EASTMAN,OH,PARKER,SMITH,SPRAFKA       (MSU)
OH        72 NP B 51 57         +EASTMAN,MING MA,PARKER,SMITH,+        (MSU)

ALSPECTO  73 PRL 30 511         ALSPECTOR,COHEN,CVIJANOVICH,+    (RUTG+UPNJ)
NICHOLSO  73 PR D 7 2572        NICHOLSON,DELORME,CARROLL,+   (CIT+ROCH+BNL)

HYAMS     74 NP B 73 202        +JONES,WEILHAMMER,BLUM,+         (CERN+MPIM)
MING MA   74 NP B68 214         +MOUNTZ,ZEMANY,SMITH                  (MICH)

DONNACHI  75 NC 26 A 317        A.DONNACHIE,P.R.THOMAS          (MANCHESTER)
EISENHAN  75 NP B 96 109        EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)

CARTER 1  77 PL 67 B 117        +COUPLAND,EISENHANDLER,ASTBURY,+(LOQM+RHEL)  JP
CARTER 2  77 PL 67 B 122        A.A.CARTER                           (LOQM)  JP
CARTER 3  77 NP B 127 202       +COUPLAND,ATKINSON,ARNISON+(LOQM+DARE+RHEL)
COUPLAND  77 PL 71 B 460        +EISENHANDLER,GIBSON,ASTBURY,+  (LOQM+RHEL)
MONTANET  77 BOSTON CONF. 260   L.MONTANET                           (CERN)

CARTER 1  78 NP B 132 176       A.A.CARTER                           (LOQM)  JP
CARTER 2  78 NP B 141 467       A.A.CARTER                           (LOQM)
CUTTS     78 PR D 17 16         +GOOD,GRANNIS,G   N,LEE,PITTMAN+(STON+WISC)

MARTIN    79 PL 86 B 53         A.D. MARTIN,M.R. PENNINGTON          (DURH)

BOWCOCK   80 LNC 28 21          J.E.BOWCOCK,D.C.HODGSON              (BIRM)
MARTIN A  80 NP B 169 216       A.D. MARTIN,M.R. PENNINGTON          (DURH)  JP
MARTIN B  80 NP B 176 355       B.R.MARTIN,D.MORGAN             (LOUC+RHEL)  JP

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δ(2450)

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24  DELTA(2450,JPG=6+-) I=1

SEEN IN PARTIAL WAVE ANALYSIS OF THE K KBAR
SYSTEM. NEEDS CONFIRMATION. OMITTED FROM TABLE.
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                    24  DELTA(2450) MASS (MEV)

M    C      2450.       20.               CLELAND   80 SPEC +- 50 PI P,KS K+-P   6/81*

M    C   FROM AN AMPLITUDE ANALYSIS

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                    24  DELTA(2450) WIDTH (MEV)

W    C       320.       40.               CLELAND   80 SPEC +- 50 PI P,KS K+-P   6/81*

W    C   FROM AN AMPLITUDE ANALYSIS

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                    24  DELTA(2450) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      DELTA(2450) INTO K KBAP                                497+ 497

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                     REFERENCES FOR DELTA(2450)

CLELAND   80  UGVA-DPNC/07-101 +GLOOR,MARTIN,NEF,+       (PITT+GEVA+LAUS)

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e^+e^-(1100–2200)

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7  E+ E-(1100-2200,JPG=1- ) I=

THIS ENTRY CONTAINS NON-STRANGE
VECTOR MESONS COUPLED TO E+ E-(PHOTON)
BETWEEN PHI AND J/PSI MASS REGION.
SEE ALSO RHO PRIME(1250) AND RHO
PRIME(1600) MINI-REVIEW.
SEE ALSO PHI PRIME(1670)
OMITTED FROM TABLE.
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              7  E+ E-(1100-2200) MASSES AND WIDTHS (MEV)

M          (1097.0)   (16.0)   (19.0)   BARTALUCC 79 OSPK    7 GAM P,E+ E- P  12/79
W            (1.0)    (24.0)   (20.0)   BARTALUCC 79 OSPK    7 GAM P,E+ E- P  12/79

M          (1830.0)  APPROX.            PETERSON  78 SPEC    GAM P,K+ K- P
W          (120.0)   APPROX.            PETERSON  78 SPEC    GAM P,K+ K- P

M  C       (2130.)   APPROX.            ESPOSITI  78 MEA     E+E-,K*(892)+..  12/78
W  C         (30.)   APPROX.            ESPOSITI  78 MEA     E+E-,K*(892)+..  12/78

M  A       (1820.)   APPROX.            SPINETTI  79 RVUE    E+E-,4 PI+- 2GAM  1/82*
W  A         (30.)   APPROX.            SPINETTI  79 RVUE    E+E-,4 PI+- 2GAM  1/82*

   A     INTEGRATED CROSS-SECTION OF BARBIELLINI 77,BACCI 77,ESPOSITO 77.
   C     NOT SEEN BY DELCOURT 79.

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                   REFERENCES FOR E+ E-(1100-2200)

BACCI     75 PL 58 B 481        +BIDOLI,PENSO,STELLA,BALDINI,+  (ROMA+FRAS)

BACCI     76 PL 64 B 356        +BIDOLI,PENSO,STELLA,BALDINI,+  (ROMA+FRAS)

BACCI     77 PL B 68 393        +DE ZORZI,PENSO,STELLA,BALDINI,+(ROMA+FRAS)
BARBIELL  77 PL B 68 397        BARBIELLINI,BARLETTA,+(FRAS+NAPL+PISA+SANI)
BARTALUC  77 NC A 39 374        BARTALUCCI BERTOLUCCI,BRADASCHIA(DESY+FRAS)
ESPOSITO  77 PL B 68 389        +FELICETTI,MARINI,+    (FRAS+NAPL+PADO+ROMA)
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AMBROSIO 78 PL 80 B 141          +CERRITO,BEMPORAD,BROSCO,+ (NAPL+PISA+ROMA)
BALDINI  78 PL 78 B 167          +BATTISTONI,CAPON,BACCI,DEZORKI+(FRAS+ROMA)
ESPOSIT1 78 LNC 22 305           ESPOSITO,FELICETTI+   (FRAS+NAPL+PADO+ROMA)
ESPOSIT2 78 LNC 23 604           ESPOSITO,FELICETTI+   (FRAS+NAPL+PADO+ROMA)
PETERSON 78 PR D 18 3955         +DIXON,EHRLICH,GALIK,LARSON+      (CORN+HARV)

BARTALUC 79 NC 49 A 207          BARTALUCCI,BASINI,BERTOLUCCI+     (DESY+FRAS)
DELCOURT 79 BATAVIA CONF.499     +BERTRAND,BISELLO,BIZOT,BUON,CORDIER+(LALO)
ESPOSITO 79 LNC 25 5             +MARINI,PALLOTTA+      (FRAS+UMD+PADO+ROMA)
SPINETTI 79 BATAVIA CONF.506     M. SPINETTI                            (FRAS)

BACCI    80 PREP. LFN 80/2       +BALDINI,BATTISTONI,CAPON,DE ZORZI+    (FRAS)
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$\bar{N}$N(1400–3600)

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51   NBAR N(1400-3600)

     THIS ENTRY CONTAINS VARIOUS HIGH
     HIGH MASS, NON-STRANGE STRUCTURES
     COUPLED TO THE BARYON-ANTIBARYON
     SYSTEM AS WELL AS QUASI-NUCLEAR
     BOUND STATES BELOW THRESHOLD.
SEE ALSO S,T,U  DATA CARD LISTINGS AND MINIREVIEWS.
EVIDENCE FOR STRUCTURES COUPLED TO THE ANTI-HYPERON
NUCLEON (OR C.C.) SYSTEM IS LISTED UNDER K*(2200).
OMITTED FROM TABLE.

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          51   NBAR N(1400-3600) MASSES AND WIDTHS (MEV)

M  W G    (1395.)                  PAVLOPOUL 78 CNTR     STOPPED PBARS     1/78

M  W G    (1646.)                  PAVLOPOUL 78 CNTR     STOPPED PBARS     1/78

M  W G    (1684.)                  PAVLOPOUL 78 CNTR     STOPPED PBARS     1/78

   W    OBSERVED WIDTHS CONSISTENT WITH EXPERIMENTAL RESOLUTION.
     G  THEY LOOKED FOR RADIATIVE TRANSITIONS TO BOUND P PBAR STATES.
     G  MONO-ENERGETIC GAMMA RAYS DETECTED.

M   ZO    (1794.5)    (1.4)        GRAY      71 DBC  -  0.PBAR D           1/72
W   ZO       (8.)   OR LESS CL=.95 GRAY      71 DBC  -  0.PBAR D           1/72
     O  DECAYS TO FOUR OR MORE PIONS,I=1.
    Z   NOT SEEN BY AMSLER 80.

M   Z     (1897.)     (1.)         KALOGERO  75 DBC  -  PBAR N ANNIH      12/75
W   Z       (25.)     (6.)         KALOGERO  75 DBC  -  PBAR N ANNIH      12/75
    Z   NOT SEEN BY ALBERI 79, AMSLER 80.

M  B      (1897.0)   (17.0)        ABASHIAN  76 STRC    8PI-P,P 3PI       12/77
W  B       (110.0)   (82.0)        ABASHIAN  76 STRC    8PI-P,P 3PI       12/77
   B    PRODUCED BACKWARDS.

M    R    (1920.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
W          (190.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
     R  I=1,JP=1- FROM A MASS DEPENDENT PARTIAL WAVE ANALYSIS TAKING
     R  SOLUTION A.

M    I      1949.       10.        DEFOIX    80 HBC   0 0-1.2 PB P,5 PI   12/79
W    I        80.       30.        DEFOIX    80 HBC   0 0-1.2 PB P,5 PI   12/79
     I  ISOSPIN = 1 FAVORED

M   Z  153(2020.0)    (3.0)        BENKHEIRI 77 OMEG  0 9,12PI-P,PPPBPI- 12/77
W   Z  153  (24.0)   (12.0)        BENKHEIRI 77 OMEG  0 9,12PI-P,PPPBPI- 12/77
    Z   NOT SEEN BY BIONTA 80, CARROLL 80, HAMILTON 80, BANKS 81, CHUNG 81.

M    T    (2020.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
W          (160.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
     T  I=0,JP=2+ FROM A MASS DEPENDENT PARTIAL WAVE ANALYSIS TAKING
     T  SOLUTION A.

M  K        2080.       10.        KREYNER   80 STRC  0 13 PI-D,PPBN(N)   4/82*
W  K         110.       20.        KREYNER   80 STRC  0 13 PI-D,PPBN(N)   4/82*
   K    NEUTRON SPECTATOR. SEE ALSO NPPBPI-(P) CHANNEL FOLLOWING.

M  L        2090.0      20.0       KREYNER   80 STRC    13 PI-D,NPPBPI-P  1/82*
W  L         170.0      50.0       KREYNER   80 STRC    13 PI-D,NPPBPI-P  1/82*
   L    PROTON  SPECTATOR. SEE ALSO PPBN(N) CHANNEL ABOVE.

M    R    (2110.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
W    R     (330.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
     R  I=1,JP=3- FROM A MASS DEPENDENT PARTIAL WAVE ANALYSIS TAKING
     R  SOLUTION A.

M    N      2110.0      10.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
W    N       190.0      10.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
     N  I=1,JP=3- FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE

M    S    (2141.)                  DONALD    73 HBC   0 S CHANNEL PBAR P   1/74
W    S      (14.)                  DONALD    73 HBC   0 S CHANNEL PBAR P   1/74
     S  SEEN IN FINAL STATE (OMEGA PI+ PI-)

M    M      2180.0      10.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
W    M       270.0      10.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
     M  I=0,JP=2+ FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE.

M    K    (2190.0)                 KALBFLEI  69 HBC   0 S-CHANNEL PBARP    7/69
W    K      BETWEEN 20 AND 80 MEV  KALBFLEI  69 HBC   0 S-CHANNEL PBARP    7/69
     K  SEEN IN PBAR P TO RHOO RHOO PIO. IG=1-.
     K  NOT SEEN BY BACON 73, DONALD 73.
     K  NOT SEEN BY ZEMANY 76 IN RHOO RHOO PI-.

M   Z   58(2204.0)   (5.0)         BENKHEIRI 77 OMEG -  9,12PI-P,PPPBPI- 12/77
W   Z   58  (15.)   OR LESS        BENKHEIRI 77 OMEG -  9,12PI-P,PPPBPI- 12/77
    Z   NOT SEEN BY BIONTA 80, BANKS 81, CHUNG 81.

M   A     (2207.)    (13.)         ALLES-BOR 67 HBC   0 5.7 PBAR P        12/66
W   A       (62.)    (52.)         ALLES-BOR 67 HBC   0 5.7 PBAR P        12/66
    A   ALLES-BORELLI 67 SEE NEUTRAL MODE ONLY (PI+PI-PIO)

M           2210.0      79.0   21.0 EVANGEL2 79 OMEG    10. PI-P,K+ K- N  12/79
W          (203.0)  APPROX.         EVANGEL2 79 OMEG    10. PI-P,K+ K- N  12/79

M    R    (2260.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
W    R     (440.0)  APPROX.        EVANGELIS 79 OMEG    10,16 PI-P,PB P   12/79
     R  I=0,JP=4+ FROM A MASS DEPENDENT PARTIAL WAVE ANALYSIS TAKING
     R  SOLUTION A.

M           2307.0       6.0       ALPER     80 CNTR  0 62 PI-P,K+ K- N    1/82*
W            245.0      20.0       ALPER     80 CNTR  0 62 PI-P,K+ K- N    1/82*

M    M      2380.0      10.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
W    M       380.0      20.0       ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
     M  I=0,JP=4+ FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE

M    M    (2450.0)   (10.0)        ROZANSKA  80 SPRK    18,PI-P,P PB N     1/80
W    M     (280.0)   (20.0)        ROZANSKA  80 SPRK    18,PI-P,P PB N    12/80*
     M  I=1,JP=5- FROM AMPLITUDE ANALYSIS ASSUMING ONE PION EXCHANGE

M  J      (2480.0)   (30.0)        CARTER    77 CNTR  0 .7-2.4PB P,PIPI   12/77
W  J       (210.0)   (25.0)        CARTER    77 CNTR  0 .7-2.4PB P,PIPI   12/77
   J    I=1,JP=5- FROM AMPLITUDE ANALYSIS OF PBAR P INTO PI PI.

M    K    (2500.0)  APPROX.        CARTER    78 CNTR  0 .7-2.4PB P,K-K+   12/78
W    K     (150.0)  APPROX.        CARTER    78 CNTR  0 .7-2.4PB P,K-K+   12/78
     K  I=0,1,JP=5- FROM BARRELET ZERO ANALYSIS.

M         (2710.0)   (20.0)        ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79
W          (170.0)   (40.0)        ROZANSKA  80 SPRK    18,PI-P,P PB N    12/79

M  V      (2850.0)    (5.0)        BRAUN     76 DBC  -  5.5PBAR D,N NBP+  12/77
W  V        (59.)   OR LESS        BRAUN     76 DBC  -  5.5PBAR D,N NBP+  12/77
   V    DECAYS TO NBAR N AND NBAR N PI

M  W      (3080.)    (20.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
W  W       (220.)    (70.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
   W    DECAYS TO 3PI+ 3PI-
   W    NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M  X      (3370.)    (10.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
W  X       (150.)    (40.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
   X    DECAYS TO 4PI+ 4PI-

M  Y      (3390.)    (20.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
W  Y       (220.)   (100.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
   Y    DECAYS TO 3PI+ 3PI-
   Y    NOT SEEN BY KALELKAR 75 WITH 1.5 TIMES MORE DATA

M  Z      (3600.)    (20.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
W  Z       (140.)    (20.)         ALEXANDER 72 HBC   0 6.94 PBAR P        1/73
   Z    DECAYS TO 4PI+ 4PI-

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REFERENCES FOR NBAR N(1400-3600)


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ALLES-BO 67 NC 50 A 776          ALLES-BORELLI,FRENCH,FRISK,+     (CERN+BONN)

KALBFLE1 69 PL 29 B  259         G.KALBFLEISCH,R.STRAND,V.VANDERBURG   (BNL)

ALEXANDE 70 PRL 25 63            +BAR-NIR,DAGAN,GIDAL,GRUNHAUS+  (TEL-AVIV)
KALBFLE1 70 PHILAD.CONF.P.409 G.KALBFLEISCH AND D.MILLER REVUES       (BNL)

GRAY     71 PRL 26 1491           +HAGERT,KALOGEROPOULOS                (SYRA)

ALEXANDE 72 NP B 45 29           ALEXANDER,BAR-NIR,BEVARY,DAGAN,+      (TELA)
BOGDANOV 72 PRL 28 1418          BOGDANOVA,DALKAROV,SHAPIRO            (ITEP)
BUGG     72 PR D 6 3047          +CONDO,HART,COHN,ENDORF,+  (TENN+ORNL+CINC)
CLAYTON  72 NP B 47 81           +MASON,MUIRHEAD,PIGOPOULOS,+     (LIVP+PATR)

BOWEN    73 PRL 30 332           +EARLES,FAISSLER,BLIEDEN,+       (NEAS+STON)
DONALD   73 NP B 61 333          +EDWARDS,GIBBINS,BRIAND,DUBOC,+ (LIVP+LPNP)
GRAY     73 PRL 30 1091          +PAPADOPOULOU,KARAGEORGOPOULOS,+ (ATEN+SYRA)
NICHOLSO 73 PR D 7 2572          NICHOLSON,DELORME,CARROLL,+ (CIT+ROCH+ANL)

HYAMS    74 NP B 73 202          +JONES,WEILHAMMER,BLUM,+         (CERN+MPIM)

DONNACHI 7  NC 26 A 317          A.DONNACHIE,P.R.THOMAS         (MANCHESTER)
EISENHAN 75 NP B 96 109          EISENHANDLER,GIBSON,+ (LOQM+LIVP+DARE+RHEL)
KALOGERO 75 PRL 34 1047          KALOGEROPOULOS,TZANAKOS               (SYRA)

ABASHIAN 76 PR D 13 5            +WATSON,GELFAND,BUTTRAM+(ILL+ANL+CHIC+IOWA)
BRAUN    76 PL B 60 481          +BRICK,FRIDMAN,GERBER,JUILLOT,MAURER+(STRB)
ZEMANY   76 NP B 103 537         +MING MA,MOUNT,..,SMITH                (MSU)

BENKHEIR 77 PL B 68 483          BENKHEIRI,BOUCROT,+    (CERN+CDEF+EPOL+LALO)
CARTER   77 PL 67 B 117          +COUPLAND,EISENHANDLER,ASTBURY,+(LOQM+RHEL) JP
EVANGELI 77 PL B 72 139          EVANGELISTA+      (BARI+BONN+CERN+DARE+GLAS+)

BALTAY   78 PR D 17 62           +CAUTIS,COHEN,CSORNA,KALELKAR+  (COLU+BING)
BENKHEIR 78 LAL-78/30            BENKHEIRI,BOUCROT+     (CERN+CDEF+EPOL+LALO)
CARTER   78 NP B 141 467         A.A.CARTER                            (LOQM)
PAVLOPOU 78 PL 72 B 415          PAVLOPOULOS+      (KARL+BASL+CERN+STOH+STRB)
PENNINGT 78 NP B 137 77          M.R. PENNINGTON                       (CERN)

ALBERI   79 PL 83 B 247          +ALVEAR,CASTELLI,POROPAT+  (TRST+CERN+IFRJ)
ALSTON-G 79 PRL 43 1901          ALSTON-GARNJOST,HAMILTON+     (LBL+MTHO+BNL)
ARMSTRON 79 PL B 85 304          ARMSTRONG+ (AACH+BARI+BONN+CERN+GLAS+LIVP+)
BENKHEIR 79 PL 81 B 380          BENKHEIRI,BOUCROT,+    (EPOL+LALO+CDEF+CERN)
CARROLL  79 PR D 19 1950         +CHIANG,KYCIA,LI,LITTENBERG,+     (BNL+ROCH)
DELCOURT 79 PL B 86 395          +DERADO,BERTRAND,BISELLO,BIZOT,BUON,+(LALO)
EVANGEL1 79 NP B 153 253         + (BARI+BONN+CERN+DARE+GLAS+LIVP+MILA+WIEN)
EVANGEL2 79 NP B 154 381         + (BARI+BONN+CERN+DARE+GLAS+LIVP+MILA+WIEN)
GIBBARD  79 PRL 42 1593          +AHRENS,BERKELMAN,CASSEL,DAY,HARDING+(CORN)
MARTIN   79 PL B 86 93           A.D. MARTIN,M.R. PENNINGTON           (DURH)

ALPER    80 PL 94 B 422          +BECKER,+      (AMST+CERN+CRAC+MPIM+OXF+RHEL)
AMSLER   80 PRL 44 853           +AUERBACH,MANDELKERN,+        (UNM+TEMP+UCI)
BIONTA   80 PRL 44 909           +CARROLL,EDELSTEIN,+    (BNL+CARN+FNAL+SMAS)
BIONTA 2 80 PRL 46 973           +CARROLL,EDELSTEIN,+    (BNL+CARN+FNAL+SMAS)
CARROLL  80 PRL 44 1572          +CHIANG,JOHNSON,CESTER,WEBB,+     (BNL+PRIN)
CHUNG    80 PRL 45 1511          +ETKIN,BENSINGER,+(BNL+BRAN+CUNY+SMAS+MASA)
DEFOIX   80 NP B 162 12          +DOBRZYNSKI,ANGELINI,BIGI,+      (CDEF+PISA)
HAMILTON 80 PRL 44 1179          +PUN,TRIPP,LAZARUS,NICHOLSON (LBL+BNL+MTHO)
KREYNER  80 PR D 22 36           +BAGGETT,FIEGUTH,ALAM,+(IND+PURD+SLAC+VAND)
ROZANSKA 80 NP B 162 505         +BLUM,DIETL,GRAYER,LORENZ+       (MPIM+CERN)

BANKS    81 PL 100 B 191         +BOOTH,CAMPBELL,ARMSTRONG,+      (LIVP+CERN)
CHUNG    81 PRL 46 395           +BENSINGER,+       (BNL+BRAN+CINC+FSU+SMAS)
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X(1900−3600)

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46   X(1900-3600)

THIS ENTRY CONTAINS VARIOUS HIGH-MASS
NON-STRANGE PEAKS, OMITTED FROM TABLE.
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The high mass region is covered nearly continuously by evidence for peaks of various widths and decay modes. As a satisfactory grouping into particles is not yet possible, we list all the Y = 0 bumps coupled neither to $\bar{N}N$ nor to e^+e^-, and having M > 1900 MeV, together, ordered by increasing mass. Note that ANTIPOV 72 ($\pi^- p \to p\, MM^-$ at 25 and 40 C.V/c) see no narrow bumps.

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                 46  X(1900-3600)  MASSES /  WIDTHS  (MEV)

M       100(1898.)   (18.)            THOMPSON  74 HBC  +  13 PI+ P,2RHO     12/75
W       100 (108.)   (41.)    (27.)   THOMPSON  74 HBC  +  13 PI+ P,2RHO     12/75

M       100(1900.)   (40.)            BOESEBECK 68 HBC  +   8 PI+ P,PI+ PI0  12/75
W       100 (216.)   (105.)           BOESEBECK 68 HBC  +   8 PI+ P,PI+ PI0  12/75

M          (1970.)   (10.)            CHLIAPNIK 80 HBC   0 32 K+ P,2KS 2PI   12/79
W          (1970.)   (10.)            CHLIAPNIK 80 HBC     .   + P,2KS 2PI   12/79

M        30(1973.0)  (15.0)           CASO      70 HBC  - ...2PI-P,RHO 2PI   12/75
W        30 (80.0)                    CASO      70 HBC  - 1'.2PI-P,RHO 2PI   12/75

M    K   40(1975.0)  (12.0)           KRAMER    70 HBC  +  13.1 PI+ P,2PI    11/70
W    K   40 (52.0)   OR LESS  CL=.90  KRAMER    70 HBC  +  13.1 PI+ P,2PI    12/75
     K   2PI PEAK OF KRAMER NOT SEEN IN SAME EXP WITH MORE DATA(THOMPSON 74)

M        50(2070.)                    TAKAHASHI 72 HBC     8. PI-P,N 2PI     12/75
W        50 (160.)                    TAKAHASHI 72 HBC     8. PI-P,N 2PI     12/75

M          (2145.)   (10.)            AJINENKO  80 HBC  +  32 K+P,PHI PI+ X   3/82*
W    W     (25.)     OR LESS          AJINENKO  80 HBC  +  32 K+P,PHI  I+ X   3/82*
     W   COMPATIBLE WITH ESTIMATED EXPERIMENTAL RESOLUTION

M  E       (2157.0)  (10.0)           KRAMER    70 HBC  +  13.1 PI+ P,2PI    11/70
W  E       (68.0)    (22.0)           KRAMER    70 HBC  +  13.1 PI+ P,2PI    11/70
   E     EVIDENCE OF KRAMER 70 DISAPPEARED WITH MORE STATISTICS(THOMPSON 74)

M          (2190.0)  (10.0)           CLAYTON   67 HBC  +  < 5PBAR,A2+OMEGA  10/67

M    C     (2207.0)  (22.0)           CASO      70 HBC  - 11.2PI- P,NOTE C    5/70
W    C     (130.0)                    CASO      70 HBC  - 11.2PI- P,NOTE C    5/70
     C   SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)

M  B    126(2340.)   (20.)            BALTAY    75 HBC +   15 PI+P,P5PI      12/75
W  B    126 (180.)   (60.)            BALTAY    75 HBC +   15 PI+P,P5PI      12/75
   B     DOMINANT DECAY INTO RHO0 RHO0 PI+. BALTAY 78 FINDS CONFIRMATION
   B     IN 2PI+PI-2PI0 EVENTS WHICH CONTAIN RHO+ RHO0 PI0 AND 2RHO+PI-.

M          (2500.0)  (32.0)           ANDERSON  69 MMS  -  16 PI- P,BACKW9    8/69
W          (87.0)                     ANDERSON  69 MMS  -  16 PI- P,BACKW9    8/69

M       550(2620.)   (20.)            BAUD      69 MMS  -  8.-10. PI- P       9/69
W       550 (85.)    (30.)            BAUD      69 MMS  -  8.-10. PI- P       9/69

M          (2676.0)  (27.0)           CASO      70 HBC  - 11.2PI- P,NOTE C    5/70
W          (150.0)                    CASO      70 HBC  - 11.2PI- P,NOTE C    5/70
     C   SEEN IN RHO- PI+ PI- (OMEGA AND ETA ANTISELECTED IN 4 PI SYSTEM)

M       640(2800.)   (20.)            BAUD      69 MMS  -  8.-10. PI- P       9/69
W       640 (46.)    (10.)            BAUD      69 MMS  -  8.-10. PI- P       9/69

M  C     15(2820.)   (10.)            SABAU     71 HBC  +  8. PI+ P          11/71
W  C     15 (50.)    (10.)            SABAU     71 HBC  +  8. PI+ P          11/71
   C     SEEN IN (K KBAR PI PI)+ MASS DISTRIBUTION

M       230(2880.)   (20.)            BAUD      69 MMS  -  8.-10. PI- P       9/69
W       230 (15.)    OR LESS          BAUD      69 MMS  -  8.-10. PI- P       9/69

M  Y     43(3013.)   (5.)             YOST      71 HBC  +  11.PI+ P,P(8PI)+  11/71
W  Y     43 (40.)    OR LESS          YOST      71 HBC  +  11.PI+ P,P(8PI)    5/71
   Y     4.3 S.D. EFFECT  . DECAY TO 7 PIONS
   Y     NOT SEEN BY KALELKAR 75 WITH 5 TIMES MORE DATA

M          (3025.0)  (20.0)           BAUD      70 MMS  - 10.5-13 PI- P       5/70
W          (25.0)    APPROX.          BAUD      70 MMS  - 10.5-13 PI- P       5/70

M          (3075.0)  (20.0)           BAUD      70 MMS  - 10.5-13 PI- P       5/70
W          (25.0)    APPROX.          BAUD      70 MMS  - 10.5-13 PI- P       5/70

M          (3145.0)  (20.0)           BAUD      70 MMS  - 10.5-15 PI- P       5/70
W          (10.0)    OR LESS          BAUD      70 MMS  - 10.5-15 PI- P       5/70

M          (3475.0)  (20.0)           BAUD      70 MMS  - 14-15.5 PI- P       5/70
W          (30.0)    APPROX.          BAUD      70 MMS  - 14-15.5 PI- P       5/70

M          (3535.0)  (20.0)           BAUD      70 MMS  - 14-15.5 PI- P       5/70
W          (30.0)    APPROX.          BAUD      70 MMS  - 14-15.5 PI- P       5/70
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REFERENCES FOR X(1900-3600)


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CLAYTON   67 HEIDBG.CONF.P.57    +MASON,MUIRHEAD,FILIPPAS+(LIVERPOOL+ATHENS)

BOESEBEC  68 NP B 4 501          BOESEBECK,DEUTSCHMANN,+(AACHEN+BERLIN+CERN)

ANDERSON  69 PRL 22 1390         +COLLINS,+                        (BNL+CARN)
BAUD      69 PL  30B 129         CERN BOSON SPECTROMETER GROUP         (CERN)

BAUD      70 PL 31 B 549         CERN BOSON SPECTROMETER GROUP         (CERN)
CASO      70 LNC 3 707           +CONTE,TOMASINI,COROS+(GENO+HAMB+MILA+SACL)
KRAMER    70 PRL 25 396          +BARTON,GUTAY,LICHTMAN,MILLER,+    (PURDUE)
SABAU     71 LNC 1 514           +UPETSKY                          (BUCH+ANL)
YOST      71 PR D 3 642          +MORRIS,ALBRIGHT,BRUCKER,LANNUTTI      (FSU)

TAKAHASH  72 PR D 6 1266         TAKAHASHI,BARISH,+      (TOHO+PENN+NDAM+ANL)

THOMPSON  74 NP B69 220          +GAIDOS,MCILWAIN,MILLER,MULERA,+      (PURD)

BALTAY    75 PRL 35 891          +CAUTIS,COHEN,KALELKAR,PISELLO,+(COLU+BING)
KALELKAR  75 THESIS(NEVIS 207)   M.S.KALELKAR                          (COLU)
KEMP      75 NC 27 A 155         +LOTTS,CONTRI,TEODORO+(DURH+GENO+MILA+LPNP)

BALTAY    78 PR D 17 52          +CAUTIS,COHEN,CSORNA,KALELKAR+  (COLU+BING)
BLANAR    75 PR D 20 615         +BOYER,EARLES,FAISSLER,GARELICK+      (NEAS)
CLINE     79 PRL 43 1771         +DE BONTE,GAIDOS,LEEDOM,KEY,+    (PURD+TNTO)

AJINENKO  80 PL 95 B 451         +CHLIAPNIKOV,+        (SERP+BELG+MONS+SACL)
CHLIAPNI  80 ZPHY C 3 285        CHLIAPNIKOV,GERDYUKOV,+    (SERP+BRUX+MONS)
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The Charmonium System

We group into this system those meson states commonly believed to consist of charmed-quark–charmed-antiquark pairs. Since the discovery of the J/ψ(3100) (AUBERT 74, AUGUSTIN 74) this family has increased to at least 14, of which we tabulate 10 as well-established particles. Figure 1 shows the states of charmonium below the ψ(3685), interpreted by the charmonium model, as of January 1982.

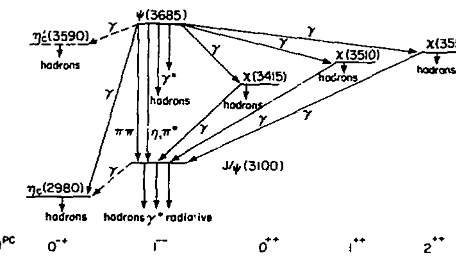

Fig. 1. The current state of knowledge of the charmonium system and transitions, as interpreted by the charmonium model. Uncertain states and transitions are indicated by dashed lines. J^{PC} quantum number assignments are in some cases tentative, but all are at least consistent with experiment; see individual particle listings for discussion. The notation γ* refers to decay processes involving intermediate virtual photons, including decays to e^+e^- and $\mu^+\mu^-$.

η_c(2980)

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26  ETA C(2980,JPG=  +) I=0

OBSERVED IN THE INCLUSIVE GAMMA SPECTRUM GENERATED FROM
PSI(3685) DECAY. THEREFORE C=+. FROM THE DECAY PI)
PI PI. G=+. THEREFORE I=0.

                26  ETA C(2980) MASS (MEV)

M  M     18 2982.       8.           HIMEL     80 SMK2    E+ E-          9/81*
M  M        2980.       9.           PARTRIDGE 80 CBAL    E+ E-          9/81*
M
M   AVG     2981.1      6.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M  M     MASS ADJUSTED BY US TO CORRESPOND TO J/PSI(3100) MASS = 3097    3/82*
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                 26   ETA C(2980) WIDTH (MEV)

W        18  (40.)   OR LESS  CL=.90   HIMEL      80 SMK2      E+ E-             9/81*
W            (20.)   OR LESS  CL=.90   PARTRIDGE  80 CBAL      E+ E-             9/81*

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                 26   ETA C(2980) PARTIAL DECAY MODES

P       HADRONIC DECAYS
P       ---------------
P11     ETA C(2980) INTO 2(PI+PI-)                              139+ 139+ 139+ 139
P12     ETA C(2980) INTO P PBAR                                 938+ 938
P13     ETA C(2980) INTO PI+ PI- P PBAR                         139+ 139+ 938+ 938
P14     ETA C(2980) INTO K KBAR PI                              497+ 497+ 139
P15     ETA C(2980) INTO PI+ PI- K+ K-                          139+ 139+ 493+ 493
P16     ETA C(2980) INTO ETA PI+ PI-                            548+ 139+ 139

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                 26   ETA C(2980) BRANCHING RATIOS

R1      ETA C(2980) INTO (2(PI+PI-))/TOTAL                   (P11)
R1 A          0.013     0.009     0.006 HIMEL      80 SMK2    PSI3685,ETAC GAM  9/81*

R2      ETA C(2980) INTO (PBAR P)/TOTAL                      (P12)
R2 A          0.002     0.002     0.001 HIMEL      80 SMK2    PSI3685,ETAC GAM  9/81*

R3      ETA C(2980) INTO (2PI PBAR P)/TOTAL                  (P13)
R3           (0.012)OR LESS  CL=.90    HIMEL      80 SMK2    PSI3685,ETAC GAM  9/81*

R4      ETA C(2980) INTO (K KBAR PI)/TOTAL                   (P14)
R4 A B        0.14      0.07      0.06  HIMEL      80 SMK2    PSI3685,ETAC GAM  9/81*

R5      ETA C(2980) INTO (2PI 2K)/TOTAL                      (P15)
R5 A          0.009     0.014     0.006 HIMEL      80 SMK2    PSI3685,ETAC GAM  9/81*

R  A    ESTIMATED USING BR ( PSI(3685) INTO ETA C(2980) GAMMA) = .0043
R  A    THE ERRORS DO NOT CONTAIN THE UNCERTAINTY IN THE PSI(3685) DECAY.
R    B  NOT SEEN BY PARTRIDGE IN K+ K- PIO.
R    D  SYSTEMATIC ERROR ADDED LINEARLY BY US.

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                          REFERENCES FOR ETA C(2980)

BLOOM     79 FERMILAB SYMP.92  E.D.BLOOM          (CIT+HARV+PRIN+SLAC+STAN)

HIMEL     80 PRL 45 1146       +TRILLING,ABRAMS,ALAM+        (SLAC+LBL+UCB)
PARTRIDG  80 PRL 45 1150       PARTRIDGE,PECK+    (CIT+HARV+PRIN+STAN+SLAC)

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$J/\psi(3100)$

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         70  J/PSI(3100,JPG=1--) I=0

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                 70   J/PSI(3100) MASS (MEV)

                 WE USE INDEPENDENT MEASUREMENTS OF THE J/PSI(3100)
                 MASS, THE PSI(3685) MASS AND THE MASS DIFFERENCE TO
                 PERFORM A CONSTRAINED FIT.

M            (3100.)                        AUBERT     74 SPEC    78. PP(E+E-)      2/75
M   L        (3105.)     (3.)               AUGUSTIN   74 SMAG         E+E-         2/75
M             3101.       6.                BEMPORAD   75 FRAB         E+E-         1/76
M   O         3095.       4.                BOYARSKI   75 SMAG         E+E-         3/75
M   S         3099.5     31.                CRIEGEE    75 PLUT         E+E-         2/75
M             3098.       6.                PREPOST    75 SPEC    13.-21.GAMMA D    1/76
M             3096.0     30.0               SNYDER     76 SPEC    400 P BE,E+E-     1/77
M   F         3097.0      1.                BRANDELIK  79 DASP    E+ E-            12/79
M      9000 (3095.44)    (0.46)             LEMOIGNE   79 GOLI  0 150 PI-BE,2MU    12/79
M       502  3096.93      0.09              ZHOLENTZ   80 OLYA    E+E- COLL.BEAMS   5/81*
M   F   38K  3098.4       2.2               BARATE     82 GOLI  0 190 PI-BE,2MU     3/82*
M             . . . . . . . . . .
M   AVG       3096.934    0.090   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.01
M   FIT       3096.93     0.09   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.01  2/82*

M   E   SYSTEMATIC ERROR ADDED LINEARLY BY US
M   F   FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
M   F   ASSUMING G(E+ E-) = G(MU+ MU-)
M
M   L   BOYARSKI 75 IS A REEVALUATION OF AUGUSTIN 74 BASED
M   L   ON A RECALIBRATION OF THE SPEAR BEAM ENERGY.
M
M   O   MASS, WIDTH, PARTIAL WIDTHS, AND BRANCHING RATIOS ALL OBTAINED
M   O   FROM ONE OVERALL FIT TO DATA OF THIS EXPERIMENT.
M
M   S   ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF
M   S   THE BEAM ENERGY.

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                 70   J/PSI(3100) WIDTH (KEV)

W             69.       15.                 BOYARSKI   75 SMAG         E+E-         3/75
W             68.       26.                 BALDINI    75 FRAG         E+E-         1/76
W             60.       25.                 ESPOSITO   75 FRAM         E+E-         1/76
W   F         53.       13.                 BRANDELIK  79 DASP    E+ E-            12/79
W   F   FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
W   F   ASSUMING G(E+ E-) = G(MU+ MU-)
W             . . . . . . . . . .
W   AVG       63.0       8.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.01

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                 70   J/PSI(3100) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      J/PSI(3100) INTO E+ E-                                .5+  .5
P2      J/PSI(3100) INTO MU+ MU-                              105+ 105
P3      J/PSI(3100) INTO HADRONS
P4      J/PSI(3100) INTO VIRTUAL GAMMA INTO HADRONS

P       HADRONIC DECAYS
P       ---------------
P11     J/PSI(3100) INTO PI+ PI-                              139+ 139
P12     J/PSI(3100) INTO PI+ PI- PIO                          139+ 139+ 134
P13     J/PSI(3100) INTO 2(PI+ PI-)                           139+ 139+ 139+ 139
P14     J/PSI(3100) INTO 2(PI+ PI-) PIO                       139+ 139+ 139+ 139+
P15     J/PSI(3100) INTO 3(PI+ PI-)
P16     J/PSI(3100) INTO 3(PI+ PI-) PIO
P17     J/PSI(3100) INTO 4(PI+ PI-)
P18     J/PSI(3100) INTO 4(PI+ PI-) PIO
P19     J/PSI(3100) INTO K KBAR                               497+ 497
P20     J/PSI(3100) INTO K KBAR PI                            497+ 497+ 139
P21     J/PSI(3100) INTO PI+ PI- K+ K-                        139+ 139+ 493+ 493
P22     J/PSI(3100) INTO 2(PI+ PI-) K+ K-
P23     J/PSI(3100) INTO PI+ PI- PIO K+ K-                    139+ 139+ 134+ 493+
P24     J/PSI(3100) INTO RHO PI                               769+ 139
P25     J/PSI(3100) INTO RHO PI PI PI                         769+ 139+ 139+ 139
P26     J/PSI(3100) INTO OMEGA PI PI                          782+ 139+ 139
P27     J/PSI(3100) INTO OMEGA 4PI                            782+ 139+ 139+ 139+
P28     J/PSI(3100) INTO OMEGA K KBAR                         782+ 497+ 497
P29     J/PSI(3100) INTO OMEGA F                              782+1273
P30     J/PSI(3100) INTO OMEGA F PRIME                        782+1520
P31     J/PSI(3100) INTO PHI PI PI                            1019+ 139+ 139
P32     J/PSI(3100) INTO PHI 2(PI+ PI-)                       1019+ 139+ 139+ 139+
P33     J/PSI(3100) INTO PHI K KBAR                           1019+ 497+ 497
P34     J/PSI(3100) INTO PHI ETA                              1019+ 548
P35     J/PSI(3100) INTO PHI ETA PRIME                        1019+ 957
P36     J/PSI(3100) INTO PHI F                                1019+1273
P37     J/PSI(3100) INTO PHI F PRIME                          1019+1520
P38     J/PSI(3100) INTO A2 PI                                1318+ 139
P39     J/PSI(3100) INTO A2 RHO                               1318+ 769
P40     J/PSI(3100) INTO K K*(892)                            497+ 891
P41     J/PSI(3100) INTO K K*(1430)                           497+1434
P42     J/PSI(3100) INTO K*(892) K*(892)                      891+ 891
P43     J/PSI(3100) INTO K*(1430) K*(1430)                    1434+1434
P44     J/PSI(3100) INTO K*(892) K*(1430)                     891+1434
P45     J/PSI(3100) INTO P PBAR                               938+ 938
P46     J/PSI(3100) INTO P PBAR PIO                           938+ 938+ 134
P47     J/PSI(3100) INTO P NBAR PI-                           938+ 939+ 139
P48     J/PSI(3100) INTO P PBAR PI+ PI-                       938+ 938+ 139+ 139
P49     J/PSI(3100) INTO P PBAR PI+ PI- PIO                   938+ 938+ 139+ 139+
P50     J/PSI(3100) INTO P PBAR ETA                           938+ 938+ 548
P51     J/PSI(3100) INTO P PBAR OMEGA                         938+ 938+ 782
P52     J/PSI(3100) INTO LAMBDA ANTILAMBDA                    1115+1115
P53     J/PSI(3100) INTO LAMBDA ANTISIGMA                     1115+1192
P54     J/PSI(3100) INTO XI ANTIXI                            1314+1314
P55     J/PSI(3100) INTO PI B                                 139+1233
P56     J/PSI(3100) INTO P PBAR ETA PRIME                     938+ 938+ 957
P57     J/PSI(3100) INTO SIGMA0 SIGMABAR0                     1192+1192
P58     J/PSI(3100) INTO 2(K+ K-)                             493+ 493+ 493+ 493
P59     J/PSI(3100) INTO N NBAR                               939+ 939
P60     J/PSI(3100) INTO N NBAR PI+ PI-                       939+ 939+ 139+ 139
P61     J/PSI(3100) INTO SIGMA- SIGMABAR-                     1192+1197

P       RADIATIVE DECAYS
P       ----------------
P70     J/PSI(3100) INTO GAMMA GAMMA                             0+    0
P71     J/PSI(3100) INTO 3 GAMMA                                 0+    0+    0
P72     J/PSI(3100) INTO PIO GAMMA                             134+    0
P73     J/PSI(3100) INTO ETA GAMMA                             548+    0
P74     J/PSI(3100) INTO ETA PRIME GAMMA                       957+    0
P75     J/PSI(3100) INTO ETA C(2980) GAMMA                    2981+    0
P76     J/PSI(3100) INTO F GAMMA                              1273+    0
P77     J/PSI(3100) INTO F PRIME GAMMA                        1520+    0
P78     J/PSI(3100) INTO D(1285) GAMMA                        1283+    0
P79     J/PSI(3100) INTO E(1420) GAMMA                        1418+    0
P80     J/PSI(3100) INTO P PBAR GAMMA                          938+ 939+    0

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                 70   J/PSI(3100) PARTIAL WIDTHS (KEV)

W1      J/PSI(3100) INTO E+ E-                               (G1)
W1            4.8       0.6                 BOYARSKI   75 SMAG         E+E-         3/75
W1  B        (4.6)     (.8)                 BALDINI    75 FRAG         E+E-         1/76
W1            4.6       1.0                 ESPOSITO   75 FRAM         E+E-         1/76
W1  B   ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-) AND (MU+MU-)
W1 F          4.4       0.6                 BRANDELIK  79 DASP    E+ E-            12/79
W1 F    FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
W1 F    ASSUMING G(E+ E-) = G(MU+ MU-)
W1            . . . . . . . . . .
W1  AVG       4.60      0.39   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.01

W2      J/PSI(3100) INTO MU+ MU-                             (G2)
W2            4.8       0.6                 BOYARSKI   75 SMAG         E+E-         3/75
W2            5.0       1.0                 ESPOSITO   75 FRAM         E+E-         1/76
W2            . . . . . . . . . .
W2  AVG       4.85      0.51   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.01

W3      J/PSI(3100) INTO HADRONS                             (G3)
W3            59.       14.                 BOYARSKI   75 SMAG         E+E-         3/75
W3            59.       24.                 BALDINI    75 FRAG         E+E-         1/76
W3            59.       25.                 ESPOSITO   75 FRAM         E+E-         1/76
W3            . . . . . . . . . .
W3  AVG       57.3      10.9   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.01

W4      J/PSI(3100) INTO GAMMA INTO HADRONS                  (G4)
W4 C          12.       2.                  BOYARSKI   75 SMAG         E+E-         1/76
W4 C    INCLUDED IN W3

W5      J/PSI(3100) INTO GAMMA GAMMA  (EV)                   (G70)
W5           (5.4)OR LESS CL=0.90           BRANDELIK  79 DASP    E+ E-            12/79

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                    TO  J/PSI(3100) BRANCHING RATIOS

          FOR THE BRANCHING RATIOS R1 - R4, SEE ALSO THE PARTIAL
          WIDTHS ABOVE, AND (PARTIAL WIDTHS)*R1 BELOW.

R1      J/PSI(3100) INTO (E+ E-)/TOTAL                     (P1)/(P1+P2+P3)
R1              0.069     0.009          BOYARSKI  75 SMAG          E+E-        3/75

R2      J/PSI(3100) INTO (MU+ MU-)/TOTAL                   (P2)/(P1+P2+P3)
R2              0.069     0.009          BOYARSKI  75 SMAG          E+E-        3/75

R3      J/PSI(3100) INTO (HADRONS)/TOTAL                   (P3)/(P1+P2+P3)
R3              0.86      0.02           BOYARSKI  75 SMAG          E+E-        3/75

R4      J/PSI(3100) INTO (E+ E-)/(MU+ MU-)                 (P1)/(P2)
R4              1.00      0.05           BOYARSKI  75 SMAG          E+E-        3/75
R4              0.93      0.10           FORD      75 SPEC          E+E-        2/75
R4               .91       .15           ESPOSITO  75 FRAM          E+E-        1/76
R4             . . . . . . . . . .
R4  AVG         0.980     0.043   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      J/PSI(3100) INTO (GAMMA INTO HADRONS)/TOTAL        (P4)
R5 C             .17       .02           BOYARSKI  75 SMAG          E+E-        1/76
R5 C     INCLUDED IN R3


R       HADRONIC DECAYS
R       ---------------

R8      J/PSI(3100) INTO (PI+ PI-)/TOTAL (UNITS 10**-4)  (P11)
R8        1     1.6       1.6            VANNUCCI  77 SMAG          E+E-        1/77
R8        5     1.0       0.5            BRANDELIK 78 DASP          E+E-       12/78
R8             . . . . . . . . . .
R8  AVG         1.05      0.48    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      J/PSI(3100) INTO (2(PI+ PI-))/TOTAL                (P13)
R9       76     .004      .001           JEAN-MARI 76 SMAG          E+E-        1/76

R10     J/PSI(3100) INTO (2(PI+ PI-) PI0)/TOTAL            (P14)
R10     675     .04       .01            JEAN-MARI 76 SMAG          E+E-        1/76
R10    1500     0.0364    0.0052         BURMESTER 77 PLUT          E+E-       12/77
R10            . . . . . . . . . .
R10 AVG         0.0372    0.0046  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11     J/PSI(3100) INTO (3(PI+ PI-))/TOTAL                (P15)
R11      32     .004      .002           JEAN-MARI 76 SMAG          E+E-        1/76

R12     J/PSI(3100) INTO (3(PI+ PI-) PI0)/TOTAL            (P16)
R12     181     .029      .007           JEAN-MARI 76 SMAG          E+E-        1/76

R13     J/PSI(3100) INTO (4(PI+ PI-) PI0)/TOTAL            (P18)
R13      13     .009      .003           JEAN-MARI 76 SMAG          E+E-        1/76

R14     J/PSI(3100) INTO (PI+ PI- K+ K-)/TOTAL             (P21)
R14     205     0.0072    0.0023         VANNUCCI  77 SMAG          E+E-        1/77

R15     J/PSI(3100) INTO (2(PI+ PI-) K+ K-)/TOTAL          (P22)
R15      30     0.0031    0.0013         VANNUCCI  77 SMAG          E+E-        1/77

R16     J/PSI(3100) INTO (RHO PI)/(PI+ PI- PI0)            (P24)/(P12)
R16            (.7)  OR MORE  CL=0.90  JEAN-MARI 76 SMAG          E+E-        1/76

R17     J/PSI(3100) INTO (RHO0 PI0)/(RHO+- PI-+)
R17             0.63      0.22           BARTEL 1  76 CNTR          E+E-        1/77
R17             0.59      0.17           JEAN-MARI 76 SMAG          E+E-        1/76
R17             0.53      0.15           ALEXANDER 78 PLUT     E+ E-            4/78
R17             0.46      0.14           BRANDELIK 78 DASP     E+E-,PI+PI-GAMMA 4/78
R17            (0.56)    (0.06)          SCHARRE   79 SMAG     E+E-            12/79
R17            . . . . . . . . . .
R17 AVG         0.534     0.081   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R18     J/PSI(3100) INTO (RHO PI)/TOTAL                    (P24)
R18     543     0.010     0.002          BARTEL 1  76 CNTR          E+E-        1/77
R18     153     0.013     0.003          JEAN-MARI 76 SMAG          E+E-        1/76
R18     183     0.016     0.004          ALEXANDER 78 PLUT     E+ E-            4/78
R18             0.0133    0.0021         BRANDELIK 78 DASP     E+E-,PI+PI-GAMMA 4/78
R18            (0.0132)  (0.0021)        SCHARRE   79 SMAG     E+E-            12/79
R18            . . . . . . . . . .
R18 AVG         0.0122    0.0012  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R19     J/PSI(3100) INTO (OMEGA PI PI)/(2(PI+ PI-) PI0)  (P26)/(P14)
R19  J         (.2)                      JEAN-MARI 76 SMAG          E+E-        1/76

R20     J/PSI(3100) INTO (RHO PI PI PI)/(2 (PI+ PI-) PI0)(P25)/(P14)
R20  J         (.3)                      JEAN-MARI 76 SMAG          E+E-        1/76

R21     J/PSI(3100) INTO (PHI PI+ PI-)/TOTAL
R21      23     0.0021    0.0009         FELDMAN   77 SMAG          E+E-       12/77

R22     J/PSI(3100) INTO (K0S K0L)/TOTAL  (UNITS 10**-4)
R22            (0.89) OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R23     J/PSI(3100) INTO (K+ K-)/TOTAL      (UNITS 10**-4)
R23       2     2.0       1.6            VANNUCCI  77 SMAG          E+E-        1/77
R23       7     2.2       0.9            BRANDELIK 79 DASP     E+ E-           12/79
R23            . . . . . . . . . .
R23 AVG         2.15      0.78    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R24     J/PSI(3100) INTO (K0 K*(892)0)/TOTAL
R24      45     0.0027    0.0006         VANNUCCI  77 SMAG          E+E-        1/77

R25     J/PSI(3100) INTO (K+- K*(892)-+)/TOTAL
R25      39     0.0041    0.0012         BRAUNSCHW 76 DASP          E+E-        1/77
R25      48     0.0032    0.0006         VANNUCCI  77 SMAG          E+E-        1/77
R25            . . . . . . . . . .
R25 AVG         0.00338   0.00054 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R26     J/PSI(3100) INTO (K0 K*(1430)0)/TOTAL
R26            (0.002) OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R27     J/PSI(3100) INTO (K+- K*(1430-+)/TOTAL
R27            (0.0033)OR LESS  CL=0.90  BRAUNSCHW 76 DASP          E+E-        1/77
R27            (0.0015)OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R28     J/PSI(3100) INTO (K*(892)0 K*(892)0)/TOTAL
R28            (0.0005)OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R29     J/PSI(3100) INTO (K*(1430)0 K*(1430)0)/TOTAL
R29            (0.0029)OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R30     J/PSI(3100) INTO (K*(892)0 K*(1430)0)/TOTAL
R30      40     0 .067    0.0026         VANNUCCI  77 SMAG          E+E-        1/77

R31     J/PSI(3100) INTO (PBAR P)/TOTAL (UNITS 10**-3)    (P45)
R31             2.0       0.5            BESCH     78 BONA          E+E-        4/78
R31  A 331      2.2       0.2            PERUZZI   78 SMAG          E+E-        4/78
R31     133     2.5       0.4            BRANDELIK 79 DASP     E+ E-           12/79
R31            . . . . . . . . . .
R31 AVG         2.23      0.17    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R32     J/PSI(3100) INTO (PBAR P)/(MU+ MU-)                (P45)/(P2)
R32  A   20    (.051)    (.02)           WIIK      75 PLUT          E+E-        1/76

R33     J/PSI INTO (LAMBDA ANTI(LAMBDA))/TOT (UNITS 10**-3)(P52)
R33     196     1.1       0.2            PERUZZI   78 SMAG     E+E-,L X,LBAR L  4/78
R33       5     2.6       1.6            BESCH     81 BONA          E+E-        1/82*
R33            . . . . . . . . . .
R33 AVG         1.12      0.20    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R34     J/PSI(3100) INTO (P PBAR PI0)/TOT (UNITS 10**-3) (P46)
R34     109     1.00      0.15           PERUZZI   78 SMAG     E+E-,P PB        4/76
R34             1.4       0.4            BRANDELIK 79 DASP     E+ E-           12/79
R34            . . . . . . . . . .
R34 AVG         1.05      0.14    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R35     J/PSI(3100) INTO (P PBAR PI+PI-)/TOT(UNTS 10**-3)(P48)
R35     533     5.5       0.6            PERUZZI   78 SMAG     E+E-,P PB 1-2PI  4/78
R35      48     3.8       1.6            BESCH     81 BONA          E+E-        1/82*
R35            . . . . . . . . . .
R35 AVG         5.29      0.56    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R36     J/PSI INTO (P PBAR PI+ PI- PI0)/TOT (UNTS 10**-3)(P49)
R36      INCLUDING P PBAR PI+PI- GAMMA AND EXCLUDING OMEGA,ETA,ETA PRIME
R36      39     1.6       0.6            PERUZZI   78 SMAG     E+E-,P PB 2PI    4/78

R37     J/PSI INTO (LAMBDA ANTISIGMA)/TOT (UNITS 10**-3) (P53)
R37            (0.15) OR LESS  CL=0.90  PERUZZI   78 SMAG     E+E-,LAMBDA X    4/78

R38     J/PSI(3100) INTO (PI+- A2)/TOTAL
R38            (0.0043)OR LESS  CL=0.90 BRAUNSCHW 76 DASP          E+E-        1/77

R39     J/PSI(3100) INTO (OMEGA PI PI)/TOTAL               (P26)
R39     215     0.0078    0.00216        BURMESTER 77 PLUT          E+E-       12/77
R39     348     0.0068    0.0019         VANNUCCI  77 SMAG          E+E-        1/77
R39            . . . . . . . . . .
R39 AVG         0.0068    0.0019  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R40     J/PSI(3100) INTO 2(K+ K-)/TOTAL                    (P58)
R40             0.0007    0.0003         VANNUCCI  77 SMAG          E+E-        1/77

R41     J/PSI(3100) INTO (OMEGA K KBAR)/TOTAL              (P28)
R41      22     0.0016    0.0010         FELDMAN   77 SMAG          E+E-       12/77

R42     J/PSI(3100) INTO (PHI K KBAR)/TOTAL                (P33)
R42      14     0.0018    0.0008         FELDMAN   77 SMAG          E+E-       12/77

R43     J/PSI(3100) INTO (PHI ETA)/TOTAL                   (P34)
R43       5     0.0010    0.0006         VANNUCCI  77 SMAG          E+E-        1/77

R44     J/PSI(3100) INTO (PHI ETA PRIME)/TOTAL             (P35)
R44            (0.0013)OR LESS  CL=0.90 VANNUCCI  77 SMAG          E+E-        1/77

R45     J/PSI(3100) INTO (PHI F PRIME)/TOTAL               (P37)
R45       6     0.0008    0.0005         VANNUCCI  77 SMAG          E+E-        1/77

R46     J/PSI(3100) INTO (P NBAR PI-)/TOT (UNITS 10**-3) (P47)
R46     194     2.16      0.29           PERUZZI   78 SMAG     E+E-,P PI-       4/78
R46B    204     2.04      0.27           PERUZZI   78 SMAG     E+E-,P PI+       4/78
R46      12     1.7       0.7            BESCH     81 BONA          E+E-        1/82*
R46B      5     1.6       1.2            BESCH     81 BONA          E+E-        1/82*
R46B     FROM ANTI-CHANNEL (PBAR N PI+)
R46            . . . . . . . . . .
R46 AVG         2.06      0.19    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R47     J/PSI(3100) INTO (P PBAR ETA)/TOT (UNITS 10**-3) (P50)
R47     197     2.3       0.4            PERUZZI   78 SMAG     E+E-,P PB 0-2PI  4/78
R47             2.5       1.2            BRANDELIK 79 DASP     E+ E-           12/79
R47            . . . . . . . . . .
R47 AVG         2.32      0.38    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R48     J/PSI(3100) INTO (P PBAR OMEGA)/TOT(UNITS 10**-3)(P51)
R48      77     1.6       0.3            PERUZZI   78 SMAG     E+E-,P PB 1-2PI  4/78

R49     J/PSI(3100) INTO (K0S K+- PI-+)/TOTAL
R49     126     0.0026    0.0007         VANNUCCI  77 SMAG          E+E-        1/77

R50     J/PSI(3100) INTO (PHI F)/TOTAL (UNITS 10**-4)    (P31)
R50            (3.7)  OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R51     J/PSI(3100) INTO (PHI 2(PI+PI-))/TOTAL             (P32)
R51            (0.0015)OR LESS  CL=0.90 VANNUCCI  77 SMAG          E+E-        1/77

R52     J/PSI(3100) INTO (OMEGA F)/TOTAL                   (P29)
R52      81     0.0019    0.0008         VANNUCCI  77 SMAG          E+E-        1/77
R52      70     0.0040    0.0016         BURMESTER 77 PLUT          E+E-       12/77
R52            . . . . . . . . . .
R52 AVG         0.00232   0.00084 AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

R53     J/PSI(3100) INTO (OMEGA F PRIME)/TOT(UNTS 10**-4)(P30)
R53            (1.6)  OR LESS  CL=0.90  VANNUCCI  77 SMAG          E+E-        1/77

R54     J/PSI(3100) INTO (PI+ PI- PI0 K+ K-)/TOTAL         (P23)
R54     309     0.012     0.003          VANNUCCI  77 SMAG          E+E-        1/77

R55     J/PSI(3100) INTO (RHO A2)/TOTAL                    (P39)
R55      36     0.0084    0.0045         VANNUCCI  77 SMAG          E+E-        1/77

R56     J/PSI(3100) INTO (OMEGA 2PI+ 2PI-)/TOTAL
R56     140     0.0085    0.0034         VANNUCCI  77 SMAG          E+E-        1/77

R57     J/PSI(3100) INTO (XI- ANTI(XI-)/TOTAL (UNITS 10**-3)
R57      51     1.4       0.5            PERUZZI   78 SMAG     E+E-,XI-X        4/78
R57 C    71    (3.2)     (0.8)           PERUZZI   78 SMAG     E+E-,L LBAR      4/78
R57 C    INCLUDES CHANNEL (XI0 ANTIXI0)

R58     J/PSI(3100) INTO (RHO+- PI-+)/(K*(892)+- K-+)
R58            (0.26)    (0.09)          PIERRE    76 SMAG          E+E-        4/77

R59     J/PSI(3100) INTO (B+- PI-+)/TOTAL
R59      87     0.0029    0.0007         BURMESTER 77 PLUT          E+E-       12/77

R60     J/PSI(3100) INTO (N NBAR)/TOTAL (UNITS 10**-2)    (P59)
R60             0.18      0.09           BESCH     78 BONA          E+E-        4/78

R61     J/PSI INTO (SIGMA0 SIGMABAR0)/TOT (UNITS 10**-3) (P57)
R61      52     1.3       0.4            PERUZZI   78 SMAG     E+E-,L LBAR      4/78
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R62     J/PSI INTO (P PBAR ETA PRIME)/TOT (UNITS 10**-3) (P56)
R62      19    1.8       0.6                  PERUZZI   78 SMAG    E+E-,P PB 1-2PI   4/78

R63     J/PSI INTO (N NBAR PI+ PI-)/TOTAL (UNITS 10**-3) (P60)
R63       5    3.8       3.6                  BESCH     81 BONA        E+E-          1/82*

R64     J/PSI INTO (SIGMA- SIGMABAR-)/TOT (UNITS 10**-3) (P61)
R64       3    2.4       2.6                  BESCH     81 BONA        E+E-          1/82*

R     J  FINAL STATE  2(PI+PI-)PI0
R     A  ASSUMING ANGULAR DISTRIBUTION (1.+COS(THETA)**2)


R       RADIATIVE DECAYS
R       ----------------

R71     J/PSI(3100) INTO (2 GAMMA)/TOTAL   (UNITS 10**-3) (P70)
R71          (0.5)  OR LESS  CL=0.90  BARTEL    77 CNTR        E+E-          4/77

R72     J/PSI(3100) INTO (PI0 GAMMA)/TOTAL (UNITS 10**-3)(P72)
R72      10    0.073     0.047                BRANDELIK 79 DASP    E+ E-             12/79

R73     J/PSI(3100) INTO (ETA GAMMA)/TOTAL (UNITS 10**-3)(P73)
R73      21    1.3       0.4                  BARTEL    77 CNTR    E+E-,3 GAMMA      1/77
R73            0.82      0.10                 BRANDELIK 79 DASP    E+ E-             12/79
R73E           0.88      0.19                 KONIGSMAN 82 CBAL    E+ E-,3 GAMMA     4/82*
R73E     SYSTEMATIC ERROR ADDED LINEARLY BY US.
R73           . . . . . . . . . .
R73 AVG        0.855     0.086   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R74     J/PSI(3100) INTO (ETA PRIME GAM)/TOT(UNTS 10**-3)(P74)
R74            (3.2)  OR LESS  CL=.90     MURTAS    76 FRAG        E+E-          4/77
R74      57    (2.4)     (0.7)                BARTEL 1  76 CNTR    E+E-,2 GAMMA RHO  1/77
R74       6    2.9       1.1                  BRANDELIK 79 DASP    E+E-,3 GAMMA      12/79
R74B           3.8       1.3                  SCHARRE   79 SMAG    E+E-, GAMMA X     12/79
R74B     FROM THE INCLUSIVE GAMMA DECAY SPECTRUM                                     12/78
R74            3.4       0.7                  SCHARRE   79 SMAG    E+E-,2 PI 2GAMMA  12/79
R74E           4.1       0.9                  KONIGSMAN 82 CBAL    E+ E-             4/82*
R74E     SYSTEMATIC ERROR ADDED LINEARLY BY US.
R74           . . . . . . . . . .
R74 AVG        3.55      0.46    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)


R78     J/PSI(3100) INTO (3 GAMMA)/TOTAL  (UNITS 10**-3) (P71)
R78          (0.055)OR LESS  CL=0.90  PARTRIDGE 80 CNTR    E+E-,3 GAMMA      12/79

R80     J/PSI(3100) INTO (GAMMA + 2 OR MORE NEUTRALS)/TOTAL   (UNITS 10**-3)
R80            7.0       2.0                  BARTEL    77 CNTR        E+E-          1/77

R81     J/PSI(3100) INTO (F GAMMA)/TOTAL (UNITS 10**-3)  (P76)
R81      35    2.0       0.7                  ALEXANDER 78 PLUT  0 E+E-              4/78
R81  T   30    1.2       0.6                  BRANDELIK 78 DASP    E+E-,PI+PI-GAMMA  4/78
R81  T  RE-STATED BY US TO TAKE ACCOUNT OF SPREAD OF E1,M2,E3 TRANSITIONS.
R81A    178    1.48      0.55                 EDWARDS   82 CBAL    E+E-,2 PI0 GAMMA  2/82*
R81A     SYSTEMATIC ERROR ADDED LINEARLY BY US
R81           . . . . . . . . . .
R81 AVG        1.51      0.35    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R82     J/PSI(3100) INTO (F PRIME GAM)/TOT (UNITS 10**-3)(P77)
R82       3    (0.23) OR LESS  CL=0.90  ALEXANDER 78 PLUT    E+E-,K+K- GAMMA   4/78
R82  S    4    (0.34) OR LESS  CL=0.90  BRANDELIK 79 DASP    E+E-,PI+PI-GAMMA  12/79
R82  S  ASSUMING ISOTROPIC PRODUCTION AND DECAY OF THE F PRIME,AND ISOSPIN.

R84     J/PSI(3100) INTO (P PBAR GAM)/TOT (UNITS 10**-3) (P80)
R84          (0.11) OR LESS  CL=0.90  PERUZZI   78 SMAG    E+E-,P PB SHOWER  4/78

R85     J/PSI(3100) INTO (D(1285) GAM)/TOTAL                 (P78)
R85  D       (0.006)OR LESS  CL=.90   SCHARRE   80 SMAG    E+E-              2/81*
R85  D  USING BR(D INTO K KBAR PI)=0.12

R86     J/PSI(3100) INTO (E(1420) GAM)/TOTAL                 (P79)
R86 E        (0.0055) (0.0022)        SCHARRE   80 SMAG    E+E-              2/81*
R86 E   USING BR(E INTO K KBAR PI)=0.65  SEE MINI-REVIEW UNDER E(1420)
        NOTE THAT RECENT EVIDENCE INDICATES THAT THIS IS NOT THE JPC=1++
        E(1420) (HENCE BR INTO K KBAR PI UNKNOWN). SEE E(1420) MINIREVIEW

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                    70  J/PSI(3100)    G(I)*G(E+E-)/G(TOTAL)  (KEV)

        THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
        INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
        CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATION.
        WE ONLY LIST DATA NOT HAVING BEEN USED TO DETERMINE THE PARTIAL
        WIDTH G(I) OR THE BRANCHING RATIO G(I)/TOTAL.

G1      G(E+E-)*G(E+E-)/G(TOTAL)
G1  S        (.32)     (.07)          BALDINI1  75 FRAG        E+E-          1/76
G1            .34       .14           BEMPORAD  75 FRAB        E+E-          1/76
G1  S        (.34)     (.09)          ESPOSITO  75 FRAM        E+E-          1/76
G1  S        (.36)     (.10)          FORD      75 SPEC        E+E-
G1           0.35      0.02           BRANDELIK 79 DASP        E+E-          12/79
G1          . . . . . . . . . .
G1  AVG      0.350     0.020   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

G2      G(MU+MU-)*G(E+E-)/G(TOTAL)
G2            .31       .09           BEMPORAD  75 FRAB        E+E-          1/76
G2            .51       .09           DASP1     75 DASP        E+E-          1/76
G2  S        (.38)     (.05)          ESPOSITO  75 FRAM        E+E-          1/76
G2  S        (.46)     (.10)          LIBERMAN  75 SPEC        E+E-          1/76
G2          . . . . . . . . . .
G2  AVG      0.41      0.10    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)

G3      G(HADRONIC)*G(E+E-)/G(TOTAL)
G3  S        (4.1)     (.8)           BALDINI1  75 FRAG        E+E-          1/76
G3  S        (3.9)     (.8)           ESPOSITO  75 FRAM        E+E-          1/76

G   S   SEE THE BRANCHING RATIOS AND PARTIAL WIDTHS ABOVE.

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                         REFERENCES FOR J/PSI(3100)

CHRISTEN 70 PRL 25 1523       CHRISTENSON,HICKS,LEDERMAN+ (COLU+BNL+CERN)

ABRAMS   74 PRL 33 1453       +BRIGGS,AUGUSTIN,BOYARSKI+        (LBL+SLAC)
ASH      74 NCL 11 705        +ZORN,BARTOLI+    (FRAS+UMD+NAPL+PADO+ROMA)
AUBERT   74 PRL 33 1404       +BECKER,BIGGS,BURGER,CHEN,EVERHART(MIT+BNL)
AUGUSTIN 74 PRL 33 1406       +BOYARSKI,ABRAMS,BRIGGS+          (SLAC+LBL)
BACCI    74 PRL 33 1408       +BARTOLI,BARBARINO,BARBIELLINI+  (FRASCATI)
   ALSO  74 PRL 33 1649       FOR ERRATA
BALDINI- 74 NCL 11 711        BALDINI-CELIO,BACCI+         (FRASCATI+ROMA)
BARBIELL 74 NCL 11 718        BARBIELLINI,BEMPORAD+ (FRAS+NAPL+PISA+ROMA)
BRAUNSCH 74 PL 53B 393        BRAUNSCHWEIG+     (AACHEN+HAMB+MUNICH+TOKYO)
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ANDREWS  75 PRL 34 231        +HARVEY,LOBKOWICZ,MAY,NORDBERG  (ROCH+CORN)
AUBERT   75 NP B 89 1         +BECKER,BIGGS,BURGER,GLENN,+        (MIT+BNL)
BACCI    75 NCL 12 269        +PENSO,STELLA,BALDINI-CELIO,+    (ROMA+FRAS)
BALDINI1 75 PL 58B 471        BALDINI-CELIO,BOZZO,CAPON,BACCI+(FRAS+ROMA)
BALDINI2 75 PL 58B 475        BALDINI-CELIO,CAPON,DEL FABBRO+ (FRAS+ROMA)
BEMPORAD 75 STANFORD SYMP.113 C.BEMPORAD                  (PISA+FRASCATI)
BLANAR   75 PRL 35 346        +BOYER,FAISSLER,GARELICK,GETTNER,+   (NEAS)
BOYARSKI 75 PRL 34 1357       +BREIDENBACH,BULOS,FELDMAN,+   (SLAC+LBL)JPC
BRAUNSCH 75 PL 53B 491        BRAUNSCHWEIG+     (AACHEN+HAMB+MUNICH+TOKYO)
BUSSER   75 PL 56 B 482       +BLUMENFELD,BANNER,+  (CERN+COLU+ROCK+SACL)
CAMERINI 75 PRL 35 483        +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)
CRIEGEE  75 PL 53B 489        +DEHNE,FRANKE,HORLITZ,KRECHLOCK+     (DESY)
DAKIN    75 PL 56 B 405       +KREISLER,BOLON,HEILE+       (MASA+MIT+SLAC)
DASP1    75 PL 56B 491        BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)
DASP2    75 PL 57B 297        BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)
ESPOSITO 75 NCL 14 73         +BARTOLI,BISELLO,+    (FRAS+NAPL+PADO+ROMA)
FORD     75 PRL 34 604        +BERON,HILGER,HOFSTADTER+       (SLAC+PENN)
GITTELMA 75 PRL 35 1616       GITTELMAN+HANSON+LARSON+LOH+          (CORN)
GRECO    75 PL 56B 367        +PANCHERI-SRIVASTAVA,SRIVASTAVA      (FRAS)
HEINTZE  75 STANFORD SYMP.97  J.HEINTZE                       (HEIDELBERG)
JACKSON  75 NIM 128 13        J.D.JACKSON,D.SCHARRE                  (LBL)
KNAPP1   75 PRL 34 1040       +LEE,BRONSTEIN+   (COLU+HAWA+CORN+ILL+FNAL)
KNAPP2   75 PRL 34 1044       +LEE,BRONSTEIN+   (COLU+HAWA+CORN+ILL+FNAL)
LIBERMAN 75 STANFORD SYMP.55  A.D.LIBERMAN                      (STANFORD)
MARTIN   75 PRL 34 288        +BOLON,DAKIN,FELDMAN,HANSON+(MIT+MASA+SLAC)
PREPOST  75 STANFORD SYMP.241 R.PREPOST                        (WISCONSIN)
SIMPSON  75 PRL 35 699        +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)
WIIK     75 STANFORD SYMP.69  B.H.WIIK                              (DESY)
YENNIE   75 PRL 34 239        D.R.YENNIE                         (CORNELL)

ANTIPOV  76 TBILISI CONF.N 8  +BESSUBOV,BUDANOV,BUSHNIN,DENISOV,+   (SERP)
BACCI    76  LNF-76/60(P)     +BALDINI-CELIO,CAPON+       (FRAS+ROMA+GENO)
BARTEL 1 76 PL 64 B 483       +DUINKER,OLSSON,STEFFEN,HEINTZE+(DESY+HEID)
BRAUNSCH 76 PL 63 B 487       BRAUNSCHWEIG,+    (AACH+DESY+HAMB+MPIM+TOKY)
BUSSER   76 NP B 113 189      +BLUMENFELD,BANNER,+  (CERN+COLU+ROCK+SACL)
JEAN-MAR 76 PRL 36 291        +ABRAMS,BOYARSKI,BREIDENBACH,+ (SLAC+LBL)IG
MURTAS   76 TBILISI CONF. N60 G.P.MURTAS                            (FRAS)
PIERRE   76 TBILISI CONF. N46 F.PIERRE                          (SLAC+LBL)
SNYDER   76 PRL 36 1415       +HOM,LEDERMAN,APPEL,KAPLAN+(COLU+FNAL+STON)

BARTEL   77 PL 66 B 489       +DUINKER,OLSSON,HEINTZE,+       (DESY+HEID)
BIDDICK  77 PRL 38 1324       +BURNETT+     (UCSD+UMD+PAVI+PRIN+SLAC+STAN)
BURMESTE 77 PL 72 B 135       BURMESTER,CRIEGEE,+   (DESY+HAMB+STEG+WUPP)
CORDEN   77 PL 68 B 96        +DOWELL,+   (BIRM+CERN+MPIM+NEUC+EPOL+RHEL)
FELDMAN  77 PL 33 C 285       +PERL                             (LBL+SLAC)
VANNUCCI 77 PR D 15 1814      +ABRAMS,ALAM,BOYARSKI,+           (SLAC+LBL)
YAMADA   77 HAMB. CONF. P. 69 YAMADA                           (DESY+TOKY)

ALEXANDE 78 PL 72 B 493       ALEXANDER,CRIEGEE,+   (DESY+HAMB+STEG+WUPP)
BESCH    78 PL 78 B 347       +EISERMANN,KOWALSKI,V EYSS+(BONN+DESY+MANZ)
BRANDELI 78 PL 74 B 292       BRANDELIK,COROS+ (AACH+DESY+HAMB+MPIM+TOKY)
PERUZZI  78 PR D 17 2901      +PICCOLO,ALAM,BOYARSKI,GOLDHABER+(SLAC+LBL)

BRANDELI 79 ZPHY C 1 233      BRANDELIK,COROS,+(AACH+DESY+HAMB+MPIM+TOKY)
KIRK     79 PRL 42 619        +GOODMAN,ALVERSON,+(FNAL+HARV+ILL+OXF+TUFT)
LEMOIGNE 79 FERMILAB CONF.524 +ABOLINS,BARATE,+     (SACL+LOIC+SHMP+IND)
SCHARRE  79  SLAC-PUB-2321    D.L. SCHARRE                      (SLAC+LBL)
    ALSO 79  LBL 9502          ABRAMS,ALAM,BLOCKER,[illegible]KI,+  (SLAC+LBL)

PARTRIDG 80 PRL 44 712        PARTRIDGE,PECK,+  (CI[illegible]+PRIN+SLAC+STAN)
SCHARRE  80 PL 97 B 329       +TRILLING,ABRAMS,ALAM,[illegible]KER+     (SLAC+LBL)
ZHOLENTZ 80 PL 96 B 214       +KURDADZE,LELCHUK,MISHNEV,NIKITIN+    (NOVO)
    ALSO 81 YAD.PHYS. 34 1471 ZHOLENTZ ET AL.                       (NOVO)

BESCH    81 ZPHY C 8 1        +EISERMANN,LOHR,KOWALSKI,+ (BONN+DESY+MANZ)

BARATE   82 MORIOND WORKSHOP  +BAREYRE,BONAMY,+      (SACL+LOIC+SHMP+IND)
    ALSO 82  CERN-EP/82-15    LEMOIGNE,BARATE,+      (SACL+LOIC+SHMP+IND)
EDWARDS  82 PR D (TO BE PUB.) +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
KONIGSMA 82 MORIOND CONF.     KONIGSMANN,+      (STAN+CIT+HARV+PRIN+SLAC)

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χ(3415)

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          56  CHI(3415,JPG=0++) I=0

                 OBSERVED IN THE RADIATIVE DECAY OF PSI(3685) INTO
        CHI(3415) GAMMA. THEREFORE C=+. THE OBSERVED DECAY INTO PI+ PI-
        OR K+ K- IMPLIES G=+, JP=0+,2+,... . THE ANGULAR DISTRIBUTION
        IS CONSISTENT WITH J=0. JP ABNORMAL EXCLUDED BY PI+ PI- AND
        K+ K- DECAYS. JP=0+ PREFERRED (FELDMAN 77) .

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                    56  CHI(3415) MASS (MEV)

M          2(3407.0)    (8.0)            WIIK      75 DASP   E+E-,J/PSI 2 GAM  1/77
M   D        3415.0      9.0             BIDDICK   77 CNTR   E+E-,MONOCHR.GAM  3/77
M   D        3422.0     10.0             BARTEL    78 CNTR   E+E-,J/PSI 2 GAM  4/78
M   D M      3416.0      4.0             TANENBAUM 78 SMAG   E+ E-             12/78
M   D E      3414.8      1.1             HIMEL     79 SMK2   E+E-,HADRONS      3/82*
M           . . . . . . . . . .
M    AVG     3415.0      1.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   D    MASS VALUE SHIFTED BY US BY AMOUNT APPROPRIATE FOR
                  PSI(3685) MASS=3686 AND PSI(3100) MASS=3097.
M     E  SYSTEMATIC ERROR ADDED LINEARLY BY US
M     M  FROM A SIMULTANEOUS FIT TO RADIATIVE AND HADRONIC DECAY CHANNELS
                  SYSTEMATIC ERROR ADDED LINEARLY BY US

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                    56  CHI(3415) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      CHI(3415) INTO PI+ PI-                          139+ 139
P2      CHI(3415) INTO K+ K-                            493+ 493
P3      CHI(3415) INTO 2(PI+ PI-)                       139+ 139+ 139+ 139
P4      CHI(3415) INTO 3(PI+ PI-)
P5      CHI(3415) INTO PI+ PI- K+ K-                    139+ 139+ 493+ 493
P6      CHI(3415) INTO J/PSI(3100) GAMMA               3096+   0
P7      CHI(3415) INTO 2 GAMMA                            0+   0
P8      CHI(3415) INTO PI+ PI- P PBAR                   139+ 139+ 938+ 938
P9      CHI(3415) INTO RHO0 PI+ PI-                     769+ 139+ 139
P10     CHI(3415) INTO K*(892)0 K+/- PI-/+              891+ 493+ 139
P11     CHI(3415) INTO P PBAR                           938+ 938

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                    56  CHI(3415) BRANCHING RATIOS

R1      CHI(3415) INTO (2 GAMMA)/TOTAL                     (P7)
R1 T         (0.0017)OR LESS  CL=0.90 YAMADA    77 DASP    E+ E-,3 GAMMA    12/77

R2      CHI(3415) INTO 2(PI+ PI-)/TOTAL                    (P3)
R2 T         0.043     0.009           TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78
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R3      CHI(3415) INTC (PI+ PI- K+ K-)/TOTAL                 (P5)
R3 T          0.034      0.009          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R4      CHI(3415) INTC 3(PI+ PI-)/TOTAL                      (P4)
R4 T          0.017      0.004          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/77

R5      CHI(3415) INTO (PI+ PI-)/TOTAL                       (P1)
R5 T          0.009      0.003          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/77
R5 T          0.008      0.003          BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79
R5             . . . . . . . . .
R5  AVG       0.0085     0.0021   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      CHI(3415) INTO (K+ K-)/TOTAL                         (P2)
R6 T          0.01       0.004          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/77
R6 T          0.007      0.003          BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79
R6             . . . . . . . . .
R6  AVG       0.0081     0.0024   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      CHI(3415) INTC (PI+ PI- P PBAR)/TOTAL                (P8)
R7 T          0.006      0.002          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R8      CHI(3415) INTO (J/PSI(3100) GAMMA)/TOTAL             (P6)
R8 T          0.024      0.024          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/77
R8 T          0.017      0.011          BARTEL    78 CNTR PSI(3685)TO GAM CHI  4/78
R8 T          0.037      0.024          BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79
R8 T          (0.068)OR LESS  CL=0.90   HIMEL     80 SMK2    PSI3685,CHI GAM   9/81*
R8 T     17   0.0073     0.0024         OREGLIA   82 CBAL PSI(3685)TO GAM CHI  2/82*
R8             . . . . . . . . .
R8  AVG       0.0082     0.0023   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      CHI(3415) INTO (RHOO PI+ PI-)/TOTAL                  (P9)
R9 T          0.017      0.006          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R10     CHI(3415) INTC (K* (892)0 K+ - PI- +)/TOTAL          (P10)
R10T          0.014      0.005          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R11     CHI(3415) INTC (P PBAR)/TOTAL (UNITS 10**-3)         (P11)
R11T          (0.11) CP LESS  CL=0.90   BRANDEL2  79 DASP PSI(3685)TO GAM CHI  3/82*

R  T    CALCULATED USING PSI(3685) TO (GAMMA CHI(3415))/TOTAL=0.082            3/82*
R  T    THE ERRORS DC NOT CONTAIN THE UNCERTAINTY IN THE PSI(3685) DECAY.

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                        REFERENCES FOR CHI(3415)

FELDMAN   75 PRL 35 821          +JEAN-MARIE,SADOULET,VANNUCCI,+  (LBL+SLAC)
    ALSO  75 PRL 35 1189   (ERRATA)
TANENBAU  75 PRL 35 1323         TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)
WIIK      75 STANFORD SYMP.69    B.H.WIIK                             (DESY)

BIDDICK   77 PRL 38 1324         +BURNETT+     (UCSD+UMD+PAVI+PRIN+SLAC+STAN)
FELDMAN   77 PL 33 C 285         +PERL                            (LBL+SLAC)
YAMADA    77 HAMB. CONF. P. 69 YAMADA                            (DESY+TOKY)

BARTEL    78 PL 79 B 492         DITTMANN,DUINKER,OLSSON,O'NEILL+(DESY+HEID)
TANENBAU  78 PR D 17 1731        TANENBAUM,ALAM,BOYARSKI,+        (SLAC+LBL)
    ALSO  82  PRIVATE COMM.      G.H.TRILLING                     (LBL+UCB)

BRANDEL1  79 ZPHY C 1 233        BRANDELIK,COROS,+(AACH+DESY+HAMB+MPIM+TOKY)
BRANDEL2  79 NP B 160 426        BRANDELIK,COROS,+(AACH+DESY+HAMB+MPIM+TOKY)
HIMEL     79 THESIS  SLAC-223    T.M.HIMEL                            (SLAC)
    ALSO  82  PRIVATE COMM.      G.H.TRILLING                     (LBL+UCB)
KIRK      79 PRL 42 619          +GOODMAN,ALVERSON,+(FNAL+HARV+ILL+OXF+TUFT)

HIMEL     80 PRL 44 920          +ABRAMS,ALAM,BLOCKER,+           (LBL+SLAC)

OREGLIA   82 PR D (TO BE PUB.) +BLOOM,BULOS,+       (SLAC+CIT+HARV+PRIN+STAN)

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P_c or χ(3510)

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55  PC OR CHI(3510,JPC=1++) I=0

               OBSERVED IN THE RADIATIVE SEQUENTIAL DECAY
               OF THE PSI(3685) INTO PC GAMMA, PC INTO
               J/PSI(3100) GAMMA. THEREFORE, C=+.
     THE LACK OF DECAYS INTO PI+ PI- OR K+K- IS SUGGESTIVE OF
     JP = ABNORMAL. THE DECAYS INTO 4PI AND 6PI IMPLY G=+, THUS I=0.
     J=0,2 EXCLUDED BY ANGULAR DISTRIBUTION IN THE (GAMMA J/PSI)
     DECAY. JP=1+ PREFERRED (FELDMAN 77, OREGLIA 82)

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                    55  PC MASS (MEV)

M          40(3500.)     (10.)          TANENBAUM 75 SMAG        HADRONS GAM 12/77
M           7(3507.0)    (7.0)          WIIK      75 DASP   E+E-,J/PSI 2 GAM  1/77
M            (3510.0)    (20.0)         BARTEL    76 CNTR   E+E-,J/PSI 2 GAM  1/77
M  D     367 3513.0       7.             BIDDICK   77 CNTR   E+E-,MONOCHR.GAM  3/77
M  D         3507.0       ..             BARTEL    78 CNTR   E+E-,J/PSI 2 GAM  4/78
M  D *       3505.0       5.0           TANENBAUM 78 SMAG   E+ E-            12/78
M         21 3509.0      11.0           BRANDEL2  79 DASP   E+E-,J/PSI 2GAM  12/79
M          15(3520.)                    LEMOIGNE  79 GOLI  D 150 PI-BE,2MU   12/79
M  D F   254 3510.1       1.1           HIMEL     80 SMK2   E+E-,J/PSI 2 GAM  9/81*
M  P      91 3507.4       1.7           BARATE    82 GOLI  D 190 PI-BE,GAM2MU 3/82*
M  E F   943 3510.4       0.6           OREGLIA   82 CBAL   E+E-,J/PSI 2 GAM  3/82*
M             . . . . . . . . . .
M   AVG      3509.95      0.55    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.1)

M  D    MASS VALUE SHIFTED BY US BY AMOUNT APPROPRIATE FOR
                   PSI(3685) MASS=3686 AND PSI(3100) MASS=3097
M  E    ASSUMING PSI(3685) MASS=3686 AND PSI(3100) MASS=3097.
M    F  SYSTEMATIC ERROR ADDED LINEARLY BY US
M    *  FROM A SIMULTANEOUS FIT TO RADIATIVE AND HADRONIC DECAY CHANNELS
                  SYSTEMATIC ERROR ADDED LINEARLY BY US
M  P    J/PSI MASS CONSTRAINED TO 3097.

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                    55  PC PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      PC INTO J/PSI(3100) GAMMA                   3096+   0
P2      PC INTO PI+ PI-                              139+ 139
P3      PC INTO K+ K-                                493+ 493
P4      PC INTO GAMMA GAMMA                            0+   0
P5      PC INTO 2(PI+ PI-)                           139+ 139+ 139+ 139
P6      PC INTO 3(PI+ PI-)
P7      PC INTO PI+ PI- K+ K-                        139+ 139+ 493+ 493
P8      PC INTO PI+ PI- P PBAR                       139+ 139+ 938+ 938
P9      PC INTO RHOO PI+ PI-                         769+ 139+ 139
P10     PC INTO K*(892)0 K+/- PI-/+                  891+ 493+ 139
P11     PC INTO P PBAR                               938+ 938

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                    55  PC BRANCHING RATIOS

R1      PC INTO (J/PSI(3100) GAMMA)/TOTAL                             (P1)
R1 T          (0.63)     (0.19)         BIDDICK   77 CNTR PSI(3685)TO GAM  PC 12/77
R1 T           0.31       0.05          BARTEL    78 CNTR PSI(3695) TO GAM PC  4/78
R1 T           0.30       0.10          TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78
R1 T           0.21       0.05          BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79
R1 T           0.30       0.08          HIMEL     80 SMK2    PSI3685,PC GAM     9/81*
R1 T     943   0.30       0.05          OREGLIA   82 CBAL PSI(3685)TO GAM CHI  2/82*
R1             . . . . . . . . .
R1  AVG        0.278      0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      PC INTO (PI+PI- AND K+K-)/TOTAL                               (P2+P3)
R2 T          (0.0019)OR LESS           FELDMAN   77 SMAG PSI(3685) TO GAM PC 12/77
R2 T          (0.0041)OR LESS CL=0.90   BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79

R3      PC INTO (GAMMA GAMMA)/TOTAL                                   (P4)
R3 T          (0.0016)OR LESS CL=0.90   YAMADA    77 DASP    E+ E-,3 GAMMA    12/77

R4      PC INTO 2(PI+ PI-)/TOTAL                                      (P5)
R4 T          0.018      0.005          TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R5      PC INTO (PI+ PI- K+ K-)/TOTAL                                 (P7)
R5 T          0.010      0.004          TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R6      PC INTO 3(PI+ PI-)/TOTAL                                      (P6)
R6 T          0.024      0.009          TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R7      PC INTO (PI+ PI- P PBAR)/TOTAL                                (P8)
R7 T          0.0015     0.0010         TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R8      PC INTO (RHOO PI+ PI-)/TOTAL                                  (P9)
R8 T          0.0043     0.0038         TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R9      PC INTO (K*(892)0 K+ - PI- +)/TOTAL                           (P10)
R9 T          0.0035     0.0023         TANENBAUM 78 SMAG PSI(3685) TO GAM PC 12/78

R11     PC INTO (P PBAR)/TOTAL                                        (P11)
R11T          (0.0013)OR LESS CL=0.90   BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79

R  T    ESTIMATED USING PSI(3685) TO (GAMMA PC)/TOTAL=0.080                     3/82*
R  T    THE ERRORS DC NOT CONTAIN THE UNCERTAINTY IN THE PSI(3685) DECAY.

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                        REFERENCES FOR PC

DASP      75 PL 57B 407          BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)
FELDMAN   75 STANFORD SYMP.39    G.J.FELDMAN                          (SLAC)
HEINTZE   75 STANFORD SYMP.97    J.HEINTZE                        (HEIDELBERG)
SIMPSON   75 PRL 35 699          +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)
TANENBAU  75 PRL 35 1323         TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)
WIIK      75 STANFORD SYMP.69    B.H.WIIK                             (DESY)

BARTEL    76 TBILISI CONF.N75    +DUINKER,OLSSON,HEINTZE,+       (DESY+HEID)

BIDDICK   77 PRL 38 1324         +BURNETT+     (UCSD+UMD+PAVI+PRIN+SLAC+STAN)
FELDMAN   77 PL 33 C 285         +PERL                            (LBL+SLAC)
YAMADA    77 HAMB. CONF. P. 69 YAMADA                            (DESY+TOKY)

BARTEL    78 PL 79 B 492         +DITTMANN,DUINKER,OLSSON,ONEILL+(DESY+HEID)
TANENBAU  78 PR D 17 1731        TANENBAUM,ALAM,BOYARSKI,+        (SLAC+LBL)
    ALSO  82 PRIVATE COMM.       G.H.TRILLING                     (LBL+UCB)

BRANDEL1  79 ZPHY C 1 233        BRANDELIK,COROS,+(AACH+DESY+HAMB+MPIM+TOKY)
BRANDEL2  79 NP B 160 426        BRANDELIK,COROS,+(AACH+DESY+HAMB+MPIM+TOKY)
KIRK      79 PRL 42 619          +GOODMAN,ALVERSON,+(FNAL+HARV+ILL+OXF+TUFT)
LEMOIGNE  79 FERMILAB CONF.524 +ABOLINS,BARATE,+         (SACL+LOIC+SHMP+IND)

HIMEL     80 PRL 44 920          +ABRAMS,ALAM,BLOCKER,+           (LBL+SLAC)
    ALSO  82 PRIVATE COMM.       G.H.TRILLING                     (LBL+UCB)

BARATE    82 MORIOND WORKSHOP  +BAREYRE,BONAMY,+         (SACL+LOIC+SHMP+IND)
    ALSO  82 CERN-EP/82-15       LEMOIGNE,BARATE,+       (SACL+LOIC+SHMP+IND)
OREGLIA   82 PR D (TO BE PUB.) +BLOOM,BULOS,+       (SLAC+CIT+HARV+PRIN+STAN)
    ALSO  82 PRIVATE COMM.       M.OREGLIA                            (EFI)

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χ(3555)

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57  CHI(3555,JPG=2++) I=0

          OBSERVED IN RADIATIVE DECAY OF PSI(3685) INTO
          CHI(3555) GAMMA. THEREFORE C=+. THE OBSERVED DECAY INTO 4PI
          AND 6PI IMPLY G=+, THUS I=0.
          J=0 IS EXCLUDED BY THE ANGULAR DISTRIBUTION IN THE HADRONIC
          DECAYS. JP ABNORMAL EXCLUDED BY PI+ PI- AND K+ K- DECAYS.
          JP=2+ PREFERRED (FELDMAN 77, OREGLIA 82).

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                    57  CHI(3555) MASS (MEV)

M            (3550.0)    (10.0)         TRILLING  76 SMAG   E+E-,HADRONS GAM  1/77
M           4(3543.0)    (10.0)         WHITAKER  76 SMAG   E+E-,J/PSI 2 GAM  1/77
M  D     360 3563.0       7.0           BIDDICK   77 CNTR   E+E-,MONOCHR.GAM  3/77
M  D         3553.0       4.0           BARTEL    78 CNTR   E+E-,J/PSI 2 GAM  4/78
M  D *       3553.0       5.0           TANENBAUM 78 SMAG   E+ E-            12/78
M         15 3551.0      11.0           BRANDEL2  79 DASP   E+E-,J/PSI 2GAM  12/79
M  D F    69 3557.        1.5           HIMEL     80 SMK2   E+E-,J/PSI 2 GAM  9/81*
M  P      66 3555.4       2.2           BARATE    82 GOLI  D 190 PI-BE,GAM2MU 3/82*
M  E F   479 3555.5       0.7           OREGLIA   82 CBAL   E+E-,J/PSI 2 GAM  3/82*
M             . . . . . . . . . .
M   AVG      3555.82      0.60    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M  D    MASS VALUE SHIFTED BY US BY AMOUNT APPROPRIATE FOR
                   PSI(3685) MASS=3686 AND PSI(3100) MASS=3097.
M  E    ASSUMING PSI(3685) MASS=3686 AND PSI(3100) MASS=3097.
M    F  SYSTEMATIC ERROR ADDED LINEARLY BY US.
M    *  FROM A SIMULTANEOUS FIT TO RADIATIVE AND HADRONIC DECAY CHANNELS
                  SYSTEMATIC ERROR ADDED LINEARLY BY US
M  P    J/PSI MASS CONSTRAINED TO 3097

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                     57  CHI(3555) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      CHI(3555) INTO PI+ PI-                                 139+ 139
P2      CHI(3555) INTO K+ K-                                   493+ 493
P3      CHI(3555) INTO 2(PI+ PI-)                              139+ 139+ 139+ 139
P4      CHI(3555) INTO 3(PI+ PI-)
P5      CHI(3555) INTO PI+ PI- K+ K-                           139+ 139+ 493+ 493
P6      CHI(3555) INTO J/PSI(3100) GAMMA                      3096+   0
P7      CHI(3555) INTO 2 GAMMA                                  0+   0
P8      CHI(3555) INTO PI+ PI- P PBAR                          139+ 139+ 938+ 938
P9      CHI(3555) INTO RHO0 PI+ PI-                            769+ 139+ 139
P10     CHI(3555) INTO K*(892)0 K+/- PI-/+                     891+ 493+ 139
P11     CHI(3555) INTO P PBAR                                  938+ 938
P12     CHI(3555) INTO J/PSI(3100) PI+ PI- PI0                3096+ 139+ 139+ 134

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                     57  CHI(3555) BRANCHING RATIOS

R1      CHI(3555) INTO (2 GAMMA)/TOTAL                         (P7)
R1 T        (0.0006)OR LESS  CL=0.9% YAMADA    77 DASP    E+ E-,3 GAMMA    12/77

R2      CHI(3555) INTO 2(PI+ PI-)/TOTAL                        (P3)
R2 T         0.023     0.005          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R3      CHI(3555) INTO (PI+ PI- K+ K-)/TOTAL                   (P5)
R3 T         0.020     0.005          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R4      CHI(3555) INTO 3(PI+ PI-)/TOTAL                        (P4)
R4 T         0.012     0.008          TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R5      CHI(3555) INTO (PI+ PI- AND K+ K-)/TOTAL               (P1+P2)
R5 T         0.0026    0.0011         TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R6      CHI(3555) INTO (PI+ PI- P PBAR)/TOTAL                  (P8)
R6 T         0.0035    0.0014         TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R7      CHI(3555) INTO (J/PSI(3100) GAMMA)/TOTAL               (P6)
R7 T        (0.30)    (0.14)          BIDDICK   77 CNTR PSI(3685)TO GAM CHI 12/77
R7 T         0.14      0.03           BARTEL    78 CNTR PSI(3685)TO GAM CHI  4/78
R7 T         0.12      0.14     0.07  SPITZER   78 PLUT PSI(3685)TO GAM CHI 12/78
R7 T         0.14      0.08           TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78
R7 T         0.19      0.05           BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79
R7 T         0.15      0.04           HIMEL     80 SMK2   PS13685,CHI GAM    9/81*
R7 T   479   0.170     0.030          OREGLIA   82 CBAL PSI(3685)TO GAM CHI  2/82*
R7          . . . . . . . . . .
R7  AVG      0.157     0.017   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8      CHI(3555) INTO (RHO0 PI+ PI-)/TOTAL                    (P9)
R8 T         0.0071    0.0042         TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R9      CHI(3555) INTO (K*(892)0 K+ - PI- +)/TOTAL             (P10)
R9 T         0.0050    0.0029         TANENBAUM 78 SMAG PSI(3685)TO GAM CHI 12/78

R10     CHI(3555) INTO (PI+ PI-)/TOTAL (UNITS 10**-3)          (P1)
R10T     4   2.0       1.1            BRANDEL1  79 DASP PSI(3685)TO GAM CHI 12/79

R11     CHI(3555) INTO (K+ K-)/TOTAL (UNITS 10**-3)            (P2)
R11T     2   1.6       1.2            BRANDEL1  79 DASP PSI(3685)TO GAM CHI 12/79

R12     CHI(3555) INTO (P PBAR)/TOTAL (UNITS 10**-3)           (P11)
R12T        (1.0)  OR LESS CL=0.90    BRANDEL2  79 DASP PSI(3685)TO GAM CHI 12/79

R13     CHI(3555) INTO (J/PSI PI+PI-PI0)/TOTAL                 (P12)
R13         (0.015)OR LESS  CL=.90    BARATE    81 SPEC    190 PI-BE,2PI2MU  1/82*

R  T     ESTIMATED USING PSI(3685) TO (GAMMA CHI(3555))/TOTAL=0.074          3/82*
R  T     THE ERRORS DO NOT CONTAIN THE UNCERTAINTY IN THE PSI(3685) DECAY.

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REFERENCES FOR CHI(3555)


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FELDMAN  75 PRL 35 821         +JEAN-MARIE,SADDULET,VANNUCCI,+  (LBL+SLAC)
   ALSO  75 PRL 35 1189  (ERRATA)
TANENBAU 75 PRL 35 1323        TANENBAUM,WHITAKER,ABRAMS,+      (LBL+SLAC)

TRILLING 76 STANFORD SYMP.437 G. H. TRILLING                         (LBL)
WHITAKER 76 PRL 37 1596        +TANENBAUM,ABRAMS,ALAM,BOYARSKI,+(SLAC+LBL)

BIDDICK  77 PRL 38 1324        +BURNETT+     (UCSD+UMD+PAVI+PRIN+SLAC+STAN)
FELDMAN  77 PL 33 C 285        +PERL                             (LBL+SLAC)
YAMADA   77 HAMB. CONF. P. 69 YAMADA                           (DESY+TOKY)

BARTEL   78 PL 79 B 492        DITTMANN,DUINKER,OLSSON,O'NEILL+(DESY+HEID)
SPITZER  78 KYOTO SUM.INST.47 H. SPITZER                            (HAMB)
TANENBAU 78 PR D 17 1731       TANENBAUM,ALAM,BOYARSKI,+         (SLAC+LBL)
   ALSO  82  PRIVATE COMM.     G.H.TRILLING                       (LBL+UCB)

BRANDEL1 79 ZPHY C 1 233       BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)
BRANDEL2 79 NP B 160 426       BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)
KIRK     79 PRL 42 619         +GOODMAN,ALVERSON,+(FNAL+HARV+ILL+OXF+TUFT)

HIMEL    80 PRL 44 920         +ABRAMS,ALAM,BLOCKER,+            (LBL+SLAC)
   ALSO  82  PRIVATE COMM.     G.H.TRILLING                       (LBL+UCB)

BARATE   81 PR D 24 2994       +ASTBURY,MCEWEN,+ (SACL+LOIC+SHMP+CERN+IND)

BARATE   82 MORIOND WORKSHOP   +BAREYRE,BONAMY,+      (SACL+LOIC+SHMP+IND)
   ALSO  82  CERN-EP/82-15     LEMOIGNE,BARATE,+      (SACL+LOIC+SHMP+IND)
OREGLIA  82 PR D (TO BE PUB.) +BLOOM,BULOS,+    (SLAC+CIT+HARV+PRIN+STAN)
   ALSO  82  PRIVATE COMM.     M.OREGLIA                             (EFI)

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$\eta_c'(3590)$

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59  ETA C(3590,JPG=   ) I=

OBSERVED IN THE RADIATIVE DECAY OF PSI(3685) INTO
ETA C(3590) GAMMA.  THEREFORE, C=+. NEEDS CONFIRMATION.
OMITTED FROM TABLE.
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Evidence for the $\eta_c'(3590)$ is based on the observation of a monochromatic gamma line in the inclusive photon spectrum for $\psi(3685)$ decays (EDWARDS 82). No exclusive decay modes are known at this time. A signal had been reported for a state at similar mass in the decay $\psi(3685) \to \gamma\gamma J/\psi(3100)$ (BARTEL 78), but this signal was not confirmed in an experiment with higher statistics (OREGLIA 82).

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                     59  ETA C(3590) MASS (MEV)

M    A     3594.0       5.0            EDWARDS   82 CBAL   E+E-,GAM INCL     1/82*
M    A  ASSUMING MASS OF PSI(3685) = 3686 MEV.

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                     59  ETA C(3590) WIDTH (MEV)

W              (8.0)  OR LESS  CL=.95  EDWARDS   82 CBAL   E+E-,GAM INCL     1/82*

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                     59  ETA C(3590) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      ETA C(3590) INTO HADRONS

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                     59  ETA C(3590) BRANCHING RATIOS

R1      ETA C(3590) INTO HADRONS                        (P1)
R1         SEEN                         EDWARDS   82 CNTR   E+E-,GAM INCL    1/82*

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REFERENCES FOR ETA C(3590)


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BARTEL   78 PL 79 B 492        +DITTMANN,DUINKER,OLSSON,+       (DESY+HEID)

PORTER   81 SLAC SUM.CONF.355 +EDWARDS,+        (CIT+HARV+PRIN+STAN+SLAC)

EDWARDS  82 PRL 48 70          +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
OREGLIA  82 PR D (TO BE PUB.) +BLOOM,BULOS,+    (SLAC+CIT+HARV+PRIN+STAN)

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$\psi(3685)$

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71  PSI(3685,JPG=1--) I=0

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                     71  PSI(3685) MASS (MEV)

                     WE USE INDEPENDENT MEASUREMENTS OF THE J/PSI(3100)
                     MASS, THE PSI(3685) MASS, AND THE MASS DIFFERENCE TO
                     PERFORM A CONSTRAINED FIT.

M  S       3680.3      37.              CRIEGEE   75 PLUT        E+E-           2/75
M   R     (3684.)     (5.)              LUTH      75 SMAG        E+E-           1/76
M          3684.        9.              PREPOST   75 SPEC    21. GAMMA D        1/76
M      140(3683.0)    (6.0)             LEMOIGNE  79 GOLI  0 150 PI-BE,2MU     12/79
M  F       3686.        3.              BRANDEL1  79 DASP    E+ E-             12/79
M      413 3686.0C      0.10            ZHOLENTZ  80 OLYA    E+E- COLL.BEAMS    9/81*
M          . . . . . . . . . .
M   AVG    3686.000     0.100   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
M   FIT    3686.00      0.10   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)  2/82*

M  F    FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
M  F    ASSUMING G(E+ E-) = G(MU+ MU-)
M   R   REDUNDANT WITH DATA IN MASS DIFFERENCE BELOW
M   S   ERROR OF ABOUT 1 PER CENT FROM THE UNCERTAINTY IN CALIBRATION OF
M   S   THE BEAM ENERGY.

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Mesons

ψ(3685)


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                    71  PSI(3685) - J/PSI(3100) MASS DIFFERENCE (MEV)

DM          588.7      .8           LUTH      75 SMAG                        1/76
DM  R      (589.07)   (0.13)        ZHOLENTZ  80 OLYA    E+E-                3/82*
DM E        589.7     1.6           BARATE    82 GOLI    190 PI-BE,2PI2MU   1/82*
DM          590.4     2.5           BARATE    82 GOLI    190 PI-BE,2MU      3/82*
DM          . . . . . . . . . .
DM  AVG     589.01    0.69   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
DM  FIT     589.06    0.13  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

DM E   SYSTEMATIC ERROR ADDED LINEARLY BY US
DM  R  REDUNDANT WITH DATA IN MASS ABOVE
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                    71  PSI(3685) WIDTH (KEV)

W           228.      56.           LUTH      75 SMAG
W  F        202.      57.           BRANDELI  79 DASP    E+ E-              12/79
W  F   FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
W  F   ASSUMING G(E+ E-) = G(MU+ MU-)
W           . . . . . . . . . .
W   AVG     215.2     39.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                    71  PSI(3685) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     PSI(3685) INTO E+ E-                               .5+  .5
P2     PSI(3685) INTO MU+ MU-                            105+ 105
P3     PSI(3685) INTO HADRONS
P4     PSI(3685) INTO VIRTUAL GAMMA INTO HADRONS

P      DECAYS INTO J/PSI(3100) + ANYTHING
P      ----------------------------------
P11    PSI(3685) INTO J/PSI(3100) + ANYTHING
P12    PSI(3685) INTO J/PSI(3100) + NEUTRALS
P13    PSI(3685) INTO J/PSI(3100) PI+ PI-               3096+ 139+ 139
P14    PSI(3685) INTO J/PSI(3100) PIO PIO               3096+ 134+ 134
P15    PSI(3685) INTO J/PSI(3100) ETA                   3096+ 548
P16    PSI(3685) INTO J/PSI(3100) GAMMA GAMMA           3096+   0+   0
P17    PSI(3685) INTO J/PSI(3100) PIO                   3096+ 134
P17                   SMALL -- NOT USED IN FIT

P      HADRONIC DECAYS
P      ---------------
P21    PSI(3685) INTO PI+ PI-                            139+ 139
P22    PSI(3685) INTO RHO PI                             769+ 139
P23    PSI(3685) INTO K+ K-                              493+ 493
P24    PSI(3685) INTO 2(PI+ PI-)                         139+ 139+ 139+ 139
P25    PSI(3685) INTO 2(PI+ PI-) PIO                     139+ 139+ 139+ 139+
P26    PSI(3685) INTO PI+ PI- K+ K-                      139+ 139+ 493+ 493
P27    PSI(3685) INTO PBAR P                             938+ 938
P28    PSI(3685) INTO LAMBDA ANTILAMBDA                 1115+1115
P29    PSI(3685) INTO XI ANTIXI                         1321+1321
P31    PSI(3685) INTO PI+ PI- P PBAR                     139+ 139+ 938+ 938
P32    PSI(3685) INTO  3(PI+ PI-)
P33    PSI(3685) INTO RHO PI+ PI-                        769+ 139+ 139
P34    PSI(3685) INTO K*(892)0 K+/- PI-/+                891+ 493+ 139

P      RADIATIVE DECAYS
P      ----------------
P51    PSI(3685) INTO GAMMA GAMMA                          0+   0
P52    PSI(3685) INTO PIO GAMMA                          134+   0
P53    PSI(3685) INTO ETA GAMMA                          548+   0
P54    PSI(3685) INTO ETA PRIME GAMMA                    957+   0
P56    PSI(3685) INTO CHI(3415) GAMMA                   3415+   0
P58    PSI(3685) INTO PC(3510) GAMMA                    3510+   0
P59    PSI(3685) INTO CHI(3555) GAMMA                   3555+   0
P60    PSI(3685) INTO PC(3510) + ANYTHING
P61    PSI(3685) INTO ETA C(2980) GAMMA                 2981+   0
P62    PSI(3685) INTO E(1420) GAMMA                     1418+   0
P63    PSI(3685) INTO ETA C(3590) GAMMA                 3594+   0
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\delta P_i \delta P_i}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above. only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	$J/\psi\,\pi^+\pi^-$	$J/\psi\,\pi^0\pi^0$	$J/\psi\,\eta$	J/ψ+OTHER	NON-J/ψ
$J/\psi\,\pi^+\pi^-$	.3260+-.0238				
$J/\psi\,\pi^0\pi^0$	.4579	.1725+-.0176			
$J/\psi\,\eta$	-.0151	-.0069	.0278+-.0037		
J/ψ+OTHER	.2147	-.4634	-.0840	.0389+-.0248	
NON-J/ψ	-.89??	-.4103	-.0265	-.5165	.4348+-.0415

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                    71  PSI(3685) PARTIAL WIDTHS (KEV)

W1     PSI(3685) INTO E+ E-                               (G1)
W1          2.1        .3           LUTH      75 SMAG          E+E-          1/76
W1 F        2.        0.3           BRANDELI  79 DASP    E+ E-              12/79
W1 F   FROM A SIMULTANEOUS FIT TO E+ E-,MU+ MU- AND HADRONIC CHANNELS
W1 F   ASSUMING G(E+ E-) = G(MU+ MU-)
W1          . . . . . . . . . .
W1  AVG     2.05      0.21     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W3     PSI(3685) INTO HADRONS                             (G3)
W3          224.      56.           LUTH      75 SMAG          E+E-          1/76

W5     PSI(3685) INTO GAMMA GAMMA     (EV)                (G51)
W5          43. OR LESS CL=0.90     BRANDELI  79 DASP    E+ E-              12/79
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                    71  PSI(3685) BRANCHING RATIOS

R1     PSI(3685) INTO (E+ E-)/TOTAL                       (P1)
R1 L       .0088     .0013          FELDMAN   77 PVUE          E+E-         12/77
R1 L   FROM AN OVERALL FIT ASSUMING EQUAL PARTIAL WIDTHS FOR (E+E-)
R1 L   AND (MU+MU-). FOR A MEASUREMENT OF THE RATIO SEE THE ENTRY R4 BELOW
R1 L   INCLUDES LUTH 75,HILGER 75,BURMESTER 77

R2     PSI(3685) INTO (MU+ MU-)/TOTAL                     (P2)
R2 H       .0077     .0017          HILGER    75 SPEC          E+E-          1/76
R2 H   RE-STATED BY US USING (J/PSI(3100)+ANYTHING)/TOTAL =0.55

R3     PSI(3685) INTO (HADRONS)/TOTAL                     (P3)
R3   P     .981      .003           LUTH      75 SMAG          E+E-          1/76
R3   P INCLUDES CASCADE DECAY INTO J/PSI(3100)                               4/77

R4     PSI(3685) INTO (MU+ MU-)/(E+ E-)                   (P2)/(P1)
R4         .89       .16            BOYARSKI  75 SMAG          E+E-         12/77

R5     PSI(3685) INTO (GAMMA INTO HADRONS)/TOTAL          (P4)
R5 C       .029      .004           LUTH      75 SMAG          E+E-          1/76
R5 C   INCLUDED IN R3


R      DECAYS INTO J/PSI(3100) + ANYTHING
R      ----------------------------------

R10    PSI(3685) INTO (J/PSI(3100) + ANYTHING)/TOTAL      (P11)
R10        .57       .08            ABRAMS    75 SMAG          E+E-          1/76
R10        0.51      0.12           BRANDELI  79 DASP    E+ E-              12/79
R10         . . . . . . . . . .
R10 AVG    0.552     0.067   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R10 FIT    0.565     0.041  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R11    PSI(3685) INTO (J/PSI+NEU)/(J/PSI+ANYTHING)        (P12)/(P11)
R11        .41       .02            TANENBAUM 76 SMAG          E+E-          1/76
R11         . . . . . . . . . .
R11 FIT    0.409     0.019  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R12    PSI(3685) INTO (J/PSI(3100) PI+ PI-)/TOTAL         (P13)
R12        .32       .04            ABRAMS1   75 SMAG          E+E-          1/75
R12        .36       .06            WIIK      75 DASP          E+E-          1/76
R12         . . . . . . . . . .
R12 AVG    0.332     0.033   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R12 FIT    0.326     0.024  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R13    PSI(3685) INTO (J/PSI(3100) PIO PIO)/TOTAL         (P14)
R13        0.17      0.029          ABRAMS1   75 SMAG          E+E-          1/77
R13        .18       .06            WIIK      75 DASP          E+E-          1/76
R13         . . . . . . . . . .
R13 AVG    0.172     0.026   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R13 FIT    0.172     0.018  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R14    PSI(3685) INTO (J/PSI PIO PIO)/(J/PSI PI+ PI-)     (P14)/(P13)
R14 H     (.64)     (.15)           HILGER    75 SPEC          E+E-          1/76
R14        0.53      0.06           TANENBAUM 76 SMAG          E+E-          1/77
R14 H  IGNORING THE (J/PSI ETA) AND (J/PSI GAMMA GAMMA) DECAYS
R14         . . . . . . . . . .
R14 FIT    0.529     0.050  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R15    PSI(3685) INTO (J/PSI(3100) ETA)/TOTAL             (P15)
R15 S   44   (.043)    (.008)       TANENBAUM 76 SMAG          E+E-          1/76
R15    164   0.036     0.005        BARTEL    78 CNTR    E+E-                4/78
R15 S   17   (0.035)   (0.009)      BRANDEL2  79 DASP    E+E-,PSI 2GAM      12/79
R15    166   0.025     0.006        HIMEL     80 SMK2    E+E-                9/81*
R15  D 386   0.0218    0.0049       OREGLIA   80 CBAL    E+E-,PSI 2GAM       9/81*
R15         . . . . . . . . . .
R15 AVG      0.0278    0.0045  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R15 FIT      0.0278    0.0037 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)
                       (SEE IDEOGRAM BELOW )
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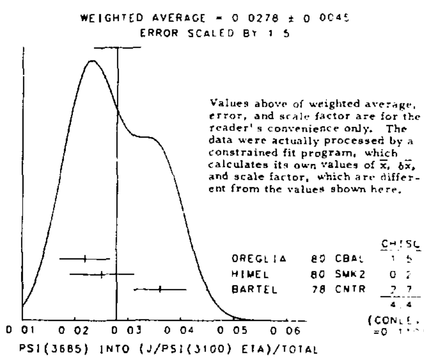


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R16    PSI(3685) INTO (J/PSI(3100) PIO)/TOTAL             (P17)
R16      7   0.0015    0.0006       HIMEL     80 SMK2    E+E-                9/81*
R16  C  23   0.0009    0.0003       OREGLIA   80 CBAL    PSI3685,PSI 2GAM    9/81*
R16         . . . . . . . . . .
R16 AVG      0.00102   0.00027  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R      HADRONIC DECAYS
R      ---------------

R20    PSI(3685) INTO (PI+ PI-)/TOTAL  (UNITS 10**-4)     (P21)
R20       (0.5)  OR LESS  CL=0.90   FELDMAN   77 SMAG          E+E-         12/77
R20        6.8       0.5            BRANDELI  79 DASP    E+ E-              12/79

R21    PSI(3685) INTO (RHO PIO)/TOTAL
R21       (.001)OR LESS  CL=.90     ABRAMS    75 SMAG          E+E-          1/76

R22    PSI(3685) INTO (2(PI+ PI-) PIO)/TOTAL              (P25)
R22        .0035     .0015          ABRAMS    75 SMAG          E+E-          1/76

R23    PSI(3685) INTO (K+ K-)/TOTAL  (UNITS 10**-4)       (P23)
R23       (0.5)  OR LESS  CL=0.90   FELDMAN   77 SMAG          E+E-         12/77
R23        1.0       0.7            BRANDELI  79 DASP    E+ E-              12/79
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R24     PSI(3685) INTO (PI+ PI- K+ K-)/TOTAL                 (P26)
R24K        0.0016     0.0004          TANENBAUM 78 SMAG         E+E-          12/78
R24K    ASSUMING ENTIRELY STRONG DECAY                                          12/78

R25     PSI(3685) INTO (PBAR PI)/TOTAL  (UNITS 10**-4)       (P27)
R25         2.3        0.7             FELDMAN   77 SMAG         E+E-          12/77
R25    4    1.4        0.8             BRANDELI  79 DASP      E+ E-            12/79
R25         . . . . . . . . . .
R25 AVG     1.91       0.53     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R26     PSI(3685) INTO (RHO PI)/TOTAL                        (P22)
R26        (0.0010)OR LESS  CL=0.90  BARTEL 1  76 CNTR           E+E-           1/77

R27     PSI(3685) INTO 2(PI+PI-)/TOTAL                       (P24)
R27         0.00045    0.0001          TANENBAUM 78 SMAG         E+E-          12/78

R28     PSI(3685) INTO (LAMBDA ANTILAMBDA)/TOTAL             (P28)
R28        (0.0004)OR LESS  CL=0.90 FELDMAN    77 SMAG           E+E-          12/77

R29     PSI(3685) INTO (XI- ANTIXI-)/TOTAL
R29        (0.0002)                    FELDMAN   77 SMAG         E+E-          12/77

R31     PSI(3685) INTO (PI+ PI- P PBAR)/TO (UNITS 10**-3)(P31)
R31S        0.8        0.2             TANENBAUM 78 SMAG       E+ E-           12/78
R31S    ASSUMING ENTIRELY STRONG DECAY

R32     PSI(3685) INTO  3(PI+ PI-)/TOTAL (UNITS 10**-3)  (P32)
R32S        0.15       0.1             TANENBAUM 78 SMAG       E+ E-           12/78

R33     PSI(3685) INTO (PHOO PI+ PI-)/TOT (UNITS 10**-3) (P33)
R33         0.42       0.15            TANENBAUM 78 SMAG       E+ E-           12/78

R34     PSI(3685) INTO(K*(892)0K+/-PI-/+)/TOT(UNTS 10**-3)P34)
R34         0.67       0.25            TANENBAUM 78 SMAG       E+ E-           12/78


R       RADIATIVE DECAYS
R       ----------------

R42     PSI(3685) INTO (PIO GAMMA)/TOTAL                     (P52)
R42  U     (.0054)R LESS  CL=.95    LIBERMAN  75 SPEC         E+E-              1/76
R42        (.01) OR LESS  CL=.90    WIIK      75 DASP         E+E-              1/76

R43     PSI(3685) INTO (ETA GAMMA)/TOTAL (UNITS 10**-2)  (P53)
R43        (0.02)OR LESS  CL=0.90   YAMADA    77 DASP      E+ E-,3 GAMMA      12/77

R44     PSI(3685) INTO (ETA PRIME GAM)/TOT (UNITS 10**-2) (P54)
R44C       (0.023)OR LESS CL=0.90   BARTEL 2  76 CNTR         E+E-             12/77
R44  R     (0.6)  OR LESS CL=0.90   BRAUNSCHW 77 DASP         E+E-             12/77

R55     PSI(3685) INTO (CHI(3415) GAM)/TOT (UNITS 10**-2)(P56)
R55  A      7.5        2.6          WHITAKER  76 SMAG         E+E-              1/77
R55  A      7.2        2.3          BIDDICK   77 CNTR    E+E-,MONOCHR.GAM      3/77
R55D A      9.7        2.2          GAISER    82 CBAL    E+E-,MONOCHR.GAM      3/82*
R55         . . . . . . . . . .
R55 AVG     8.2        1.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R58     PSI(3685) INTO (PC(3510) GAM)/TOT (UNITS 10**-2) (P58)
R58  B      7.1        1.9          BIDDICK   77 CNTR    E+E-,MONOCHR.GAM      3/77
R58D G      8.8        1.9          GAISER    82 CBAL    E+E-,MONOCHR.GAM      3/82*
R58         . . . . . . . . . .
R58 AVG     7.9        1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R59     PSI(3685) INTO (CHI(3555) GAM)/TOT (UNITS 10**-2)(P59)
R59  B      7.0        2.0          BIDDICK   77 CNTR    E+E-,MONOCHR.GAM      3/77
R59D F      7.7        1.7          GAISER    82 CBAL    E+E-,MONOCHR.GAM      3/82*
R59         . . . . . . . . . .
R59 AVG     7.4        1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)


R60     PSI(3685) INTO (ETA C(2980) GAM)/TOT(UNTS 10**-2)(P61)
R60  D      0.43       0.26            PARTRIDGE 80 CBAL     E+E-,MONOCHR.GAM  9/81*


R61     PSI(3685) INTO (E(1420) GAM)/TOT (UNITS 10**-3)  (P62)
R61  E     (0.18) OR LESS  CL=.90   SCHARRE   80 SMAG     E+E-                 2/81*

R62     PSI(3685) INTO (ETA C(3590) GAM)/TOT(UNTS 10**-2)(P63)
R62        (0.2) TO  1.3   CL=.95   EDWARDS   82 CBAL    E+E-,MONOCHR.GAM      1/82*

R     A  ANGULAR DISTRIBUTION (1+COS**2) ASSUMED
R     B  VALID FOR ISOTROPIC DISTRIBUTION OF THE PHOTON
R   C    THE VALUE IS NOR  IZED TO THE BRANCHING RATIO FOR PSI(3685)
R   C    INTO (J/PSI(3100) ETA)/TOTAL.
R     D  SYSTEMATIC ERROR ADDED LINEARLY BY US.
R     E  USING BR(E INTO K KBAR PI)=0.65
R     F  ANGULAR DISTRIBUTION (1-0.052*COS**2) ASSUMED
R     G  ANGULAR DISTRIBUTION (1-0.189*COS**2) ASSUMED
R     U  RE-STATED BY US USING (MU+MU-)/TOTAL * .0077
R     R  RE-STATED BY US USING TOTAL DECAY WIDTH 228 KEV.
R    S   LOW STATISTICS DATA REMOVED FROM AVERAGE.

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                71  PSI(3685)     G(I)*G(E+E-)/G(TOTAL)  (KEV)

        THIS COMBINATION OF A PARTIAL WIDTH WITH THE PARTIAL WIDTH
        INTO E+E- AND WITH THE TOTAL WIDTH IS OBTAINED FROM THE INTEGRATED
        CROSS-SECTION INTO CHANNEL(I) IN THE E+E- ANNIHILATION.
        WE ONLY LIST DATA NOT HAVING BEEN USED TO DETERMINE THE PARTIAL
        WIDTH G(I) OR THE BRANCHING RATIO G(I)/TOTAL.

G3      G(HADRONIC)*G(E+E-)/G(TOTAL)
G3          2.2        .4              ABRAMS    75 SMAG         E+E-           1/76

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                       REFERENCES FOR PSI(3685)

ABRAMS    74 PRL 33 1453         +BRIGGS,AUGUSTIN,BOYARSKI+        (LBL+SLAC)

ABRAMS    75 STANFORD SYMP.28  G.S.ABRAMS                            (LBL)
ABRAMS1   75 PRL 34 1181         +BRIGGS,CHINOWSKY,FRIEDBERG,+    (LBL+SLAC)
AUBERT    75 PRL 33 1624         +BECKER,BIGGS,BURGER,GLENN+        (MIT+BNL)
BOYARSKI  75 PALERMO CONF. 54    +BREIDENBACH,BULOS,ABRAMS,BRIGGS+(SLAC+LBL)
CAMERINI  75 PRL 35 483          +LEARNED,PREPOST,ASH,ANDERSON,+ (WISC+SLAC)
CRIEGEE   75 PL 53B 489          +DEHNE,FRANKE,HORLITZ,KRECHLOCK+     (DESY)
DASP3     75 PL 57B 407          BRAUNSCHWEIG,KONIGS,+ (AACH+DESY+MPIM+TOKY)
FELDMAN   75 PRL 35 821          +JEAN-MARIE,SADOULET,VANNUCCI,+  (LBL+SLAC)
GRECO     75 PL 56B 367          +PANCHERI-SRIVASTAVA,SRIVASTAVA      (FRAS)
JACKSON   75 NIM 128 13          J.D.JACKSON,D.SCHARRE                 (LBL)
HILGER    75 PRL 35 625          +BERON,FORD,HOFSTADTER,HOWELL,+ (STAN+PENN)
LIBERMAN  75 STANFORD SYMP.55    A.D.LIBERMAN                     (STANFORD)
LUTH      75 PRL 35 1124         +BOYARSKI,LYNCH,BREIDENBACH,+   (SLAC+LBL)JP
PREPOST   75 STANFORD SYMP.241 R.PREPOST                         (WISCONSIN)
SIMPSON   75 PRL 35 699          +BERON,FORD,HILGER,HOFSTADTER,+ (STAN+PENN)
WIIK      75 STANFORD SYMP.69    B.H.WIIK                             (DESY)

BARTEL 1  76 PL 64 B 483         +DUINKER,OLSSON,STEFFEN,HEINTZE+(DESY+HEID)
BARTEL 2  76 TBILISI CONF.N56    +DUINKER,OLSSON,HEINTZE,+       (DESY+HEID)
SNYDER    76 PRL 36 1415         +HOM,LEDERMAN,APPEL,KAPLAN+(COLU+FNAL+STON)
TANENBAU  76 PRL 36 402          TANENBAUM,ABRAMS,BOYARSKI,BULOS,+(SLAC+LBL)IG
WHITAKER  76 PRL 37 1596         +TANENBAUM,ABRAMS,ALAM,BOYARSKI,+(SLAC+LBL)

BIDDICK   77 PRL 38 1324         +BURNETT+    (UCSD+UMD+PAVI+PRIN+SLAC+STAN)
BRAUNSCH  77 PL 67 B 249         BRAUNSCHWEIG,+    (AACH+DESY+HAMB+MPIM+TOKY)
BURMESTE  77 PL 66 B 395         BURMESTER,CRIEGEE,+  (DESY+HAMB+SIEG+WUPP)
FELDMAN   77 PL 33 C 285         +PERL                            (LBL+SLAC)
YAMADA    77 HAMB. CONF. P. 69 YAMADA                            (DESY+TOKY)

BARTEL    78 PL 79 B 492         DITTMANN,DUINKER,OLSSON,O'NEILL+(DESY+HEID)
TANENBAU  78 PR D 17 1731        TANENBAUM,ALAM,BOYARSKI,+        (SLAC+LBL)

BRANDEL1  79 ZPHY C 1 233        BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)
BRANDEL2  79 NP B 160 426        BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)
LEMOIGNE  79 FERMILAB CONF.524 +ABOLINS,BARATE,+        (SACL+LOIC+SHMP+IND)

HIMEL     80 PRL 44 920          +ABRAMS,ALAM,BLOCKER,+           (LBL+SLAC)
OREGLIA   80 PRL 45 959          +PARTRIDGE+          (SLAC+CIT+HARV+PRIN+STAN)
PARTRIDG  80 PRL 45 1150         PARTRIDGE,PECK+    (CIT+HARV+PRIN+STAN+SLAC)
SCHARRE   80 PL 97 B 329         +TRILLING,ABRAMS,ALAM,BLOCKER+   (SLAC+LBL)
ZHOLENTZ  80 PL 96 B 214         +KURDADZE,LELCHUK,MISHNEV,NIKITIN+    (NOVO)
     ALSO 81 YAD.PHYS. 34 1471 ZHOLENTZ ET AL.                          (NOVO)

BARATE    81 PR D 24 2994        +ASTBURY,MCEWEN,+ (SACL+LOIC+SHMP+CERN+IND)

BARATE    82 MORIOND WORKSHOP    +BAREYRE,BONAMY,+        (SACL+LOIC+SHMP+IND)
EDWARDS   82 PRL 48 70           +PARTRIDGE,PECK,+ (CIT+HARV+PRIN+STAN+SLAC)
GAISER    82 MORIOND WORKSHOP    +EDWARDS,+         (CIT+HARV+PRIN+STAN+SLAC)
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ψ(3770)

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        53  PSI(3770,JPG=1- ) I=

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                 53  PSI(3770) MASS (MEV)

M   E      3772.0     (6.0)           RAPIDIS   77 SMAG  0 E+E-          12/77
M   E      3770.      (6.0)           BACINO    78 DLCO  0 E+E-           4/78
M   E      3764.0     (5.0)           SCHINDLER 80 SMAG    E+ E-         12/79
M   E    ERRORS INCLUDE SYSTEMATIC COMMON TO ALL EXPERIMENTS
M          . . . . . . . . . .
M  MASS    3769.9      2.5     FROM PSI(3685) MASS AND MASS DIFFERENCE
M                              BELOW

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                 53  PSI(3770) - PSI(3685) MASS DIFFERENCE (MEV)
DM            88.0       3.0          RAPIDIS   77 SMAG    E+E-          12/77
DM S          86.0       2.0          BACINO    78 DLCO    E+E-           2/82*
DM S     SPEAR PSI PRIME MASS (3684) SUBTRACTED (SEE SCHINDLER 80)
DM            80.0       2.0          SCHINDLER 80 SMAG    E+ E-         12/79
DM            . . . . . . . . . .
DM  AVG       83.9       2.4     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)
                         (SEE IDEOGRAM BELOW )
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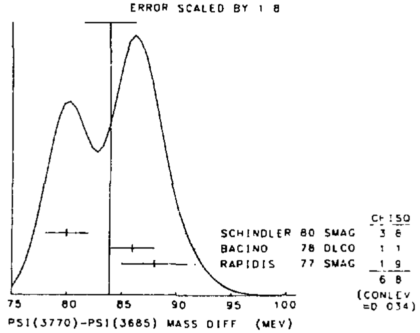
WEIGHTED AVERAGE = 83.9 ± 2.4
ERROR SCALED BY 1 8

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                 53  PSI(3770) WIDTH (MEV)

W             28.0       5.0          RAPIDIS   77 SMAG  0 E+E-          12/77
W             24.0       5.0          BACINO    78 DLCO  0 E+E-           4/78
W             24.0       5.0          SCHINDLER 80 SMAG    E+ E-         12/79
W             . . . . . . . . . .
W   AVG       25.3       2.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 53  PSI(3770) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      PSI(3770) INTO E+ E-                               .5+ .5
P2      PSI(3770) INTO D DBAR                            1869+1869

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Mesons
ψ(3770), ψ(4030), ψ(4160), ψ(4415)


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                   53  PSI(3770) PARTIAL WIDTHS (KEV)

W1      PSI(3770) INTO E+E-                                (G1)
W1 R          0.37       0.09        RAPIDIS    77 SMAG  0 E+E-          12/77
W1            0.18       0.06        BACINO     78 DLCO  0 E+E-           4/78
W1            0.276      0.050       SCHINDLER 80 SMAG     E+ E-         1/82*
W1 R      SEE ALSO R2 BELOW
W1               . . . . . . . . . .
W1  AVG       0.257      0.046    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

                   53  PSI(3770) BRANCHING RATIOS

R1      PSI(3770) INTO (D DBAR)/TOTAL                       (P2)
R1          DOMINANT                 PERUZZI    77 SMAG    E+E-,D DBAR    12/77

R2      PSI(3770) INTO (E+ E-)/TOTAL (UNITS 10**-5)         (P1)
R2           1.3        0.2          RAPIDIS    77 SMAG  0 E+E-           12/77
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REFERENCES FOR PSI(3770)


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PERUZZI   77 PRL 39 1301       +PICCOLO,FELDMAN,PERL,+(SLAC,LBL,NWES+HAWA)
RAPIDIS   77 PRL 39 526        +GOBBI,LUKE,PERL,+(STAN+SLAC+LBL+NWES+HAWA)

BACINO    78 PRL 40 671        +BAUNGARTEN,BIRKWOOD,+ (SLAC+STAN+UCLA+UCI)

SCHINDLE 80 PR D 21 2716       SCHINDLER,SIEGRIST,ALAM,BOYARSKI+(SLAC+LBL)
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ψ(4030)

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72  PSI(4030,JPG=1- ) I=

SEEN CLEARLY SEPARATED FROM THE PSI(4160)
BY DASP AND CONFIRMED WITH LESS STATISTICS BY PLUTO
SEEN ALSO BY MARK I, DELCO AND THE CRYSTAL BALL
(KIRKBY 79).

                   72  PSI(4030) MASS (MEV)

M          4028.0       2.5          GOLDHABER 77 SMAG        E+E-       12/77
M          4040.0      10.0          BRANDELIK 78 DASP    E+E-            4/78
M             . . . . . . . . . . .
M   AVG    4028.7       2.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

                   72  PSI(4030) WIDTH (MEV)

W             52.0     10.0          BRANDELIK 78 DASP    E+E-            4/78

                   72  PSI(4030) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      PSI(4030) INTO D DBAR                              1869+1869
P2      PSI(4030) INTO D* DBAR AND D*BAR D                 2007+1864
P3      PSI(4030) INTO D* D*BAR                            2007+2007
P4      PSI(4030) INTO J/PSI(3100) HADRONS
P5      PSI(4030) INTO E+ E-                                 .5+  .5
P6      PSI(4030) INTO MU+ MU-                              105+ 105

                   72  PSI(4030) PARTIAL WIDTHS (KEV)

W1      PSI(4030) INTO E+E-                                (G5)
W1            0.75       0.15        BRANDELIK 78 DASP     E+ E-         12/78

                   72  PSI(4030) BRANCHING RATIOS

R1      PSI(4030) INTO (D DBAR)/(D* DBAR+D*BAR D)          (P1)/(P2)
R1            0.05       0.03        GOLDHABER 77 SMAG  0 E+ E-          12/77

R2      PSI(4030) INTO J/PSI(3100) HADRONS                 (P4)
R2          LOOKED FOR               BURMESTER 77 PLUT        E+E-        4/77

R3      PSI(4030) INTO (D* D*BAR)/(D* DBAR+D*BAR D)        (P3)/(P2)
R3           32.0       12.0         GOLDHABER 77 SMAG  0 E+ E-          12/77

R4      PSI(4030) INTO (E+ E-)/TOTAL  (UNITS 10**-5)       (P5)
R4          (1.0) APPROX.            FELDMAN   77 SMAG    E+ E-          12/77
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REFERENCES FOR PSI(4030)


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AUGUSTIN 75 PRL 34 764        +BOYARSKI,ABRAMS,BRIGGS+          (SLAC+LBL)
BACCI     75 PL 58B 481       +BIDOLI,PENSO,STELLA,+            (ROMA+FRAS)
BOYARSKI 75 PRL 34 762        +BREIDENBACH,ABRAMS,BRIGGS,+      (SLAC+LBL)
ESPOSITO 75 PL 58B 478        +FELICETTI,PERUZZI,+  (FRAS+NAPL+PADO+ROMA)

PERUZZI   76 PRL 37 569       +PICCOLO,FELDMAN,NGUYEN,WISS,+    (SLAC+LBL)

BURMESTE 77 PL 66 B 395       +CRIEGEE,DEHNE+          (DESY+HAMB+SIEG+WUPP)
GOLDHABE 77 PL 69 B 503       GOLDHABER,WISS,ABRAMS,ALAM,LUTH,+(LBL+SLAC)
FELDMAN   77 PL 33 C 285      +PERL                             (LBL+SLAC)
LUTH      77 PL 70 B 120      +PIERRE,ABRAMS,ALAM,BOYARSKI,+    (LBL+SLAC)

BRANDELI 78 PL 76 B 361       BRANDELIK,CORDS+ (AACH+DESY+HAMB+MPIM+TOKY)
    ALSO 79 ZPHY C 1 233      BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)

KIRKBY    79 FERMILAB SYMP.10T J. KIRKBY RAPPORTEUR                (SLAC)
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ψ(4160)

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25  PSI(4160,JPG=1- ) I=

SEEN CLEARLY SEPARATED FROM THE PSI(4030)
BY DASP AND CONFIRMED WITH LESS STATISTICS BY PLUTO .
MARK I,DELCO AND THE CRYSTAL BALL SEE A PROMINENT
SHOULDER BUT NO SEPARATION (KIRKBY 79)

                   25  PSI(4160) MASS (MEV)

M          4159.0      20.0          BRANDELIK 78 DASP    E+E-            4/78

                   25  PSI(4160) WIDTH (MEV)

W            78.0      20.0          BRANDELIK 78 DASP    E+E-            4/78

                   25  PSI(4160) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      PSI(4160) INTO E+ E-                                 .5+  .5

                   25  PSI(4160) PARTIAL WIDTHS (KEV)

W1      PSI(4160) INTO E+ E-                               (G1)
W1            0.77       0.23        BRANDELIK 78 DASP     E+ E-         12/78
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REFERENCES FOR PSI(4160)


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BURMESTE 77 PL 66 B 395       +CRIEGEE,DEHNE+          (DESY+HAMB+SIEG+WUPP)

BRANDELI 78 PL 76 B 361       BRANDELIK,CORDS+ (AACH+DESY+HAMB+MPIM+TOKY)

KIRKBY    79 FERMILAB SYMP.10T J. KIRKBY RAPPORTEUR                (SLAC)
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ψ(4415)

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73  PSI(4415,JPG=1- ) I=

                   73  PSI(4415) MASS (MEV)

M          4414.        7.           SIEGRIST  76 SMAG        E+E-        2/76
M         (4400.)    APPROX.         KNIES     77 PLUT  0 E+E-,MU+ MU-   12/77
M          4417.0      10.0          BRANDELIK 78 DASP    E+E-            4/78
M             . . . . . . . . . . .
M   AVG    4415.0       5.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

                   73  PSI(4415) WIDTH (MEV)

W             33.      10.           SIEGRIST  76 SMAG        E+E-        2/76
W             66.0     15.0          BRANDELIK 78 DASP    E+E-            4/78
W             . . . . . . . . . . .
W   AVG       43.2     15.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.8)

                   73  PSI(4415) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      PSI(4415) INTO E+ E-                                 .5+  .5

                   73  PSI(4415) PARTIAL WIDTHS (KEV)

W1      PSI(4415) INTO E+ E-                               (G1)
W1            0.49       0.13        BRANDELIK 78 DASP     E+ E-         12/78

                   73  PSI(4415) BRANCHING RATIOS

R1      PSI(4415) INTO (E+ E-)/TOTAL (UNITS 10**-5)
R1           1.3         .3          SIEGRIST  76 SMAG        E+E-        2/76

R2      PSI(4415) INTO HADRONS/TOTAL
R2          DOMINANT                 SIEGRIST  76 SMAG        E+E-        1/77
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REFERENCES FOR PSI(4415)


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SIEGRIST 76 PRL 36 700        +ABRAMS,BOYARSKI,BREIDENBACH,+    ([illegible]+SLAC)

BURMESTE 77 PL 66 B 395       +CRIEGEE,DEHNE+          (DESY+HAMB+[illegible]+WUPP)
KNIES     77 HAMBURG SYMP.93  G.KNIES HAMBURG TALK ON PLUTO COLL.S.(DESY)
LUTH      77 PL 70 B 120      +PIERRE,ABRAMS,ALAM,BOYARSKI,+    (LBL+SLAC)

BRANDELI 78 PL 76 B 361       BRANDELIK,CORDS+ (AACH+DESY+HAMB+MPIM+TOKY)
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Υ(9460)

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49  UPSILON(9460,JPG=1- 1 I=

                  49  UPSILON(9460) MASS  (MEV)

M       FIXED TARGET EXPERIMENTS
M   I     (9410.)    (13.)          INNES     77 SPEC  0 400 P+A,MU+MU-   12/77

M       E+E- AT DORIS
M           9460.    (10.)          BIENLEIN  78 CNTR    E+E-             4/78
M   D       9456.3   (11.0)         BERGER    79 PLUT    E+E-            12/79
M           9457.    (10.)          DARDEN    79 DASP    E+E-            12/79
M   D       9461.6   (10.6)         NICZYPORU 81 LENA    E+E-,HADRONS     9/81*
M           . . . . . . . . . .
M   AVG     9458.7    10.0    AVERAGE (ERROR IS COMMON UNCERTAINTY IN
                                   ABSOLUTE BEAM ENERGY CALIBRATION)

M       E+E- AT CESR
M   D       9433.    (30.)          ANDREWS   80 CLEO    E+E-,HADRONS     9/81*
M   D       9434.5   (30.0)         BOHRINGER 80 CUSB    E+E-,HADRONS     9/81*
M           . . . . . . . . . .
M   AVG     9433.8    30.0    AVERAGE (ERROR IS COMMON UNCERTAINTY IN
                                   ABSOLUTE BEAM ENERGY CALIBRATION)

M   AVG     9456.2     9.5    AVERAGE (FROM DORIS AND CESR AVERAGES ABOVE)
M
M   D    SYSTEMATIC ERROR ADDED LINEARLY BY US.
M   I    FROM 2-PEAK FIT

                  49  UPSILON(9460) WIDTH (KEV)

W            (60.)                  DARDEN    79 DASP    E+E-            12/79
W    B       47.      37.     15.   ALBRECHT  80 DASP    E+E-,MU+MU-      9/81*
W    B       45.      30.     14.   BERGER    80 PLUT    E+E-             9/81*
W   D B      35.      34.     17.   NICZYPORU 81 LENA    E+E-,MU+MU-,HADR 9/81*
W           . . . . . . . . . .
W   AVG      42.2     14.9    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W    B  FROM R1,R2,W1 BELOW AND ASSUMING E-MU-TAU UNIVERSALITY
W   D   SYSTEMATIC ERRORS ADDED LINEARLY BY US.

                  49  UPSILON(9460) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      UPSILON(9460)  INTO MU+ MU-                      105+ 105
P2      UPSILON(9460)  INTO  E+  E-                      .5+  .5

                  49  UPSILON(9460) PARTIAL WIDTHS (KEV)

W1      UPSILON(9460)  INTO  E+  E-                      (G2)
W1  E        (1.33)   (0.14)        BERGER    79 PLUT    E+E-            12/79
W1 D          1.35     0.33         ALBRECHT  80 DASP    E+E-,MU+MU-      9/81*
W1            1.08     0.25         BOCK      80 CNTR    E+E-,HADRONS     9/81*
W1 D          1.07     0.23         MAGERAS   81 CUSB    E+E-,E+E-PI+PI-  9/81*
W1 D A        1.23     0.28         NICZYPORU 81 LENA    E+E-,MU+MU-,HADR 9/81*
W1          . . . . . . . . . .
W1  AVG       1.15     0.13   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W1   A  ASSU ING E-MU-TAU UNIVERSALITY
W1 D    SYSTEMATIC ERRORS ADDED LINEARLY BY US.
W1  E   ASSUMING HADRONIC PARTIAL WIDTH EQUAL TO TOTAL WIDTH

                  49  UPSILON(9460) BRANCHING RATIOS

R1      UPSILON(9460)  INTO(MU+ MU-)/TOTAL                (P1)
R1           0.022    0.020         BERGER    79 PLUT    E+E-            12/79
R1   A       0.025    0.021         DARDEN    79 DASP    E+E-            12/79
R1   A       0.031    0.016         ALBRECHT  80 DASP    E+E-,MU+MU-      9/81*
R1           0.014    0.034   0.014 BOCK      80 CNTR    E+E-,MU+MU-      9/81*
R1       11  0.039    0.011         MUELLER   81 CLEO    E+E-,PI+PI-E+E-  9/81*
R1 D A       0.035    0.014         NICZYPORU 81 LENA    E+E-,MU+MU-      9/81*
R1          . . . . . . . . . .
R1  AVG      0.0316   0.0058  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R1   A  ASSUMING E-MU-TAU UNIVERSALITY
R1 D    SYSTEMATIC ERRORS ADDED LINEARLY BY US.

R2      UPSILON(9460)  INTO (E+  E-)/TOTAL                (P2)
R2           0.051    0.030         BERGER    80 PLUT    E+E-             9/81*
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REFERENCES FOR UPSILON(9460)


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COBB      77 PL 72 B 273       +IWATA,FABJAN,GOLDBERG+(BNL+CERN+SYRA+YALE)
HERB      77 PRL 39 252        +HOM,LEDERMAN,APPEL,ITO,+  (COLU+FNAL+STON)
INNES     77 PRL 39 1240       +APPEL,BROWN,HERB,HOM,FISK+(COLU+FNAL+STON)

BERGER    78 PL 76 B 243       +ALEXANDER,DAUM,+(AACH+DESY+HAMB+SIEG+WUPG)
BIENLEIN  78 PL 78 B 360       +GLAWE,BOCK,BLANAR,+  (DESY+HAMB+HEID+MPIM)
DARDEN    78 PL 76 B 246       +HOFMANN,ALBRECHT,+   (DESY+DORT+HEID+LUND)
GARELICK  78 PR D 18 945       +GAUTHIER,HICKS,OLIVER,+   (NEAS+WASH+TUFT)
KAPLAN    78 PRL 40 435        +APPEL,HERB,HOM,LEDERMAN,+ (STON+FNAL+COLU)
YOH       78 PRL 41 684        +HERB,HOM,LEDERMAN,UENO,+  (COLU+FNAL+STON)

ANGELIS   79 PL 87 B 398       +BESCH,BLUMENFELD,+    (CERN+COLU+OXF+ROCK)
BADIER    79 PL 86 B 98        +BOUCROT,BURGUN+ (SACL+CERN+CDEF+EPOL+LALO)
BERGER    79 ZPHY C 1 343      +ALEXANDER+        (AACH+DESY+HAMB+SIEG+WUPG)
DARDEN    79 PL 80 B 419       +HOFMANN,ALBRECHT,+   (DESY+DORT+HEID+LUND)

ALBRECHT  80 PL 93 B 500       +CHILDERS,DARDEN+(DESY+DORT+HEID+LUND+ITEP)
ANDREWS   80 PRL 44 1108       + (CORN+HARV+ITHA+LEMO+ROCH+RUTG+SYRA+VAND)
BERGER    80 PL 93 B 497       +LACKAS,RAUPACH,+(AACH+DESY+HAMB+SIEG+WUPP)
BOCK      80 ZPHY C 6 125      +BLANAR,BLUM,BIENLEIN+(HEID+MPIM+DESY+HAMB)
BOHRINGE  80 PRL 44 1111       BOHRINGER,COSTANTINI,FINOCCHIARO(COLU+STON)
KOURKOUM  80 PL 91 B 481       KOURKOUMELIS+(ATHU+NTUA+BNL+CERN+SYRA+YALE)

MAGERAS   81 PRL 46 1115       +BOHRINGER,FINOCCHIARO+(COLU+STON+LSU+MPIM)
MUELLER   81 PRL 46 1181       + (RUTG+SYRA+LEMO+VAND+CORN+ITHA+HARV+ROCH)
NICZYPOR  81 PRL 46 92         NICZYPORUK,CHEN,VOGEL,WEGENER+(LENA COLLAB)
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Υ(10020)

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52  UPSILON(10020,JPG=1- ) I=

                  52  UPSILON(10020) MASS  (GEV)

M   I      (10.060)  (0.030)        INNES     77 SPEC    400 P+A,MU+MU-  12/77
M    R     (10.020)  (0.020)        BIENLEIN  78 CNTR    E+E-             4/78
M    R     (10.012)  (0.020)        DARDEN    78 DASP    E+E-             4/78
M    RD    (10.0136) (0.0112)       NICZYPO1  81 LENA    E+E-,HADRONS     9/81*
M           . . . . . . . . . .
M    MASS   10.016    0.010   FROM UPSILON(9460) MASS AND MASS DIFFERENCE
M                             BELOW

M   D    SYSTEMATIC ERRORS ADDEED LINEARLY BY US
M   I    FROM 2-PEAK FIT
M   R    REDUNDANT WITH DATA IN MASS DIFFERENCE BELOW

                  52  UPSILON(10020) WIDTH (KEV)

W    B        14. OR MORE     CL=0.90  NICZYPO1  81 LENA    E+E-,MU+MU-,HADR 9/81*
W    M        31.      10.      7.     NICZYPO2  81 LENA    E+E-,L+L-PI+PI-  9/81*

W    B  FROM W1 AND R1 ABOVE AND ASSUMING E-MU-TAU UNIVERSALITY
W    M  FROM W1 AND R1 ABOVE AND ASSUMING A LOG QUARKONIUM POTENTIAL

                  52  UPSILON(10020)-UPSILON(9460) MASS DIFFERENCE (MEV)

DM           560.0     10.0         BIENLEIN  78 CNTR    E+E-             4/78
DM           555.0     11.0         DARDEN    78 DASP    E+E-             4/78
DM A         574.0     27.0         UENO      79 SPEC    400 P PT,MU+MU- 12/79
DM   D       560.7      3.8         ANDREWS   80 CLEO    E+E-,HADRONS     9/81*
DM   D       559.       4.          BOHRINGER 80 CUSB    E+E-,HADRONS     9/81*
DM   D       552.      11.          NICZYPO1  81 LENA    E+E-,HADRONS     9/81*
DM          . . . . . . . . . .
DM  AVG      559.4      2.5   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DM A    FIXING THE UPSILON(9460) MASS AT 9460 MEV
DM   D  SYSTEMATIC ERROR ADDED LINEARLY BY US.

                  52  UPSILON(10020) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      UPSILON(10020) INTO MU+ MU-                      105+ 105
P2      UPSILON(10020) INTO  E+  E-                      .5+  .5
P3      UPSILON(10020) INTO UPSILON(9460) PI PI          9456+ 139+ 139

                  52  UPSILON(10020) PARTIAL WIDTHS (KEV)

W1      UPSILON(10020) INTO  E+  E-                      (G2)
W1  E        (0.35)   (0.14)        DARDEN    78 DASP    E+E-             4/78
W1 D S        0.56     0.13         ANDREWS   80 CLEO    E+E-,HADRONS     9/81*
W1  E        (0.37)   (0.16)        BOCK      80 CNTR    E+E-,HADRONS     9/81*
W1 D S        0.50     0.15         BOHRINGER 80 CUSB    E+E-,HADRONS     9/81*
W1   S        0.65     0.09         MAGERAS   81 CUSB    E+E-,E+E-PI+PI-  9/81*
W1 D S        0.55     0.15   0.09  NICZYPO1  81 LENA    E+E-,MU+MU-,HADR 9/81*
W1          . . . . . . . . . .
W1  AVG       0.586    0.058  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W1 D    SYSTEMATIC ERROR ADDED LINEARLY BY US.
W1  E   ASSUMING HADRONIC PARTIAL WIDTH EQUAL TO TOTAL WIDTH
W1   S  USING UPSILON(9460) PARTIAL WIDTH TO E+E- = 1.27 KEV

                  52  UPSILON(10020) BRANCHING RATIOS

R1      UPSILON(10020) INTO(MU+ MU-)/TOTAL                (P1)
R1           SEEN                   HERB      77 SPEC    400 P A,MU+ MU- 12/78
R1         (0.038)OR LESS CL=0.90   NICZYPO1  81 LENA    E+E-,MU+MU-      9/81*

R2      UPSILON(10020) INTO (E+  E-)/TOTAL                (P2)
R2           SEEN                   COBB      77 SPEC    P P,E+ E- X     12/78

R3      UPSILON(10020) INTO (UPSILON(9460) PI PI)/TOTAL  (P3)
R3   E  23   0.30     0.10          MAGERAS   81 CUSB    E+E-,E+E-PI+PI-  9/81*
R3     841   0.29     0.09          MUELLER   81 CLEO    E+E-,PI+PI- MM   9/81*
R3   E   7   0.31     0.10          NICZYPO2  81 LENA    E+E-,L+L-PI+PI-  9/81*
R3   E  ASSUMING THE BRANCHING RATIO OF UPSILON(9460) TO E+E- TO BE 0.032
R3          . . . . . . . . . .
R3  AVG      0.299    0.056   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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REFERENCES FOR UPSILON(10020)


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COBB      77 PL 72 B 273       +IWATA,FABJAN,GOLDBERG+(BNL+CERN+SYRA+YALE)
HERB      77 PRL 39 252        +HOM,LEDERMAN,APPEL,ITO,+  (COLU+FNAL+STON)
INNES     77 PRL 39 1240       +APPEL,BROWN,HERB,HOM,FISK+(COLU+FNAL+STON)

BIENLEIN  78 PL 78 B 360       +GLAWE,BOCK,BLANAR,+  (DESY+HAMB+HEID+MPIM)
DARDEN    78 PL 78 B 364       +HOFMANN,ALBRECHT,+   (DESY+DORT+HEID+LUND)
KAPLAN    78 PRL 40 435        +APPEL,HERB,HOM,LEDERMAN,+ (STON+FNAL+COLU)
YOH       78 PRL 41 684        +HERB,HOM,LEDERMAN,UENO,+  (COLU+FNAL+STON)

UENO      79 PRL 42 486        +BROWN,HERB,HOM,FISK,ITO,+ (FNAL+COLU+STON)

ANDREWS   80 PRL 44 1108       + (CORN+HARV+ITHA+LEMO+ROCH+RUTG+SYRA+VAND)
BOCK      80 ZPHY C 6 125      +BLANAR,BLUM,BIENLEIN+(HEID+MPIM+DESY+HAMB)
BOHRINGE  80 PRL 44 1111       BOHRINGER,COSTANTINI,FINOCCHIARO(COLU+STON)
KOURKOUM  80 PL 91 B 481       KOURKOUMELIS+(ATHU+NTUA+BNL+CERN+SYRA+YALE)

MAGERAS   81 PRL 46 1115       +BOHRINGER,FINOCCHIARO+(COLU+STON+LSU+MPIM)
MUELLER   81 PRL 46 1181       + (RUTG+SYRA+LEMO+VAND+CORN+ITHA+HARV+ROCH)
NICZYPO1  81 PL 99 B 169       NICZYPORUK,CHEN,VOGEL,WEGENER+(LENA COLLAB)
NICZYPO2  81 PL 100 B 95       NICZYPORUK,CHEN,FOLGER,LURZ,+ (LENA COLLAB)
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Mesons
Υ(10350), Υ(10570), K±, K0, K*(892)

Υ(10350)

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48  UPSILON(10350,JPG=1- ) I=

                  48  UPSILON(10350) MASS  (GEV)

M   MASS    10.347    0.010   FROM UPSILON(9460) MASS AND MASS DIFFERENCE
M                             BELOW

                  48  UPSILON(10350)-UPSILON(9460) MASS DIFFERENCE (MEV)

DM A        950.0     30.0          UENO      79 SPEC   400 P PT,MU+MU-   12/79
DM   D      891.1      5.7          ANDREWS   80 CLEO   E+E-,HADRONS       9/81*
DM   D      889.       6.           BOHRINGER 80 CUSB   E+E-,HADRONS       9/81*
DM          . . . . . . . . . .
DM  AVG     891.2      4.1    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DM A    FIXING THE UPSILON(9460) MASS AT 9460 MEV AND THE
DM A    UPSILON(10020)-UPSILON(9460) MASS DIFFERENCE AT 558 MEV.
DM   D  SYSTEMATIC ERROR ADDED LINEARLY BY US.

                  48  UPSILON(10350) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      UPSILON(10350) INTO MU+ MU-                       105+ 105
P2      UPSILON(10350) INTO  E+  E-                        .5+  .5

                  48  UPSILON(10350) PARTIAL WIDTHS (KEV)

W1      UPSILON(10350) INTO (E+ E-)/TOTAL                 (G2)
W1 D S        0.44      0.09        ANDREWS   80 CLEO   E+E-,HADRONS       9/81*
W1 D S        0.41      0.09        BOHRINGER 80 CUSB   E+E-,HADRONS       9/81*
W1          . . . . . . . . . .
W1  AVG       0.425     0.064   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W1 D    SYSTEMATIC ERROR ADDED LINEARLY BY US.
W1   S  USING UPSILON(9460) PARTIAL WIDTH TO E+E- = 1.27 KEV
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REFERENCES FOR UPSILON(10350)


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COBB      77 PL 72 B 273      +IMATA,FABJAN,GOLDBERG+(BNL+CERN+SYRA+YALE)
HERB      77 PRL 39 252       +HOM,LEDERMAN,APPEL,ITO,+  (COLU+FNAL+STON)
INNES     77 PRL 39 1240      +APPEL,BROWN,HERB,HOM,FISK+(COLU+FNAL+STON)

KAPLAN    78 PRL 40 435       +APPEL,HERB,HOM,LEDERMAN,+ (STON+FNAL+COLU)
YOH       78 PRL 41 684       +HERB,HOM,LEDERMAN,UENO,+  (COLU+FNAL+STON)

UENO      79 PRL 42 486       +BROWN,HERB,HOM,FISK,ITO,+ (FNAL+COLU+STON)

ANDREWS   80 PRL 44 1108      + (CORN+HARV+ITHA+LEMO+ROCH+RUTG+SYRA+VAND)
BOHRINGE  80 PRL 44 1111      BOHRINGER,COSTANTINI,FINOCCHIARO(COLU+STON)
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Υ(10570)

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47  UPSILON(10570,JPG=1- ) I=

                  47  UPSILON(10570) MASS  (GEV)

M   MASS    10.569    0.010   FROM UPSILON(9460) MASS AND MASS DIFFERENCE
M                             BELOW

                  47  UPSILON(10570) WIDTH (MEV)

W   D      19.8      10.5           ANDREWS   80 CLEO   E+E-,HADRONS       9/81*
W          12.6       6.0           FINOCCHIA 80 CUSB   E+E-,HADRONS       9/81*
W          . . . . . . . . . .
W  AVG     14.4       5.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   D  SYSTEMATIC ERROR ADDED LINERALY BY US.

                  47  UPSILON(10570)-UPSILON(9460) MASS DIFFERENCE (MEV)

DM         1112.      5.            ANDREWS   80 CLEO   E+E-,HADRONS       9/81*
DM  D      1114.      7.            FINOCCHIA 80 CUSB   E+E-,HADRONS       9/81*
DM         . . . . . . . . . .
DM  AVG    1112.7     4.1     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

DM  D  SYSTEMATIC ERROR ADDED LINERALY BY US.

                  47  UPSILON(10570) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     UPSILON(10570) INTO MU+ MU-                        105+ 105
P2     UPSILON(10570) INTO  E+  E-                         .5+  .5

                  47  UPSILON(10570) PARTIAL WIDTHS (KEV)

W1     UPSILON(10570) INTO (E+ E-)/TOTAL                  (G2)
W1   S        0.24      0.08        ANDREWS   80 CLEO   E+E-,HADRONS       9/81*
W1   S        0.32      0.09        FINOCCHIA 80 CUSB   E+E-,HADRONS       9/81*
W1          . . . . . . . . . .
W1  AVG       0.275     0.060   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W1   S  USING UPSILON(9460) PARTIAL WIDTH TO E+E- = 1.27 KEV
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REFERENCES FOR UPSILON(10570)


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ANDREWS   80 PRL 45 219       + (CORN+HARV+ITHA+LEMO+ROCH+RUTG+SYRA+VAND)
FINOCCHI  80 PRL 45 222       FINOCCHIARO,GIANNINI,BOHRINGER,+(COLU+STON)
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S=±1, C=0 MESON STATES

K±

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10  CHARGED K(494,JP=0-) I=1/2
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SEE STABLE PARTICLE DATA CARD LISTINGS

K0

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11  NEUTRAL K(498,JP=0-) I=1/2
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SEE STABLE PARTICLE DATA CARD LISTINGS

K*(892)

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18  K*(892,JP=1-) I=1/2

                  18  K*(892) MASS (MEV)

M  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
M  W 1700  891.0     1.2        WOJCICKI  64 HBC  -   1.7 K-P(KO PI-) 12/75
M    D 620 891.      2.3        DE BAERE  67 HBC  +  3.5 K+P (KO PI+) 12/75
M      720 890.      3.0        BARLOW    67 HBC  +- 1.2 PBARP(KO PI) 12/75
M      600 889.      3.0        BARLOW    67 HBC  +- 1.2 PBARP(K PI)  12/75
M    0 540 888.      2.5        DE WIT    68 HBC  - 3.0 K-P           12/75
M    0 341 892.0     2.6        SCHWEINGR 68 HBC  -  5.5 K-P(KO PI-)  12/75
M     1000 891.0     2.0        CRENNELL  69 DBC  -  3.9 K-N (KOPI-)  12/75
M     2086 894.      1.0        FRIEDMAN  69 HBC  -  2.1 K-P(KO PI-)  12/75
M      728 892.      2.         FRIEDMAN  69 HBC  - 2.45 K-P(KO PI-)  12/75
M     3229 892.      1.0        FRIEDMAN  69 HBC  - 2.6  K-P(KO PI-)  12/75
M    01027 892.      1.6        FRIEDMAN  69 HBC  - 2.7  K-P(KO PI-)  12/75
M     4404 892.2     1.5        AGUILAR1  71 HBC  -  3.9,4.6 K- P     11/71
M    D 765 894.2     2.0        CLARK     73 HBC  - 3.13 K-P(KO PI-)  12/75
M  W 01150 894.3     1.5        CLARK     73 HBC  -  3.3 K-P,P PI- KO 12/75
M   I 9000 (891.9)   (0.7)      PALER     75 HBC  - 14.3 K-P,K*- X+   12/75
M     1800 890.7     0.9        AGUILAR   78 HBC  +- .76 PB P,K KS PI 12/78
M     1225 886.6     2.4        BALANO    78 HBC  +- 12 PB P,INCLUSIV  4/78
M     6706 891.7     0.6        COOPER    78 HBC  +- .76 PB P,INCLUSV  4/78
M  X       895.3     4.0        MARTIN    78 SPEC +  10 K+-P,KS PI P  12/78
M  X       889.5     4.1        MARTIN    78 SPEC -  10 K+-P,KS PI P  12/78
M          892.8     1.6        AJINENKO  80 HBC  +  32 K+P            9/81*
M      380 896.0     1.9        DELFOSSE  81 SPEC +  K+-P,K+- PI0 P    1/82*
M      187 886.0     2.3        DELFOSSE  81 SPEC -  K+-P,K+- PI0 P    1/82*
M     4100 891.0     1.0        TOAFF     81 HBC  -  6.5 K-P,KO PI- P  1/82*
M          . . . . . . . . . .
M   AVG    891.77    0.36   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)

M  NEUTRAL ONLY.
M    01040 894.7     1.4        DAUBER    67 HBC   0 2.0 K-P(K-PI+)   12/75
M      10K 893.7     2.0        DAVIS     69 HBC   0  12. K+P(K+PI-)  12/75
M  W  4300 895.0     1.0        HABER     70 DBC   0  3. K-N (K-PI+)  12/75
M    02934 897.9     1.1        AGUILAR1  71 HBC   0  3.9,4.6 K- P    12/75
M    05362 898.0     0.7        AGUILAR1  71 HBC   0  3.9,4.6 K- P    12/75
M    01700 898.4     1.3        BUCHNER   72 DBC   0 4.6 K+ N,K+ PI-  12/72
M     3186 896.0     1.0        LEWIS     73 HBC   0 2.1-2.7 K+P       2/74
M    C     894.0     1.3        LINGLIN   73 HBC   0 2-13 K+P,K+PI-   12/75
M      10K 896.0     0.6        FOX       74 RVUE  0  2 K-P,K-PI+N    12/75
M          896.0     0.6        FOX       74 RVUE  0  2 K+N,K+PI-P    12/75
M    C     896.      2.         MATISON   74 HBC   0 12 K+P,K+PI-     12/75
M     3600 895.5     1.0        MCCUBBIN  75 HBC   0  3.6 K-P,K-PI+N  12/75
M  I   22K (897.1)   (0.7)      PALER     75 HBC   0 14.3 K-P,K*0 XO  12/75
M          897.6     0.9        BOWLER    77 DBC   0 5.4 K+D,K+PI-P P 12/77
M     1180 898.4     1.4        AGUILAR   78 HBC   0 .76 PB P,K KS PI 12/78
M  P       895.7     0.3        ESTABROOK 78 ASPK  0 13 K+-P,K+-PI+-  12/77
M          894.9     1.6        WICKLUND  78 ASPK  0 3,4,6 PI+-PN      4/78
M   C      (892.8)   (1.3)      LANG      79 RVUE  0                   1/82*
M      28K 897.      1.         EVANGELIS 80 OMEG  0 10 PI-P           9/81*
M          894.6      .8        ASTON     81 LASS  0 11 K-P,K- PI+ N   1/82*
M          . . . . . . . . . .
M   AVG    896.05    0.25   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                            (SEE IDEOGRAM BELOW )
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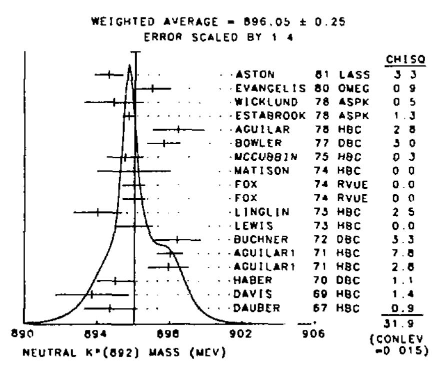

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M    C   FROM POLE EXTRAPOLATION.
M     D  MASS ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
M    I   INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
M  P     FROM PHASE SHIFT ANALYSIS OF 155000 EVENTS.
M  W     NUMBER OF EVENTS IN PEAK REEVALUATED BY US
M  X     SYSTEMATIC ERROR ADDED
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Note on $K^*(892)$ Masses and Mass Differences

Unrealistically small errors are reported by some experiments. We use simple "realistic" tests for the minimum errors on the determination of mass and width from a sample of N events:

$$\delta_{min}(m) = \frac{\Gamma}{\sqrt{N}} , \qquad \delta_{min}(\Gamma) = 4\frac{\Gamma}{\sqrt{N}} .$$

(For detailed discussion see the April 1971 edition of this note.) We consistently increase unrealistic errors before averaging.

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                     18  K*(0) - K*(+-) MASS DIFF. (MEV)

D  W   283    6.3      4.1            BARASH    67 HBC     0 PBAR P          12/75
D   SD1400  (6.5)    (5.0)            FICENEC1  68 HBC       1.3 K- P        12/75
D   SD1600  (9.5)    (5.0)            FICENEC2  68 HBC       2.7 K- P        12/75
D     7338    5.7      1.7            AGUILAR1  71 HBC   -0 3.9,4.6 K- P     11/71
D     2980    7.7      1.7            AGUILAR   78 HBC  +- .76 PB P,K KS PI  12/78
D          . . . . . . . . . .
D   AVG       6.7      1.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

D    D  MASS ERRORS ENLARGED BY US TO   GAMMA/SQRT(N). SEE TYPED NOTE.
D   S   DATA WITH MASS ERROR OF 3 MEV OR MORE NOT AVERAGED
D  W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US
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                     18  K*(892) WIDTH (MEV)

W  CHARGED ONLY. THIS IS WHAT APPEARS ON MESON TABLE
W  W D1700   45.0      5.0            WOJCICKI  64 HBC   -  1.7 K-P(K0 PI-) 12/75
W    D 620   56.0      9.0            DE BAERE  67 HBC  +   3.5 K+P(K0 PI+) 12/75
W      720   43.       9.0            BARLOW    67 HBC  +- 1.2 PBARP(K0 PI) 12/75
W    D 600   53.       9.0            BARLOW    67 HBC  +- 1.2 PBARP(K PI)  12/75
W    D 540   44.0      8.0            DE WIT    68 DBC   -  3. K- D         12/75
W    D2886   53.       4.0            FRIEDMAN  69 HBC   -  2.1 K-P(K0 PI-) 12/75
W    D 728   49.       7.3            FRIEDMAN  69 HBC   -  2.45K-P(K0 PI-) 12/75
W    D3229   46.       3.2            FRIEDMAN  69 HBC   -  2.6 K-P(K0 PI-) 12/75
W    D1027   49.       6.1            FRIEDMAN  69 HBC   -  2.7 K-P(K0 PI-) 12/75
W    D4404   54.3      3.3            AGUILAR1  71 HBC   -  3.9,4.6 K- P    12/75
W    D 765   46.3      6.7            CLARK     73 HBC  -  3.13K-P,P PI- K0 12/75
W  W D1150   48.2      5.7            CLARK     73 HBC  -  3.3 K-P,P PI- K0 12/75
W   I 9000  (52.1)    (2.2)           PALER     75 HBC   - 14.3 K-P,K*- X+  12/75
W     1800   45.8      3.6            AGUILAR   78 HBC  +- .76 PB P,K KS PI 12/78
W     1225   43.0      8.4            BALAND    78 HBC  +- 12 PB P,INCLUSIV  4/78
W    D6706   52.0      2.5            COOPER    78 HBC  +- .76 PB P,INCLUSV  4/78
W            50.9      2.3            MARTIN    78 SPEC +  10 K+-P,KS PI P  12/78
W            50.5      5.6            AJINENKO  80 HBC  +  32 K+P            9/81*
W      380   62.6      3.8            DELFOSSE  81 SPEC +  K+-P,K+- PI0 P    1/82*
W      187   50.5      3.9            DELFOSSE  81 SPEC -  K+-P,K+- PI0 P    1/82*
W     4100   51.0      2.0            TOAFF     81 HBC  -  6.5 K-P,K0 PI- P  1/82*
W          . . . . . . . . . .
W   AVG      50.78     0.90    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W  NEUTRAL ONLY.
W    D2040   44.       5.5            DAUBER    67 HBC    0  2.0 K- P        12/75
W    D 10K   53.2      2.1            DAVIS     69 HBC    0 12. K+P(K+PI-)   12/75
W  W D4300   54.0      3.3            HABER     70 DBC    0 3. K-N (K-PI+)   12/75
W     2934   55.8      4.2     3.4    AGUILAR1  71 HBC    0 3.9,4.6 K- P     11/71
W    D5362   48.5      2.7            AGUILAR1  71 HBC    0 3.9,4.6 K- P     12/75
W    D1700   51.4      5.             BUCHNER   72 DBC    04.6 K+ N,K+ PI-P  12/72
W    D3186   46.0      3.             LEWIS     73 HBC    02.1-2.7 K+P       12/75
W   C       (46.5)    (1.5)           LINGLIN   73 HBC    02-13 K+P,K+PI-     1/74
W      10K   47.       2.             FOX       74 RVUE   0 2 K-P,K-PI+N     12/75
W            51.       2.             FOX       74 RVUE   0 2 K+N,K+PI-P     12/75
W   C       (47.)     (3.)            MATISON   74 HBC    012 K+P,K+PI-      12/75
W     3600   43.       3       2.     MCCUBBIN  75 HBC    0 3.6 K-P,K-PI+N   12/75
W   I  22K  (50.6)    (2.5)           PALER     75 HBC    014.3 K-P,K*0 K0   12/75
W            48.9      2.5            BOWLER    77 DBC    05.4 K+D,K+PI-P P  12/77
W     1180   45.9      4.8            AGUILAR   78 HBC   0 .76 PB P,K KS PI  12/78
W  P         52.9      0.4            ESTABROOK 78 ASPK   013 K+-P,K+-PI+-   12/77
W            51.2      1.7            WICKLUND  78 ASPK  0 3,4,6 PI+-PN       4/78
W   C       (40.1)    (6.0)           LANG      79 RVUE  0                    1/82*
W      28K   54.       2.             EVANGELIS 80 OMEG  0 10 PI-P            9/81*
W            49.8      1.2            ASTON     81 LASS  0 11 K-P,K- PI+ N    1/82*
W          . . . . . . . . . .
W   AVG      52.09     0.50    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                               (SEE IDEOGRAM BELOW )

W    C   FROM POLE EXTRAPOLATION.
W    D   WIDTH ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE.
W   I    INCLUSIVE REACTION. COMPLICATED BACKGROUND AND PHASE-SPACE EFFECTS
W  P     FROM PHASE SHIFT ANALYSIS OF 155000 EVENTS.
W  W     NUMBER OF EVENTS IN PEAK REEVALUATED BY US
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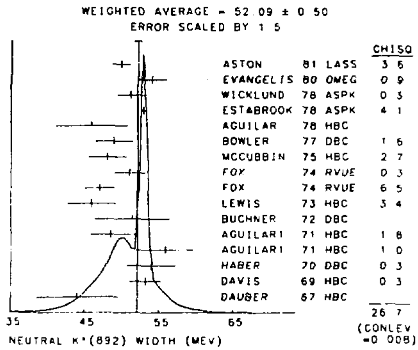


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                     18  K*(892) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     K*(892) INTO K PI                                      493+ 139
P2     K*(892) INTO K PI PI                                   493+ 139+ 139
P3     K*(892) INTO K GAMMA                                   493+   0
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                     18  K*(892) PARTIAL WIDTHS (KEV)

W1     K*(892) INTO (K GAMMA)                           (G3)
W1          62.0     14.0          BERG       81 SPEC -  156 K-A,K PI A      1/82*
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                     18  K*(892) BRANCHING RATIOS

R1     K*(892) INTO (K PI PI)/(K PI)                          (P2)/(P1)
R1       0   (0.002)OR LESS             WOJCICKI2 64 HBC   -  1.7 K-P
R1       0   (0.0007)OR LESS  CL=0.95   JONGEJANS 78 HBC      4 K-P,P K0 2PI     4/76

R2     K*(892)  INTO (K  GAMMA)/TOTAL  (UNITS 10**-3)    (P3)
R2          (1.6)  OR LESS  CL=.95   BEMPORAD  72 CNTR +  10.-16. K+A,COUL  1/73
R2           1.5      0.7            CARITHERS 75 CNTR  0 8-16K0BAR A,COUL 12/75

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                          REFERENCES FOR K*(892)

ALSTON   61 PRL 6 300          ALSTON,ALVAREZ,EBERHARD,GOOD,GRAZIANO+(LRL)

ALEXANDE 62 PRL 8 447          ALEXANDER,KALBFLEISCH,MILLER,G SMITH  (LRL)
COLLEY   62 CERN CONF 315      D COLLEY,N GELFAND +     (COLUMBIA+RUTGERS)

CHADWICK 63 PL 6 309           CHADWICK,CRENNELL,DAVIES,BETTINI+(OXF+PADO)
GOLDHABE 63 ATHENS CONF 92     SULAMITH GOLDHABER                    (LRL)

WOJCICKI 64 PR 135 B 484       STANLEY G WOJCICKI                    (LRL)

ADELMAN  65 ATHENS 527         STUART LEE ADELMAN             (CAVENDISH)
FERRO-LU 65 NC 36 1101         FERRO-LUZZI,GEORGE,HENRI,JONGEJANS   (CERN)
FERRO-LU 65 NC 39 417          FERRO-LUZZI,GEORGE,GOLDSCHMIDT-CLER+ (CERN)
GELSEMA  65 THESIS             E.S.GELSEMA (SEE ALSO PL 10 341)(AMSTERDAM)
WANGLER  65 PR 137 B 414       WANGLER,ERWIN,WALKER            (WISCONSIN)

BARASH   67 PR  156  1399      BARASH,KIRSCH,MILLER,TAN        (COLUMBIA)
BARLOW   67 NC   50 A  701     +MONTANET,D-ANDLAU+   (CERN+CDEF+IRAD+LIVP)
BOMSE    67 PR 158 1298        +BORENSTEIN+COLE+GILLESPIE+  (JOHN HOPKINS)
CONFORTO 67 NP 83 469          +MARECHAL,MONTANET+CERN+CDEF+IPN+LIVERPOOL
DAUBER   67 PR 153 1403        +SCHLEIN,SLATER,TICHO                (UCLA)
DE BAERE 67 NC 51 A 401        +GOLDSCHMIDT-CLERMONT,HENRI+    (BRUX+CERN)
FRENCH   67 NC 47A 442         +KINSON+MCDONALD+RIDDIFORD+     (CERN+BIRM)
GEORGE   67 NC 49A 9           +GOLDSCHMIDT-CLERMONT+HENRI+    (CERN+BRUX)
SALLSTRO 67 NC 49A 348         SALLSTROM+OTTER+EKSPONG         (STOCKHOLM)

DE WIT   68  THESIS            S. DE WIT                       (AMSTERDAM)
FICENEC1 68 PR 169 1034        +HULSIZER+SWANSON+TROWER              (ILL)
FICENEC2 68 PR 175 1725        FICENEC, GORDON, TROWER          (ILLINOIS)
KANG     68 PR 176 1587        Y.W.KANG                             (IOWA)
SCHWEING 68 PR 166 1317        SCHWEINGRUBER,DERRICK,FIELDS+    (ANL+NWES)

CRENNELL 69 PRL 22  487        +KARSHON,LAI,ONEALL,SCARR             (BNL)
DAVIS    69 PRL 23 1071        +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE 69 NC 61 A 397        +GOLDSCHMIDT-CLERMONT,HENRI,+   (BELG+CERN)
FRIEDMAN 69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS               (LRL)
JUHALA   69 PR 184  1461       +LEACOCK,RHODE,KOPELMAN,LIBBY,+  (ISU+COLO)
LIND     69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER    (LRL) JP

ATHERTON 70 NP B 16 416        +FRANEK,FRENCH,FRISK,BECNAR+    (CERN+PRAG)
HABER    70 NP B 17 289        +SHAPIRA,ALEXANDER+    (REHO+SACL+BGNA+EPOL)

AGUILAR  71 PRL 26 466         +BARNES,BASSANO,EISNER,KINSON,SAMIOS  (BNL)
AGUILAR1 71 PR D 4 2583        +EISNER,KINSON                        (BNL)
BARNHAM  71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLAS)
BUCHNER  71 NP B 29 381        +DEHM,GOEBEL,GOLDSCHMIDT,+ (MPIM+CERN+BELG)
COROS    71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+      (PURD+UCD+IUPU)
MERCER   71 NP B32 381         +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA     71 PRL 26 1502        +DERRICK,ENGELMANN,MUSGRAVE          (ANL+EFI)
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ABRAMOVI  72 NP B 39 189      ABRAMOVICH,CHALOUPKA,CHUNG,HILPERT,+ (CERN)
BINGHAM   72 NP B 41 1        +            (INTERNATIONAL K+ COLLABORATION)
BEMPORAD  72 NP B 51 1        +BEUSCH,FREUDENREICH,+       (CERN+ETH+LOIC)
BRUNET    72 NP B 37 114      +DANYSZ,GOLDSACK,+      (CDEF+SACL+LOIC+LOWC)
BUCHNER   72 NP B 45 333      +DEHM,CHARRIERE,CORNET,+     (MPIM+CERN+BRUX)
CRENNELL  72 PR D 6 1220      +GORDON,KWAN-WU LAI,SCARR                (BNL)
DEUTSCHM  72 NP B 36 373      DEUTSCHMANN,+            (ABCLV COLLABORATION)
ENGELMAN  72 PR D 5 2162      ENGELMANN,MUSGRAVE,FORMAN,+          (ANL+EFI)
ROUGE     72 NP B 46 29       +VIDEAU,VOLTE,DE BRION,+            (EPOL+SACL)
TIECKE    72 NP B 39 596      +GRIJNS,HEINEN,DE GROOT,+           (NIJM+AMST)

BERTHON   73 NP B 63 54       +MONTANET,PAUL,BERTRANET,+          (CERN+SACL)
CHARRIER  73 NP B 51 317      CHARRIERE,DRIJARD,DE BAERE,+        (CERN+BELG)
CLARK     73 NP B 54 432      +LYONS,RADOJICIC                        (OXFORD)
LEWIS     73 NP B 60 283      +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
LINGLIN   73 NP B 55 408      D.LINGLIN                               (CERN)
MALUCH    73 PR D 8 2837      +FLATTE,FRIEDMAN                         (LBL)

FOX       74 NP B80 403       G.C.FOX,M.L.GRISS                        (CIT)
MATISON   74 PR D9 1872       +GALTIERI,GARNJOST,FLATTE,FRIEDMAN,+     (LBL)

BRANDENB  75 PL 59 B 405      BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)
CARITHER  75 PRL 35 349       CARITHERS,MUHLEMANN,UNDERWOOD,+ (ROCH+MCGI)
MCCUBBIN  75 NP B86 13        N.A.MCCUBBIN,L.LYONS                     (OXF)
PALER     75 NP B96 1         +TOVEY,SHAH,SPIRO,CHAURAND+(RHEL+SACL+EPOL)

KIRK      76 NP B 116 99      +KLEIN,COUNIHAN,+(AACH+BERL+CERN+LOIC+WIEN)

BOWLER    77 NP B 126 31      +DAINTON,DRAKE,WILLIAMS                 (OXFORD)

AGUILAR   78 NP B 141 101     +FERNANDEZ,COOPER,+     (MADR+TIFR+CERN+CDEF)
BALAND    78 NP B 140 220     +GRARD,JOHNSON,+ (MONS+BELG+CERN+LOIC+LALO)
BALDI     78 NP B 134 365     +BOHRINGER,DORSAZ,HUNGERBUHLER+         (GEVA)
COOPER    78 NP B 136 365     +GURTU,DOBRZYNSKI,+     (TIFR+CERN+CDEF+MADR)
ENGELEN   78 NP B 134 14      +JONGEJANS,HEMINGWAY,+  (NIJM+ZEEM+CERN+OXF)
ESTABROO  78 NP B 133 490     ESTABROOKS,CARNEGIE,+ (MONT+CARL+DURH+SLAC)
    ALSO  78 PR D 17 658      ESTABROOKS,CARNEGIE+  (MONT+CARL+DURH+SLAC)
JONGEJAN  78 NP B 139 383     JONGEJANS,CERRADA,+     (ZEEM+CERN+NIJM+OXF)
MARTIN    78 NP B 134 392     +SHIMADA,BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)
WICKLUND  78 PRD 17 1197      +AYRES,DIEBOLD,GREENE,KRAMER,PAWLICKI (ANL)

LANG      79 PR D 19 956      C.B.LANG,A.MAS-PARAREDA                 (GRAZ)

AJINENKO  80 ZPHY 5 177       +BARTH,DUJARDIN,+       (SERP+LIBH+MONS+SACL)
EVANGELI  80 NP B 165 383     + (BARI+BONN+CERN+DARE+GLAS+LIVP+MILA+WIEN)

ASTON     81 PL 106 B 235     +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)  JP
BERG      81 PL 98 B 119      +CHANDLEE,BIEL,HEPPELMANN,+(ROCH+FNAL+MINN)
DELFOSSE  81 NP B 183 349     +GUISAN,MARTIN,MUHLEMANN,WEILL,+(GEVA+LAUS)
TOAFF     81 PR D 23 1500     +MUSGRAVE,AMMAR,DAVIS,ECKLUND,+   (ANL+KANS)

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Note on the $Q_1(1280)-Q_2(1400)$

Since all the recent high-statistics experiments investigating the partial-wave contents of the $K\pi\pi$ system diffractively produced on protons (BRANDERBURG 76, OTTER 76, VERGEEST 79, DAUM 81) give consistent evidence for the existence of two strangeness-one axial vector mesons, we have split the "Q region" entry of our last edition into two entries: one for the $Q_1(1280)$ resonance, with a mass around 1280 MeV, a width of the order of 100 MeV, and mainly coupled to the $K\rho$ channel; and another one for the $Q_2(1400)$ resonance, with a mass around 1400 MeV, a width of the order of 180 MeV, and mainly coupled to the $K^*\pi$ channel.

Notice that, whereas both $Q_1(1280)$ and $Q_2(1400)$ are produced in diffractive processes, the non-dif-diffractive reactions (ARMENTEROS 64, CRENNELL 67, 72, ASTIER 69, GAVILLET 78, ETKIN 80, RODEBACK 81) select preferentially the production of one of the two states.

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$Q_1(1280)$

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28  Q1(1280,JP=1+) I=1/2

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                 28  Q1(1280) MASS  (MEV)

M   PRODUCED BY BEAMS OTHER THAN K MESONS
M  A      1242.0      9.0     10.0  ASTIER    69 HBC    0 PBAR P          9/69
M  A   THIS IS THE C MESON.
M      45(1300.)                    CRENNELL  67 HBC    0 6 PI- P,LK2PI   7/67
M      40(1300.)                    CRENNELL  72 HBC    0 4.5PI-P,LK2PI  12/72
M     310(1294.)    (10.)           RODEBACK  81 HBC    4 PI-P,LAM K 2PI  1/82*

M   PRODUCED BY K-, BACKWARDS SCATTERING, HYPERON EXCHANGE
M     700 1275.0     10.0           GAVILLET  78 HBC  + 4.2 K-P,XI-KPIPI  4/78

M   PRODUCED BY K BEAMS
M        (1260.)                    DAVIS     72 HBC  + 12. K+ P         12/72
M        (1234.)    (12.)           FIRESTONE 72 DBC  + 12. K+ D          2/73
M        (1300.)  APPROX.           BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P 12/75
M  E     (1289.0)   (25.0)          CARNEGIE  77 ASPK +- 13 K+-P,P KPIPI 12/77
M        (1270.0) APPROX.           OTTER     76 HBC  - 10-14-16K-P      12/77
M        (1300.0) APPROX.           VERGEEST  79 HBC  +- 4.2 K-P,K PI PI 12/79
M          1270.      10.           DAUM      81 CNTR - 63 K-P,K 2PI P    1/82*

M  E   FROM A MODEL DEPENDENT FIT WITH GAUSSIAN BACKGROUND TO
M  E   BRANDENBURG 76 DATA.

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                 28  Q1(1280) WIDTH  (MEV)

W   PRODUCED BY BEAMS OTHER THAN K MESONS
W         127.0       7.0     25.0  ASTIER    69 HBC    0 PBAR P          9/69
W     45  (60.)                     CRENNELL  67 HBC    0 6 PI- P         7/67
W     40  (60.)                     CRENNELL  72 HBC    0 4.5PI-P,LK2PI  12/72
W    310  (66.)     (15.)           RODEBACK  81 HBC    4 PI-P,LAM K 2PI  1/82*

W   PRODUCED BY K-, BACKWARDS SCATTERING, HYPERON EXCHANGE
W    700   75.0      15.0           GAVILLET  78 HBC  + 4.2 K-P,XI-KPIPI  4/78

W   PRODUCED BY K BEAMS
W        (120.)                     DAVIS     72 HBC  + 12. K+ P         12/72
W        (188.)     (21.)           FIRESTONE 72 DBC  + 12. K+ D         12/75
W        (200.)   APPROX.           BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P 12/75
W  E     (150.00)   (71.0)          CARNEGIE  77 ASPK +- 13 K+-P,P KPIPI 12/77
W        (150.0)  APPROX.           VERGEEST  79 HBC  +- 4.2 K-P,K PI PI 12/79
W          90.        8.            DAUM      81 CNTR - 63 K-P,K 2PI P    1/82*

W  E   SEE NOTE E ABOVE.

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                 28  Q1(1280) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1    Q1(1280) INTO K*(892) PI                        891+ 139
P2    Q1(1280) INTO K RHO                             497+ 769
P3    Q1(1280) INTO K PI                              497+ 139
P4    Q1(1280) INTO K ETA                             497+ 548
P5    Q1(1280) INTO K OMEGA                           497+ 782
P6    Q1(1280) INTO K PI PI                           497+ 139+ 139
P7    Q1(1280) INTO KAPPA PI                         1350+ 139
P8    Q1(1280) INTO K EPSILON                         497+1300

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                 28  Q1(1280) PARTIAL WIDTHS (MEV)

W1    Q1(1280) INTO K RHO                          (G2)
W1         75.0       6.0       CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78
W1         57.0       5.0       MAZZUCATO 79 HBC  +  4.2 K-P,XI-KPIPI 12/79
W1       . . . . . . . . . .
W1  AVG    64.4       8.9       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)

W2    Q1(1280) INTO K* PI                          (G1)
W2          2.0       2.0       CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78
W2         14.0      11.0       MAZZUCATO 79 HBC  +  4.2 K-P,XI-KPIPI 12/79
W2       . . . . . . . . . .
W2  AVG     2.4       2.0       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W3    Q1(1280) INTO K OMEGA                        (G5)
W3         24.0       3.0       CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78
W3          4.9       4.00      MAZZUCATO 79 HBC  +  4.2 K-P,XI-KPIPI 12/79
W3       . . . . . . . . . .
W3  AVG    16.8       9.6       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 4.0)

W4    Q1(1280) INTO KAPPA PI                       (G7)
W4         26.0       6.0       CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78

W5    Q1(1280) INTO EPSILON K                      (G8)
W5         22.0       5.0       CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78

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                 28  Q1(1280) BRANCHING RATIOS

R1    Q1 INTO K* PI                                (P1)
R1 F     0.16      0.05       DAUM      81 CNTR    63 K-P,K 2PI P     1/82*

R1    Q1 INTO K RHO                                (P2)
R2 F     0.42      0.06       DAUM      81 CNTR    63 K-P,K 2PI P     1/82*
R2     DOMINANT               RODEBACK  81 HBC     4 PI-P,LAM K 2PI   1/82*

R3    Q1 INTO K OMEGA                              (P5)
R3 F     0.11      0.02       DAUM      81 CNTR    63 K-P,K 2PI P     1/82*

R4    Q1 INTO KAPPA PI                             (P7)
R4 F     0.28      0.04       DAUM      81 CNTR    63 K-P,K 2PI P     1/82*

R5    Q1 INTO K EPSILON                            (P8)
R5 F     0.03      0.02       DAUM      81 CNTR    63 K-P,K 2PI P     1/82*

R6    Q1 INTO (K OMEGA)/(K RHO)                    (P5)/(P2)
R6     (0.30) OR LES.  CL=.95  RODEBACK  81 HBC    4 PI-P,LAM K 2PI   1/82*

R9    D/S RATIO FOR Q1 INTO K*(892) PI
R9 F     1.0       0.7        DAUM      81 CNTR    63 K-P,K 2PI P     1/82*

R  F   AVERAGE FROM LOW AND HIGH T DATA.

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                              REFERENCES FOR Q1(1280)

ARMENTER 64 DUBNA CONF 1 577   ARMENTEROS,EDWARDS,D-ANDLAU +   (CERN+CDEF)
    ALSO 64 DUBNA CONF 1 617   R ARMENTEROS (RAPPORTEUR)
ARMENTER 64 PL 9 207           ARMENTEROS,EDWARDS,D-ANDLAU,+   (CERN+CDEF)
    ALSO 66 PR  145  1095      BARASH,KIRSCH,MILLER,TAN           (COLUMBIA)

ALMEIDA  65 PL 16 184          ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+ (CAVE)

SHEN     66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING    (LRL)
    ALSO 66  (PRIVATE COMMUNIGERSON GOLDHABER                         (LRL)

BASSOMPI 67 PL 26B 30          BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)JP
BERLINGH 67 PRL 18 1087        BERLINGHIERI+FARBER+FERBEL+FORMAN     (ROCH)JP
CRENNELL 67 PRL 19  44         +KALBFLEISCH,LAI,SCARR,SCHUMANN       (BNL)I
DE BAERE 67 NC 49A 374         +DEBAISIEUX+FAST+FILIPPAS+         (CERN+BRUX)
    ALSO PRIVATE COMMUNICATION BY B. JONGEJANS
GOLDHABE 67 PRL 19 976         G.GOLDHABER                            (LBL)

BARTSCH  68 NP B8 9            +COCCONI,+          (AACH+BERL+CERN+LOIC+VIEN)
BOMSE    68 PRL 20 1519        +BORENSTEIN,CALLAHAN,COLE,COX,+ (JOHNHOPK)  I+
DENEGRI  68 PRL 20 1194        +CALLAHAN+ETTLINGER+GILLESPIE+  (JOHNHOPK)  I+

ALEXANDE 69 NP B 13 503        G.ALEXANDER,FIRESTONE,GOLDHABER,+      (LRL)
ANDREWS  69 PRL 22 731         +LACH,LUDLAM SANDWEISS,BERGER,+  (YALE+LRL)
ASTIER   69 NP B 10 65         +MARECHAL,MONTANET,+   (CDEF+CERN+IPNP+LIVP)JP
BARBARO  69 PRL 22 1207        BARBARO-GALTIERI,DAVIS,FLATTE,+        (LRL)
BETTINI  69 NC 62 A 1038       +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)I
BISHOP   69 NP B 9 403         +GOSHAW,ERWIN,WALKER                  (WISC)
CHIEN    69 PL 29B 433         +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+     (UCLA)
CHUNG    69 PR 182 1443        +EISNER+BALI+LUERS                     (BNL)
COLLEY   69 NC A 59 519        +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)
ERWIN    69 NP B 5 364         +WALKER,GOSHAW,WEINBERG      (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS                (LRL)
WERNER   69 PR 188 2023        +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) I+

ABRAMS   70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,O-HALLORAN,+ (ILL)
ANTICH   70 NP B 20 201        +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  I+
BOWLER   70 PL 31 B 318        M.G.BOWLER                          (OXFORD)
FARBER   70 PR D 1 78          +FERBEL,SLATTERY,YUTA                 (ROCH)  I+

BARNHAM  71 NP B25 65          +COLLEY,GRIFFITHS,ALPER, +   (BIRM+GLAS+OXF)
DENEGRI  71 NP B 28 13         +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+   (JHU)  I+
FORMAN   71 PR D 3 2610        +GELFAND,LEARY,MOSER,SEIDL,WOLFSON     (EFI)
GARFINKE 71 PRL 26 1505        GARFINKEL,HOLLAND,CARMONY,LANDER+(PURD+UCD)  I+

ANDERSON 72 PR D 6 1823        +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN  (COLO)
BINGHAM  72 NP B 48 589        +EISENSTEIN,GRARD,HENQUET,+     (CERN+BRUX)
BRANDENB 72 NP B 45 397        BRANDENBURG,BRODY,JOHNSON,LEITH,LOOS+(SLAC)
BRANDENB 72 PRL 28 932         BRANDENBURG,JOHNSON,LEITH,LOOS,LUSTE+(SLAC)
CRENNELL 72 PR D 6 1220        +GORDON,KWAN-WU LAI,SCARR              (BNL)
DAVIS    72 PR D 5 2688        +ALSTON,BARBARO,FLATTE,FRIEDMAN,LYNCH+(LBL)
FIRESTON 72 PR D 5 505         FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
FIRESTON172 NP B 47 348        A.FIRESTONE                            (CIT)
FRATI    72 PR D 6 2361        +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
HAATUFT  72 NP B 48 78         +ARNOLD,HAGUENAUER,+   (BERG+STRB+EPOL+MAUR)

BARLOUTA 73 NP B 59 374        +DREVILLON,SHAH,+          (SACL+EPOL+RHEL)  JP
BINGHAM  73 NP B 52 31         +FARWEL,+       (LBL+ORSAY+BNL+SACLAY+MILAN)  JP
DE JONGH 73 NP B 58 110        +CORNET,CHARRIERE,+    (BRUX+MONS+CERN+MPIM)
JONES    73 NP B 52 393        G.T.JONES                             (CERN)  JP
LEWIS    73 NP B 60 283        +ALLEN,JACOBS,DANYSZ,BORG,+ (LOWC+LOIC+COEF)
WERNER   73 PR D 7 1275        +SLATTERY,FERBEL                 (ROCHESTER)

ANGELOPO 74 NC 20A 49          ANGELOPOULOS,FILIPPAS+(ATHU+ATEN+LIVP+VIEN)  JP
BOWLER   74 NP B74 493         +DAINTON,KADDOURA,AITCHISON             (OXF)
DAVIDSON 74 PR D9 77           +CHAPMAN,GREEN,LYS,ROE                 (MICH)
DEUTSCHM 74 PL 49B 388         DEUTSCHMANN,+       (AACH+BERL+CERN+LOIC+VIEN)  JP

ANTIPOV  75 NP B86 381         +ASCOLI,BUSNELLO,KIENZLE+    (SERP+CERN+ILL)  JP
BOWLER   75 NP B97 227         +GAME,AITCHISON,DAINTON            (OXF+DARE)
DORE     75 LNC 13 265         +GUIDONI,LARASO,MARINI,CONFORTO+(ROMA+RHEL)
DREVILLO 75 PL 55 B 245        DREVILLON,BORENSTEIN+       (EPOL+BOHR+CDEF)  JP
DUNWOODI 75 NP B91 189         DUNWOODIE,GRANT+        (CERN+BELG+MONS+MPIM)  JP
OTTER1   75 NP B84 397         + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)  JP
OTTER2   75 NP B93 365         +RUDOLPH,RUMPF+   (AACH+BERL+CERN+LOIC+VIEN)  JP
OTTER3   75 NP B96 29          +RUDOLPH,SEYFERT+(AACH+BERL+CERN+LOIC+VIEN)I.JP
TOVEY    75 NP B95 109         +HANSEN,BORENSTEIN,BORG+   (RHEL+EPOL+SACL)I,JP

BASDEVAN 76 PRL 37 977         BASDEVANT,BERGER                  (FNAL+ANL)
BOAL     76 PR D 14 2998       +EDWARDS,KAMAL,TORGESON              (ALBERTA)
BOWLER   76 JPG 3 775          M.G.BOWLER                           (OXFORD)
BRANDENB 76 PRL 26 703         BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP
OTTER    76 NP B 106 77        + (AACH+BERL+CERN+LOIC+VIEN+LPNP+RHEL+SACL)  JP
VERGEEST 76 PL 62 B 471        +ENGELEN,JONGEJANS,+    (AMST+CERN+NIJM+OXF)  JP

CARNEGIE 77 NP B 127 509       +CASHMORE,DAVIER,DUNWOODIE,LASINSKI+ (SLAC)
CARNEGIE177 PL B 68 287        +CASHMORE,DUNWOODIE,LASINSKI,+        (SLAC)

BEUSCH   78 PL 74 B 282        +BIRMAN,KONIGS,OTTER,+       (CERN+AACH+ETH)  JP
GAVILLET 78 PL 76 B 517        +DIAZ,DIONISI,+         (AMST+CERN+NIJM+OXF)  JP
WOHL     78 NP B 132 401       +FELLER,CHAURAND,+        (LPNP+RHEL+SACLAY)

BASDEVAN 79 PR D 19 246        BASDEVANT,BERGER                        (ANL)
MAZZUCAT 79 NP B 156 532       MAZZUCATO,PENNINGTON+   (CERN+ZEEM+NIJM+OXF)
VERGEEST 79 NP B 158 265       +JONGEJANS,DIONISI,+    (NIJM+AMST+CERN+OXF)

BACON    80 NP B 162 189       +BARREY,BUTTERWORTH,ANSORGE,+   (LOIC+CAVE)
DIONISI  80 NP B 169 1         +GAVILLET,ARMENTEROS+ (CERN+MADR+CDEF+STOH)
ETKIN    80 PR D 22 42         +FOLEY,LINDENBAUM,KRAMER,+        (BNL+CUNY)  JP
IRVING   80 JPG 6 153          A.C.IRVING                             (LIVP)
RADFORD  80 NP B 167 181       RADFORD,BRANDENBURG                     (MIT)

DAUM     81 NP B 187 1         +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
OTTER    81 NP B 191 1          (AACH+BERL+LOIC+VIEN+BIRM+BELG+CERN+MONS)
RODEBACK 81 ZPHY C 9 9         +SJOGREN,ARMENTEROS,+ (CERN+CDEF+MADR+STOH)

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$\kappa(1350)$

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19   KAPPA(1350,JP=0+) I=1/2
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The isodoublet S-wave $K\pi$ phase shift δ_0^1 is compatible with elastic unitarity up to the $K\eta'$ threshold. It grows monotonically, reaching 90° at about 1350 MeV (MERCER 71, BINGHAM 72, FIRESTONE 71,72, MATISON 72,74, GALTIERI 73, YUTA 73, FOX 74, BAKER 75, LAUSCHER 75, BOWLER 77, ESTABROOKS 78, ASTON 81). The ambiguous "up" solution in the region of the $K^*(892)$ has been ruled out conclusively (MATISON 72,74, GALTIERI 73, BOWLER 77, ESTABROOKS 78).

The first inelastic two-body threshold is $K\eta$, which, however, is very weakly coupled to κ, in accordance with the SU(3) prediction for the $\kappa K\eta$ coupling.

In the energy range 1350-1450 MeV the phase shift exhibits rapid motion (BOWLER 77, ESTABROOKS 78, MARTIN 78), which has been taken as an indication for a κ resonance at 1500 MeV (ESTABROOKS 79). However, the phase-shift behavior can also be understood as a cusp effect due to the nearby $K\eta'$ threshold at 1455 MeV (TORNQVIST 82). Above this energy the inelasticity due to $K\eta'$ is important. The phase shift can be fitted up to about 1500 MeV in a unitary coupled-channel analysis with proper analytic structure with one resonance, the $\kappa(1350)$, without background (TORNQVIST 82). This supports earlier interpretations (FIRESTONE 71,72, FRATI 72, ROUGE 72, CORDS 73, LAUSCHER 75, MORGAN 75, ENGELEN 78, ASTON 81) that the κ mass indeed is where δ_0^1 passes through 90°.

At still higher energies some evidence for a second scalar resonance exists (ASTON 81).

See also Appendix IIC.

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                     19   KAPPA MASS (MEV)

M   C     (1425.)   APPROX.               ESTABROOK 78 ASPK    13 K+- P           12/77
M         (1450.0)  APPROX.               MARTIN    78 SPEC    10 K+-P,KS PI P    12/75
M   P     (1278.)    150.)                LANG      79 RVUE  0                     1/82*
M         (1400.)   APPROX.               ASTON     81 LASS  0 11 K-P,K- PI+ N     1/82*
M         (1350.)                         TORNQVIS  82 RVUE    13 K+- P            1/82*

M   C   FROM ELASTIC K PI PARTIAL WAVE ANALYSIS ( SEE KAPPA MINI-REVIEW )
M   P   POLE EXTRAPOLATION USING FIRESTONE 72 AND MATISON 74 DATA.

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                     19   KAPPA WIDTH (MEV)

W   C      200-300 APPROX.                ESTABROOK 78 ASPK    13 K+- P           12/77
W   P      (540.)    (106.)               LANG      79 RVUE  0                     1/82*
W          (250.)    APPROX.              ASTON     81 LASS  0 11 K-P,K- PI+ N     1/82*
W          (435.)    OR MORE              TORNQVIS  82 RVUE    13 K+- P            1/82*

W   C   FROM ELASTIC K PI PARTIAL WAVE ANALYSIS ( SEE KAPPA MINI-REVIEW )
W   P   POLE EXTRAPOLATION USING FIRESTONE 72 AND MATISON 74 DATA.

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                     19   KAPPA PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      KAPPA INTO K PI                                    497+ 134
P2      KAPPA INTO K ETA                                   497+ 548
P3      KAPPA INTO K ETA PRIME                             497+ 957

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                     19   KAPPA BRANCHING RATIOS

R1      KAPPA INTO (K PI)/TOTAL                     (P1)
R1            (0.85) APPROX.          ASTON     81 LASS  0 11 K-P,K- PI+ N     1/82*
R1            (0.93) APPROX.          TORNQVIS  82 RVUE    13 K+-P             1/82*

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                              REFERENCES FOR KAPPA

TRIPPE    68 PL 28 B 703           +CHIEN,MALAMUD,MELLEMA,SCHLEIN,+        (UCLA)

CRENNELL 69 PRL 22 487             +KARSHON,LAI,O,NEALL,SCARR               (BNL)
DODD      69 PR 177 1994           +JOLDERSMA,PALMER,SAMIOS                 (BNL)
GOLDBERG 69 PL 30 B 434            SABRE COLLABOR.  (SACL+AMST+BGNA+RCHO+EPOL)
SCHLEIN   69 ARGONNE CONF. 446 P.SCHLEIN                                    (UCLA)

FIRESTON 71 PRL 26 1460            A.FIRESTONE,G.GOLDHABER,D.LISSAUER       (LRL)
MERCER    71 NP B32 381            +ANTICH,CALLAHAN,CHIEN,COX,+ (JOHN HOPKINS)
YUTA      71 PRL 26 1502           +DERRICK,ENGELMANN,MUSGRAVE          (ANL+EFI)

AGUILAR   72 PR D 6 11             AGUILAR-BENITEZ,CHUNG,EISNER             (BNL)
BINGHAM   72 NP B 41 1             +            (INTERNATIONAL K+ COLLABORATION)
BUCHNER   72 NP B 45 333           +DEHM,CHARRIERE,CORNET,+   (MPIM+CERN+BRUX)
CHUNG     72 PRL 29 1570           +EISNER,AGUILAR-BENITEZ                  (BNL)
CRENNELL 72 PR D 6 1220            +GORDON,KWAN-WU LAI,SCARR                (BNL)
DIEBOLD   72 BATAV.CONF. V.3 178.DIEBOLD  RAPPORTEUR TALK                  (ANL)
ENGELMAN 72 PR D 5 2162            ENGELMANN,MUSGRAVE,FORMAN,+          (ANL+EFI)
FIRESTON 72 PR D 5 2188            +GOLDHABER, LISSAUER, TRILLING       (LBL)PWA
FRATI     72 PR D 6 2361           +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
MATISON   72 LBL 1537 (THESIS) REVISED VERSION WILL GO T. PHYS.REV.     LBL
ROIGE     72 NP B 46 29            +VIDEAU,VOLTE,DE BRION,+            (EPOL+SACL)

CORDS     73 NP B 54 109           +CARMONY,LANDER,MEIERE,+    (PURD+UCD+IUPU)
GALTIERI T3  LBL 1772              +MATISON,GARNJOST,FLATTE,FRIEDMAN+       (LBL)
LINGLIN   73 NP B 55 408           D.LINGLIN                               (CERN)
YUTA      73 NP B 52 70            +ENGELMANN,MUSGRAVE,FORMAN,+         (ANL+EFI)

FOX       74 NP B80 433            G.C.FOX,M.L.GRISS                        (CIT)
MATISON   74 PR D9 1872            +GALTIERI,GARNJOST,FLATTE,FRIEDMAN,+    (LBL)
MORGAN    74 PL 51B 71             D.MORGAN                                (RHEL)

BAKER     75 NP B99 211            +BANERJEE,CAMPBELL,ALLEN,MARCH+ (LOIC+LOWC)
LAUSCHER 75 NP B86 189             +OTTER,WIECZOREK,+     (ABCLV COLLABORATION)
MORGAN    75 ARGONNE CONF. 45      D.MORGAN                                (RHEL)

CHIEN     76 NP B 106 355          +FEIOCK,LUCAS,PEVSNER,ZCANIS       (BALTIMORE)

BOWLER    77 NP B 126  31          +DAINTON,DRAKE,WILLIAMS               (OXFORD)
SPIRO     77 NP B 125 162          +BARLOUTAUD,COMBER,PALER,+ (SACL+RHEL+EPOL)

BALDI     78 NP B 134 365          +BOHRINGER,DORSAZ,HUNGERBUHLER+        (GEVA)
ENGELEN   78 NP B 134 14           +JONGEJANS,HEMINGWAY,+ (NIJM+ZEEM+CERN+OXF)
ESTABROD 78 NP B 133 490           ESTABROOKS,CARNEGIE,+ (MONT+CARL+DURH+SLAC)
MARTIN    78 NP B 134 392          +SHIMADA,BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)

ESTABROD 79 PR D 19 2678           P.ESTABROOKS                            (CARL)
LANG      79 PR D 19 956           C.B.LANG,A.MAS-PARAREDA                 (GRAZ)

ASTON     81 PL 106 B 235          +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)  JP
TOAFF     81 PR D 23 1500          +MUSGRAVE,AMMAR,DAVIS,ECKLUND,+   (ANL+KANS)

TORNQVIS 82  HU-TFT-82-1           N.A.TORNQVIST                           (HELS)

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Q_2(1400)

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64  Q2(1400,JP=1+) I=1/2

SEE MINI-REVIEW UNDER Q1(1280)

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                 64  Q2(1400) MASS (MEV)

M          (1420.)                 DAVIS     72 HBC  +  12. K+ P              12/72
M          (1368.)    (18.)        FIRESTONE 72 DBC  +  12. K+ D              12/77
M          (1400.)    APPROX.      BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P      12/75
M     E    (1404.0)   (10.0)       CARNEGIE  77 ASPK +- 13 K+-P,P KPIPI       12/77
M          (1400.0)   APPROX.      VERGEEST  79 HBC  +- 4.2 K-P,K PI PI       12/79
M           1415.      15.         ETKIN     80 MPS   0 6 K-P,K0 PI+ PI-      1/82*
M           1410.      25.         DAUM      81 CNTR -  63 K-P,K 2PI P        1/82*
M          . . . . . . . . . .
M   AVG     1413.7     12.9    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M     E   FROM A MODEL DEPENDENT FIT WITH GAUSSIAN BACKGROUND TO
M     E   BRANDENBURG 76 DATA.

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                 64  Q2(1400) WIDTH (MEV)

W           (83.)                  DAVIS     72 HBC  +  12. K+ P              12/72
W          (241.)     (30.)        FIRESTONE 72 DBC  +  12. K+ D              12/75
W          (160.)     APPROX.      BRANDENB  76 ASPK +- 13 K+-P,(KPIPI)P      12/75
W     E    (142.0)    (16.0)       CARNEGIE  77 ASPK +- 13 K+-P,P KPIPI       12/77
W          (200.0)    APPROX.      VERGEEST  79 HBC  +- 4.2 K-P,K PI PI       12/79
W           180.       10.         ETKIN     80 MPS   0 6 K-P,K0 PI+ PI-      1/82*
W           195.       25.         DAUM      81 CNTR -  63 K-P,K 2PI P        1/82*
W          . . . . . . . . . .
W   AVG     187.1       9.3    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W     E   [illegible]   E ABOVE.

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                 64  Q2(1400) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     Q2(1400) INTO K*(892) PI                           891+ 139
P2     Q2(1400) INTO K RHO                                497+ 769
P3     Q2(1400) INTO K PI                                 497+ 139
P4     Q2(1400) INTO K ETA                                497+ 548
P5     Q2(1400) INTO K OMEGA                              497+ 782
P6     Q2(1400) INTO K PI PI                              497+ 139+ 139
P7     Q2(1400) INTO KAPPA PI                            1350+ 139
P8     Q2(1400) INTO K EPSILON                            497+1300

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                 64  Q2(1400) PARTIAL WIDTHS (MEV)

W1     Q2 INTO K RHO                                (G2)
W1          2.0        1.0        CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78

W2     Q2 INTO K* PI                                (G1)
W2        117.0       10.0        CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78

W3     Q2 INTO K OMEGA                              (G5)
W3         23.0       12.0        CARNEGIE1 77 ASPK +- 13 K+-P,(KPIPI)P 12/78

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                 64  Q2(1400) BRANCHING RATIOS

R1     Q2 INTO K* PI                                      (P1)
R1  F        0.94       0.06          DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R2     Q2 INTO K RHO                                      (P2)
R2  F        0.03       0.03          DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R3     Q2 INTO K OMEGA                                    (P5)
R3  F        0.01       0.01          DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R4     Q2 INTO KAPPA PI                                   (P7)
R4  F        (0.00) APPROX.           DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R5     Q2 INTO K EPSILON                                  (P8)
R5  F        0.02       0.02          DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R9     D/S RATIO FOR QM INTO K*(892) PI
R9  F        0.04       0.01          DAUM      81 CNTR    63 K-P,K 2PI P    1/82*

R   F    AVERAGE FROM LOW AND HIGH T DATA.

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                       REFERENCES FOR Q2(1400)

ARMENTER 64 DUBNA CONF 1 577       ARMENTEROS,EDWARDS,D-ANDLAU +    (CERN+CDEF)
   ALSO  64 DUBNA CONF 1 617       R ARMENTEROS (RAPPORTEUR)
ARMENTER 64 PL 9 207               ARMENTEROS,EDWARDS,D-ANDLAU,+    (CERN+CDEF)
   ALSO  66 PR  145  1095          BARASH,KIRSCH,MILLER,TAN          (COLUMBIA)

ALMEIDA   65 PL 16 184             ALMEIDA,ATHERTON,BYER,DORNAN,FORSON+ (CAVE)

SHEN      66 PRL  17  726          +BUTTERWORTH,FU,GOLDHABERS,TRILLING  (LRL)
   ALSO  66  (PRIVATE COMMUNIGERSON GOLDHABER                          (LRL)

BASSOMPI 67 PL 26B 30              BASSOMPIERRE,GOLDSCHMIDT+ (CERN+BRUX+BIRM+ILP
BERLINGH 67 PRL 18 1087            BERLINGHIERI+FARBER+FERBEL+FORMAN   (ROCH+IJP
CRENNELL 67 PRL 19  44             +KALBFLEISCH,LAI,SCARR,SCHUMANN         (BNL)
DE BAERE 67 NC 49A 374             +DEBAISIEUX+FAST+FILIPPAS+       (CERN+BRUX)
   ALSO  PRIVATE COMMUNICATION BY B. JONGEJANS
GOLDHABER 67 PRL 19 976            G.GOLDHABER                             (LBL)

BARTSCH   68 NP B8 9               +COCCONI,+          (AACH+BERL+CERN+LOIC+VIE+
BOESE     68 PRL 20 1519           +BORENSTEIN,CALLAHAN,COLE,COX,+ (JOHNHOPK) 1+
DENEGRI   68 PRL 20 1194           +CALLAHAN+ETTLINGER+GILLESPIE+   (JOHNHOPK) 1+

ALEXANDE 69 NP B 13 503            G.ALEXANDER,FIRESTONE,GOLDHABER,+       (LRL)
ANDREWS   69 PRL 22 731            +LACH,LUDLAM,SANDWEISS,BERGER,+   (YALE+ANL)
ASTIER    69 NP B 10 65            +MARECHAL,MONTANET,+ (CDEF+CERN+IPNP+LIVP)JP
BARBARO   69 PRL 22 1207           BARBARO-GALTIERI,DAVIS,FLATTE,+         (LRL)
BETTINI   69 NC 62 A 1038          +CRESTI,LIMENTANI,BERTAUZA,BIGI+(PADO+PISA)I
BISHOP    69 NP B 9 403            +GOSHAW,ERWIN,WALKER                   (WISC)
CHIEN     69 PL 29B 433            +MALAMUD,MELLEMA,RUDNICK,SCHLEIN+      (UCLA)
CHUNG     69 PR 182 1443           +EISNER+BALI+LUERS                      (BNL)
COLLEY    69 NC A 59 519           +EASTWOOD,+  (BIRM+GLAS+LOIL+MPIM+OXF+RHEL)
ERWIN     69 NP B 9 364            +WALKER,GOSHAW,WEINBERG     (WISC+PRIN+VAND)
FRIEDMAN 69  UCRL-19860            J.FRIEDMAN, PH.D. THESIS                (LRL)
WERNER    69 PR 188 2023           +AMMAR,DAVIS,KROPAC,YARGER,CHO,+ (NWES+ANL) 1+

ABRAMS    70 PR D 1 2433           +EISENSTEIN,KIM,MARSHALL,O-HALLORAN,+ (ILL)
ANTICH    70 NP B 20 201           +CARSON,CHIEN,COX,DENEGRI,ETTLINGER,+ (JHU)  1+
BOWLER    70 PL 31 B 318           M.G.BOWLER                            (OXFORD)
FARBER    70 PR D 1 78             +FERBEL,SL    FRY,YUTA                  (ROCH)  1+

BARNHAM   71 NP B25 49             +COLLEY,GRIFFITHS,ALPER, +   (BIRM+GLA.+OXF)
DENEGRI   71 NP B 28 13            +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+    (JHU)  1+
FORMAN    71 PR D 3 2610           +GELFAND,LEARY,MOSER,SEIDL,WOLFSON      (EFI)
GARFINKE 71 PRL 26 1505            GARFINKEL,HOLLAND,CARMONY,LANDER+(PURD+UCD)  1+

ANDERSON 72 PR D 6 1823            +FRANKLIN,GODDEN,KOPELMAN,LIBBY,TAN   (COLO)
BINGHAM   72 NP B 48 589           +EISENSTEIN,GRARD,HERQUET,+        (CERN+BRUX)
BRANDENB 72 NP B 45 397            BRANDENBURG,BRODY,JOHNSON,LEITH,LOOS+(SLAC)
BRANDENB 72 PRL 28 932             BRANDENBURG,JOHNSON,LEITH,LOOS,LUSTE+(SLAC)
CRENNELL 72 PR D 6 1220            +GORDON,KWAN-WU LAI,SCARR               (BNL)
DAVIS     72 PR D 5 2688           +ALSTON,BARBARO,FLATTE,FRIEDMAN,LYNCH+(LBL)
FIRESTON 72 PR D 5 505             FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)
FIRESTON1 72 NP B 47 348           A.FIRESTONE                             (CIT)
FRATI     72 PR D 6 2361           +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
HAATUFT   72 N  B 48 77            +ARNOLD,HAGUENAUER,+    (BERG+STRB+EPOL+MADR)

BARLOUTA 73 NP B 59 374            +DREVILLON,SHAH,+          (SACL+EPOL+RHEL)  JP
BINGHAM   73 NP B 52 31            +FARWEL,+      (LBL+ORSAY+BNL+SACLAY+MILAN)  JP
DE JONGH 73 NP B 58 110            +CORNET,CHARRIERE,+      (BRUX+MONS+CERN+MPIM)
JONES     73 NP B 52 383           G.T.JONES                              (CERN)  JP
LEWIS     73 NP B 60 283           +ALLEN,JACOBS,DANYSZ,BORG,+(LOWC+LOIC+CDEF)
WERNER    73 PR D 7 1275           +SLATTERY,FERBEL                  (ROCHESTER)

ANGELOPO 74 NC 20A 49              ANGELOPOULOS,FILIPPAS+(ATHU+ATEN+LIVP+VIEN)  JP
BOWLER    74 NP B74 493            +DAINTON,KADDOURA,AITCHISON              (OXF)
DAVIDSON 74 PR D9 77               +CHAPMAN,GREEN,LYS,ROE                 (MICH)
DEUTSCHM 74 PL 49B 399             DEUTSCHMANN,+      (AACH+BERL+CERN+LOIC+VIEN)  JP

ANTIPOV   75 NP B86 381            +ASCOLI,BUSNELLO,KIENZLE+    (SERP+CERN+ILL)  JP
BOWLER    75 NP B97 227            +GAME,AITCHISON,DAINTON             (OXF+DARE)
DORE      75 LNC 13 285            +GUIDONI,LAAKSO,MARINI,CONFORTO+(ROMA+RHEL)
DREVILLO 75 PL 5- B 245            DREVILLON,BORENSTEIN+        (EPOL+ROMR+CDEF)  JP
DUNWOODI 75 NP B91 199             DUNWOODIE,GRANT+       (CERN+BELG+MONS+MPIM)  JP
OTTER1    75 NP B84 333            + (AACH-BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)  JP
OTTER2    75 NP B93 365            +RUDOLPH,RUMPF+    (AACH+BERL+CERN+LOIC+VIEN)  JP
OTTER3    75 NP B96 29             +RUDOLPH,SEYFERT+(AACH+BERL+CERN+LOIC+VIEN)I,JP
TOVEY     75 NP B95 109            +HANSEN,BORENSTEIN,BORG+    (RHEL+EPOL+SACL)I,JP

BASDEVAN 76 PRL 37 977             BASDEVANT,BERGER                    (FNAL+ANL)
BOAL      76 PR D 14 2998          +EDWARDS,KAMAL,TORGESON              (ALBERTA)
BOWLER    76 JPG 3 775             M.G.BOWLER                            (OXFORD)
BRANDENB 76 PRL 26 703             BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP
OTTER     76 NP B 106 77           + (AACH+BERL+CERN+LOIC+VIEN+LPNP+RHEL+SACL)  JP
VERGEEST 76 PL 62 B 471            +ENGELEN,JONGEJANS,+    (AMST+CERN+NIJM+OXF)  JP

CARNEGIE 77 NP B 127 509           +CASHMORE,DAVIER,DUNWOODIE,LASINSKI+ (SLAC)
CARNEGIE1 77 PL B 68 287           +CASHMORE,DUNWOODIE,LASINSKI,+        (SLAC)

BEUSCH    78 PL 74 B 282           +BIRMAN,KONIGS,OTTER,+        (CERN+AACH .THI  JP
GAVILLET 78 PL 76 B 517            +DIAZ,DIONISI,+         (AMST+CERN+NIJM+OXF)  JP
WOHL      78 NP B 132 401          +PALER,CHAURAND,+        (LPNP+RHEL+SACLAY)

BASDEVAN 79 PR D 19 246            BASDEVANT,BERGER                        (ANL)
MAZZUCAT 79 NP B 156 532           MAZZUCATO,PENNINGTON+   (CERN+ZEEM+NIJM+OXF)
VERGEEST 79 NP B 158 265           +JONGEJANS,DIONISI,+    (NIJM+AMST+CERN+OXF)

BACON     80 NP B 162 189          +FARNEY,BUTTERWORTH,ASCORGE,+      (LOIC+CAVE)
DIONISI   80 NP B 169 1            +GAVILLET,ARMENTEROS+ (CERN+MADR+CDEF+STOH)
ETKIN     80 PR D 22 42            +FOLEY,LINDENBAUM,KRAMER,+         (BNL+CUNY)  JP
IRVING    80 JPG 6 159             A.C.IRVING                             (LIVP)
RADFORD   80 NP B 167 181          RADFORD,BRANDENBURG                    (MIT)
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DAUM      81 NP B 187 1        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
OTTER     81 NP B 181 1          (AACH+BERL+LOIC+VIEN+BIRM+BELG+CERN+MONS)
RODEBACK  81 ZPHY C 9 9        +SJOGREN,ARMENTERDS,+ (CERN+CDEF+MADR+STOH)
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K'(1400)

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21  K PRIME(1400,JP=0-) I=1/2

OBSERVED IN K PI PI PARTIAL-WAVE ANALYSIS.
NOT SEEN BY VERGEEST 79.
WAIT CONFIRMATION. OMITTED FROM TABLE.

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                  21  K PRIME MASS (MEV)

M  A      (1400.)  APPROX.      BRANDENBU 76 ASPK +- 13 K+-P,KPIP(   12/77
M         (1460.)  APPROX.      DAUM      81 CNTR -  63 K-P,K 2PI P   1/82*

M  A      COUPLED MAINLY TO K EPSILON. DECAY INTO K*(892) PI SEEN.
M

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                  21  K PRIME WIDTH (MEV)

W  A      (250.)   APPROX.      BRANDENBU 76 ASPK +- 13 K+-P,KPIPI   12/77
W         (260.)   APPROX.      DAUM      81 CNTR -  63 K-P,K 2PI P   1/82*

W  A      COUPLED MAINLY TO K EPSILON. DECAY INTO K*(892) PI SEEN.

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                  21  K PRIME PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     K PRIME INTO K*(892) PI                         891+ 139
P2     K PRIME INTO K RHO                              493+ 769
P3     K PRIME INTO KAPPA PI                          1350+ 139

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                  21  K PRIME PARTIAL WIDTHS (MEV)

W1     K PRIME INTO K*(892) PI                      (G1)
W1         (109.)  APPROX.      DAUM      81 CNTR    63 K-P,K 2PI P   1/82*

W2     K PRIME INTO K RHO                           (G2)
W2          (34.)  APPROX.      DAUM      81 CNTR    63 K-P,K 2PI P   1/82*

W3     K PRIME INTO KAPPA PI                        (G3)
W3         (117.)  APPROX.      DAUM      81 CNTR    63 K-P,K 2PI P   1/82*

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REFERENCES FOR K PRIME


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BRANDENB 76 PRL 36 1239       BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)  JP

VERGEEST 79 NP B 158 265      +JONGEJANS,DIONISI,+    (NIJM+AMST+CERN+OXF)

DAUM     81 NP B 187 1        +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
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K*(1430)

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22 . K*(1430,JP=2+) I=1/2

WE CONSIDER THAT PHASE-SHIFT ANALYSES PROVIDE MORE
RELIABLE DETERMINATIONS OF THE MASS AND WIDTH.
SEE RHO(770) MINI-REVIEW.

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                  22  K*(1430) MASS (MEV)

M   CHARGED ONLY, WITH FINAL STATE K PI
M    D  39 1423.      11.0         BASSANO    67 HBC  - 4.6-5.0K-P,KOPI- 12/75
M    D  63 1427.0     12.0         SCHWEINGR  66 HBC  -  5.5 K- P (K PI) 12/77
M      220 1416.0     10.0         CRENNELL   69 DBC  -  3.9 K-N (KOPI-)  7/69
M    D  60 1414.      13.0         LIND       69 HBC  +   9. K+ PIKO PI+) 12/77
M     1400 1420.0      3.1         AGUILAR1   71 HBC  -  3.9,4.6 K- P    11/71
M  W D 225 1425.       8.0         BARNHAM    71 HBC  +  K+ P,KO PI+ P   12/75
M    B     1428.0      4.6         MARTIN     78 SPEC + 10 K+-P,KS PI P H
M    B     1423.8      4.6         MARTIN     78 SPEC - 10 K+-P,KS PI P H
M    D 579(1448.5)    (5.0)        DELFOSSE   81 SPEC +  K+-P,K+- PI0 P   1/82*
M    D 292(1431.8)    (5.6)        DELFOSSE   81 SPEC -  K+-P,K+- PI0 P   1/82*
M      935 1423.0      5.0         TOAFF      81 HBC  -  6.5 K-P,KO PI- P 1/82*
M           . . . . . . . . . . .
M   AVG    1422.6      1.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M   NEUTRAL ONLY
M     2200 1421.1      2.6         DAVIS      69 HBC   0 12. K+ P(K+PI-)  9/69
M     1800 1419.1      3.7         AGUILAR1   71 HBC   0 3.9,4.6 K- P    11/71
M      600 1416.       6.          CORDS      71 DBC  0 9. K+ N,K+ PI- P  2/72
M     1100 1427.       3.          BUCHNER    72 DBC  0 4.6 K+ N,K+ PI-P 12/72
M   C      1420.1      4.3         LINGLIN    73 HBC  0 2-13 K+P,K+PI-   12/75
M      800 1421.6      4.2         MCCUBBIN   75 HBC   0 3.6 K-P,K-PI+N  12/75
M  E      (1423.0)    (3.0)        ETKIN      76 SPEC  06.K-P,KO PI+PI-   7/77
M      300 1420.0      7.0         HENDRICKX  76 DBC    8.25 K+N,K+PI     7/77
M  P       1440.0     10.0         BOWLER     77 DBC  0 5.5 K+D,K PI P P 12/77
M  P       1434.0      2.0         ESTABROOK  78 ASPK  0 13K+-P,P K PI   12/77
M          1450.      30.          ETKIN      80 SPEC  0 6.K-P,KO PI+PI-N 3/82*
M          1428.       3.          ASTON      81 LASS  0 11 K-P,K- PI+ N  1/82*
M           . . . . . . . . . . .
M   AVG    1426.4      2.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
                             (SEE IDEOGRAM BELOW )

M    B  SYSTEMATIC ERROR ADDED BY US.
M    C  FROM POLE EXTRAPOLATION, USING WORLD K+P DST
M    D  ERRORS ENLARGED BY US TO   GAMMA/SORT(N). SEE TYPED NOTE ON K*
M   E   SEE MORE RECENT PARTIAL WAVE ANALYSIS (ETKIN 80)
M  P    FROM PHASE SHIFT ANALYSIS.
M  W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US
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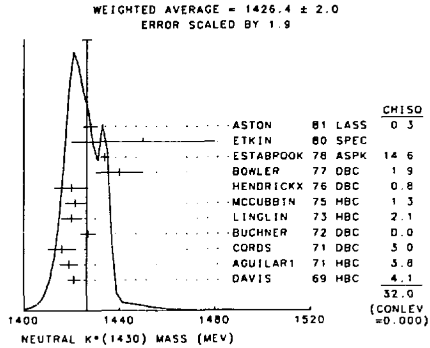


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                  22  K*(1430) WIDTH (MEV)

W   CHARGED ONLY, WITH FINAL STATE K PI
W     1400   94.7     15.1     12.5  AGUILAR1  71 HBC  -  3.9,4.6 K- P    11/71
W            96.5      3.8           MARTIN    78 SPEC + 10 K+-P,KS PI P  12/78
W            97.7      4.0           MARTIN    78 SPEC - 10 K+-P,KS PI P  12/78
W    0 579  118.9     20.0           DELFOSSE  81 SPEC +  K+-P,K+- PI0 P   1/82*
W    0 292   96.0     22.5           DELFOSSE  81 SPEC -  K+-P,K+- PI0 P   1/82*
W      935   85.0     16.0           TOAFF     81 HBC  -  6.5 K-P,KO PI- P 1/82*
W            . . . . . . . . . . .
W   AVG      97.0      2.6     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   NEUTRAL ONLY
W     2200  101.      10.            DAVIS     69 HBC   0 12. K+ P (K PI)  9/69
W     1800  116.6     10.3     15.5  AGUILAR1  71 HBC   0 3.9,4.6 K- P     1/71
W    01100  109.      14.0           BUCHNER   72 DBC  0 4.6 K+ N,K+ PI-P  2/75
W   C      (61.0)    (14.0)          LINGLIN   73 HBC  0 2-13 K+P,K+PI-    1/74
W      800  116.      18.            MCCUBBIN  75 HBC   0 3.6 K-P,K-PI+N  12/75
W  P      (170.0)    (20.0)          BOWLER    77 DBC  0 5.5 K+D,K PI P P 12/77
W  P         98.0      5.0           ESTABROOK 78 ASPK  0 13K+-P,P K PI   12/77
W  P        140.      30.            ETKIN     80 SPEC  0 6.K-P,KO PI+PI-N  /82*
W            98.       8.            ASTON     81 LASS  0 11 K-P,K- PI+ N   /82*
W            . . . . . . . . . . .
W   AVG     101.7      3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W   C   FROM POLE EXTRAPOLATION, USING WORLD K+P DST
W    O  ERRORS ENLARGED BY US TO 4*GAMMA/SORT(N). SEE K* TYPED NOTE.
W  P    FROM PHASE SHIFT ANALYSIS.
W  W    NUMBER OF EVENTS IN PEAK REEVALUATED BY US

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                  22  K*(1430) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     K*(1430) INTO K PI                              493+ 139
P2     K*(1430) INTO K*(892) PI                        891+ 139
P3     K*(1430) INTO K RHO                             493+ 769
P4     K*(1430) INTO K OMEGA                           493+ 782
P5     K*(1430) INTO K ETA                             493+ 548
P6     K*(1430) INTO K*(892) PI PI                     891+ 139+ 139
P7     K*(1430) INTO K OMEGA PI                        493+ 782+ 139

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1         P 2         P 3         P 4         P 5         P 6
P 1  .4479+-.0226
P 2   .0842   .2458+-.0701
P 3  -.0109     .4180   .0879+-.0108
P 4  -.1587    -.2389    -.1755  .0415+-.0152
P 5  -.4414    -.4415    -.3130    -.0918  .0470+-.0266
P 6  -.3913    -.4361    -.3126    -.0987    -.1155  .1299+-.0255

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                  22  K*(1430) BRANCHING RATIOS

R1      K*(1430) INTO (K PI)/TOTAL                       (P1)
R1 P           0.49       0.02        ESTABROOK 78 ASPK +- 13K+-P,P K PI    12/77
R1 P           0.43       0.01        ASTON     81 LASS  0 11 K-P,K- PI+ N   1/82*
R1 P     FROM PHASE SHIFTS ANALYSIS.
R1             . . . . . . . . . . .
R1  AVG        0.442      0.024   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.7)
R1  FIT        0.448      0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.7)

R2      K*(1430) INTO (K*(892) PI)/(K PI + K PI PI)      (P2)/(P1+P2+P3)
R2  QR        (0.45)     (0.13)       BADIER    65 HBC  -  3.0 K-P            1/78
R2  Q         (0.47)     (0.10)       BASSANO   67 HBC  -0 4.6, 5.0 K- P     10/67
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R3     K*(1430) INTO (K RHO)/(K PI + K PI PI)                    (P3)/(P1+P2+P3)
R3  DR        (0.14)    (0.07)             BADIER     65 HBC   -  3.0 K-P             1/78
R3  Q         (0.14)    (0.10)             BASSANO    67 HBC   -0 4.6, 5.0 K- P     10/67

R4     K*(1430) INTO (K*(892) PI) / (K PI)                       (P2)/(P1)
R4             0.65      0.20              SHEN       66 HBC     0  N* PRODUCED     10/66
R4  D         (0.63)    (0.20)             SHEN       66 HBC   +    NO N* PRODUCED 10/66
R4             0.52      0.12              SCHWEINGR  68 HBC     0 4.1+5.5 K- P     10/67
R4  Q    84   (0.93)    (0.11)             BISHOP     69 HBC       3.5 K+ P          9/69
R4             0.47      0.08              AGUILAR1   71 HBC       3.9,4.6 K- P     11/71
R4 AQ   150   (0.65)    (0.25)             ANTIPOV    75 ASPK  - 40 K-P,K+- P       12/75
R4             0.54      0.16              DEHM       74 DBC   0 4.6 K+ N           12/75
R4             0.62      0.19              LAUSCHER   75 HBC    010,16 K-P,K-PI+N  12/75
R4 A    K* PI SIGNAL FROM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R4            . . . . . . . . . . .
R4  AVG        0.517     0.056   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  FIT        0.549     0.051  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R5     K*(1430) INTO (K OMEGA) / K PI                            (P4)/(P1)
R5   R         0.19      0.16              BADIER     65 HBC   -  3.0 K-P             1/78
R5            (0.08) OR LESS               SHEN       66 HBC      4.6 K+P            8/66
R5            (0.2)  OR LESS               BASSOMPIE  69 HBC   +   5 K+ P            9/69
R5             0.13      0.07              BASSOMPIE  69 HBC    0 5 K+ P             9/69
R5             0.05      0.04              AGUILAR1   71 HBC      3.9-4.6 K- P      11/71
R5            (0.2)  OR LESS   CL=.95      CHUNG      74 HBC   - 7.3 K-P,K+- P      12/75
R5            . . . . . . . . . . .
R5  AVG        0.075     0.034   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R5  FIT        0.093     0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R6     K*(1430) INTO (K RHO) / (K PI)                            (P3)/(P1)
R6            (0.09) OR LESS               CHUNG      65 HBC   + 0  3.9-4.2 PI- P    8/66
R6             0.26      0.16              SCHWEINGR  68 HBC     0 4.1+5.5 K- P     10/67
R6            (0.2)  OR LESS               BASSOMPIE  69 HBC   +   5 K+ P            9/69
R6            (0.3)  OR LESS               BASSOMPIE  69 HBC    0 5 K+ P             9/69
R6  Q    15   (0.11)    (0.06)             BISHOP     69 HBC      3.5 K+ P           9/69
R6             0.16      0.05              AGUILAR1   71 HBC      3.9,4.6 K- P      11/71
R6             0.02      0.10     0.02     DEHM       74 DBC   0 4.6 K+ N           12/75
R6  S         (0.24)    (0.14)             LAUSCHER   75 HBC    010,16 K-P,K-PI+N  12/75
R6  S   USES RESULTS OF OTTER 75 (SEE R7 BELOW). WE DO NOT AVERAGE THIS
R6  S   STATISTICALLY REDUNDANT RATIO, BUT KEEP THE LAUSCHER 75 RESULT
R6  S   FOR R4 ABOVE.
R6            . . . . . . . . . . .
R6  AVG        0.111     0.054   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
R6  FIT        0.196     0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.4)

R7     K*(1430) INTO (K RHO) / (K*(892) PI)                      (P3)/(P2)
R7            (0.39) OR LESS               BASSOMPIE  67 HBC   +   5. K+ P           9/67
R7            (0.40) OR LESS   CL=.90      FIELD      67 HBC   - 3.8 K- P            6/67
R7 P    130    0.13      0.09              OTTER      75 HBC    08,10,16 K-P,K* N  12/75
R7 AN         (0.03)    (0.03)             ANTIPOV    75 ASPK  - 40 K-P,K*- P       12/75
R7 P           0.36      0.10              VERGEEST   76 HBC   0 4.2 K-P,P K0PIPI  12/77
R7 P          (0.33) APPROX.               ETKIN      80 SPEC  0 6.K-P,K0 PI+PI-N   3/82*
R7             0.39      0.03              DAUM       81 CNTR    63 K-P,K 2PI P      1/82*
R7  N   K RHO MODE NOT OBSERVED
R7 A    FROM PARTIAL WAVE ANALYSIS OF (K-PI+PI-) SYSTEM
R7 P    FROM PARTIAL WAVE ANALYSIS OF (K0 PI+ PI-) SYSTEM
R7            . . . . . . . . . . .
R7  AVG        0.364     0.053   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
R7  FIT        0.358     0.041  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R8     K*(1430) INTO (K OMEGA) / (K*(892) PI)                    (P4)/(P2)
R8  Q         (0.10)    (0.04)             FIELD      67 HBC   - 3.8 K- P            6/67

R9     K*(1430) INTO (K ETA) / (K*(892) PI)                      (P5)/(P2)
R9  Q         (0.07)    (0.04)             FIELD      67 HBC   - 3.8 K- P            6/67

R10    K*(1430) INTO (K ETA) / (K PI)                            (P5)/(P1)
R10  R         0.05      0.06              BADIER     65 HBC   -  3.0 K-P             1/78
R10  R        (0.065)OR LESS               BASSOMPIE  69 HBC      5.0 K+P            1/78
R10           (0.02) OR LESS               BISHOP     69 HBC      3.5 K+ P           9/69
R10           (0.04) OR LESS   CL=.95      AGUILAR1   71 HBC      3.9-4.6 K- P      11/71
R10           . . . . . . . . . . .
R10 FIT        0.105     0.062  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R11    K*(1430) INTO (K*(892) PI PI)/TOTAL                       (P6)
R11T           0.12      0.04              GOLDBERG   76 HBC   -  3 K-P,P K0PIPIPI 12/77
R11           . . . . . . . . . . .
R11 FIT        0.130     0.026  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R12    K*(1430) INTO (K*(892) PI PI)/(K PI)                      (P6)/(P1)
R12T R         0.21      0.08              JONGEJANS  78 HBC   -  4K-P,P K0OPIPIPI  4/78
R12           . . . . . . . . . . .
R12 FIT        0.290     0.064  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R13    K*(1430) INTO (K OMEGA PI)/TOTAL  (UNITS 10**-3) (PT)
R13        0   (0.72) OR LESS  CL=0.95  JONGEJANS 78 HBC      4 K-P,P K0 4PI     4/78

R   Q   FOLLOWING SUGGESTION BY AGUILAR 70, WE DO NOT MAKE USE OF MEASURE-
R   Q   MENTS WHERE THE (K PI PI) BACKGROUND SUBTRACTION IS DIFFICULT DUE
R   Q   TO THE NEARBY Q REGION.
R    R  RESTATED BY US.
R   T   ASSUMING PI PI SYSTEM HAS ISO-SPIN 1, WHICH IS SUPPORTED BY
R   T   THE DATA

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REFERENCES FOR K*(1430)


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BADIER    65 PL 19 612          BADIER,DEMOULIN,GOLDBERG+   (EPOL+SACL+AMST)
CHUNG     65 PRL 15 325         +DAHL,HARDY,HESS,JACOBS,KIRZ,MILLER     (LRL)
FOCARDI   65 PL 16 351          FOCARDI,MINGUZZI RANZI,SERRA+(BOLOGNA+SACL)

SHEN      66 PRL  17  726       +BUTTERWORTH,FU,GOLDHABERS,TRILLING     (LRL)
   ALSO 66  (PRIVATE COMMUN)GERSON GOLDHABER                            (LRL)

BASSANO   67 PRL  19  968       +GOLDBERG,GOZ,BARNES,LEITNER+(BNL+SYRACUSE)
BASSOMPI  67 PL 26B 30          BASSOMPIERRE,GOLDSCHMIDT+  (CERN+BRUX+BIRM)JP
CRENNELL  67 PRL 19  44         +KALBFLEISCH,LAI,SCARR,SCHUMANN        (BNL)
DAHL      67 PR 163 1377        +HARDY+HESS+KIRZ+MILLER                (LRL)
   ALSO 65 PRL 14 401           HARDY,CHUNG,DAHL,HESS,KIRZ,MILLER      (LRL)
DE BAERE  67 NC 51 A 401        +GOLDSCHMIDT-CLERMONT,HENRI+      (BRUX+CERN)
FIELD     67 PL 24B 638         +HENDRICKS+PICCIONI+YAGER          (LAJOLLA)
GOLDHABE  67 PRL 19  972        G.GOLDHABER,FIRESTONE,SHEN             (LRL)

ADERHOLZ  68 NP B 5  567        +DEUTSCHMANN+  (AACH+BERL+CERN+LOIC+VIENNA)
   ALSO 66 PL 22 357            BARTSCH,DEUTSCHMANN,MORRISON+   (ABCLV)CIV)
ANTICH    68 PRL 21 1842        +CALLAHAN,CARSON,COX,DENEGRI,+          (JHU)
DUBAL     68 THESIS   1456      L.DUBAL                              (GENEVE)
KANG      68 PR 176 1587        Y.W.KANG                               (IOWA)
SCHWEING  68 PR 166 1317        SCHWEINGRUBER,DERRICK,FIELDS+     (ANL+NWES)
   ALSO 67  THESIS              F.L.SCHWEINGRUBER (NORTHWESTERN,EVANSTON)

BASSOMPI  69 NP  B13 189        BASSOMPIERE,GOLDSCHMIDT-CLERM.+ (CERN+BRUX) JP
BISHOP    69 NP B 9 403         +GOSHAW,ERWIN,WALKER                   (WISC)
CRENNELL  69 PRL 22  487        +KARSHON,LAI,ONEALL,SCARR               (BNL)
DAVIS     69 PRL 23 1071        +DERENZO,FLATTE,ALSTON,LYNCH,SOLMITZ  (LRL)
DE BAERE  69 NC 61 A 397        +GOLDSCHMIDT-CLERMONT,HENRI,+   (BELG+CERN)
FRIEDMAN  69  UCRL-18860        J.FRIEDMAN,PH.D. THESIS                 (LRL)
LIND      69 NP B 14 1          +ALEXANDER,FIRESTONE,FU,GOLDHABER      (LRL) JP

ABRAMS    70 PR D 1 2433        +EISENSTEIN,KIM,MARSHALL,O.HALLORAN,+ (ILL)
AGUILAR   70 PRL 25 1362        AGUILAR-BENITEZ,BASSANO,EISNER,+ (BNL+PUR?)

AGUILAR1  71 PR D 4 2583        +EISNER,KINSON                          (B?
BARNHAM   71 NP B 28 171        +COLLEY,JOBES,GRIFFITHS,HUGHES,+(BIRM+GLA
CORDS     71 PR D 4 1974        +CARMONY,ERWIN,MEIERE,+         (PURD+UCD+IUP

BUCHNER   72 NP B 45 333        +DEHN,CHARRIERE,CORNET,+    (MPIM+CERN+BRUX
CRENNELL  72 PR D 6 1220        +GORDON,KWAN-WU LAI,SCARR               (BNL)
DEUTSCHM  72 NP B 36 373        DEUTSCHMANN,+          (ABCLV COLLABORATION)
ENGELMAN  72 PR D 5 2162        ENGELMANN,MUSGRAVE,FORMAN,+        (ANL+EFI)
FRATI     72 PR D 6 2361        +HALPERN,HARGIS,SNAPE,CARNAHAN,+(PENN+CINC)
ROUGE     72 NP B 46 29         +VIDEAU,VOLTE,DE BRION,+        (EPOL+SACL)
TIECKE    72 NP B 39 596        +GRIJNS,HEINEN,DE GROOT,+       (NIJM+AMST)

CHARRIER  73 NP B 51 317        CHARRIERE,ORIJARD,DE BAERE,+    (CERN+BELG)
   ALSO 75  (PRIVATE COMMUNICATION) GOLDSCHMIDT-CLERMONT             (CERN)
CLARK     73 NP B 54 432        +LYONS,RADOJICIC                     (OXFORD)
DE JONGH  73 NP B 58 110        +CORNET,CHARRIERE,+    (BRUX+MONS+CERN+MPIM)
LINGLIN   73 NP B 55 408        D.LINGLIN                              (CERN)
MALUCH    73 PR D 8 2637        +FLATTE,FRIEDMAN                        (LBL)

CHUNG     74 PL 51B 413         +EISNER,PROTOPOPESCU,SAMIOS,STRAND      (BNL)
DEHM      74 NP B75 47          +GOEBEL,WITTEK,WOLF,+ (MPIM+BRUX+MONS+CERN)

ANTIPOV   75 NP B86 381         +ASCOLI,BUSNELLO,KIENZLE+     (SERP+CERN+ILL)
LAUSCHER  75 NP B86 189         +OTTER,WIECZOREK,+     (ABCLV COLLABORATION)  JP
MCCUBBIN  75 NP B86 13          N.A.MCCUBBIN,L.LYONS                    (OXF)
OTTER     75 NP B84 333         + (AACH+BERL+CERN+LOIC+VIEN+ATHU+ATEN+LIVP)

ETKIN     76 PRL 36 1482        +FOLEY,GOLDMAN,LINDENBAUM,KIM,+  (BNL+CUNY)
GOLDBERG  76 LNC 17 253         J.GOLDBERG                            (HAIFA)
HENDRICK  76 NP B 112 189       +VIGNAUD,BURLAUD,+      (MONS+SACL+LPNP+BELG)
KIRK      76 NP B 116 99        +KLEIN,COUNIHAN,+(AACH+BERL+CERN+LOIC+WIEN)
VERGEEST  76 PL 62 B 471        +ENGELEN,JONGEJANS,+    (AMST+CERN+NIJM+OXF)  JP

BOWLER    77 NP B 126  31       +DAINTON,DRAKE,WILLIAMS               (OXFORD)

BALDI     78 NP B 134 365       +BOHRINGER,DORSAZ,HUNGERBUHLER+        (GEVA)
BOHM      78 PRL 41 1761        +VAN DALEN,+ (AACH,UCR+CERN+HARV+MUNI+NWES)
ENGELEN   78 NP B 134 14        +JONGEJANS,HEMINGWAY,+ (NIJM+ZEEM+CERN+OXF)
ESTABROO  78 NP B 133 490       ESTABROOKS,CARNEGIE,+ (MONT+CARL+DURH+SLAC)
   ALSO 78 PR D 17 658          ESTABROOKS,CARNEGIE+  (MONT+CARL+DURH+SLAC)
JONGEJAN  78 NP B 139 383       JONGEJANS,CERRADA,+    (ZEEM+CERN+NIJM+OXF)
MARTIN    78 NP B 134 392       +SHIMADA,BALDI,BOHRINGER,DORSAZ+(DURH+GEVA)

ETKIN     80 PR D 22 42         +FOLEY,LINDENBAUM,KRAMER,+       (BNL+CUNY)  JP

ASTON     81 PL 106 B 235       +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)  JP
DAUM      81 NP B 187 1         +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
DELFOSSE  81 NP B 183 349       +GUISAN,MARTIN,MUHLEMANN,WEILL,+(GEVA+LAUS)
TOAFF     81 PR D 23 1500       +MUSGRAVE,AMMAR,DAVIS,ECKLUND,+  (ANL+KANS)

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L(1580)

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39  L(1580,JP=2-) I=1/2

SEEN IN PARTIAL WAVE ANALYSIS OF THE K-PI+PI- SYSTEM
(OTTER 78). SEE L(1770) MINIREVIEW.
NEED CONFIRMATION OMITTED FROM TABLE.

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                    39  L(1580) MASS (MEV)

M        (1580.)   APPROX.          OTTER     79      -  10,14,16 K- P    12/79

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                    39  L(1580) WIDTH (MEV)

W         (110.)   APPROX.          OTTER     79      -  10,14,16 K- P    12/79

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                    39  L(1580) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      L(1580) INTO K*(892) PI                        891+ 139
P2      L(1580) INTO K*(1430) PI                      1434+ 139

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                    39  L(1580) BRANCHING RATIOS

W1      L(1580) INTO K*(892) PI                       (P1)
W1         SEEN                     OTTER     79 HBC  -  10,14,16 K- P    12/79

W2      L(1580) INTO K*(1430) PI                      (P2)
W2         POSSIBLY SEEN            OTTER     79 HBC  -  10,14,16 K- P    12/79

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REFERENCES FOR L(1580)


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OTTER     79 NP B 147 1        +RUDOLPH,+        (AACH+BERL+CERN+LOIC+WIEN)  JP

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K*(1650)

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29  K*(1650,JP=1-) I=1/2

    THIS ENTRY CONTAINS VARIOUS PEAKS OBSERVED IN THE
    1- WAVE OF THE K PI AND K PI PI SYSTEMS.
    WAIT CONFIRMATION.OMITTED FROM TABLE.

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                29  K*(1650) MASS (MEV)

M        (1660.)                  CHARRIERE 73 HBC   0 5. K+ P,K P 3PI   1/73
M        (1650.)   APPROX.        ESTABROOK 78 ASPK  0 13 K+-P,K+-PI+-N 12/78
M         1500.      30.          ETKIN     80 MPS   0 6 K-P,KO PI+ PI-  1/82*
M         1800.      70.          ETKIN     80 MPS   0 6 K-P,KO PI+ PI-  1/82*
M        (1700.)   APPROX.        ASTON     81 LASS  0 11 K-P,K- PI+ N   1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.9)

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                29  K*(1650) WIDTH (MEV)

W         (60.)                   CHARRIERE 73 HBC   0 5. K+ P,K P 3PI   1/73
W         250-300 APPROX.         ESTABROOK 78 ASPK  0 13 K+-P,K+-PI+-N 12/78
W         170.       30.          ETKIN     80 MPS   0 6 K-P,KO PI+ PI-  1/82*
W         500.      100.          ETKIN     80 MPS   0 6 K-P,KO PI+ PI-  1/82*
W        (200.)    APPROX.        ASTON     81 LASS  0 11 K-P,K- PI+ N   1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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                29  K*(1650) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     K*(1650) INTO K PI                            497+ 134
P2     K*(1650) INTO K ETA                           497+ 548

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                29  K*(1650) BRANCHING RATIOS

R1     K*(1650) INTO (K PI)/TOTAL                 (P1)
R1          (0.35) APPROX.        ASTON     81 LASS  0 11 K-P,K- PI+ N   1/82*

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                     REFERENCES FOR K*(1650)

CHARRIER 73 NP B 51 317     CHARRIERE,ORIJARD,DE BAERE,+    (CERN+BELG)

ESTABROO 78 NP B 133 490    ESTABROOKS,CARNEGIE,+ (MCNT+CARL+DURH+SLAC)

ETKIN    80 PR D 22 42      +FOLEY,LINDENBAUM,KRAMER,+         (BNL+CUNY)  JP

ASTON    81 PL 106 B 735    +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)  JP

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L(1770)

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23  L(1770, JP=2-) I = 1/2
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The L(1770) is seen as a bump at a mass ~1.8 GeV in the diffractive-like processes KN → (Kππ)N. The effect is largely dominated by the $J^P=2^-$ partial waves.

The long-standing questions concerning the resonant nature of the enhancement as well as its possible decay modes have been largely clarified since our last edition. A detailed partial-wave analysis based on 200,000 diffractive $K^-p \to K^-\pi^+\pi^-p$ events (DAUM 81) establishes resonance-like phase variations and isolates several decay modes. The behavior of the extracted 2^- waves requires the existence of at least one L meson, but there are indications suggesting the presence of a second state in this mass region.

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                23  L(1770) MASS (MEV)

M           1745.0     20.0            AGUILAR   70 HBC   -  4.6 K- P         6/70
M           1780.0     15.0            BARTSCH   70 HBC   -  10.1 K- P        1/71
M          (1760.0)   (15.0)           LUDLAM    70 HBC   -  12.6 K- P        1/73
M   X       1765.0     40.0            COLLEY    71 HBC   +  10.K+P,K 2PI     1/73
M          (1743.0)                    DENEGRI   71 DBC   - 12.6 K-D,K 2PI D  5/71
M           1767.       6.             BLIEDEN   72 MMS   -  11.-16. K- P    12/72
M   P   306 1730.      20.             FIRESTONE 72 DBC   +  12. K+ D         1/73
M        60 1710.      15.             CHUNG     74 HBC   - 7.3K-P,K-OMEGA P 12/75
M          (1820.)   APPROX.           DAUM      81 CNTR  -  63 K-P,K 2PI P   1/82*
M            . . . . . . . . . .
M   AVG     1758.9     10.0      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.1)

M   P    PRODUCED IN CONJUNCTION WITH D*
M   X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.

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                23  L(1770) WIDTH (MEV)

W           100.0     50.0             AGUILAR   70 HBC   -  4.6 K- P         6/70
W           138.0     40.0             BARTSCH   70 HBC   -  10.1 K- P        1/71
W           (50.0)   (40.0)   (20.0)   LUDLAM    70 HBC   -  12.6 K- P        1/73
W   X        90.      70.              COLLEY    71 HBC   +  10.K+P,K 2PI     1/73
W          (130.0)                     DENEGRI   71 DBC   - 12.6 K-D,K 2PI D  5/71
W           100.      26.              BLIEDEN   72 MMS   -  11.-16. K- P    12/72
W   P   306 210.      30.              FIRESTONE 72 DBC   +  12. K+ D        12/72
W        60 110.      50.              CHUNG     74 HBC   - 7.3K-P,K-OMEGA P 12/75
W          (200.)    APPROX.           DAUM      81 CNTR  -  63 K-P,K 2PI P   1/82*
W            . . . . . . . . . .
W   AVG     135.1     20.9       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

W   P    PRODUCED IN CONJUNCTION WITH D*
W   X    SYSTEMATIC ERRORS ADDED CORRESP. TO SPREAD OF DIFFERENT FITS.

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                23  L(1770) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     L INTO K PI PI                                497+ 134+ 134
P2     L INTO K*(1430) PI                            134+1434
P3     L INTO K PI PI PI                             497+ 134+ 134+ 134
P4     L INTO K*(892) PI                             891+ 134
P5     L INTO K*(892) RHO                            891+ 769
P6     L INTO K*(892) OMEGA                          891+ 782
P7     L INTO K*(892) PI PI                          891+ 134+ 134
P8     L INTO K OMEGA                                497+ 782
P9     L INTO K F                                    497+1273

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                23  L(1770) BRANCHING RATIOS

R1     L INTO (K*(1430) PI) / (K PI PI )                    (P2)/(P1)
R1                 (K*(1430) INTO K PI)
R1          (1.0)                     BARBARO   69 HBC  +  12.0 K+ P      1/71
R1           0.2      0.2             AGUILAR   70 HBC  -  4.6 K- P       1/71
R1          (1.0)  OR  LESS           BARTSCH   70 HBC  -  10.1 K- P      1/71
R1          (1.0)  OR LESS            COLLEY    71 HBC     10. K+ P      11/71
R1  P       (1.0)  APPROX.            FIRESTONE 72 DBC  +  12. K+ D      12/72
R1          (0.6)  APPROX.            DAUM      81 CNTR    63 K-P,K 2PI P 1/82*
R1  P   PRODUCED IN CONJUNCTION WITH D*
R1   R  FOR DISCUSSION OF THE EXPERIMENTAL EVIDENCE ON OTHER DECAY
R1   R  MODES SEE HUGHES 71,SLATTERY 71,EISNER 74.

R2     L INTO (K OMEGA)/TOTAL                              (P8)
R2        SEEN                        CHUNG     74 HBC  -  7.3K-P,K-OMEGAP  1/82*
R2        SEEN                        OTTER     81 HBC  ←  8.25,10,16 K+-P  1/82*

R3     L INTO (K*(892) PI)/(K PI PI)                       (P4)/(P1)
R3          (0.24) APPROX.            DAUM      81 CNTR    63 K-P,K 2PI P   1/82*

R4     L INTO (K F)/(K PI PI)                              (P9)/(P1)
R4                  (F INTO PI PI)
R4          (0.16) APPROX.            DAUM      81 CNTR    63 K-P,K 2PI P   1/82*

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                       REFERENCES FOR L(1770)

BARTSCH  66 PL 22 357        +DEUTSCHMANN,+    (AACH+BERL+CERN+LOIC+VIEN

BERLINGH 67 PRL 18 1087      BERLINGHIERI+FARBER+FERBEL+FORMAN+    (ROCH)
CARMONY  67 PRL  18  615     D.CARMONY,T.HENDRICKS,L.LANDER   (LA JOLLA)
JOBES    67 PL 26B 49        +BASSOMPIERRE,DE BAERE +   (BIRM+CERN+BRUX)

BARTSCH  68 NP B8 9          +COCCONI,+         (AACH+BERL+CERN+LOIC+VIEN)
DENEGRI  68 PRL 20 1194      +CALLAHAN+ETTLINGER+GILLESPIE+            (JHU)

ANDREWS  69 PRL 22 731       +LACH,LUDLAM,SANDWEISS,BERGER,+  (YALE+LRL)
BARBARO  69 PRL 22 1207      BARBARO-GALTIERI,DAVIS,FLATTE,+         (LRL)
COLLEY   69 NC A 59 519      +EASTWOOD,+  (BIRM+GLAS+LOIC+MPIM+OXF+RHEL)

AGUILAR  70 PRL 25 54        AGUILAR-BENITEZ,BARNES,BASSANO,CHUNG,+(BNL)
BARTSCH  70 PL 33 B 186      +DEUTSCHMANN,+    (AACH+BERL+CERN+LOIC+VIEN)
LUDLAM   70 PR D 2 1234      +SANDWEISS,SLAUGHTER                   (YALE)

COLLEY   71 NP B 26 71       +JOBES,KENYON,PATHAK,HUGHES,+    (BIRM+GLAS)
DENEGRI  71 NP B 28 13       +ANTICH,CALLAHAN,CARSON,CHIEN,COX,+    (JHU)  JP

ANDERSON 72 PR D 6 1823      +FRANKLIN,GOODEN,KOPELMAN,LIBBY,TAN  (COLO)
BLIEDEN  72 PL 39 B 668      +FINOCCHIARO,BOWEN,EARLES,+      (STON+NEAS)
FIRESTON 72 PR D 5 505       FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

BARLOUTA 73 NP B 59 374      +DREVILLON,SHAH,+          (SACL+EPOL+RHEL)
BINGHAM  73 NP B 52 31       +FARWEL,+       (LBL+ORSAY+BNL+SACLAY+MILAN)
CHARRIER 73 NP B 51 317      CHARRIERE,ORIJARD,DE BAERE,+    (CERN+BELG)

CHUNG    74 PL 51B 412       +EISNER,PROTOPOPESCU,SAMIOS,STRAND     (BNL)
DEUTSCHM 74 PL 49B 388       DEUTSCHMANN,+     (AACH+BERL+CERN+LOIC+VIEN)  JP
EISNER   74 BOSTON CONF.     R.L.EISNER  REVIEW TALK                (BNL)

ANTIPOV  75 NP B86 381       +ASCOLI,BUSNELLO,KIENZLE+   (SERP+CERN+ILL)  JP
OTTER    75 NP B93 365       +RUDOLPH,RUMPF+ (AACH+BERL+CERN+LOIC+VIEN)  JP

OTTER    79 NP B 147 1       +RUDOLPH,+        (AACH+BERL+CERN+LOIC+VIEN)  JP

DAUM     81 NP B 187 1       +HERTZBERGER+(AMST+CERN+CRAC+MPIM+OXF+RHEL)
OTTER    81 NP B 181 1        (AACH+BERL+LOIC+VIEN+BIRM+BELG+CERN+MONS)

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K*(1780)

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60  K*(1780,JP=3-) I = 1/2
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All the recent high-statistics experiments studying the Kπ system in KN → KπN interactions have shown clear evidence for the existence of a resonant effect at ~1800 MeV in the $J^P=3^-$ partial wave (BALDI 76, BRANDENBURG 76, CHUNG 78, CLELAND 80, ASTON 81). The intensity of the 3^- partial wave of the Kππ system produced in the charge-exchange process $K^-p \to K^0\pi^+\pi^-n$ also shows resonance-like behavior at ~1800 MeV (BEUSCH 78, ETKIN 80). Since the mass values quoted for the Kπ and Kππ modes are not significantly different, it seems natural to consider them as alternative decay modes of a single resonance.

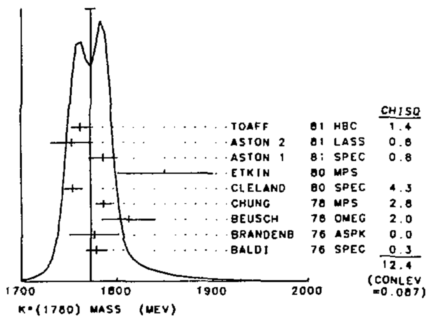
There appears to be some disagreement in the values of the width obtained using the Kπ channel. The measured values tend to become larger when the number of angular moments included in the fit increases. For the time being the observed discrepancies seem to originate from the explicit parametrization of the experimental distributions rather than from the data themselves.

```
60  K*(1780) MASS (MEV)

M    M      1779.0    11.0              BALDI     76 SPEC +  10 K+P,KO PI+P     12/77
M    A      1776.     26.               BRANDENB  76 ASPK   013 K+-P,K+-PI-+    12/75
M           1812.0    28.0              BEUSCH    78 OMEG    10K-P,KO PI+PI-N   4/78
M           1786.0     8.0              CHUNG     78 MPS   0 K-P,K-PI+N 6 GEV   1/78
M           1754.      9.               CLELAND   80 SPEC +- 50.K+-P,KS PI P    2/81*
M           1850.     50.               ETKIN     80 MPS   0 6 K-P,KO PI+ PI-   1/82*
M    J      1786.     15.               ASTON 1   81 SPEC   011.K-P,K- PI+ N    2/81*
M    K      1753.     25.        18.    ASTON 2   81 LASS  0 11 K-P,K- PI+ N    1/82*
M       190 1762.0     9.0              TOAFF     81 HBC  -  6.5 K-P,KO PI- P   1/82*
M           . . . . . . . . . .
M    AVG    1772.7     5.5      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
                              (SEE IDEOGRAM BELOW )

M    A  CONFIRMED BY PHASE SHIFT ANALYSIS OF ESTABROOKS 77,YIELDS JP=3-
M    J  FROM A FIT TO Y(6,0) MOMENT.
M    K  FROM ENERGY INDEPENDENT PWA.
M    M  FROM A FIT TO Y(6,2) MOMENT. JP=3- FOUND.
```

WEIGHTED AVERAGE = 1772.7 ± 5.5
ERROR SCALED BY 1.3

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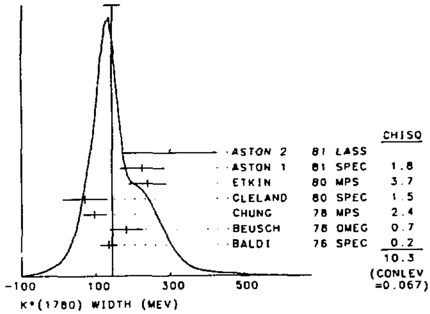
60  K*(1780) WIDTH (MEV)

W    M       135.0    22.0              BALDI     76 SPEC +  10 K+P,KO PI+P     12/77
W   E       (270.)   (70.)              BRANDENB  76 ASPK   013 K+-P,K+-PI-+    12/75
W  O         181.0    44.0              BEUSCH    78 OMEG    10K-P,KO PI+PI-N   4/78
W             96.0    31.0              CHUNG     78 MPS   0 K-P,K-PI+N 6 GEV   1/78
W             70.     60.               CLELAND   80 SPEC +- 50.K+-P,KS PI P    2/81*
W            240.     50.               ETKIN     80 MPS   0 6 K-P,KO PI+ PI-   1/82*
W    J       225.     60.               ASTON 1   81 SPEC   011.K-P,K- PI+ N    2/81*
W    K       300.    170.        80.    ASTON 2   81 LASS  0 11 K-P,K- PI+ N    1/82*
W       190  (80.)   APPROX.            TOAFF     81 HBC  -  6.5 K-P,KO PI- P   1/82*
W            . . . . . . . . . .
W    AVG     144.2    21.1      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)
                              (SEE IDEOGRAM BELOW )

W    O  ERRORS ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE K* TYPED NOTE.
W   E   ESTABROOKS 77 FIND THAT BRANDENBURG 76 DATA ARE CONSISTENT
W   E   WITH 175 MEV WIDTH.NOT AVERAGED.
W    J  FROM A FIT TO Y(6,0) MOMENT.
W    K  FROM ENERGY INDEPENDENT PWA.
W    M  FROM A FIT TO Y(6,2) MOMENT. JP=3- FOUND.
```

WEIGHTED AVERAGE = 144.2 ± 21.1
ERROR SCALED BY 1.4

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60  K*(1780) PARTIAL DECAY MODES

                                                        DECAY MASSES
P1      K*(1780) INTO K PI                               493+ 139
P2      K*(1780) INTO K*(892) PI                         891+ 139
P3      K*(1780) INTO K RHO                              493+ 769
P4      K*(1780) INTO K*(1430) PI                       1434+ 139
P5      K*(1780) INTO K PI PI                            493+ 139+ 139
P6      K*(1780) INTO K*(892) RHO                       1275+ 769
```

```
60  K*(1780) BRANCHING RATIOS

R4      K*(1780) INTO (K PI )/TOTAL                      (P1)
R4           0.19      0.02          ESTABROO  78 ASPK  0 13 K+-P,K PI      12/77
R4           0.16      0.01          ASTON 2   81 LASS  0 11 K-P,K- PI+ N    1/82*
R4          . . . . . . . . . .
R4  AVG      0.166     0.012   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
```

REFERENCES FOR K*(1780)

CARMONY 71 PRL 27 1160   +CORDS,CLOPP,ERWIN,MEIERE,+ (PURD+UCD+IUPU)
FIRESTON 71 PL 36 B 513   FIRESTONE,GOLDHABER,LISSAUER,TRILLING (LBL)

AGUILAR 73 PRL 30 672   +CHUNG,EISNER,PROTOPOPESCU,SAMIOS,+   (BNL)
MALUCH   73 PR D 8 2837   +FLATTE,FRIEDMAN   (LBL)

BALDI   76 PL 63 B 344   +BOEHRINGER,DORSAZ,HUNGERBUHLER,+   (GENEVA) JP
BRANDENB 76 PL 60 B 478   BRANDENBURG,CARNEGIE,CASHMORE,DAVIER+(SLAC)   JP
SPIRO   76 PL 60 B 389   +BARLOUTAUD,PALER,CHAURAND+(SACL+RHEL+EPOL)   JP

BOWLER   77 NP B 126 31   +DAINTON,DRAKE,WILLIAMS   (OXFORD) JP
CARMONY 77 PRD 16 1251   +CLOPP,LANDER,MEIERE,YEN,+ (PURD+UCD+IUPU)
GRASSLER 77 NP B 125 189   +KLUGOW,+ (AACHEN+BERLIN+CERN+LOIC+VIENNA)

BEUSCH   78 PL 74 B 282   +BIRMAN,KONIGS,OTTER,+   (CERN+AACH+ETH)   JP
CHUNG   78 PRL 40 355   +ETKIN,FLAMINO+   (BNL+BRAN+CUNY+MASA+PENN)   JP
ESTABROO 78 NP B 133 490   ESTABROOKS,CARNEGIE,+ (MONT+CARL+DURH+SLAC)   JP
    ALSO 78 PR D 17 658   ESTABROOKS,CARNEGIE+ (MONT+CARL+DURH+SLAC)

CLELAND 80 PL 97B 465   +DORSAZ,MARTIN,NEF,+ (PITT+GEVA+LAUS+DURH)   JP
ENGELEN 80 NP B 167 61   +JONGEJANS,DIONISI+   (NIJM+AMST+CERN+OXF)   JP
ETKIN   80 PR D 22 42   +FOLEY,LINDENBAUM,KRAMER,+   (BNL+CUNY) JP

ASTON 1 81 PL 99 B 502   +DUNWOODDIE,DURKIN,FIEGUTH+ (SLAC+CARL+OTTA)JP
ASTON 2 81 PL 106 B 235   +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)   JP
TOAFF   81 PR D 23 1500   +MUSGRAVE,AMMAR,DAVIS,ECKLUND,+ (ANL+KANS)

K*(2060)

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35  K*(2060,JP=4+) I=1/2

OMITTED FROM TABLE.
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35  K*(2060) MASS (MEV)

M       488 2115.      46.                CARMONY   77 HBC    0 9 K+D,K+ PIONS   12/78
M    A      2024.      20.                CLELAND   80 SPEC +- 50.K+-P,KS PI P    1/82*
M    B      2023.      10.                CLELAND   80 SPEC +- 50.K+-P,KS PI P    1/82*
M    C      2092.      21.                ASTON 1   81 LASS   011.K-P,K- PI+ N    1/82*
M    D      2070.     100.         40.    ASTON 2   81 LASS   011.K-P,K- PI+ N    1/82*
M           . . . . . . . . . .
M    AVG    2036.7     16.2      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)

M    A  FROM A FIT TO Y(6,0), Y(6,2) AND Y(8,0) MOMENTS.
M    B  FROM A FIT TO 9 MOMENTS.
M    C  FROM A FIT TO Y(5,0), Y(7,0) AND Y(8,0) MOMENTS.
M    D  FROM ENERGY INDEPENDENT PWA.
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```
               35  K*(2060) WIDTH (MEV)

M          300.       200.                CARMONY   77 HBC    0 9 K+0,K+ PIONS    12/78
M    A     136.        65.                CLELAND   80 SPEC +- 50.K+-P,KS PI P    1/82*
M    B     324.        45.                CLELAND   80 SPEC +- 50.K+-P,KS PI P    1/82*
M    C     205.        70.      55.       ASTON 1   81 LASS   011.K-P,K- PI+ N    1/82*
M    D     240.       500.     100.       ASTON 2   81 LASS   011.K-P,K- PI+ N    1/82*
M          . . . . . . . . . .
M    AVG   249.2       45.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

M    A  FROM A FIT TO Y(6,0), Y(6,2) AND Y(8,0) MOMENTS.
M    B  FROM A FIT TO 9 MOMENTS.
M    C  FROM A FIT TO Y(5,0), Y(7,0) AND Y(8,0) MOMENTS.
M    D  FROM ENERGY INDEPENDENT PWA.
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               35  K*(2060) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     K*(2060) INTO K PI                                     493+ 139
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               35  K*(2060) BRANCHING RATIOS

R1     K*(2060) INTO (K PI )/TOTAL                            (P1)
R1            0.07      0.01             ASTON 2   81 LASS   0 11 K-P,K- PI+ N   1/82*
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                        REFERENCES FOR K*(2060)

CARMONY   71 PRL 27 1160          +COROS,CLOPP,ERWIN,MEIERE,+   (PURD+UCD+IND)

CARMONY   77 PRD 16 1251          +CLOPP,LANDER,MEIERE,YEN,+    (PURD+UCD+IUPU)

BROMBERG  80 PR D 22 1513         +HAGGERTY,ABRAMS,DZIERBA(CIT+FNAL+ILLC+IND)
CLELAND   80 PL 97B 465           +DORSAZ,MARTIN,NEF,+   (PITT+GEVA+LAUS+DURH)JP

ASTON 1   81 PL 99 B 502          +DUNWOODIE,DURKIN,FIEGUTH+ (SLAC+CARL+OTTA)JP
ASTON 2   81 PL 106 B 235         +CARNEGIE,DUNWOODIE,DURKIN+(SLAC+CARL+OTTA)  JP
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$K^*(2200)$

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40  K*(2200,JP=  )
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THIS ENTRY CONTAINS VARIOUS PEAKS IN STRANGE MESON
SYSTEMS REPORTED IN THE 2100-2500 MEV REGION AS WELL AS
ENHANCEMENTS SEEN IN ANTIHYPERON NUCLEON MASS
SPECTRA. OMITTED FROM THE TABLE.
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               40  K*(2200) MASS (MEV)

M          20(2240.)    (20.)            LISSAUER  70 HBC      9. K+ P           11/71
M  C         (2200.)    APPROX.          SLATTERY  71 RVUE     8-13 K+ P         11/71
M          37(2147.)    (4.)             CHLIAPNIK 79 HBC  +   K+P TO LAM-BAR P  1/80
M    D       2235.       50.             BAUBILLIE 81 HBC  -   8. K-P,LAM PBAR   1/82*
M    Q       2260.       20.             CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*
M    P       2320.       30.             CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*
M    R       2490.       20.             CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*
M          . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 5.0)

M  C    COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13.  GEV/C
M    P  JP=3+ FROM MOMENTS ANALYSIS.
M    Q  JP=2- FROM MOMENTS ANALYSIS.
M    R  JP=4- FROM MOMENTS ANALYSIS.
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               40  K*(2200) WIDTH (MEV)

M          20  (80.)    (20.)            LISSAUER  70 HBC      9. K+ P           11/71
M  C          (200.)    APPROX.          SLATTERY  71 RVUE     8-13 K+ P         11/71
M          37  (40.)    APPROX.          CHLIAPNIK 79 HBC  +   K+P TO LAM-BAR P  1/80
M    Q        (200.)    APPROX.          BAUBILLIE 81 HBC  -   8. K-P,LAM PBAR   1/82*
M    Q         210.      30.             CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*
M    P        (250.)    APPROX.          CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*
M    R        (250.)    APPROX.          CLELAND   81 SPEC +- 50 K+P,LAM PBAR    1/82*

M  C    COMPILATION OF (ANTIHYP.-NUCLEON) MASS IN K+ P 8.-13.  GEV/C
M    P  JP=3+ FROM MOMENTS ANALYSIS.
M    Q  JP=2- FROM MOMENTS ANALYSIS.
M    R  JP=4- FROM MOMENTS ANALYSIS.
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                        REFERENCES FOR K*(2200)

ALEXANDE 68 PRL 20 755          ALEXANDER,FIRESTONE,GOLDHABER,SHEN     (LRL)

LISSAUER 70 NP B 18 491         +ALEXANDER,FIRESTONE,GOLDHABER         (LBL)

SLATTERY 71  UR-875-332(PREP) P.SLATTERY,A REVIEW OF STRANGE MESONS(ROCH)

CHLIAPNI 79 NP B 158 253        CHLIAPNIKOV,GERDYUKOV+      (CERN+BELG+MONS)

BAUBILLI 81 NP B 183 1          BAUBILLIER,+       (BIRM+CERN+GLAS+MSU+LPNP)  JP
CLELAND  81 NP B 184 1          +NEF,MARTIN,+         (PITT+GEVA+LAUS+DURH)  JP
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C=±1 MESON STATES

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$D^\pm$

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               31  CHARGED D(1869,JP=0-) I=1/2

               SEE STABLE PARTICLE DATA CARD LISTINGS
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D^0

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               32  NEUTRAL D(1865,JP=0-) I=1/2

               SEE STABLE PARTICLE DATA CARD LISTINGS
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$D^{*\pm}(2010)$

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62  CHARGED D*(2010,JP=1-) I=1/2
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               62  CHARGED D*(2010) MASS (MEV)

M    G      (2008.)      (3.)            GOLDHABE  77 SMAG +- E+E-               12/77
M    P      (2008.6)     (1.0)           PERUZZI   77 SMAG +- E+E-               12/77
M           . . . . . . . . . .
M    MASS   2010.1       0.7     FROM DO MASS (TRILLING 81 RVUE) AND
M                                MASS DIFFERENCE BELOW

M    G   FROM SIMULTANEUS FIT TO D*+,D*0,D+,AND DO,NOT INDEPENDENT OF
M    G   FELDMAN 77 MASS DIFFERENCE BELOW.
M    P   PERUZZI 77 MASS NOT INDEPENDENT OF FELDMAN 77 MASS DIFFERENCE
M    P   BELOW AND PERUZZI 77 DO MASS VALUE.
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               62  (D*+) - (DO) MASS DIFFERENCE (MEV)

DM         30  145.3       0.5           FELDMAN   77 SMAG     D*+ TO DO PI+     12/77
DM          2  145.2       0.6           BLIETSCHA 79 BEBC     NEUTRINO P        12/79
DM            (145.5)    APPROX.         AVERY     80 SPEC     GAMMA A           1/82*
DM         60  145.5       0.3           FITCH     81 SPEC     PI- A             1/82*
DM             . . . . . . . . . .
DM   AVG       145.41      0.?6    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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               62  (D*+) - (D*0) MASS DIFFERENCE (MEV)

EM   P         2.6        1.8            PERUZZI   77 SMAG +- E+E-               12/77
EM   P  NOT INDEPENDENT OF FELDMAN 77 MASS DIFFERENCE ABOVE, PERUZZI 77
EM   P  DO MASS, AND GOLDHABER 77 D*0 MASS.
EM             . . . . . . . . . .
EM   DMASS     2.9        1.3    FROM (D*+)-(DO) AND (D*0)-(DO)
EM                               MASS DIFFERENCES
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               62  CHARGED D*(2010) WIDTH (MEV)

W          18  (20.0)   OR LESS          PERUZZI   76 SMAG +- E+E-,PSI(4030)     1/77
W          30  (2.0)    OR LESS  CL=.90  FELDMAN   77 SMAG     D*+ TO DO PI+     12/77
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               62  CHARGED D*(2010) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1     D*+(2010) INTO DO PI+                                  1864+ 139
P2     D*+(2010) INTO D+ GAMMA                                1869+   0
P3     D*+(2010) INTO D+ PIO                                  1869+ 134

P      D*-(2010) MODES ARE CHARGE CONJUGATES OF ABOVE MODES
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               62  CHARGED D*(2010) BRANCHING RATIOS

R1     D*+(2010) INTO (DO PI+)/TOTAL                          (P1)
R1 G          0.6       0.15             GOLDHABE  77 SMAG +  E+E-               12/77
R1 G    ASSUMING THAT ISOSPIN IS CONSERVED IN THE DECAY

R2     D*+(2010) INTO (D+ GAMMA)/TOTAL                        (P2)
R2            0.08      0.0?             KIRKBY    79 RVUE    E+ E-              12/79

R3     D*+(2010) INTO (D+ PIO)/TOTAL                          (P3)
R3   G        0.28      0.09             KIRKBY    79 RVUE    E+ E-              12/79
****** ********* ********* ********* ********* ********* ********* ********

                   REFERENCES FOR CHARGED D*(2010)

PERUZZI  76 PRL 37 569          +PICCOLO,FELDMAN,NGUYEN,WISS,+   (SLAC+LBL)

FELDMAN  77 PRL 38 1313         +PERUZZI,PICCOLO,ABRAMS,ALAM+    (SLAC+LBL)
PERUZZI  77 PRL 39 1301         +PICCOLO,FELDMAN,PERL,+(SLAC,LBL,NWES+HAWA)
GOLDHABE 77 PL 69 B 503         +WISS,ABRAMS,ALAM,BOYARSKI,+     (LBL+SLAC)

BLIETSCH 79 PL 86 B 108         BLIETSCHAU,+       (AACH+BONN+CERN+MPIM+OXF)
KIRKBY   79 BATAVIA CONF.107    J. KIRKBY                             (SLAC)

AVERY    80 PRL 44 1309         +WISS,BINKLEY,ATIYA,+       (ILL+FNAL+COLU)

FITCH    81 PRL 46 761          +DEVAUX,CAVAGLIA,MAY,+ (PRIN+SACL+TORI+BNL)
TRILLING 81 PRPL 75 57          G.H.TRILLING                       (LBL+UCB)
****** ********* ********* ********* ********* ********* ********* ********
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$D^{*0}(2010)$

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61  NEUTRAL D*(2010,JP=1-) I=1/2

               J CONSISTENT WITH 1, VALUE 0 RULED OUT (NGUYEN 77).
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               61  NEUTRAL D*(2010) MASS (MEV)

M    G      (2006.)      (1.5)           GOLDHABE  77 SMAG     E+E-              12/77
M    G   FROM SIMULTANEUS FIT TO D*+, D*0, D+, AND DO.
M           . . . . . . . . . .
M    MASS   2007.2       2.1     FROM DO MASS (TRILLING 81 RVUE) AND
M                                MASS DIFFERENCE BELOW
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                     61  (D*0) - (D0) MASS DIFFERENCE (MEV)

DM G        142.7      1.7            GOLDHABE  77 SMAG  0 E+E-              3/82*
DM          142.2      2.0            SADROZIN  80 CBAL  0 D*D TO D0 PI0     3/82*
DM G    FROM SIMULTANEOUS FIT TO D*+, D*D, D+, AND D0.
DM           . . . . . . . . . .
DM  AVG     142.5      1.3     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                     61  NEUTRAL D*(2010) WIDTH (MEV)

W            (5.)   OR LESS           GOLDHAB2  76 SMAG    E+E- TO D*D*      3/77

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                     61  NEUTRAL D*(2010) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      D*0(2010) INTO D0 PI0                                1864+ 134
P2      D*0(2010) INTO D0 GAMMA                              1864+   0

P       D*0(2010)BAR MODES ARE CHARGE CONJUGATES OF ABOVE MODES

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                     61  NEUTRAL D*(2010) BRANCHING RATIOS

R1      D*0(2010) INTO (D0 GAMMA)/(D0 PI0 + D0 GAMMA)     (P2)/(P1+P2)
R1   G        0.45      0.15          GOLDHABE  77 SMAG    E+E-             12/77
R1   G  WE QUOTE THE NORMAL FIT VALUE FROM TABLE 1. THE ISO-SPIN
R1   G  CONSTRAINED FIT IS NOW KNOWN TO GIVE A D0 GAMMA FRACTION WHICH IS
R1   G  TOO LARGE. SEE DETAILS IN FOOTNOTE 21 OF FELDMAN 77 REVIEW.

R2      D*0(2010) INTO (D0 PI0)/TOTAL                       (P1)
R2   G        0.55      0.15          KIRKBY    79 RVUE    E+ E-            12/79

****** ********* ********* ********* ********* ********* ********* ********

                          REFERENCES FOR NEUTRAL D*(2010)

GOLDHAB1 76 PRL 37 255         GOLDHABER,PIERRE,ABRAMS,ALAM,+     (LBL+SLAC)
GOLDHAB2 76 SLAC CONF. 379     G.GOLDHABER (AVAIL. AS LBL-5534) (LBL+SLAC)

GOLDHABE 77 PL 69 B 503        GOLDHABER,ABRAMS,ALAM+             (LBL+SLAC)
   ALSO  77 BANFF SUM.INST 75  G.J.FELDMAN                            (SLAC)
NGUYEN   77 PRL 39 262         +WISS,ABRAMS,ALAM,BOYARSKI,+       (LBL+SLAC) J

KIRKBY   79 BATAVIA CONF.107   J. KIRKBY                              (SLAC)

SADROZIN 80 MADISON CONF. 681  SADROZINSKI,+        (PRIN+CIT+HARV+SLAC+STAN)

TRILLING 81 PRPL 75 57         G.H.TRILLING                        (LBL+UCB)

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F±

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                     34  F+-(20.0,JP=  1 I=
                     SEE STABLE PARTICLE DATA CARD LISTINGS

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F*(2140)

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                     74  F*(2140,JPG=   ) I=
                     OMITTED FROM TABLE.

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                     74  F* MASS (MEV)

M           2140.0     60.            BRANDELIK 77 DASP +- E+E-,PI 3 GAMMA  12/77

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                     74  (F*+) - (F0) MASS DIFFERENCE (MEV)

DM           110.      46.            BRANDELIK 79 DASP +- E+E-,F GAMMA     12/79

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                     74  F* PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      F* INTO F GAMMA                                      2021+   0

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                     74  F* BRANCHING RATIOS

R1      F* INTO (F GAMMA)/TOTAL                             (P1)
R1       PROBABLY SEEN                BRANDELIK 77 DASP    E+E-             12/77

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                          REFERENCES FOR F*(2140)

BRANDELI 77 PL 70 B 132       BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)

BRANDELI 78 PL 76 B 361       BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)

BRANDELI 79 PL 80 B 412       BRANDELIK,CORDS,+(AACH+DESY+HAMB+MPIM+TOKY)

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B=±1 MESON STATE

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B

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                  39  BOTTOM MESON B(5200,JP=   )
                  SEE STABLE PARTICLE DATA CARD LISTINGS

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EXOTIC MESON STATES

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EXOTICS

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                  50  EXOTICS

                  THE PURPOSE OF THIS ENTRY IS TO PROVIDE A LIST OF
                  REFERENCES FOR EXOTIC MESON SEARCHES (SEE MAIN TEXT,
                  SEC. 3 AND TABLE 1), AS WELL AS THEORETICALLY BASED
                  SUGGESTIONS FOR EXPERIMENTS. NOTE THAT LIPKIN 73
                  PROPOSES EXPERIMENTS WHICH ARE CONCLUSIVE EVEN IF
                  NEGATIVE RESULTS ARE OBTAINED.

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                          REFERENCES FOR EXOTICS

                          REPORTS ON SEARCHES

ROSENFEL 68 PHILA.CONF.P.455  A.H.ROSENFELD                           (LRL)

DODD     69 PR 177 1991       +JOLDERSMA, PALMER, SAMIOS              (BNL)

CHO      70 PL 32 B 409       +DERRICK,JOHNSON,MUSGRAVE,+ (ANL+NWES+KANS)
GIACOMEL 70 PL  33 B 373      G.GIACOMELLI +    (BGNA+SACL+AMST+REHO+EPOL)
LYS      70 PR D 2 2525       J.LYS+                                 (MICH)
ROSNER   70 EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499

BUHL     72 NP B 37 421       +CLINE,TERRELL                    (WISCONSIN)

COHEN    73 NP B 53 1         +FERBEL,SLATTERY,WERNER          (ROCHESTER)
DURUSOY  73 PL 45 B 517       +BAUBILLIER,GEORGE,ARMENISE,+    (LPNP+BARI)

ALAM     74 PL 53B 207        +BRABSON,GALLOWAY,+     (IND+PURO+SLAC+VAND)
COHEN    74  BOSTON           D.COHEN  REVIEW TALK                   (COLU)
OREN     74 NP B71 189        +COOPER,FIELDS,RHINES,WHITMORE,+  (ANL+OXF)
BALTAY   75 PL 57B 293        +CAUTIS,COHEN,KALELKAR,PISELLO,+(COLU+BING)
DAVIS    75 NP B96 426        +AMMAR,KROPAC,YARGER,+      (KANS+CCAC+ANL)

BRUNDIER 76 PL 64 B 107       BRUNDIERS,BRUN,FLURI,+  (FREIBURG+SACL+ETH)

BOUCROT  77 NP B 121 251      +NAVACH,RIVET,+          (LALO+CERN+CDEF+EPOL)
HOOGLAND 77 NP B 126 109      +GRAYER,HYAMS,BLUM,DITL,+  (AMST+CERN+MPIM)
HOOGLAND 77 NP B 126 109      +GRAYER,HYAMS,BLUM,DITL,+  (AMST+CERN+MPIM)
MOSER    77 NP B 129 28       F.L.MOSER                               (EFI)

ALAM     78 PRL 40 1685       +BAGGETT,BAGLIN,BONAMY+(IND+PURO+SLAC+VAND)
ARMSTRON 78 PL 77 B 447       AMSTRONG,FRAME,HUGHES,BIENLEIN+ (GLAS+DESY)

LEMOIGNE 79 BATAVIA CONF.524  +ABOLINS,BARATE+        (SACL+LOIC+SHMP+IND)

KOOIJMAN 80 PRL 45 316        +ARENTON,AYRES,DIEBOLD,MAY+        (ANL+EFI)

AGUILAR  81 ZPHY C 6 109      +ALBAJAR,SJOGREN,+      (CERN+CDEF+MADR+STOH)
APEL     81 NP B 193 269      +AUGENSTEIN,BERTOLUCCI,DONSKOV,+(SERP+CERN)
BIONTA   81 PRL 46 970        +CARROLL,EDELSTEIN,+    (BNL+CARN+FNAL+SMAS)
EVANGELI 81 NP B 178 197      EVANGELISTA+(BARI+BONN+CERN+DARE+LIVP+MILA)
FRAME    81 PL 107 B 301      +HUGHES,COLLEY,ARMSTRONG,+ (GLAS+BIRM+CERN)
IRVING   81 NP B 193 1        +LOVERRE,AGUILAR,+      (CERN+CDEF+MADR+STOH)

                          SUGGESTIONS FOR SEARCHES

ROSNER   68 PRL 21 950,1468   J.L.ROSNER                         (TEL-AVIV)

ROSNER   70 EXP.MESON SPECTROSCOPY,ED. C.BALTAY AND A.H.ROSENFELD,P.499

FAIMAN   73 PL 43 B 307       D.FAIMAN,G.GOLDHABER,Y.ZARMI           (CERN)
LIPKIN   73 PR D 7 2262       H.J.LIPKIN                     (ARGONNE+FNAL)

HOLMGREN 76 PL 77 B 204       +PENNINGTON                       (STOH+CERN)

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Note on N's and Δ's

I. Introduction

For this edition, three N's and one Δ have been promoted to the Baryon Table, and several new resonances that are not yet established appear in the Data Card Listings. Table I.1 lists all the entries in the Listings, and gives our evaluation of the status of each, both overall and channel by channel.

The masses, widths, and branching fractions of the N and Δ resonances come mainly from a few comprehensive partial-wave analyses. There are also several other recent analyses based on more limited data sets and/or energy ranges. Production and total-cross-section experiments can be valuable in establishing the existence of high mass bumps, but at lower energies these experiments have limited statistics compared to formation experiments, and it is seldom clear which of several states having nearly the same mass is being observed.

Even when there are good scattering data, there are two main problems in obtaining reliable resonance parameters from partial-wave analyses. First, there is sometimes disagreement among analyses on the partial-wave amplitudes themselves. This obviously depends on the quality and quantity of the scattering data and on the procedures used to determine the amplitudes from the data. Secondly, even if smooth curves were available for the amplitudes, there would still be some parametrization-dependent uncertainty about the values of the usual Breit-Wigner resonance parameters. From a theoretical standpoint, the most unambiguously defined resonance parameters are the pole position and residue, and it has been found in practice that, given sufficiently precise partial-wave amplitudes, these quantities can be extracted in a stable and parametrization-independent way, in spite of the fact that an extrapolation away from the physical region is required. This point has been discussed in detail with regard to the Δ(1232) in earlier editions of this review.[1,2] Pole parameters have now been determined for many of the N and Δ resonances, and these are included in the Data Card Listings. In most cases, we specify pole parameters by giving the real and imaginary parts

TABLE I.1. STATUS OF N* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

			STATUS AS SEEN IN --							
PARTICLE	LIJ	OVERALL STATUS	TOTAL* CR.S.	PI N	ETA N	K LAM	K SIG	PI DE	GAM N	OTHER CHANN.
N(939)	P11	****								
N(1440)	P11	****		****	*			***	***	EPS N
N(1520)	D13	****	****	****	*			***	***	RHO N
N(1535)	S11	****		****	****			*	***	RHO N
N(1540)	P13	*						*		RHO N
N(1650)	S11	****		****	*	***	**	***	***	RHO N
N(1675)	D15	****	***	****	*	*		***	***	RHO N
N(1680)	F15	****	***	****				***	***	RHO N
N(1700)	D13	****		***	*	**	*	**	**	RHO N
N(1710)	P11	****		****	*	**	*	***	**	RHO N
N(1720)	P13	****		****	*	**	*	*	*	RHO N
N(1990)	F17	***		***	*	*	*		*	
N(2000)	F15	**		**	*	*	*			
N(2080)	D13	***		***	*	*			*	
N(2100)	S11	*		*						
N(2100)	P11	*		*						
N(2190)	G17	****	***	****	*	*	*		*	
N(2200)	D15	***		***	*	*				
N(2220)	H19	****	***	****	*					
N(2250)	G19	****		****	*					
N(2600)	I111	***		***						
N(2700)	K113	*		*						
N(2800)	G19	*		*						
N(3030)		***	***	*						
N(3245)		*	*							
N(3690)		*	*							
N(3755)		*	*							
DEL(1232)	P33	****	****	****	F				****	
DEL(1550)	P31	**			O			*		RHO N
DEL(1600)	P33	***		***	R			***	*	RHO N
DEL(1620)	S31	****	**	****	B			***	**	RHO N
DEL(1700)	D33	****	***	****	I		*	***	***	RHO N
DEL(1900)	S31	***	*	***	D		*			
DEL(1905)	F35	****	*	****	D		*	**	**	RHO N
DEL(1910)	P31	****	*	****	E		*	*	*	RHO N
DEL(1920)	P33	***		***	N		*			
DEL(1930)	D35	****	*	****	F		*	*	*	
DEL(1940)	D33	*		*	O					
DEL(1950)	F37	****	***	****	R		*	**	***	RHO N
DEL(2150)	S31	*		*	B					
DEL(2160)		*		*	I		*			
DEL(2200)	G37	**		**	D					
DEL(2300)	H39	**		**	D					
DEL(2350)	D35	*		*	E					
DEL(2400)	F37	*		*	N					
DEL(2400)	G39	n		*	F					
DEL(2420)	H311	***	***	***	O				*	
DEL(2750)	I313	*		**	R					
DEL(2850)		***	***	**	B					
DEL(2950)	K315	*		**	I					
DEL(3230)		***	***	*	D					

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.
* ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

of the pole position and residue. It should be noted that these real and imaginary parts tend to be highly correlated. In particular, the absolute value of the residue is often better determined than is the phase. For further discussion, see the relevant references, e.g., NOGOVA 73, SPEARMAN 74, BALL 75, LICHTENBERG 75, VASAN 76, LONGACRE 77, ZIDELL 78, CUTKOSKY 79, MIROSHNICHENKO 79, ZIDELL 80, and CUTKOSKY 80.

The following sections discuss various recent developments in experimental N and Δ spectroscopy. For a discussion of earlier results, see our 1980 edition[3] and the reviews of R.L. Kelly,[4] R. Koch,[5] and A.J.G. Hey and R.L. Kelly.[6]

References for Section I

1. Particle Data Group, Rev. Mod. Phys. 43, S114 (1971).

2. Particle Data Group, Phys. Lett. 39B, 103 (1972).
3. Particle Data Group, Rev. Mod. Phys. 52, S175 (1980).
4. R.L. Kelly, in Proceedings of the IVth International Conference on Baryon Resonances (Toronto, 1980), ed. N. Isgur, p. 149.
5. R. Koch, in Proceedings of the Conference on Low and Intermediate Energy Kaon-Nucleon Physics (Rome, 1980), p. 1.
6. A.J.G. Hey and R.L. Kelly, Physics Reports C (to be published).

II. Two-Body Partial-Wave Analyses and New Resonances

(by R.E. Hendrick, St. Bonaventure University)

Several new partial-wave analyses have appeared and several older analyses have been extended to include new scattering data since our 1980 edition.[1] For $\pi N \to \pi N$ reactions, we have included results of new analyses by CUTKOSKY 80, ZIDELL 80, KOCH 80, and CHEW 80. CUTKOSKY 80 includes new elastic cross-section and polarization data and extends the mass range of the CUTKOSKY 79 analysis up to 2500 MeV. This analysis reports several new baryon states and confirms several tentative states in the 2000–2400 MeV region. A brief discussion of the revised status of these N and Δ states is given below. ZIDELL 80 performs an energy-dependent partial-wave analysis from threshold to 350 MeV. Deviations from isospin invariance are reported, and new masses, widths, and pole positions of the Δ^0 and Δ^{++} are given. KOCH 80 performs an energy-independent analysis over a similar low-energy range, but finds little evidence of isospin invariance violation. CHEW 80 uses a Barrelet-zero technique to analyze π^+p elastic data between 1550 and 2100 MeV and reports several new S31 and P31 states, but disagrees with the parameters of the two 4-star S31 and P31 resonances established by other analyses.

Two new inelastic analyses have been reported: an energy-dependent analysis of $\pi^-p \to \Lambda K^0$ below 1900 MeV by MUSETTE 80, and an energy-dependent analysis of the three isospin-coupled reactions $\pi^-p \to \Sigma^-K^+$, $\pi^-p \to \Sigma^0K^0$, and $\pi^+p \to \Sigma^+K^+$ up to 2000 MeV by LIVANOS 80. A number of resonance masses, widths, and πN to $K\Sigma$ branching ratios have been included from this analysis.

This year, four new N and Δ resonances have been promoted from 2-star to 3-star status and added to the Baryon Table: the D13 N(2080), D15 N(2200), S31 Δ(1900), and P33 Δ(1920). The D35 Δ(1930), already listed in the Baryon Table, has been promoted from 3-star to 4-star status.

A number of weak, higher-mass states have been added to the N and Δ Listings. These include a third P11 at 2100 MeV, a second D33 at 1940 MeV, a third S31 at 2150 MeV, a second D35 at 2350 MeV, and a second F37 at 2400 MeV. The G37 Δ(2200) has been separated from the Δ(2160) listing and has been given a separate listing with 2-star status. The H39 Δ(2300) has been promoted from 1-star to 2-star status. In addition, a number of nominal resonance masses have been changed from our last edition to put them in better agreement with recent results.

Figure II.1 shows the partial-wave amplitudes obtained by HOEHLER 79 and by CUTKOSKY 80.

Reference for Section II

1. Particle Data Group, Rev. Mod. Phys. 52, S1 (1980).

III. The $\pi N \to \pi\pi N$ Channel

(by R.L. Crawford, University of Glasgow)

A general $\pi N \to \pi\pi N$ event may be described by the center-of-mass energy W, three angles α, β, and γ, and two sub-energies, say $w_{\pi N}$ and $w_{\pi\pi}$. Unlike 2 → 2-body reactions, fits of $\pi N \to \pi\pi N$ distributions at single values of W cannot be parametrized in terms of a set of constants without introducing some assumptions into the analysis. All fits to $\pi N \to \pi\pi N$ use the *isobar* model, which notes that almost all such events lie in quasi-2-body bands in the Dalitz plot. Thus it is assumed that any purely 3-body interaction is negligible and that the reaction proceeds by the formation of quasi-2-body intermediate states.

The basic form used for the amplitudes is

$$\begin{aligned} T(\pi N \to \pi\pi N) = \sum \Big[& T^{JILL'}_{\Delta\pi}(W)\cdot BW_{\Delta}(w_{\pi N})\cdot X^{JILL'}_{\Delta\pi} \\ & + T^{JILL'}_{N^*\pi}(W)\cdot BW_{N^*}(w_{\pi N})\cdot X^{JILL'}_{N^*\pi} \\ & + T^{JILL'}_{\rho N}(W)\cdot BW_{\rho}(w_{\pi\pi})\cdot X^{JILL'}_{\rho N} \\ & + T^{JILL'}_{\epsilon N}(W)\cdot BW_{\epsilon}(w_{\pi\pi})\cdot X^{JILL'}_{\epsilon N} \Big] \end{aligned}$$

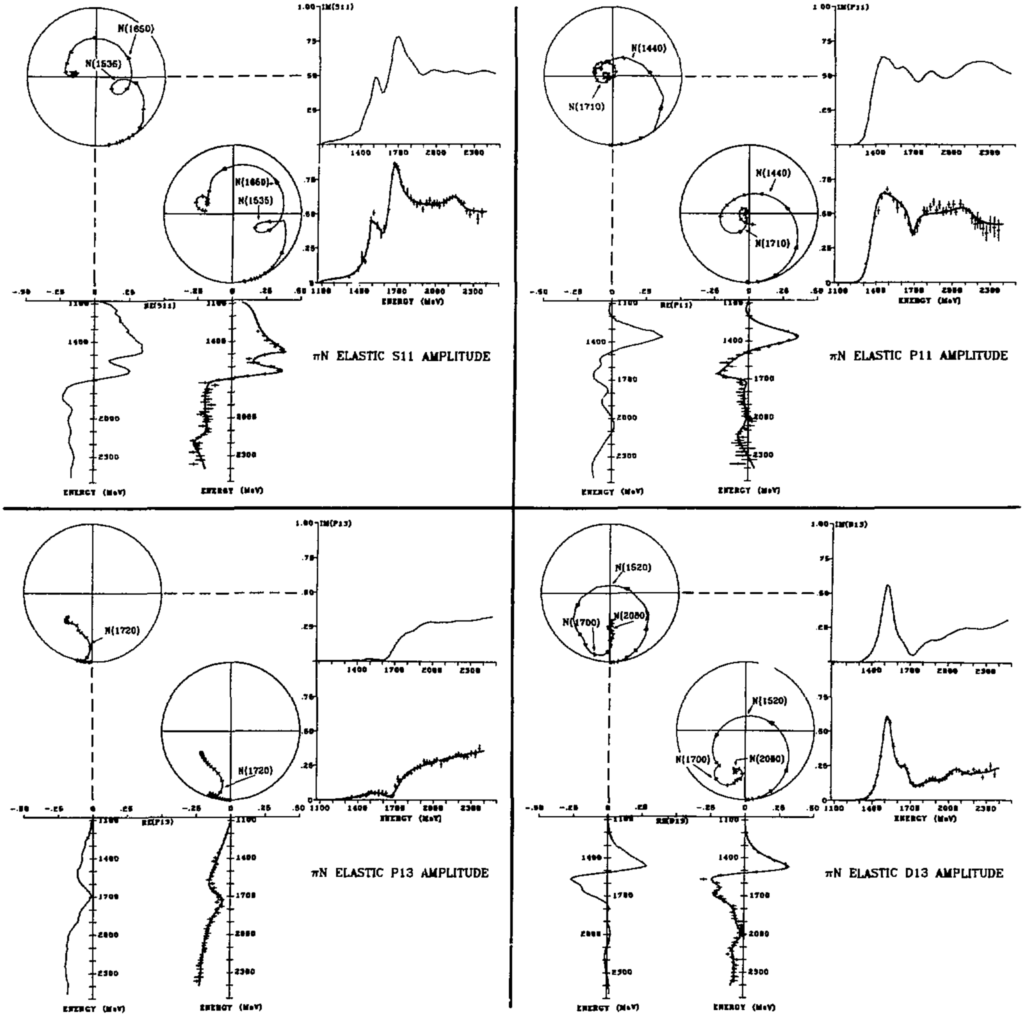

Fig. II.1(a). The L·2I·2J = S11, P11, P13, and D13 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

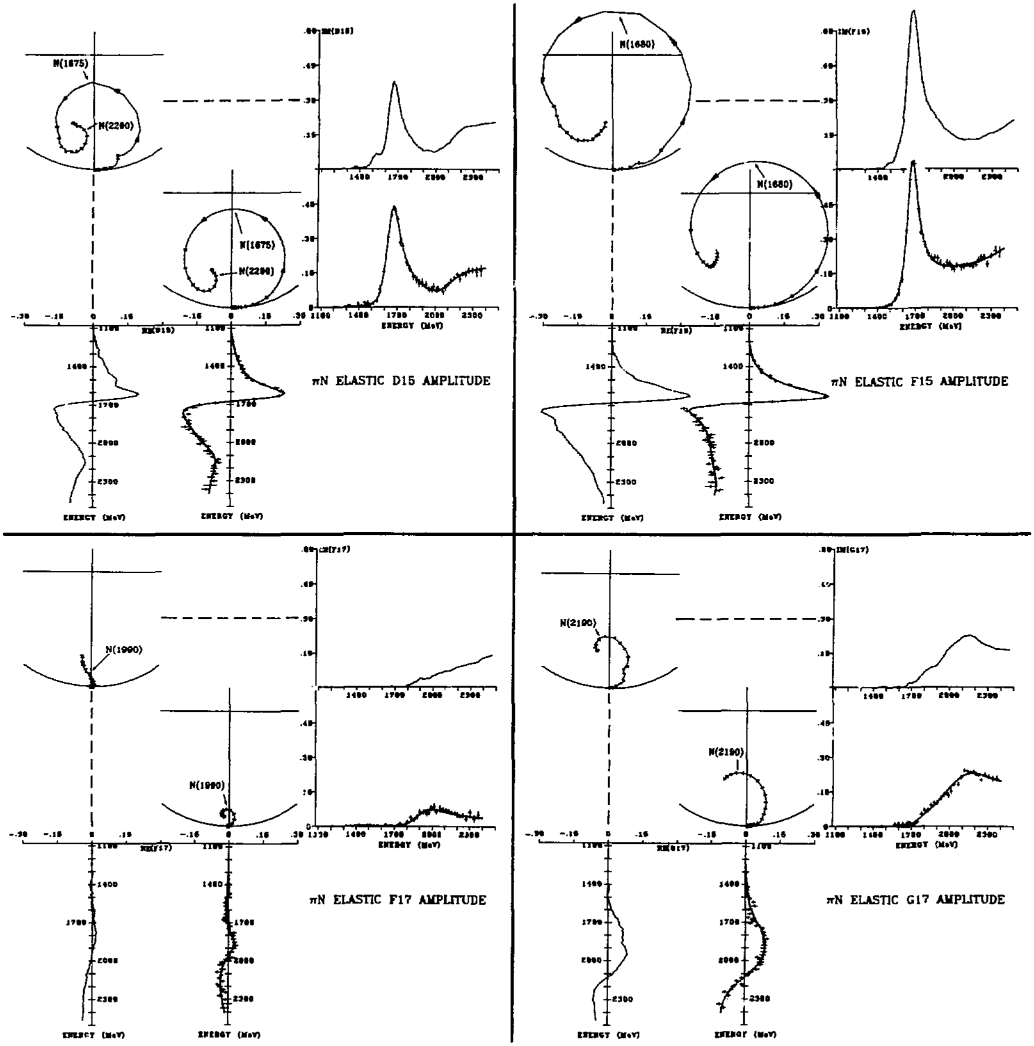

Fig. II.1(b). The L·2I·2J = D15, F15, F17, and G17 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

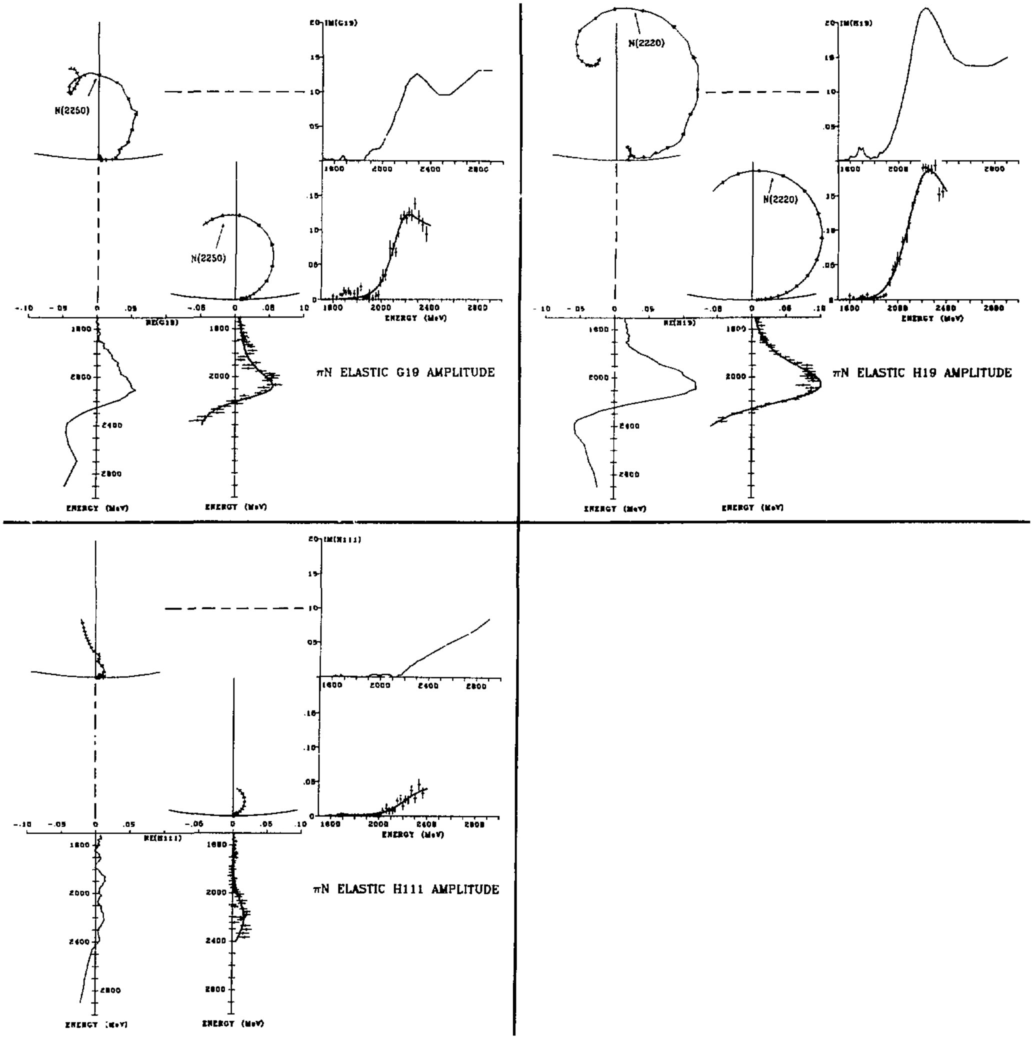

Fig. II.1(c). The L·2I·2J = G19, H19, and H111 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

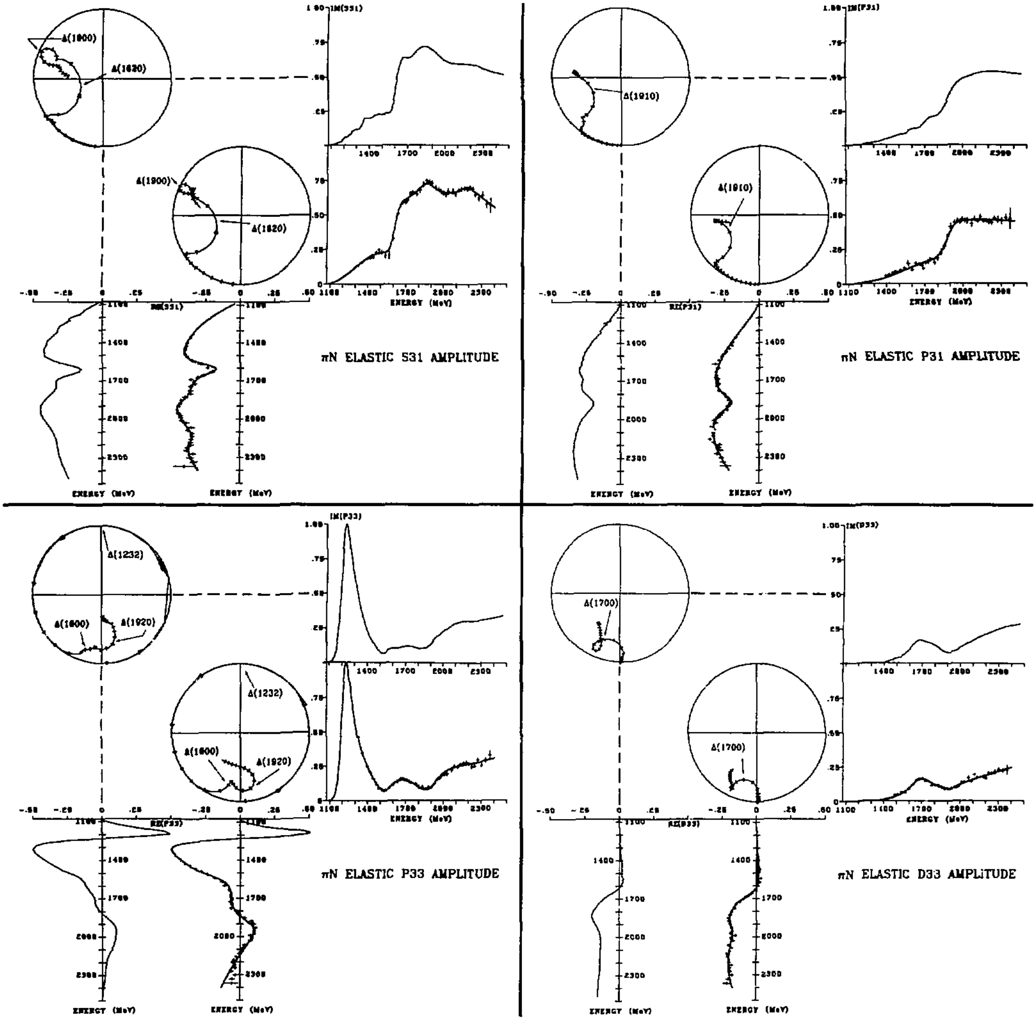

Fig. II.1(d). The L·2I·2J = S31, P31, P33, and D33 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

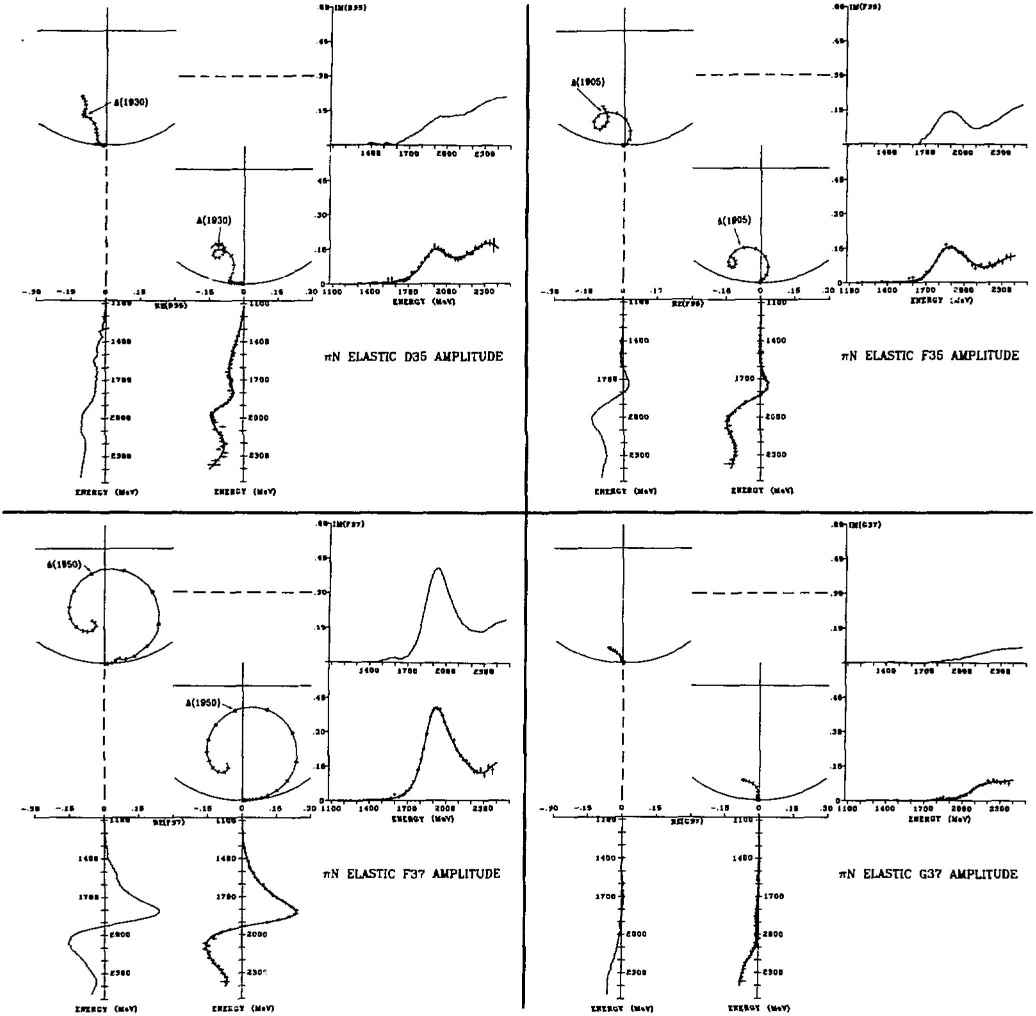

Fig. II.1(e). The L·2I·2J = D35, F35, F37, and G37 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

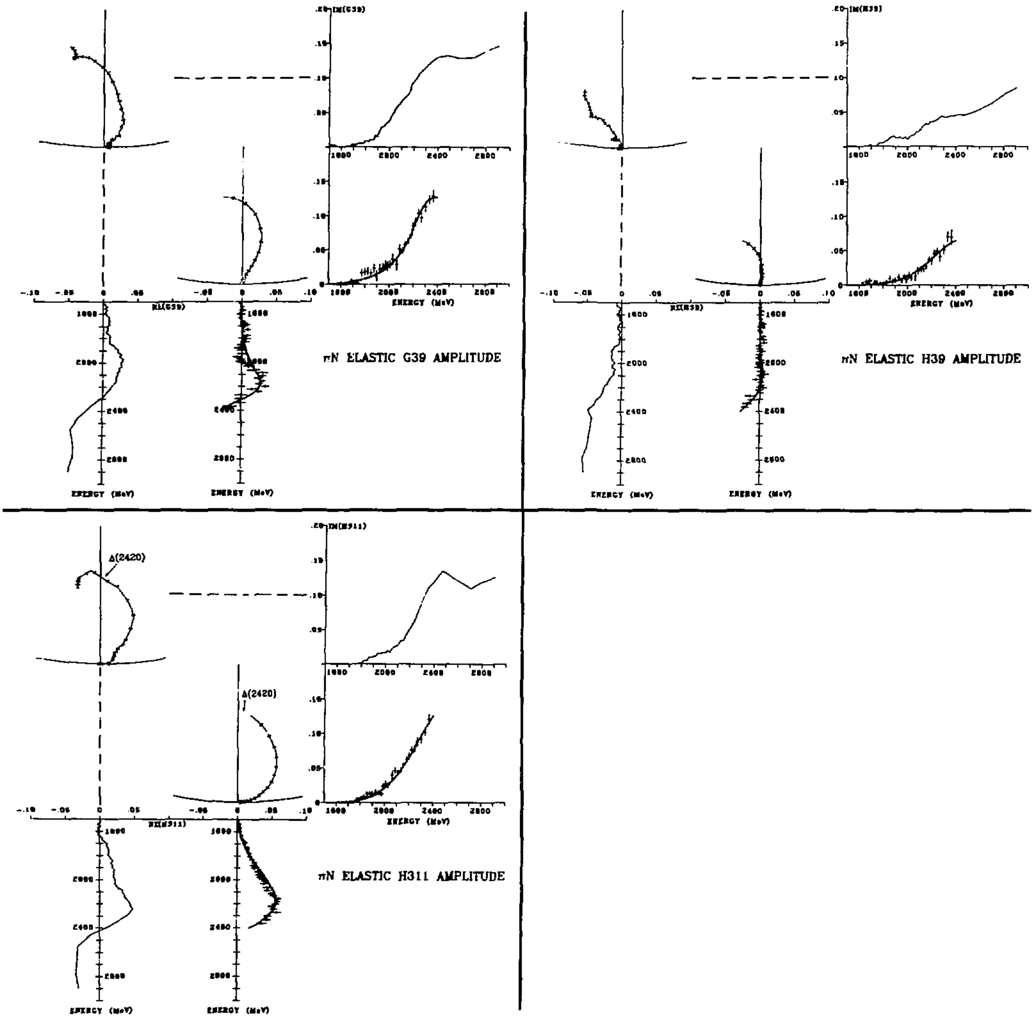

Fig. II.1(f). The L·2I·2J = G39, H39, and H311 partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

where in present analyses Δ is the Δ(1232), N^* is the N(1440), ρ is the ρ(770), and ε is the S-wave, I=0 ππ enhancement (not all these isobars are included in every analysis). Here, BW denotes the appropriate Breit-Wigner or corresponding 2-body amplitude from πN or ππ analyses, and X is a well-defined function containing all the angular information. The decays of the resonances that are formed in the reaction are described by the partial-wave amplitudes $T^{JILL'}_{\Delta\pi}$, etc., where J is the total angular momentum and I is the total isospin of the state formed, and L and L′ are the orbital angular momenta in the initial 2-body and the final quasi-2-body states. So $\vec{J} = \vec{L} + \vec{S} = \vec{L}' + \vec{S}'$, where S and S′ are the initial and final total spins. For the ρN amplitude, it is necessary to add the suffix 2S′, equal to 1 or 3, to indicate the total ρN spin. The partial-wave amplitudes are often denoted by Δ·L·L′·2I·2J, $\rho_{2S'}$·L·L′·2I·2J, etc.

The Listings give the results from four analyses.

LONGACRE 75 (LBL-SLAC) is an analysis of 200K $\pi^-p \to \pi^-\pi^0 p$, $\pi^-p \to \pi^-\pi^+ n$, and $\pi^+p \to \pi^+\pi^0 p$ events for 1300 ≤ W ≤ 2000 MeV. Approximate unitarity constraints are imposed using a simplified K-matrix formalism that links the ππN channel to the πN channel. This gives smooth solutions and eliminates the overall phase ambiguity at each energy. The Δπ, ρN, and εN intermediate states are included. Couplings and T-matrix pole positions are given for 14 resonances.

LONGACRE 77 (Saclay) is a coupled-channel analysis similar to LONGACRE 75 that fits 100K events for 1380 ≤ W ≤ 1740 MeV. The couplings and pole positions are found for 16 resonances, including a P13 N(1540) and a P31 Δ(1550) suggested for the first time by this analysis.

NOVOSELLER 78 (CIT) is an analysis of $\pi^-p \to \pi^-\pi^0 p$, $\pi^-p \to \pi^-\pi^+ n$, and $\pi^+p \to \pi^+\pi^0 p$ for 1630 ≤ W ≤ 1990 MeV based on the LBL-SLAC energy-independent analysis.[1] Again the Δπ, ρN, and εN states are used, but the resonances are fitted using a simple Breit-Wigner amplitude rather than the K-matrix formalism of LONGACRE 75. Single-pion exchange with ππ rescattering is used to calculate the higher partial waves (taking account of a criticism made of earlier analyses), and it is concluded that this improves the fit above 1800 MeV and helps eliminate the phase ambiguity. Another study of the importance of single-pion exchange has been made by Aaron et al.,[2] who also find that it can give important corrections to the angular dependence. NOVOSELLER 78 gives two solutions, the second including the effects of pion exchange. They are given in the Listings as fits to LONGACRE 75 and NOVOSELLER 78.

BARNHAM 80 (Imperial College) is an analysis of 44K $\pi^+p \to \pi^+\pi^0 p$ and $\pi^+p \to \pi^+\pi^+ n$ events for 1440 ≤ W ≤ 1700 MeV. It thus concerns only the Δ resonances, and it uses data that were not available to the other analyses. The intermediate states are Δπ, ρN, and πN(1440), the last being necessary to account for the difference between the $\pi^+\pi^0 p$ and $\pi^+\pi^+ n$ cross sections. Also included is the effect of single-pion exchange leading to the S-wave ππ state with I = 2. The phase ambiguity is resolved by requiring that the πΔ amplitude for the D33 Δ(1700) have a Breit-Wigner phase. The parameters are found for four resonances, including the P31 Δ(1550), but since some of the data were also used by LONGACRE 77 it is not clear that this resonance is being confirmed. However, there is now some evidence that it has also been seen in single-pion photoproduction.[3]

There have also been analyses of $\pi^-p \to \pi^-\pi^+ n$ for W ≤ 1400 MeV,[4,5] a range dominated by the low energy tail of the P11 N(1440), with εN as the dominant intermediate state. The energy range of these analyses is too low for them to determine decay coupling constants, and they do not appear in the Listings.

It is difficult to assess the systematic uncertainties of these analyses or of the quoted couplings of the resonances to the isobar states. However, those that are indicated in the Listings as being well determined by LONGACRE 77 do in general agree, at least in sign, with the values from the other analyses, although some of the ρ_3 couplings have not been measured elsewhere. The Imperial College group also claims clear measurements of the signs of ρ_1SS31, ρ_1DD33, and N^*PP33.

All existing isobar models can be criticized for neglecting possible sub-energy dependence of the partial-wave amplitudes, which makes them possibly inconsistent with unitarity.[6] This has been studied by Aitchison and Brehm,[7] who derive an isobar expansion that is consistent with Bose symmetry and with sub-energy analyticity and unitarity. The resulting coupled integral equations are suitable for both dynamical and phenomenological studies of $\pi N \to \pi\pi N$. They estimate the sub-energy corrections to the isobar model and conclude that such corrections may not be significant for existing isobar fits but that they could become so with better data.[8] A rough estimate of these corrections has also been made by the Imperial College group,[9] who also find that they are small.

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IV. Photoproduction and Compton Scattering

(by R.L. Crawford, University of Glasgow)

The γN couplings of an N or Δ resonance can be studied in any photon-induced formation process in which the coupling of the resonance to the final state is well known. In practice, this limits accurate sources for such information to partial-wave analyses of single-pion photoproduction, where there is a large amount of data and where the final state is well known from $\pi N \to \pi N$ partial-wave analyses. Recently, however, some couplings have been obtained from Compton scattering on protons. All photoproduction analyses rely heavily on $\pi N \to \pi N$ analyses for the existence, masses, and widths of the resonances. In only a few photoproduction analyses are the masses and widths treated as free parameters. However, the photoproduction results for the masses and widths are of interest since they give access to the charge +1 states.

The most important analyses of single-pion photoproduction are reviewed below. The formalism has been described in an earlier edition of this Review,[1] to which the reader is referred for additional information. There are three basic methods of analysis. All have to cope with the stability problems of having four independent complex spin amplitudes at any energy and angle, but only six (and frequently fewer) independent experimental measurements.

(a) Simple isobar model: This is the simplest form of energy-dependent analysis. The partial waves are parametrized as a smooth background to which Breit-Wigner resonances are added. Usually the electric but not the magnetic Born terms are included explicitly to reproduce the forward peak in charged pion production. This method is sufficiently flexible to give excellent fits to the data, but there are in principle difficulties concerning the uniqueness of the solution due to the large number of waves involved. This problem is eliminated by the form of the parametrization, but it is not clear how this may bias the solution.

The most extensive analysis of this type is METCALF 74 (for references in this form, see the Data Card Listings), which is an extension of the arlier Walker analysis.[2] It fits $\gamma p \to \pi^+ n$, $\gamma p \to \pi^0 p$, and $\gamma n \to \pi^- p$ from the first to the fourth resonance regions. FELLER 76 is a similar analysis which does not fit $\gamma n \to \pi^- p$, but uses data that were not available to METCALF 74. Other isobar analyses are ROSSI 73, HEMMI1 73, HEMMI2 73, BENEVENTANO 74, KRIVETS 74, TAKEDA 80, and BRATASHEVSKIJ 80; these have used relatively small and sometimes restricted data sets, usually in association with a particular experiment. ISHII 80 is an isobar analysis of proton Compton scattering for laboratory photon energies from 550 MeV to 950 MeV, covering the second resonance region.

(b) Fixed-t dispersion relations (FTDR): This technique uses the apparent resonance dominance of the photoproduction amplitudes to get a relatively simple parametrization of their imaginary parts. Fixed-t dispersion relations are then used to calculate the real parts; sometimes a few but usually no additional free parameters are introduced. Since there are fewer free parameters, the probability of having multiple solutions is reduced, and the requirements of analyticity are automatically satisfied. However, the method is inflexible compared to the isobar model and gives poorer fits. Also, as has been described in NOELLE 78 and elsewhere,[3] the divergence of the partial-wave expansions for the dispersion integrals does not allow the use of data at all angles above the third resonance region. Some but not all analyses satisfy the constraints of unitarity and time reversal invariance as given by Watson's theorem.[4]

FTDR analyses have been made by groups at Berkeley (MOORHOUSE 73, KNIES 74, and MOORHOUSE 74), at Lancaster (DEVENISH 73 and DEVENISH2 74), at Glasgow (CRAWFORD 75, BARBOUR 76, BARBOUR 78, and CRAWFORD 80), at Yerevan (AZNAURYAN 77), and at Tokyo (ARAI 80 and FUJII 81). NOELLE 78 is a hybrid analysis incorporating FTDR in a coupled-channel isobar calculation.

(c) Energy independent analyses: These evaluate the partial waves by making fits at a set of essentially single energies, and are thus the least biased of all analyses. It is necessary to use Watson's theorem to fix the complex phases of many of the partial waves and thus to get a unique solution. Due to the onset of inelasticity, this becomes difficult above the first resonance region, and only BERENDS 77 extends into the second resonance region. This analysis gets significantly different couplings from the other analyses for the D13 N(1520).

New analyses in the Data Card Listings: ARAI 80 is an FTDR analysis of $\gamma p \to \pi^+ n$, $\gamma p \to \pi^0 p$, and $\gamma n \to \pi^- p$ using 7768 data points for energies from 1168 to 2078 MeV and for momentum transfers t out to -1.6 $(\mathrm{GeV}/c)^2$. A K-matrix formalism is used to parametrize the resonances, and a Regge formalism is used for the high energy part of the dispersion integrals.

CRAWFORD 80 is an extension of earlier Glasgow analyses to include more data and more resonances. The imaginary parts of the partial waves are parametrized as Breit-Wigner amplitudes plus background in the S and P waves. The high energy parts of the dispersion integrals are parametrized using a Regge formalism, and data are fitted at all energies for $\gamma p \to \pi^+ n$, $\gamma p \to \pi^0 p$, and $\gamma n \to \pi^- p$. A total of 8838 data points are used for energies up to 2.5 GeV and for t out to -1.5 $(\mathrm{GeV}/c)^2$. Evidence is found to suggest that the P31 Δ(1550) is photoproduced, but it is not conclusive.

BRATASHEVSKIJ 80 is an isobar analysis of $\gamma p \to \pi^0 p$ using recoil proton polarization data from Kharkov and is essentially a variation of METCALF 74.

TAKEDA 80 is similarly a variation of METCALF 74 to fit new recoil proton polarization data in $\gamma n \to \pi^- p$.

FUJII 81 is based on the ARAI 80 analysis and includes new neutron target data.

Resonance couplings and errors in the Data Card Listings: The Listings give the results of all recent and extensive analyses. If no error is given, only a unique result is quoted. The Berkeley analyses and CRAWFORD 75 give for errors the spread of solutions around a central value. The Lancaster group gives for errors the change of value that is required to increase the ``best possible χ^2'' by 1%. METCALF 74, FELLER 76, AZNAURYAN 77, and ARAI 80 quote similar errors. In BARBOUR 78 and CRAWFORD 80, the systematic differences due to the different methods of analysis are considered to be at least as important as the purely statistical errors, and the errors quoted are obtained by comparing with other analyses as well as from the spread of parameters over a number of fits. Thus there is often a wide variation in what the errors quoted in the Listings mean.

Table IV.1 gives a compilation of the γN decay couplings from METCALF 74, KNIES 74, MOORHOUSE 74, DEVENISH2 74, BARBOUR 76, BARBOUR 78, ARAI 80, and CRAWFORD 80. The errors quoted are a combination

Table IV.1. A compilation of measured YN decay couplings and of predictions of the quark model. Sources are given in the text.

Resonance	Target	Helicity	Couplings ($GeV^{-1/2} \times 10^{-3}$) Partial-Wave Analyses	Quark Model Predictions
P_{11} N(1440)	p	1/2	−70 ± 9	−5 to −50
	n	1/2	+42 ± 19	+4 to +38
D_{13} N(1520)	p	1/2	−17 ± 11	−41 to +6
		3/2	+166 ± 7	+95 to +174
	n	1/2	−69 ± 14	−23 to −52
		3/2	−136 ± 14	−102 to −144
S_{11} N(1535)	p	1/2	+67 ± 15	+68 to +147
	n	1/2	−78 ± 29	−83 to −119
S_{11} N(1650)	p	1/2	+45 ± 17	−9 to +95
	n	1/2	−23 ± 33	−45 to +4
D_{15} N(1675)	p	1/2	+13 ± 8	0 to +12
		3/2	+22 ± 12	0 to +16
	n	1/2	−37 ± 24	−31 to −55
		3/2	−54 ± 24	−44 to −78
F_{15} N(1680)	p	1/2	−13 ± 10	−7 to +24
		3/2	+132 ± 15	+47 to +154
	n	1/2	+29 ± 15	−32 to +27
		3/2	−28 ± 16	−25 to +2
D_{13} N(1700)	p	1/2	−20 ± 12	−7 to +9
		3/2	+1 ± 17	−12 to +33
	n	1/2	0 ± 50	−15 to +25
		3/2	+8 ± 42	−17 to −76
P_{11} N(1710)	p	1/2	+3 ± 15	−7 to −37
	n	1/2	+9 ± 30	−21 to +29
P_{13} N(1720)	p	1/2	+60 ± 36	−133 to +74
		3/2	−34 ± 26	−65 to +46
	n	1/2	−6 ± 25	−23 to +57
		3/2	−26 ± 90	−61 to +12
F_{17} N(1990)	p	1/2	+17 ± 35	−8 to −10
		3/2	0 ± 20	−10 to −13
	n	1/2	−82 ± 25	−18 to −19
		3/2	−86 ± 40	−23 to −25
G_{17} N(2190)	p	1/2	−43 ± 40	
		3/2	+131 ± 100	
	n	1/2	−64 ± 45	
		3/2	−60 ± 130	
P_{33} Δ(1232)	p	1/2	−141 ± 6	−94 to −127
		3/2	−258 ± 8	−162 to −220
P_{33} Δ(1600)	p	1/2	+2 ± 30	−61 to +2
		3/2	−3 ± 30	−107 to +4
S_{31} Δ(1620)	p	1/2	+23 ± 38	+43 to +86
D_{33} Δ(1700)	p	1/2	+109 ± 31	+78 to +106
		3/2	+73 ± 35	+78 to +105
F_{35} Δ(1905)	p	1/2	+33 ± 10	−10 to +44
		3/2	−38 ± 19	−41 to +15
P_{31} Δ(1910)	p	1/2	−24 ± 15	−16 to +15
D_{35} Δ(1930)	p	1/2	−46 ± 50	−17
		3/2	+13 ± 50	−24
F_{37} Δ(1950)	p	1/2	−73 ± 12	−25 to −48
		3/2	−85 ± 13	−32 to −69

of the statistical errors from these analyses and the systematic differences between them. Also shown for comparison are the range of predictions for the couplings from recent quark model calculations.[5-8] While the quantitative agreement between the quark models and the measured couplings is not yet good, there is qualitative agreement to the extent that at least one quark model gives the correct sign in the cases where the sign has been clearly measured.

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V. Electroproduction

(by F. Foster, University of Lancaster)

Introduction: Since this review of resonance electroproduction was last revised (1978), several new data sets on virtual photoproduction of single pions have become available. The DESY group has completed its detailed survey of the whole resonance region at values of Q^2 from 0.6 to 3.0 GeV^2. The new data on π^+ and π^0 production and an analysis using the fixed-t dispersion relation methods of Devenish and Lyth[1] are available in internal DESY reports,[2,3] and those on η production are available in reports[2,4] and a publication.[5] Data at smaller Q^2 continue to appear from the Bonn group, for η production[6] at Q^2 = 0.4 GeV^2 and for π^+ and π^0 production[7] at Q^2 = 0.3 GeV^2. The Lancaster-Manchester group working at Daresbury has also completed new data sets at 0.5 and 1.0 GeV^2 using both hydrogen[8,9] and deuterium as targets.[10-12]

Analysis of the new data in terms of the appropriate resonance multipole amplitudes has been facilitated by the availability of the Devenish-Lyth fitting program, which uses fixed-t dispersion relation constraints.[1] Ch. Gerhardt has analyzed much of the data available to 1978,[13] while Davenport and Morris have analyzed recent Daresbury data[14] and V. Gerhardt has analyzed the recent DESY data.[3] There are now quite consistent results for, in addition to the P33 Δ(1232) and the S11 N(1535) resonance multipoles, the D13 N^+(1520) and the F15 N^+(1680) multipoles for Q^2 up to 3.0 GeV^2, and there are some clear indications of the behavior of the D33 Δ^+(1700). Analysis of the Daresbury "neutron target" data[12] has also given good results for the S11 N^0(1535) and D13 N^0(1520) multipoles at Q^2 = 0.5 GeV^2 and allowed significant tests of the generalized $SU(6)_W$ or single-quark excitation models. On the theoretical side, Alcock et al.[15] have presented an excellent review of all recent quark models for resonance electroproduction, as well as their own proposals for suitable quark models on a proper relativistic basis. They conclude that the single-quark transition model can reproduce qualitatively the observed behavior of the orbit-flip, spin-flip, and spin-orbit parameters for the excitation of members of the $[70,1^-]$ multiplet.

<u>First resonance region</u>: Excitation of the P33 Δ(1232) resonance proceeds mainly via the magnetic M_{1+} multipole; the electric E_{1+} multipole is consistent with zero as is expected from SU(6) and the quark model. The scalar multipole has a small but significant negative value with S_{1+} being between 5 and 10% of M_{1+}, and as Q^2 increases the background amplitudes E_{0+} and M_{1-} account for an increasing fraction of the single-pion cross section. The new DESY data[2,3] at Q^2 = 3.0 GeV^2 give $E_{1+}/M_{1+} \approx 0.05 \pm 0.05$ and $S_{1+}/M_{1+} \approx -0.12 \pm 0.05$ at 1230 MeV, and the background ratios are $E_{0+}/M_{1+} \approx 0.5$ and $M_{1-}/M_{1+} \approx -0.3$ near resonance. From its measurements of M_{1+}, the DESY group also obtains a value for the transition form factor $G_M^*(Q^2)$ at Q^2 = 3.0 GeV^2 that is much less subject to systematic error than were the earlier "single arm" measurements of the total cross section. The results confirm that $G_M^*(Q^2)$ falls more rapidly with Q^2 than does the nucleon "dipole" form factor. It is also clear that at the high values of Q^2 the Devenish-Lyth program has great difficulty in fitting the shape of the M_{1+} variation with mass, and also in accommodating the observed background excitation, particularly above 1300 MeV. An unfortunate consequence is that the program cannot give unambiguous results for the excitation of the P11 N(1440) Roper resonance.

<u>The $[70,1^-]$ resonances</u>: Table V.1 gives the results of the various dispersion-relation fits for the low-lying negative-parity resonances S11 N(1535), D13 N(1520), S11 N(1650), and D33 Δ(1700) from the $[70,1^-]$ multiplet. It is difficult to

Table V.1. Results of recent fits to π^0, π^+, and η data for members of the $[70,1^-]$ multiplet.

	Resonance	Multipole (π^+)	$\mu b^{1/2}$
Q^2 = 0.3 GeV^2 Bonn (Refs. 7, 17)	D13 N^+(1520)	E_{2-}	0.34 ± 0.03
		M_{2-}	0.58 ± 0.06
	S11 N^+(1535)	E_{0+}	0.60 ± 0.07
	S11 N^+(1650)	E_{0+}	0.33 ± 0.04
Q^2 = 0.5 GeV^2 Lancaster-Manchester (Ref. 14)	D13 N^+(1520)	E_{2-}	0.37 ± 0.13
		M_{2-}	0.53 ± 0.07
		S_{2-}	0.10 ± 0.10
	D33 Δ^+(1700)	E_{2-}	0.23 ± 0.13
		M_{2-}	-0.17 ± 0.03
		S_{2-}	-0.05 ± 0.05
Q^2 = 1.0 GeV^2 Lancaster-Manchester (Ref. 14)	D13 N^+(1520)	E_{2-}	0.08 ± 0.02
		M_{2-}	0.43 ± 0.05
		S_{2-}	0.0
	D33 Δ^+(1700)	E_{2-}	0.18 ± 0.07
		M_{2-}	-0.06 ± 0.02
		S_{2-}	-0.04

Resonance	Multipole (π^+)	DESY data (Ref. 3) $\mu b^{1/2}$ Q^2=0.6	1.0	2.0	3.0 GeV^2
S11 N(1535)	E_{0+}	0.52	0.51	0.39	0.32
	S_{0+}	-0.30	0.00	-0.11	-0.10
D13 N(1520)	E_{2-}	0.13	-0.04	-0.11	-0.08
	M_{2-}	0.47	0.35	0.17	0.063
	S_{2-}	0.06	0.00	0.00	0.00

assign uncertainties to these results, but where this has been done it reflects the spread observed in independent fits to the same experimental data. Also, the S11 N(1535) multipoles may be regarded as being very well determined since they are extracted from η electroproduction data of high accuracy. The low-Q^2 data from Bonn were analyzed for the helicity 1/2 couplings only, and the multipoles here have been extracted by combining the helicity 3/2 couplings from the analysis of Ch. Gerhardt.[13] The trends in the data are clear: the E_{0+} multipole falls off very slowly so that the S11 N(1535) is the dominant component of the second resonance at $Q^2 > 1.0$ GeV^2. Using only η production cross sections and resonance peak heights from total-cross-section measurements, the following results are obtained:[3]

Q^2 (GeV^2)	σ_{peak} (μb)	S11 (μb)	D13 (μb)
2.0	15.0 ± 1.0	10.07 ± 0.56	5.0 ± 1.2
3.0	7.7 ± 1.1	6.85 ± 0.37	0.88 ± 1.2

It has also been demonstrated that the effect is unlikely to be due to scalar/longitudinal photon excitation, since the following results are obtained for σ_L/σ_T using η production cross sections at different values of the photon polarization:

Q^2 (GeV^2)	σ_L/σ_T	Reference
0.4	0.23 ± 0.14	6
0.6	0.25 ± 0.23	4
1.0	−0.13 ± 0.16	4

In contrast, the electric multipoles for the D13 and D33 resonances fall rather rapidly with Q^2. This is particularly noticeable for the D13 N(1520), where E_{2-} falls from 1.05 μb$^{1/2}$ at $Q^2 = 0$ to less than 0.1 μb$^{1/2}$ at $Q^2 = 1.0$ GeV^2, while the magnetic multipole M_{2-} falls much more slowly. The effect is associated with the well-known rapid changes in excitation of the resonances from mainly helicity 3/2 at $Q^2 = 0$ to mainly helicity 1/2 at $Q^2 > 1$ GeV^2. More detailed discussions may be found elsewhere (e.g., Ref. 17). An alternative and more instructive point of view is to compare the Q^2 variation of the single-quark-transition-model (SQTM) parameters A, B, and C which describe the excitation of all the members of the $[70,1^-]$ multiplet: A and B correspond to orbit- and spin-flip excitation, and C corresponds to simultaneous spin and orbit excitation. The SQTM works well in the photoproduction limit where the parameters are necessary and sufficient to describe all the excitation[16] and A, B, and C are roughly in the ratio 9:4:4. The relations between A, B, and C and the dominant multipole amplitude are given in Ref. 17, and it is straightforward to determine A, B, and C as functions of Q^2 using the results outlined in Table V.1. Figure V.1 shows these results, and it is certain that at high Q^2 the spin-flip amplitude B dominates. This behavior is expected from most explicit quark models,[15,17] and Fig. V.1 also shows the results of a recent quark model calculation[18] based on the successful photoproduction model of Kubota and Ohta.[19] Two points may be mentioned: (1) agreement between the explicit model and the data could only be achieved by including an effective quark "form factor;" and (2) at high Q^2 the spin-orbit term C seems to go significantly negative in contradiction to quark model expectations.[15,20]

The SQTM may be further tested by comparing the predictions for the neutron-target multipoles of I=1/2 resonances calculated from the observed values of A, B, and C with the results of the Daresbury deuterium-target experiments. This has been done with some degree of success by the Daresbury group,[10-12,17] and their results are given in Table V.2.

<u>The P11 N(1440)</u>: Interest in this enigmatic resonance persists because two rather different theoretical approaches both predict that the M_{1-} multipole sign will change as Q^2 increases from zero. In photoproduction, M_{1-} has the wrong sign according to the simplest quark models, but consideration of the large spin-orbit contribution to the excitation in an explicit model[19] gives rough agreement with experiment. As in the $[70,1^-]$ multiplet, spin-orbit excitations become less important as Q^2 increases, so the multipole should revert quickly to its nominal sign.[18] The same effect is predicted by Gavela[21] using a "bag" model for electroproduction. Experimentally the situation is still far from clear, but such sign changes

are certainly not ruled out.[17]

The F15 N(1680): All analyses of the data near the third resonance give consistent values for

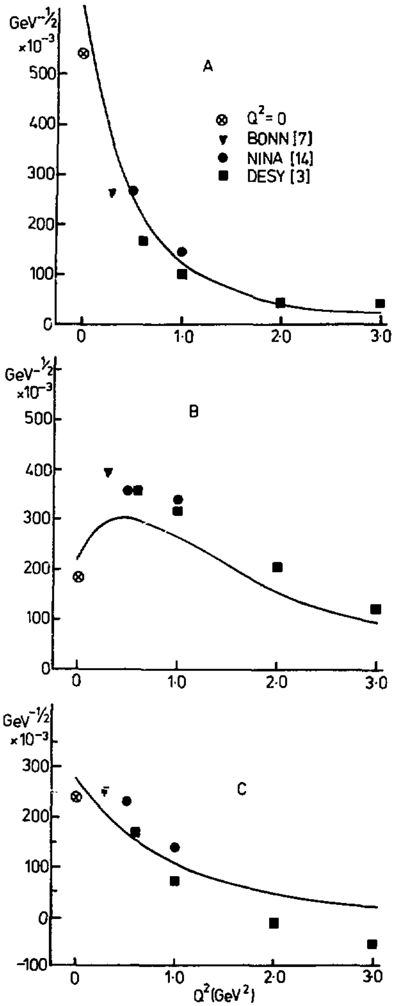

Fig. V.1. The Q^2 variation of the orbit-flip, spin-flip, and spin-orbit-flip parameters A, B, and C for the [70, 1$^-$] multiplet. The curves are from Ref. 18.

the E_{3-} and M_{3-} multipoles for this [56,2$^+$] multiplet member. Table V.3 shows the results, and again the electric multipole falls much more rapidly than the magnetic multipole. This clearly agrees with the quark model expectation that spin-flip amplitudes must dominate at high Q^2.

References for Section V

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Table V.2. A comparison of neutron-target results at Q^2=0.5 GeV^2 (Ref.12) with SQTM predictions.

Resonance	Multipole (π^-)	$\mu b^{1/2}$ Data	SQTM
S11 N^0(1535)	E_{0+}	−0.11	−0.46
D13 N^0(1520)	E_{2-}	−0.55	−0.43
	M_{2-}	−0.16	−0.07
D33 Δ(1700)	E_{2-}	−0.13	−0.20
	M_{2-}	+0.029	+0.036
D13 N(1700)	E_{2-}	−0.034	−0.093
	M_{2-}	+0.016	−0.037
S11 N(1650)	E_{0+}	−0.09	−0.34

Table V.3. The F15 N(1680) resonance amplitudes.

Q^2 (GeV^2)	Amplitudes $(\mu b)^{1/2}$ E_{3-}	M_{3-}	S_{3-}	Ref.
0.0	0.47	0.16	--	
0.3	0.16 ± 0.02	0.27 ± 0.03	--	7
0.5	0.12 ± 0.10	0.27 ± 0.01	−0.02 ± 0.02	14
0.6	0.13	0.17	0.01	3
1.0	0.01	0.23 ± 0.02	0.01 ± 0.01	14
1.0	0.07	0.15	0.00	3
2.0	0.013	0.083	0.00	3
3.0	−0.084	0.038	0.00	3

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21. M. Gavela, Phys. Rev. D21, 182 (1980).

VI. Production Experiments

Partial-wave analyses of course separate partial waves, whereas a peak in a cross section or an invariant mass distribution usually cannot be disentangled from background and analyzed for its quantum numbers; and more than one resonance may be contributing to the peak. Thus results from production experiments are kept under separate headings in the Listings (e.g., 1520 MEV REGION -- PRODUCTION EXPERIMENTS), and they are not used for getting numbers in the Baryon Table.

There is not much new on N and Δ resonances from production experiments in this edition, so we refer to the previous edition for a lengthy review of the diffractive production of Nπ and Nππ systems.[1]

Reference for Section VI

1. Particle Data Group, Rev. Mod. Phys. 52, S188 (1980).

S=0 I=1/2 NUCLEON STATES (N)

p

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16  PROTON(938, J=1/2)  I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS
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n

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17  NEUTRON(939, J=1/2)  I=1/2
SEE STABLE PARTICLE DATA CARD LISTINGS
```

N(1440) **P11**

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61  N*1/2(1440, JP=1/2+) I=1/2

MASS AND WIDTH ARE BEST DETERMINED FROM PARTIAL WAVE
ANALYSES.  WE LIST PRODUCTION EXPERIMENTS SEPARATELY --
SEE THE NEXT ENTRY IN THE LISTINGS.

AYED 76 CLAIMS TWO P11 STATES IN THE 1500 MEV REGION.
WE TENTATIVELY LIST BOTH HERE.

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             61  N*1/2(1440) MASS (MEV)

M         (1370.0)                  BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M         (1380.0)                  ROPER     65 RVUE    PHASE-SHIFT ANAL  9/66
M   1     (1410.0)                  BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/57
M   1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3     (1466.0)                  DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/59
M   6     (1461.0)                  AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1462.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7     (1470.)                   ALMEHED   72 IPWA                      2/72
M          1405. TO 1420.           CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
M    L     1415. CR 1390.           LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75
M   2     (1413.)                   AYED      76 IPWA                     11/77
M   2     (1532.)                   AYED      76 IPWA                     11/77
M   2   AYED 76 FINDS 2 DIFFERENT P11 RESONANCES IN THIS REGION IN CONTRAST 11/77
M   2   TO ALL OTHER PWAS.  WE LIST BOTH TOGETHER HERE UNTIL               11/77
M   2   SITUATION IS FURTHER CLARIFIED.                                    11/77
M         (1404.)                   BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M         (1460.)                   BERENDS   77 IPWA    PI-N PHOTOPROD.   1/78
M   8     (1380.)                   LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M   8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                        11/77
M    9    (1417.)                   BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M    9  SUPERSEDES BARBOUR 76.                                             3/79
M   5     (1472.)                   BAKER     79 DPWA  0 PI- P TO ETA N   12/79
M         (1450.)     (30.)         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M          1410.      12.           HOEHLER   79 IPWA    PI N TO PI N     12/79
M         (1411.0)                  CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M          1440.      30.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

---------------------------------------------------------------

             61  N*1/2(1440) WIDTH (MEV)

W   1      (255.0)                  BAREYRE   68 RVUE                     11/67
W   3      (211.0)                  DONNACHI  68 RVUE                      6/68
W   6      (164.0)                  AYED      70 IPWA                      1/71
W   4      (391.)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W   7      (720.)                   ALMEHED   72 IPWA                      2/72
W           255. TO  396.           CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
W    L      180. CR  200.           LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W   2      (182.)   (SMALLER MASS)  AYED      76 IPWA                     11/77
W   2       (75.)   (LARGER MASS)   AYED      76 IPWA                     11/77
W          (330.)                   BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W          (279.)                   BERENDS   77 IPWA    PI-N PHOTOPROD.   1/76
W   8      (200.)                   LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W    9     (331.)                   BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W   5      (113.)                   BAKER     79 DPWA  0 PI- P TO ETA N   12/79
W          (970.)     (80.)         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W           135.      10.           HOEHLER   79 IPWA    PI N TO PI N     12/79
W          (334.0)                  CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W           340.      70.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

---------------------------------------------------------------

             61  N*1/2(1440) REAL PART OF POLE POSITION (MEV)          1/74

RE        (1375.)     (5.)          LEE       73         FIT TO ALMEHED72  1/74
RE        (1381.)                   LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE  8      1360. OR 1333.           LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE        (1369.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE         1375.      30.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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             61  N*1/2(1440) -2*IMAG PART OF POLE POSITION (MEV)       1/74

IM         (216.)     (10.)         LEE       73         FIT TO ALMEHED72  1/74
IM         (209.)                   LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM  8       167. OR 234.            LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM         (178.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM          180.      40.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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             61  N*1/2(1440) REAL PART OF ELASTIC POLE RESIDUE (MEV)

REF         (-9.)                   CUTKOSKY  79 IPWA    PI N T  PI N     12/79
REF          -9.      31.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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Data Card Listings

For notation, see key at front of Listings.

Baryons

N(1440)

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                61  N*1/2(1440) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR      (-48.)                   CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR       -51.      7.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                61  N*1/2(1440) ABSOLUTE VALUE OF POLE RESIDUE (MEV)     1/74

ABS      (74.)     (5.)           LEE       73         FIT TO ALMEHED72   1/74
ABS       52.       5.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                61  N*1/2(1440) PHASE OF POLE RESIDUE (RADIANS)          1/74

PH       (-1.4)                   LEE       73         FIT TO ALMEHED72   1/74
PH        -1.75     0.61          CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                61  N*1/2(1440) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      N*1/2(1440) INTO PI N                          139+ 938
P2      N*1/2(1440) INTO N EPSILON                     938+1300
P3      N*1/2(1440) INTO N*3/2(1232) PI               1232+ 139
P4      N*1/2(1440) INTO N PI PI                       938+ 139+ 139
P5      N*1/2(1440) INTO GAMMA N                         0+ 938
P6      N*1/2(1440) INTO N RHO                         938+ 769
P7      N*1/2(1440) INTO GAM P, HELICITY=1/2             0+ 938
P8      N*1/2(1440) INTO GAM N, HELICITY=1/2             0+ 939
P9      N*1/2(1440) INTO ETA N                         939+ 548
P10     N*1/2(1440) INTO K LAMBDA                      497+1115
P11     N*1/2(1440) INTO N RHO,S=1/2,P-WAVE            938+ 769
P12     N*1/2(1440) INTO N RHO,S=3/2,P-WAVE            938+ 769

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                61  N*1/2(1440) BRANCHING RATIOS

R1      N*1/2(1440) INTO (PI N)/TOTAL                      (P1)
R1  L        (0.68)                BAREYRE   68 RVUE                     11/67
R1  3        (0.658)               DONNACHI  68 RVUE                      6/68
R1  6        (0.564)               AYED      70 IPWA                      1/71
R1  4        (0.49)                DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1  A        (0.67)   (0.18)       SAXON     70 HBC     AT 1400 MEV       6/70
R1  B        (0.58)   (0.09)       SAXON     70 HBC                       6/70
R1  7        (0.65)                ALMEHED   72 IPWA                      2/72
R1  2        (0.54) (SMALLER MASS) AYED      76 IPWA                     11/77
R1  2        (0.16) (LARGER MASS)  AYED      76 IPWA                     11/77
R1  A A AND B CORRESPOND TO THE 2 BEST SOLUTIONS.  ANALYSIS IS DONE ON THRE
R1  B BODY DECAYS, ASSUMING ONLY P1, P2 AND P3 DECAYS PRESENT.
R1           (0.65)   (0.05)       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
R1            0.51     0.05        HOEHLER   79 IPWA    PI N TO PI N     12/79
R1            0.68     0.04        CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1           . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      N*1/2(1440) INTO (N EPSILON)/TOTAL                 (P2)
R2          DOMINANT INELASTIC DECAY   THURNAUER 65 RVUE -                11/67
R2          DOMINANT INELASTIC DECAY   NAMYSLOWS 66 RVUE -                11/67
R2          DOMINANT INELASTIC DECAY   ROSENFELD 67 RVUE -                11/67
R2          DOMINANT INELASTIC DECAY   MORGAN    68 RVUE    ISOBAR MODEL   6/68
R2  D        (0.16)                DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R2  D       ASSUMING  R1= 0.61
R2  A        (0.30)   (0.20)       SAXON     70 HBC                       6/70
R2  B        (0.20)   (0.12)       SAXON     70 HBC                       6/70
R2  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS. SEE NOTE IN R1.

R3      N*1/2(1440) INTO (N*3/2(1232) PI)/TOTAL            (P3)
R3  D        (0.17)                DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R3  D       ASSUMING  R1= 0.61
R3  A        (0.03)   (0.20)       SAXON     70 HBC                       6/70
R3  B        (0.22)   (0.12)       SAXON     70 HBC                       6/70
R3  A AND B CORRESPOND TO THE 2 BEST SOLUTIONS. SEE NOTE IN R1.
R3  R        (0.20)                MAKAROV   71 IPWA  0 PI- P TO PI PI N  3/72
R3  R   ASSUMES R1=0.6. MAXIMUM CM ENERGY ANALYZED WAS 1495 MEV.

R4      N*1/2(1440) INTO (GAMMA N)/(PI N)                  (P5)/(P1)
R4   F       STRONG INDICATION     ROSSI     73 DBC   0 GAM N TO PI-P     2/73
R4   F  DISAGREES WITH OTHER DATA                                         2/73

R5      N*1/2(1440) INTO (N RHO )/TOTAL                    (P6)
R5  D        (0.07)                DIEM      70 IPWA    3 BODY ANALYSIS   1/71
R5  D       ASSUMING  R1= 0.61

R6      N*1/2(1440) INTO (GAMMA N)/TOTAL                   (P5)
R6  E        (0.0006)              MICKENS   71            THEORETICAL EST. 10/71
R6  E   TOTAL WIDTH TAKEN AS 250 MEV.

R7      N*1/2(1440) FROM PI N INTO ETA N                   SQRT(P1*P9)        2/74
R7           (+0.23)               LEMOIGNE  73 DPWA     1488 TO 1685 MEV   2/74
R7  9        (+0.328)              FELTESSE  75 DPWA  0 1488 TO 1745 MEV  11/75
R7  9   SUPERSEDES LEMOIGNE 73. USES M AND W OF AYED 76 (LARGER MASS).    11/75
R7  9   AN ALTERNATIVE WHICH CAN NOT BE DISTINGUISHED FROM THIS IS TO HAVE  11/75
R7  9   A P13 RESONANCE WITH M=1530, W=79, AND COUPLING=+.271             11/75
R7  5   BAKER 79 FINDS A COUPLING OF THE N*(1440) TO THE ETA N CHANNEL    12/79
R7  5   NEAR (BUT SLIGHTLY BELOW) THRESHOLD.                              12/79

R8      N*1/2(1440) FROM PI N TO K LAMBDA                  SQRT(P1*P10)       4/75
R8 C         -0.296    0.068       DEVENISH  74          0 FIXED T DISP REL  4/75
R8 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.             4/75

R9      N*1/2(1440) FROM PI N TO N*3/2(1232) PI            SQRT(P1*P3)       11/75
R9   L       (-0.30)OR -0.37       LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R9  B        (-0.41)               LONGACRE  77 IPWA    PI N TO 2PI N    11/77
R9  B   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R10     N*1/2(1440) FROM PI N TO N RHO,S=1/2,P-WAVE        SQRT(P1*P11)      11/75
R10  L       (0.0) OR -0.23        LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R10 B        (+0.11)               LONGACRE  77 IPWA    PI N TO 2PI N    11/77

R11     N*1/2(1440) FROM PI N TO N RHO,S=3/2,P-WAVE        SQRT(P1*P12)      11/77
R11 B        (-0.18)               LONGACRE  77 IPWA    PI N TO 2PI N    11/77
R11 B   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R12     N*1/2(1440) FROM PI N TO N EPSILON                 SQRT(P1*P2)       11/75
R12  L       (0.18)OR +0.23        LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R12 B        (+0.18)               LONGACRE  77 IPWA    PI N TO 2PI N    11/77

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                61  N*1/2(1440) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1440) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1            -0.096     0.022       DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A1           (-0.080)                HEMMI1    73       * FND PI0 PHTOPROD   2/74
A1            -0.055     0.028       MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A1            -0.079     0.012       DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A1            -0.066     0.013       KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A1            -0.070     0.023       METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A1            -0.087     0.002       MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A1            -0.070     0.040       CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A1           (-0.071)                KRIVETS   75 DPWA    PI-N PHOTOPROD.    1/78
A1           (-0.053)                BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1            -0.087     0.00        FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A1            -0.038     0.01        AZNAURYAN 77 DPWA    PI0 PHTPRD.SOL 1 12/79
A1            -0.019     0.011       AZNAURYAN 77 DPWA    PI0 PHTPRD.SOL 2 12/79
A1           (-0.076)                BERENDS   77 IPWA    PI-N PHOTOPROD.    1/78
A1    9       -0.075     0.015       BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1    N      (-0.125)                NOELLE    78         PI-N PHOTOPROD.    1/80
A1    N  CONVERTED TO OUR CONVENTIONS USING M=1.486, W=.613 FROM NOELLE 78.    1/80
A1            -0.069     0.004       ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A1            -0.066     0.004       ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A1            -0.079     0.009       BRATASHEV 80 DPWA    PI N PHOTOPROD.  12/81*
A1            -0.068     0.015       CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1            -0.0584    0.0148      ISHII     80 DPWA    P COMPTON SCAT   12/81*
A1           . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

A2      N*1/2(1440) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2             0.089     0.056       DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A2 B         (-0.001)                HEMMI2    73       0 GAM N TO PI0 N     4/75
A2 B     CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.55    4/75
A2            +0.002     0.025       MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A2 F           0.117     0.011       ROSSI     73 DPWA  0 GAM N TO PI- P     4/75
A2 F     CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.55    4/75
A2 5          (0.083)                BENEVENT  74 DPWA  0 GAM N TO PI- P     4/75
A2 5     CONVERTED TO OUR CONVENTIONS USING M=1470 MEV, W=230 MEV, X=.55     4/75
A2             0.041     0.025       DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2             0.000     0.013       KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2             0.043     0.035       METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2             0.033     0.013       MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A2            +0.044     0.007       CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2           (+0.058)                BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2    9       +0.059     0.016       BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2    N       (0.062)                NOELLE    78         PI-N PHOTOPROD.    1/80
A2    N  CONVERTED TO OUR CONVENTIONS USING M=1.486, W=.613 FROM NOELLE 78.    1/80
A2             0.023     0.009       ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A2             0.019     0.012       ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A2             0.056     0.015       CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2            -0.029     0.035       TAKEDA    80 DPWA    PI N PHOTOPROD.  12/81*
A2             0.030     0.003       FUJII     81 DPWA    PI N PHOTOPROD.  12/81*
A2           . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                         REFERENCES FOR N*1/2(1440)

BRANDSEN 6  PR 139 B1566        +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190         LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985          P G THURNAUER                          (ROCH)

NAMYSLOW 66 PR 157 1328         NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)

ROSENFEL 67 IRVINE CONF         A H ROSENFELD, P SODING                  (LRL)

BAREYRE  68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR - TALK           (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731         D MORGAN                               (RHEL)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.          + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)
SAXON    70 PR D2 1790          SAXON, MULVEY, CHINOWSKY           (OXF,LRL)

MAKAROV  71 SJNP 13 510         +GASILOVA,NELYUBIN,++         (IOFFE INST)IJP
MICKENS  71 LNC  1  707         R E MICKENS                            (FISK)
ALMEHED  72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79           HEMMI,INAGAKI+           (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333          +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEE      73 PRL 31 1029         LEE,SHAW        (UCI+ROYAL HOLLOWAY COLLEGE)IJP
LEMOIGNE 73 PURDUE CONF. 93     +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                (GLAS+LBL)IJP
ROSSI    73 NC 13A 59           +PIAZZA,SUSINNO,+     (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1163          CARBONARA,FIORE,+     (NAPL,FRAS,PAVIA,ROMA)IJP

BENEVENT 74 NC 19A 529          BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK             (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                    (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                             (GLAS)IJP
FELTESSE 75 NP B93 242          +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KRIVETS  75 SJNP 20 433         +MIROSHNICHENKO,NIKIFOROV,SANIN+         (KIEV)IJP
    ALSO 74 SJNP 19 112         KRIVETS,NIKIFOROV,SANIN,SHALATSKII      (KIEV)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+          (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795         LONGACRE,LASINSKI,ROSENFELD+         (LBL,SLAC)

AYED     76 CEA-N-1921          AYED (THESIS)                            (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD             (GLAS)IJP
FELLER   76 NP B104 219         +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77     +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BERENDS  77 NP B136 317         F.A.BERENDS,A.DONNACHIE             (LEID,MCHS)IJP
LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                         (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET            (SACL)IJP

BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS                 (GLAS)
NOELLE   78 PTP 6C 778          P. NOELLE                                (NAGO)
BAKER    79 NP B156 93          +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+   (RHEL)IJP
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY              (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN            (KARLSRUHE)IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                             (KARLSRUHE)IJP
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ARAI      80  TORONTO CONF 93  I. ARAI                             (TOKY)
BRATASHE 80 NP B166 525        BRATASHEVSKIJ,GORBENKO,DEREBCHINSKIJ+(KHAR)
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                         (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
ISHII    80 NP B165 189        ISHII,EGAWA,KATO,MIYACHI+         (KYOT+TOKY)
TAKEDA   80 NP B168 17         TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+      (TOKY)
FUJII    81 NP B187 53         FUJII,HAYASHII,IWATA,KAJIKAWA+        (TOKY)

                               PAPERS NOT REFERRED TO IN DATA CARDS

BAREYRE  64 PL 8 137           +BRICMAN,VALLADAS,VILLET, +   (SACLAY,CAEN) IJ
BAREYRE  65 PL 18 342          +BRICMAN, STIRLING, VILLET        (SACLAY)IJP
DALITZ   65 PL 14 159          R H DALITZ, R G MOORHOUSE          (OXF,RHEL)
JOHNSON  67 UCRL-17683 THESIS C W JOHNSON                              (LRL)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
WALKER   69 PR 182 1729        R L WALKER                            (CIT)IJP
AYED     70 PL 31B 598         +BAREYRE,VILLET                      (SACLAY)
BERARDO  70 PRL 24 419         +HADDOCK,NEFKENS,...,PARSONS+..   (UCLA+LRL)
AYED     72 BATAVIA CONF       R AYED,P BAREYRE, Y LEMOIGNE           (SACL)

     THE FOLLOWING ARE THEORETICAL PAPERS CONCERNING THE N*1/2(1440) --
RESNICK  66 PR 150 1292        L RESNICK                        (NIELS BOHR)
SCHWARZ  66 PR 152 1325        J H SCHWARZ                             (LRL)
BALL     67 PR 155 1725        JS BALL, GL SHAW, DY WONG   (UCLA,UCI,UCSD)
GOLDBERG 67 PR 154 1558        H GOLDBERG                          (CORNELL)
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1440 MEV REGION - PRODUCTION EXPERIMENTS

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              91  N*1/2(1440, JP=     ) I=1/2   PRODUCTION EXPERIMENTS

              UNDER THIS HEADING WE INCLUDE ALL BUMPS WHICH LIE WELL
              BELOW 1500 MEV.  SEE THE MINI-REVIEW PRECEDING THE N
              AND DELTA LISTINGS FOR A DISCUSSION OF PRODUCTION
              EXPERIMENTS.

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              91  N*1/2(1440) MASS (MEV) (PROD.EXP.)

M         (1400.)   APPROX             COCCONI   64 CNTR +  PP 3.6-12 GEV/C
M         (1425.)   APPROX             ADELMAN   65 HBC  +  K-P 1.45 GEV/C   7/66
M         (1430.)   APPROX             ANKENBRAN 65 CNTR +  PP 7.1 GEV/C     7/66
M         (1400.)   APPROX             BELLETTIN 65 SPRK +  PP,D 10-26 GEV/C 7/66
M         (1405.)    (15.)             ANDERSON  66 SPRK +  PP, 6-30 GEV/C   7/66
M         (1410.)    (15.)             BLAIR     66 CNTR +  PP 2.8-7.9 GEV/C 7/66
M         (1400.)    (30.)             FOLEY     67 CNTR    PI+- P AND PP   11/67
M         (1450.)    (17.)             ALMEIDA   68 HBC  +  PP-P2PI. 10GEV/C 10/69
M         (1425.)   APPROX             BELL      68 HBC     PI+- P, 6 GEV/C  6/68
M         (1400.)   APPROX             LAMSA     68 HBC     PI-P, 8 GEV/C    6/68
M   S  175(1446.)    (11.)             SHAPIRA   68 DBC     INTO PPI,PN 7.0 10/69
M   S   THE EFFECT OF SHAPIRA 68, WITH MUCH IMPROVED DATA, HAS ALMOST       11/77
M   S   DISAPPEARED (YEKUTIELI 72).                                         11/77
M         (1390.)    (20.)             TAN       68 HBC     PP TO PIP, 6.1  10/69
M      120(1443.)    (15.)             RHODE     69 HBC     PP 22 GEV/C     10/69
M         (1410.)    (13.)             ANDERSON  70 MMS  -  PI- P TO PI- MMS 2/71
M         (1430.)    (20.)             BALLAM    71 HBC  +- PI+-P AT 16GEV   2/72
M         (1460.)                      BEKETOV   71 HBC  +  PI- P 4.45GEV/C  3/72
M         (1461.)    (10.)             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD 3/72
M      120(1462.0)    (6.0)   120/80   MA        71 HBC  +  P P TO P N PI   10/71
M         (1425.)    (25.)             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV 2/72
M         (1411.0)   (10.0)            EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV   1/73
M       64(1410.0)   (33.0)            GAGE      72       D PD  5.9GEV/C    12/72
M         (1464.0)    (7.0)    45/45   KARSHON   72 DBC  +  PD--PD2PI 7 GEV 12/72
M         (1440.)    (15.)             RONAT     72  HBC    PI+P TO 3PI P    2/73
M         (1479.)     (8.)             LICHTMAN  74 HBC  +  PI+P TO 3PI P    4/75
M         (1430.)     (8.)             LICHTMAN  74 HBC  +  PI-P TO 3PI P    4/75
M   I     (1450.)                      BLOBEL    75 HBC  +  PP TO P(PI+PI-P) 1/76
M   I   PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY AN                    1/76
M   I   S-WAVE DELTA++PI- SYSTEM WITH I,JP=1/2,3/2-.                         1/76
M         (1450.)    (16.)             CAVALLI   75 SPEC +  PP TO 2N*,W=23GV 1/76
M         (1462.)    (11.)             CAVALLI   75 SPEC +  PP TO 2N*,W=31GV 1/76
M         (1466.)    (28.)             CAVALLI   75 SPEC +  PP TO 2N*,W=53GV 1/76
M         (1390.)    (10.)             MUSGRAVE  75 HBC     K+ P TO K PI N  11/75
M          1350. TO 1400.              STRACHMA  75  BC     NBAR (N PI)      1/76
M         (1450.)    (10.)             ATHERTON  76 HBC     PBAR P 5.7 GEV   2/77
M          1400. TO 1420.              RUSHBROD  76  HBC    P PI- S1-WAVE    2/77
M          1400. TO 1425.              RUSHBROD  76  HBC    P PI- P1-WAVE    2/77
M         (1459.)    (20.)             APPLE     77 SPEC +  P P TO P (P PI0) 1/78
M         (1473.)     (5.)             APPLE     77 SPEC +  P P TO P (N PI+) 1/78
M         (1460.)    (10.)             HEINEN    77 HBC  +  K-P TO K- N*+    1/78
M         (1473.)    (10.)             HEINEN    77 HBC   0 K-P TO K0BAR N*0 1/78
M         (1490.)    (20.)             EKELOF    78 SPEC +  P HE--P PI PI HE 1/78
M   W  707(1454.)    (20.)             KENNEDY   78 HBC  +  PI+ P 10.3 GEV/C 3/77
M   W   WIDTH FIXED AT 180 MEV.
M   G  870(1419.)     (7.)             APELDOORN 79 HBC  +- PBAR P 7.2 GEV/C 12/79
M   G  300(1409.)     (7.)             APELDOORN 80 HBC  +- PBAR P 12 GEV/C  2/82*
M   G   PEAK COULD NOT BE FITTED WITH SINGLE BREIT-WIGNER.  GAUSSIAN OF     12/79
M   G   SIGMA 51 MEV FOLDED IN.                                             12/79
M       1K(1451.)     (7.)             FUKUNAGA  80 HBC  +  PI+P TO PI PI N  2/82*

M       WE LIST BELOW THOSE (PI N) ENHANCEMENTS PEAKING WELL BELOW 1400 MEV
M       AND PRODUCED WITHOUT CHARGE EXCHANGE AT LOW MOMENTUM TRANSFER.
M         (1250.)                      LISSAUER  72 DBC   0 K+N TO K+N* 12GV 1/78
M         (1250.)                      BERLAND   74 HBC  +0 ISOSPIN ANALYSIS 10/7+
M   B     (1230.)                      BRAUNZ    75  BC     PBAR P AND D,5.7 11/75
M   B     (1230.)                      STRACHMA  75  BC     NBAR (N PI)      1/76
M   B   BRAUNZ 75 AND STRACHMAN 75 ANALYSE THE SAME DATA.                    1/78
M   I     (1350.)                      CHADWICK  78 HYBR +  PI+-P  14 GEV/C  1/78
M   I   CHADWICK 78 CONCLUDE THAT AN INTERPRETATION OF THEIR PEAK AS A       1/78
M   I   RESONANCE IS HIGHLY IMPROBABLE.                                      1/78
M      600(1344.)     (5.)             FUKUNAGA  80 HBC  +  PI+P TO PI PI N  2/82*

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              91  N*1/2(1440) WIDTH (MEV) (PROD. EXP.)

W          (100.)                      BELL      68 HBC     PI+- P AND PP    6/68
W   S  175 (198.)    (40.)             SHAPIRA   68 DBC                     10/69
W          (150.)    (60.)             TAN       68 HBC  +                  10/69
W      120 (100.)    (15.)             RHODE     69 HBC     PP 22 GEV/C     10/69
W          (210.)    (15.)             ANDERSON  70 MMS  -  PI- P TO PI- MMS 2/71
W          (150.)    (40.)             BALLAM    71 HBC  +- PI+-P AT 16GEV   2/72
W          (100.)                      BEKETOV   71 HBC  +  P PI+ PI- MASS   3/72
W           (60.)    (20.)             BOESEBEC  71 RVUE    PP,PI-P,K-P PROD 3/72
W   T  120  (54.0)   (12.0)   120/80   MA        71 HBC  +  P P TO P N PI   10/71
W   T   NARROW WIDTH SUGGESTS THIS IS NOT THE USUAL N*(1440).               10/71
W          (125.)    (25.)             RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV 2/72
W          (188.0)   (38.0)            EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV   1/73
W          (212.0)   (62.0)            GAGE      72 DBC   0 PD  5.9GEV/C    12/72
W          (124.0)   (20.0)            KARSHON   72 DBC  +  PD--PD2PI 7 GEV 12/72
W          (100.)    (30.)             RONAT     72  HBC    PI+P TO 3PI P    2/73
W           (50.)    (25.)             LICHTMAN  74 HBC  +  PI+P TO 3PI P    4/75
W           (62.)    (18.)             LICHTMAN  74 HBC  +  PI-P TO 3PI P    4/75
W          (250.)    (95.)             CAVALLI   75 SPEC +  PP TO 2N*,W=23GV 1/76
W          (249.)    (90.)             CAVALLI   75 SPEC +  PP TO 2N*,W=31GV 1/76
W          (205.)   (105.)             CAVALLI   75 SPEC +  PP TO 2N*,W=53GV 1/76
W          (145.)    (35.)             MUSGRAVE  75 HBC     K+ P TO K PI N  11/75
W          (145.)    (18.)             ATHERTON  76 HBC     PBAR P 5.7 GEV   2/77
W          (145.)    (30.)             RUSHBROD  76  HBC    P PI- S1-WAVE    2/77
W          (273.)    (90.)             RUSHBROD  76  HBC    P PI- P1-WAVE    2/77
W          (120.)    (20.)             APPLE     77 SPEC +  P P TO P (P PI0) 1/78
W           (30.)    (30.)             APPLE     77 SPEC +  P P TO P (N PI+) 1/78
W          (120.)    (20.)             HEINEN    77 HBC  +  K-P TO K- N*+    1/78
W           190.)    (30.)             HEINEN    77 HBC   0 K-P TO K0BAR N*0 1/78
W          (200.)                      EKELOF    78 SPEC +  P HE--P PI PI HE 1/78
W   G  870 (120.)    (10.)             APELDOORN 79 HBC  +- PBAR P 7.2 GEV/C 12/79
W   G  300  (87.)     (1.)             APELDOORN 80 HBC  +- PBAR P 12 GEV/C  2/82*
W   G   PEAK COULD NOT BE FITTED WITH SINGLE BREIT-WIGNER.  GAUSSIAN OF
W   G   SIGMA 51 MEV FOLDED IN.
W       1K (132.)    (22.)             FUKUNAGA  80 HBC  +  PI+P TO PI PI N  2/82*

W        (PI N) ENHANCEMENTS PEAKING WELL BELOW 1400 MEV.
W          (300.)                      LISSAUER  72 DBC   0 K+N TO K+N* 12GV 1/78
W      600  (66.)    (14.)             FUKUNAGA  80 HBC  +  PI+P TO PI PI N  2/82*

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              91  N*1/2(1440) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      N*1/2(1440) INTO PI N                            139+ 938
P2      N*1/2(1440) INTO N PIPI(J,I=0)                   938+ 139+ 139
P3      N*1/2(1440) INTO N*3/2(1232) PI                 1232+ 139
P4      N*1/2(1440) INTO N PI PI                         938+ 139+ 139
P5      N*1/2(1440) INTO GAMMA N                           0+ 938
P6      N*1/2(1440) INTO N RHO                           939+ 769

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              91  N*1/2(1440) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(1440) INTO (PI N)/TOTAL                    (P1)
R1            (0.66)                  TAN       68 HBC     PP TO PIP, 6.1  10/69

R2      N*1/2(1440) INTO (N*3/2(1232) PI)/TOTAL          (P3)
R2            PROBABLY SEEN           JESPERSEN   HBC      PP 22 BEV/C     11/68
R2            PROBABLY SEEN           LAMSA     68 HBC     PI-P 8 BEV/C    11/68
R2            DOMINANT                BLOBEL    75 HBC  +  PP TO P(PI+PI-P) 1/78

R3      N*1/2(1440) INTO (N*3/2(1232) PI)/(N P PI)       (P3)/(P4)
R3 P          0.5       0.2           HEINEN    77 HBC  +  K-P TO K- N*+    1/78
R3 P     FOR THE P PI+ PI- FINAL STATE ONLY.                                1/78
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                                REFERENCES FOR N*1/2(1440) (PROD. EXP.)

COCCONI  64 PL    8 134         +LILLETHUN,SCANLON,STAHLBRANDT, +     (CERN)
ADELMAN  65 PRL 14 1043         S L ADELMAN                (CAMBRIDGE(CERN))
ANKENBRA 65 NC   35 1052        ANKENBRANDT,CLYDE,CORK,KEEFE,KERTH+    (LRL)
BELLETTI 65 PL   18 167         BELLETTINI,COCCONI,DIDDENS +          (CERN)
ANDERSON 66 PRL 16   855        +BLESER,COLLINS,FUJII,+           (BNL,CARN)
BLAIR    66 PRL 17   789        +TAYLOR,CHAPMAN,+  (HARWELL,QUEENMARY,RHEL)

FOLEY    67 PRL 19   397        +JONES,LINDENBAUM,LOVE,OZAKI+          (BNL)
ALMEIDA  68 PR 174 1638         +RUSHBROOKE,SCHARENGUIVEL+      (CAVE,DESY)
BELL     68 PRL 20   164        +CRENNELL,HOUGH,KARSHON,LAI+     (BNL,CUNY)
JESPERSE 68 PRL 21 1368         JESPERSEN,KANG,KERNAN+          (IOWA STATE)
LAMSA    68 PR 166 1395         +CASON,BISWAS,DERADO,GROVES,+  (NOTRE DAME)
SHAPIRA  68 PRL 21 1835         +BENARY,EISENBERG,RONAT,YAFFE+        (REHO)
TAN      68 PL 28B 195          TAN,PERL,MARTIN,VHIN' ...KU +  (SLAC+LRL+UCI)
RHODE    69 PR 187 1844         RHODE, LEACOCK, KERNAN, JESPERSEN,+    (ISU)
ANDERSON 70 PRL 25 699          +BLESER,BLIEDEN,COLLINS++        (BNL,CARN)

BALLAM   71 PR D4 1946          +CHADWICK,GUIRAGOSSIAN,JOHNSON,++   (SLAC) I
BEKETOV  71 SJNP 13 605         +ZOMBKOVSKII,KONDVALOV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445          BOESEBECK,GRAESSLER,KRAUS,+++    (ABBCHLY) I
MA       71 PRL  26  333        +COLTON                          (MSU+LBL)I
RUSHBROO 71 PR D4 3273          RUSHBROOKE,WILLIAMS+BAREFORD++ (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073          EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
GAGE     72 NP B46 21           W GAGE,E COLTON,W CHINOWSKI           (LBL)
LISSAUER 72 PRD 6 1852          +FIRESTONE,GINESTET,GOLDHABER,TRILLING(LBL)IJP
KARSHON  72 NP B37 371          +YEKUTIELI,YAFFE,SHAPIRA,RONAT,+     (REHO) I
RONAT    72 NP B38 20           +EISENBERG,LYONS,SHAPIRA,TOAFF+      (REHO)
YEKUTIEL 72 NP B40 77           YEKUTIELI,YAFFE,SHAPIRA,RONAT +      (REHO)

BERLAND  74 NP B75 93           BERLAND,HABER,HODOUS,HULSIZER,+      (MIT)I
    ALSO 74 PL 51B 187          BERLAND,HABER,HODOUS,HULSIZER,+      (MIT)I
LICHTMAN 74 NP B81 31           LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BLOBEL   75 NP B97 201          +ESKREYS,FESEFELDT,FRANZ+   (BONN+HAMB+MPIM)IJP
BRAUNZ   75 NP B95 503          +GERBER,MAURER,MICHALON,SCHIBY+ STBRB,LPNP I
CAVALLI  75 LNC 14 353          CAVALLI-SFORZA,CONTA+           (PAVIA+PRIN)
    ALSO 75 LNC 14 345+359      CAVALLI-SFORZA,CONTA+           (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365          +PEETERS,SCREINER,WHITMORE,YUTA       (ANL)
STRACHMA 75 NP B98 120          STRACHMAN,BRAUN,GERBER,MAURER+ (LPNP+STRB)I
    ALSO 76 NP B107 330         STRACHMAN                           (LPNP)I

ATHERTON 76 NP B103 381         ATHERTON,FRENCH,SKURA,BOHM+      (CERN+PRAG)
RUSHBROO 76 PRD 13 1935         RUSHBROOKE,RAJA,ANSORGE,CARTER,NEALE (CAVE) JP
APPLE    77 LNC 18 167          +ASH,CHENG,COYNE,GROSSMAN+      (PRIN+PAVIA)
HEINEN   77 NP B122 443         +ENGELEN,KITTEL,METZGER+   (NIJM+AMST+CERN)IJP

CHADWICK 78 PRD 17 1713         +CARROLL,CHALOUPKA,BALLAM+   (SLAC+CIT+LBL)IJP
EKELOF   78 NP B132 212         +HERZ,HAGBERG,KULLANDER+    (CERN+UPPS+LOUC)IJ
KENNEDY  78 PRD 17 2888         +ZEMANY,BEAUFAYS,KEY,LUSTE,PRENTICE+ (TNTO)
APELDOOR 79 NP B156 111         VAN APELDOORN,HARTING,HOLTHUIZEN+     (AMST)
APELDOOR 80 NP B169 365         VAN APELDOORN,HARTING+(AMST+HELS+LIVP+STOH)
FUKUNAGA 80 NC 58A 199          +HAMATSU,HIROSE,KITAMURA,YAMAGATA     (TOKY)I
    ALSO 79 NC 50A 120          HIROSE,KANAI,KITAMURA,KOBAYASHI       (TOKY)I

                                PAPERS NOT REFERRED TO IN DATA CARDS

GELLERT  66 PRL 17 884          +SMITH,WOJCICKI,COLTON,SCHLEIN + (LRL,UCLA)
ALBERT   68 PR 176 1631         +APPEL,BUDNITZ,CHEN,DUNNING,GOITEIN+ (HARV)
WALKER   68 PRL 20 133          +THOMPSON,ROBERTSON,OH,LEE,HARTUNG,+ (WISC)
CLEGG    69 NP B13 222          CLEGG                                 (LANC)
ALEXANDE 73 NP B52 221          ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
ANSORGE  73 NP B63 93           ANSORGE,MADEN,NEALE,RUSHBROOKE        (CAVE)
BEAUPRE  73 NP B66 93                  (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
COOPER   74 NP B79 259          COOPER,SEIDL,VANDERVELDE              (MICH)IJP
DEUTSCHM 75 NP B99 397          DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HETD)
OCHS     75 NP B86 253          +DAVIDSON,DZIERBA,FIRESTONE+ (CIT+SLAC+LBL)IJP
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CARNEY    76 NP B110 248        +COLLEY,JONES,KENYON+ (BIRM+BRUX+CERN+MONS)IJP
DEKERRET  76 PL 63B 477,483     +NAGY,REGLER,BRANDT+    (CERN+HAMB+IPN+VIEN)
RUSHBROO  76 PRD 13 1835        RUSHBROOKE,RAJA,ANSORGE,CARTER,NEALE (CAVE)IJP
SOTIRIOU  76 NP B107 457        D.SOTIRIOU                            (CERN)IJP
BACON     77 NC 42A 431         +BARNHAM,DORNAN,EASON,POLLOCK+        (LOIC)IJP
HARRIS    77 NP B119 189        +LUBATTI,MORIYASU,BINGHAM+          (WASH+UCB)
OTTER     77 NP B130 349        +RUDOLPH,WIECZOREK+    (AACH+BERL+BONN+CERN)IJP
BIEL      78 PRD 18 3079        +FERBEL,SLATTERY+      (ROCH+NWES+FNAL+SLAC)
   ALSO   76 PRL 36 504,507     BIEL,BLESER,FERBEL+    (ROCH+FNAL+SLAC+NWES)
GOGGI1    78 PL 79B 165         +CAVALLI-SFORZA,CONTA+             (CERN+PAVI)
   ALSO   77 PL 72B 261         GOGGI,MANTOVANI,CAVALLI-SFORZA+ (CERN+PAVI)
GOGGI2    78 NP B143 365        +CAVALLI-SFORZA,CONTA+             (CERN+PAVI)
TOSCHOK   78 NC 48A 395         +SCHRODER,BLOBEL,FRANZ+     (BONN+HAMB+MPIM)IJP
   ALSO   75 BLOBEL
OTTER     78 NP B139 365        +RUDOLPH+           (AACH+BERL+CERN+LOIC+VIEN)IJP
MUHLEMAN  78 NP B133 189        MUHLEMANN,CARITHERS,FERBEL,LAM+ (ROCH+MCGI)
BAKKEN    79 NC 49A 465         +JACOBSEN,GENNOW+          (OSLO+STOH+HELS+ABO)
GOGGI     79 NP B161 14         +CONTA,FRATERNALI,LIVAN+    (CERN+PAVI+TRST)
MACGREGO  80 LNC 28 85          M.H.MACGREGOR                           (LLL)

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N(1520) — D_{13}

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62  N*1/2(1520, JP=3/2-) I=1/2

THIS RESONANCE IS WELL ESTABLISHED.

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                62  N*1/2(1520) MASS (MEV)

M           (1530.0)                     BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M           (1536.0)                     ROPER     65 RVUE    PHASE-SHIFT ANAL  9/66
M    1      (1510.0)                     BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3      (1541.0)                     DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M    6      (1523.0)                     AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4      (1512.0)                     DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
M    7      (1520.)                      ALMEHED   72 IPWA                      2/72
M            1501. TO 1503.              CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
M     L      1524. OR 1520.              LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.     11/75
M           (1525.)                      AYED      76 IPWA                     11/77
M           (1503.)                      BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M           (1510.)                      BERENDS   77 IPWA    PI-N PHOTOPROD.   1/78
M    8      (1510.)                      LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M    8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M    8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                           11/77
M     A     (1503.)                      BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M     A  SUPERSEDES BARBOUR 76.                                                 3/79
M           (1525.)      (15.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M            1519.         4.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M           (1504.0)                     CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M            1525.        10.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M            . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                62  N*1/2(1520) WIDTH (MEV)

W    1      (125.0)                      BAREYRE   68 RVUE                     11/67
W    3      (145.0)                      DONNACHI  68 RVUE                      6/68
W    6      (131.0)                      AYED      70 IPWA                      1/71
W    4      (106.0)                      DAVIES    70 RVUE    P-S ANAL   SOL A
W    7      (120.)                       ALMEHED   72 IPWA                      2/72
W            115. TO  150.               CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
W     L      120. OR  150.               LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W           (122.)                       AYED      76 IPWA                     11/77
W           (137.)                       BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W           (105.)                       BERENDS   77 IPWA    PI-N PHOTOPROD.   1/78
W    8      (110.)                       LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W     A     (135.)                       BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W           (183.)                       BAKER     79 DPWA  0 PI- P TO ETA N   12/79
W           (125.)       (25.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W            114.          7.            HOEHLER   79 IPWA    PI N TO PI N     12/79
W           (124.0)                      CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W            120.         15.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W            . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                62  N*1/2(1520) REAL PART OF POLE POSITION (MEV)         11/75

RE          (1514.)                      LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE   8       1508. OR 1505.              LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE          (1510.)                      CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE           1510.         5.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                62  N*1/2(1520) -2*IMAG PART OF POLE POSITION (MEV)     11/75

IM          (146.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM   8       109. OR 107.                LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM          (114.)                       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM           114.         10.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                62  N*1/2(1520) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER         (34.)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER          34.           2.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                62  N*1/2(1520) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         (-8.)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR          -7.           3.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                62  N*1/2(1520) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*1/2(1520) INTO PI N                              139+ 938
P2      N*1/2(1520) INTO N*3/2(1232) PI                   1232+ 139
P3      N*1/2(1520) INTO N PI PI                           938+ 139+ 139
P4      N*1/2(1520)+ INTO NEUTRON PI+                      939+ 139
P5      N*1/2(1520)+ INTO PROTON PI+ PI-                   938+ 139+ 139
P6      N*1/2(1520) INTO N ETA                             939+ 548
P7      N*1/2(1520) INTO N EPSILON                         938+1300
P8      N*1/2(1520) INTO N RHO                             939+ 769
P9      N*1/2(1520) INTO GAM P, HELICITY=1/2                 0+ 938
P10     N*1/2(1520) INTO GAM P, HELICITY=3/2                 0+ 938
P11     N*1/2(1520) INTO GAM N, HELICITY=1/2                 0+ 939
P12     N*1/2(1520) INTO GAM N, HELICITY=3/2                 0+ 939
P13     N*1/2(1520) INTO K LAMBDA                          497+1115
P14     N*1/2(1520) INTO N*3/2(1232) PI,S-WAVE            1232+ 139
P15     N*1/2(1520) INTO N*3/2(1232) PI,D-WAVE            1232+ 139
P16     N*1/2(1520) INTO N RHO,S=3/2,S-WAVE                939+ 769

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                62  N*1/2(1520) BRANCHING RATIOS

R1      N*1/2(1520) INTO (PI N)/TOTAL                           (P1)
R1   1        (0.54)                     BAREYRE   68 RVUE                     11/67
R1   3        (0.509)                    DONNACHI  68 RVUE                      6/68
R1   6        (0.593)                    AYED      70 IPWA                      1/71
R1   4        (0.45)                     DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
R1   7        (0.58)                     ALMEHED   72 IPWA                      2/72
R1            (0.56)                     AYED      76 IPWA                     11/77
R1            (0.56)    (0.06)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
R1             0.54      0.03            HOEHLER   79 IPWA    PI N TO PI N     12/79
R1             0.58      0.03            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
R1
R1   ALMOST THE ENTIRE INELASTICITY IS IN N PI PI (ONLY N ETA COULD COMPETE,
R1   AND IT DOESNT).  THE N PI PI SEEMS TO BE MAINLY N*3/2(1232) PI, IN BOTH
R1   S AND D WAVES.
R1              . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*1/2(1520) INTO (N*3/2(1232) PI)/TOTAL                 (P4)
R2             0.20      0.05            KIRZ      66 HBC    0 ASSUMING P1=0.72  9/66
R2            DOMINANT INEL DECAY        OLSSON    66 RVUE     PI P TO PI PI N   5/66
R2   D        (0.40)                     DIEM      70 IPWA     3 BODY ANALYSIS   1/71
R2   D         ASSUMING  R1= 0.5

R3      N*1/2(1520) INTO (N*3/2(1232) PI)/(N PI PI)             (P2)/(P3)
R3              LARGE                    THURNAUER 65 RVUE -                   11/67
R3              LARGE                    NAMYSLOWS 66 RVUE -                   11/67
R3              LARGE                    ROBERTS   67 RVUE -                   11/67
R3              LARGE                    ROSENFELD 67 RVUE -                   11/67
R3              LARGE                    MORGAN    68 RVUE     ISOBAR MODEL      6/68

R4      N*1/2(1520) INTO (N EPSILON)/TOTAL                      (P7)
R4            PROBABLY PRESENT           MORGAN    68 RVUE     ISOBAR MODEL      6/68
R4   D        (0.02)                     DIEM      70 IPWA     3 BODY ANALYSIS   1/71
R4   D         ASSUMING  R1= 0.5

R5      N*1/2(1520) INTO (N ETA)/TOTAL                          (P6)
R5   D        (0.006)   APPROX           DAVIES    67 RVUE                     11/67
R5    DAVIES 67 GIVES SEVERAL VALUES DEPENDING ON INPUT DATA.  ALL ARE SMALL
R5   B        (0.014)                    BOTKE     69 MPWA     T POLE+ RESON.   10/69
R5   B        (0.003)   (0.001)          DEANS     69 MPWA     T POLE+ RESON.    5/70
R5   B        (0.002)OR 0.004            CARRERAS  70 MPWA     T POLE+ RESON.    5/70
R5   B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R5            SEEN                       LEMOIGNE  73 DPWA     1488 TO 1685 MEV  2/74

R6      N*1/2(1520) INTO (N RHO )/TOTAL                         (P8)
R6   D        (0.07)                     DIEM      70 IPWA     3 BODY ANALYSIS   1/71
R6   D         ASSUMING  R1= 0.5

R7      N*1/2(1520) FROM PI N TO K LAMBDA                       SQRT(P1*P13)     4/75
R7 C          -0.076    0.032            DEVENISH  74          C FIXED T DISP REL 4/75
R7 C     EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.               4/75

R8      N*1/2(1520) FROM PI N INTO N EPSILON                    SQRT(P1*P7)     11/75
R8    L       (0.0) OR +0.17             LONGACRE  75 IPWA     PI N TO 2PI N    11/75
R8   8        (+0.13)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77

R9      N*1/2(1520) FROM PI N TO N*3/2(1232) PI,S-WAVE          SQRT(P1*P14)    11/75
R9    L       (+0.27)OR +0.24            LONGACRE  75 IPWA     PI N TO 2PI N    11/75
R9   8        (+0.26)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77
R9   8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R10     N*1/2(1520) FROM PI N TO N*3/2(1232) PI,D-WAVE          SQRT(P1*P15)    11/75
R10  L        (+0.24)OR +0.30            LONGACRE  75 IPWA     PI N TO 2PI N    11/75
R10 8         (+0.21)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77
R10 8    LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R11     N*1/2(1520) FROM PI N TO N RHO,S=3/2,S-WAVE             SQRT(P1*P16)    11/75
R11  L        (+0.32)OR +0.24            LONGACRE  75 IPWA     PI N TO 2PI N    11/75
R11 8         (+0.35)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77
R11 8    LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R12     N*1/2(1520) FROM PI N TO ETA N                          SQRT(P1*P6)      1/76
R12  9        (+0.011)OR +0.058          FELTESSE  75 DPWA   0 1488 TO 1745 MEV  1/76
R12  9   SUPERSEDES LEMOIGNE 73, USES M AND W OF AYED 76.                       11/77
R12           (0.02)                     BAKER     79 DPWA   0 PI- P TO ETA N   12/79

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                62  N*1/2(1520) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI
   REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1520) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1             0.010     0.022           DEVENISH  73 DPWA     PI N PHOTOPROD.   2/74
A1            (-0.026)                   HEMMI1    73        + FWD PI0 PHOTOPROD 2/74
A1            -0.026     0.015           MOORHOUS  73 DPWA     PI N PHOTOPROD.   2/73
A1            -0.008     0.015           DEVENIS2  74 DPWA     PI N PHOTOPROD.   4/75
A1            -0.019     0.008           KNIES     74 DPWA     PI N PHOTOPROD.   2/74
A1            -0.006     0.006           METCALF   74 DPWA     PI N PHOTOPROD.   2/74
A1             0.000     0.006           MOORHOUS  74 DPWA     PI N PHOTOPROD.   2/74
A1            -0.009     0.004           CRAWFORD  75 DPWA     PI N PHOTOPROD.   1/76
A1            (+0.011)                   KRIVETS   75 DPWA     PI-N PHOTOPROD.   1/78
A1            (-0.012)                   BARBOUR   76 DPWA     PI N PHOTOPROD.   1/76
A1            -0.005     0.005           FELLER    76 DPWA     PI N PHOTOPROD.   2/77
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A1          -0.033      0.003        AZNAURYAN 77 DPWA    PIO PHTPRD.SOL 1 12/79
A1          -0.030      0.002        AZNAURYAN 77 DPWA    PIO PHTPRD.SOL 2 12/79
A1         (-0.021)                  BERENDS   77 IPWA    PI-N PHOTOPROD.   1/78
A1   A      -0.016      0.008        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A1   N     (-0.008)                  NOELLE    78         PI-N PHOTOPROD.   1/80
A1   N  CONVERTED TO OUR CONVENTIONS USING M=1.528, W=.187 FROM NOELLE 78.   1/80
A1          -0.032      0.005        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A1          -0.032      0.004        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A1          -0.031      0.009        BRATASHEV 80 DPWA    PI N PHOTOPROD.  12/81*
A1          -0.019      0.007        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1          -0.0430     0.0063       ISHII     80 DPWA    P COMPTON SCAT   12/81*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

A2     N*1/2(1520) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2           0.180      0.017        DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A2          +0.194      0.031        MOORHOUS  73 DPWA    PI N PHOTOPROD.   2/73
A2           0.171      0.012        DEVENIS2  74 DPWA    PI N PHOTOPROD.   4/75
A2           0.169      0.012        KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A2          +0.165      0.011        METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A2           0.174      0.006        MOORHOUS  74 DPWA    PI N PHOTOPROD.   2/74
A2          +0.162      0.004        CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A2         (+0.138)                  KRIVETS   75 DPWA    PI-N PHOTOPROD.   1/78
A2         (+0.158)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A2          +0.164      0.008        FELLER    76 DPWA    PI N PHOTOPROD.   2/77
A2          +0.182      0.006        AZNAURYAN 77 DPWA    PIO PHTPRD.SOL 1 12/79
A2          +0.133      0.002        AZNAURYAN 77 DPWA    PIO PHTPRD.SOL 2 12/79
A2         (+0.075)                  BERENDS   77 IPWA    PI-N PHOTOPROD.   1/78
A2   A      +0.157      0.007        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A2   N      (0.206)                  NOELLE    78         PI-N PHOTOPROD.   1/80
A2   N  CONVERTED TO OUR CONVENTIONS USING M=1.528, W=.187 FROM NOELLE 78.   1/80
A2           0.178      0.003        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A2           0.162      0.003        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A2           0.166      0.005        BRATASHEV 80 DPWA    PI N PHOTOPROD.  12/81*
A2           0.167      0.010        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2           0.1695     0.0014       ISHII     80 DPWA    P COMPTON SCAT   12/81*
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 5.3)

A3     N*1/2(1520) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          -0.075      0.037        DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A3          -0.085      0.014        MOORHOUS  73 DPWA    PI N PHOTOPROD.   2/73
A3 2        +0.037      0.012        ROSSI     73 DPWA  0 GAM N TO PI- P    4/75
A3 2   CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.56    4/75
A3          (0.)                     BENEVENT  74 DPWA  0 GAM N TO PI- P    4/75
A3          -0.087      0.019        DEVENIS2  74 DPWA    PI N PHOTOPROD.   4/75
A3          -0.077      0.005        KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A3          -0.066      0.010        METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A3          -0.088      0.007        MOORHOUS  74 DPWA    PI N PHOTOPROD.   2/74
A3          -0.067      0.004        CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A3         (-0.056)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A3   A      -0.055      0.014        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A3   N     (-0.060)                  NOELLE    78         PI-N PHOTOPROD.   1/80
A3   N  CONVERTED TO OUR CONVENTIONS USING M=1.528, W=.187 FROM NOELLE 78.   1/80
A3          -0.076      0.006        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A3          -0.071      0.011        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A3          -0.056      0.011        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A3          -0.050      0.014        TAKEDA    80 DPWA    PI N PHOTOPROD.  12/81*
A3          -0.067      0.004        FUJII     81 DPWA    PI N PHOTOPROD.  12/81*
A3          . . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

A4     N*1/2(1520) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4          -0.126      0.028        DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A4 8       (-0.087)                  HEMMI2    73       0 GAM N TO PIO N    4/75
A4 8   CONVERTED TO OUR CONVENTIONS USING M AND W FROM WALKER69 AND X=.56   4/75
A4 2        -0.016      0.016   0.018 ROSSI    73 DPWA  0 GAM N TO PI- P    4/75
A4          -0.124      0.013        MOORHOUS  73 DPWA    PI N PHOTOPROD.   2/73
A4 5       (-0.035)                  BENEVENT  74 DPWA  0 GAM N TO PI- P    4/75
A4 5   CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=120 MEV, X=.56      4/75
A4          -0.155      0.019        DEVENIS2  74 DPWA    PI N PHOTOPROD.   4/75
A4          -0.120      0.010        KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A4          -0.118      0.013        METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A4          -0.119      0.025        MOORHOUS  74 DPWA    PI N PHOTOPROD.   2/74
A4          -0.133      0.003        CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A4         (-0.136)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A4   A      -0.141      0.015        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A4   N     (-0.127)                  NOELLE    78         PI-N PHOTOPROD.   1/80
A4   N  CONVERTED TO OUR CONVENTIONS USING M=1.528, W=.187 FROM NOELLE 78.   1/80
A4          -0.147      0.008        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A4          -0.148      0.009        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A4          -0.144      0.015        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A4          -0.118      0.011        TAKEDA    80 DPWA    PI N PHOTOPROD.  12/81*
A4          -0.158      0.003        FUJII     81 DPWA    PI N PHOTOPROD.  12/81*
A4          . . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)

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REFERENCES FOR N*1/2(1520)

SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.


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BRANDSEN 65 PR 139 B1566       +DONNELL, MOORHOUSE           (DURHAM, RHEL)IJP
ROPER    65 PR 138 B190        LD ROPER,RM WRIGHT,BT FELD    (LRL-LVMR,MIT)IJP
THURNAUE 65 PRL 14 985         P G THURNAUER                          (ROCH)

KIRZ     66 PRIVATE COMM       J KIRZ                                  (LRL)
   NUMBER EXTRACTED FROM DATA DISCUSSED IN KIRZ 63, Z 63.
NAMYSLOW 66 PR 157 1328        NAMYSLOWSKI,RAZMI,ROBERTS  (STAN,EDIN,LOIC)
OLSSON   66 PR 145 1309        M G OLSSON, G B YODH               (WISC,UMD)

DAVIES   67 NC 52A 1112        A T DAVIES, R G MOORHOUSE   (GLASGOW, RHEL)
ROBERTS  67 PREPRINT           R G ROBERTS                          (DURHAM)
ROSENFEL 67 IRVINE CONF        A H ROSENFELD, P SODING                 (LRL)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                            (EDIN)
MORGAN   68 PR 166 1731        D MORGAN                               (RHEL)

BOTKE    69 PR 180 1417        J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN            (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE           (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                               (GLAS)
DIEM     70 KIEV CONF.         + SHADJA, CHAVANON, DELER, DOLBEAU+    (SACL)
ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH         (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79          HEMMI,INAGAKI+          (KYOTO+SAGA+KEK+TOKY)IJP
HEMMI2   73 NP B55 333         +INAGAKI,KIKUCHI,MAKI,MIYAKE+ (KYOTO,TOKYO)IJP
LEMOIGNE 73 PURDUE CONF. 93    +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK              (GLAS+LBL)IJP
ROSSI    73 NC 13A 59          +PIAZZA,SUSINNO,+      (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1193         CARBONARA,FIORE,+      (NAPL,FRAS,PAVIA,ROMA)IJP

BENEVENT 74 NC 19A 529         BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTINIDESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                  (CIT)IJP
MOORHOUS 74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                           (GLAS)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KRIVETS  75 SJNP 20 430        +MIROSHNICHENKO,NIKIFOROV,SANIN+       (KIEV)IJP
    ALSO 74 SJNP 19 112        KRIVETS,NIKIFOROV,SANIN,SHALATSKII     (KIEV)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SHADJA+       (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795        LONGACRE,LASINSKI,ROSENFELD+        (LBL,SLAC)

AYED     76 CEA-N-1921         AYED (THESIS)                          (SACL)IJP
BARBOUR  76 NP B111 358        I. M. BARBOUR,R. L. CRAWFORD           (GLAS)IJP
FELLER   76 NP B104 219        +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BERENDS  77 NP B136 317        F.A.BERENDS,A.DONNACHIE             (LEID,MCHS)IJP
LONGACRE 77 NP B122 493        LONGACRE,DOLBEAU                       (SACL)IJP
    ALSO 76 NP B108 365        DOLBEAU,TRIANTIS,NEVEU,CADIET          (SACL)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS               (GLAS)
NOELLE   78 PTP 60 778         P. NOELLE                              (NAGO)
BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+    (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY            (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN           (KARLSRUHE)IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                            (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93   I. ARAI                                (TOKY)
BRATASHE 80 NP B166 525        BRATASHEVSKIJ,GORBENKO,DEREBCHINSKIJ+(KHAR)
CRAWFORD 80  TORONTO CONF 107  R.L.CRAWFORD                           (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK   (CARN+LBL)IJP
ISHII    80 NP B165 189        ISHII,EGAWA,KATO,MIYACHI+          (KYOT+TOKY)
TAKEDA   80 NP B168 17         TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+       (TOKY)
FUJII    81 NP B187 53         FUJII,HAYASHII,IWATA,KAJIKAWA+         (TOKY)

                               PAPERS NOT REFERRED TO IN DATA CARDS

KIRZ     63 PR 130 2481        J KIRZ, J SCHWARTZ, R D TRIPP            (LRL)
BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
CROUCH   65 DESY CONF II 21    +  (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244    +KENNEY,LAMSA, +      (NOTRE DAME,KENTUCKY)
MERLO    66 P ROY SOC 289 489  J P MERLO, G VALLADAS              (SACLAY)
   THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE REONANCE.
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                          (LRL)
DEANS    69 PRL 177 2623       S R DEANS                  (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
WALKER   69 PR 182 1729        R L WALKER                           (CIT)IJP
AYED     70 PL 31B 598         +BAREYRE+VILLET                      (SACLAY)
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1520 MEV REGION - PRODUCTION EXPERIMENTS

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            B  N*1/2(1520, JP=    ) I=1/2    PRODUCTION EXPERIMENTS

       SEE THE MINI-REVIEW PRECEDING THE N AND DELTA LISTINGS
       FOR A DISCUSSION OF PRODUCTION EXPERIMENTS.

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            B  N*1/2(1520) MASS (MEV) (PROD. EXP.)

M            1507.0      6.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV    10/71
M            1503.       6.           ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
M            1500.0     10.0          AMALDI    71 SAS     P P AT 24 GEV    10/71
M            1512.0      2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M            1460. TO 1510.           MORSE     71 HBC  +0 PI-P,  7 GEV/C   11/77
M           (1510.0)   (20.0)         MORSE     71 HBC   + PI-P, 25 GEV/C   11/77
M            1501.0      5.7          EDELSTEIN 72 MMS   + PP 6 TO 30 GEV    1/73
M     I     (1500.)                   DH        72 DBC   0 PI-N TO PI-PI-P   2/73
M     I   DETERMINE J=3/2,D13 PROBABLE                                       2/73
M            1515.      11.           COOPER    74 HBC   0 D P CEX           4/75
M           (1490.)                   BRAUNI    75 HBC     PBAR P 5.7 GEV   11/75
M            1510.       7.           MUSGRAVE  75 HBC     K+ P TO K PI N   11/75
M           (1500.)                   STRACHMA  75  BC     NBAR (N PI)       1/76
M            1500.       8.           WEBB      75 ISR   + P P TO P N*       1/76
M     A      1515.       5.           ROUGE     77 OMEG  0 PI-P 9.12 GEV/C   1/78
M     A   BACKWARD PRODUCTION. PI- P --> (P PI-) PIO
M     B   1K 1515.       6.           FERRER    78 OMEG  0 PI-P 9.12 GEV/C   3/79
M     B   BACKWARD PRODUCTION. PI- P --> (P PI-) PI+ PI-
M     C  202 1518.      10.           FERRER    78 OMEG  + PI-P 9.12 GEV/C   3/79
M     C   BACKWARD PRODUCTION. PI  P --> (P PI+ PI-) PI-

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            B  N*1/2(1520) WIDTH (MEV) (PROD. EXP.)

W             55.0      15.0          A-BORELLI 67 HBC   0 PBAR P 5.7 GEV   10/71
W            120.       10.           ANDERSON  70 MMS   - PI- P TO PI- MMS  2/71
W            118.0      20.0          AMALDI    71 SAS     P P AT 24 GEV    10/71
W             48.0       2.0          ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W             80. TO   120.           MORSE     71 HBC   + PI-P,  7 GEV/C   11/77
W           (100.0)    (30.0)         MORSE     71 HBC   + PI-P, 25 GEV/C   11/77
W            140.0      43.0          EDELSTEIN 72 MMS   + PP 6 TO 30 GEV    1/73
W            106.       39.     53.   COOPER    74 HBC   0 D P CEX           4/75
W           (200.)                    BRAUNI    75 HBC     PBAR P 5.7 GEV   11/75
W            101.       26.           MUSGRAVE  75 HBC     K+ P TO K PI N   11/75
W            150.       50.           WEBB      75 ISR   + P P TO P N*       1/76
W     A      105.       17.           ROUGE     77 OMEG  0 PI-P 9.12 GEV/C   1/78
W     B   1K 105.       10.           FERRER    78 OMEG  0 PI-P 9.12 GEV/C   3/79
W     C  202 112.       15.           FERRER    78 OMEG  + PI-P 9.12 GEV/C   3/79
         SEE THE NOTES ACCOMPANYING THE MASSES QUOTED ABOVE.

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            P   N*1/2(1520) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1     N*1/2(1520) INTO PI N                              139+ 938
P2     N*1/2(1520) INTO N*3/2(1232) PI                   1232+ 139
P3     N*1/2(1520) INTO N PI PI                           938+ 139+ 139
P4     N*1/2(1520)+ INTO NEUTRON PI+                      939+ 139
P5     N*1/2(1520)+ INTO PROTON PI+ PI-                   938+ 139+ 139
P6     N*1/2(1520) INTO N ETA                             939+ 548
P7     N*1/2(1520) INTO N PIPI(J,I=0)                     939+ 139+ 139
P8     N*1/2(1520) INTO N RHO                             938+ 769
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            R   N*1/2(1520) BRANCHING RATIOS (PROD. EXP.)

R1     N*1/2(1520) INTO (N PI)/TOTAL                      (P1)
R1        N*(1520)  INTO   (N PI)/TOTAL   PRODUCTION EXPERIMENTS
R1          .78       0.24           BASSOMPIE 67 HBC  +  K+P TO K* N*     11/68

R2     N*1/2(1520) INTO (NEUTRON PI+)/(P PI+ PI-)         (P4)/(P5)
R2          0.77      0.45           ALEXANDER 67 HBC  +  PP 5.5 BEV/C      9/66

R3     N*1/2(1520) INTO (N PI)/(N PI PI)                  (P1)/(P3)
R3          1.25      0.44      0.71 A-BORELLI 67 HBC   0 PBAR P 5.7 BEV/C  9/66

R4     *1/2(1520) INTO (N*3/2(1232) PI)/(N PI PI)         (P2)/(P3)
R4          0.00      0.09           A-BORELLI 67 HBC                       9/66

R5     N*1/2(1520) INTO (N PI PI)/TOTAL                   (P3)
R5        (0.08) OR LESS             BASSOMPIE 67 HBC  +  K+P TO K* N*     11/68

R6     N*1/2(1520) INTO (N ETA)/TOTAL                     (P6)
R6          0.22      0.14           BASSOMPIE 67 HBC  +  K+P TO K* N*     11/68

R7     N*1/2(1520) INTO (PI N)/(PI N*3/2(1232))           (P1)/(P2)
R7        (0.42) OR LESS             LEE          67 HBC    PI-P 3.6  GEV/C 11/67

R8     N*1/2(1520) INTO (N PIPI(J,I=0))/TOTAL             (P7)
R8               MAIN DECAY MODE     MORSE        71 HBC  + PI-P 7.75 GEV/C 11/77
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                         REFERENCES FOR N*1/2(1520) (PROD. EXP.)

A-BORELL 67 NC 47 232          ALLES-BORELLI,FRENCH,FRISK,MICHEJDA  (CERN)
ALEXANDE 67 PR 154 1284        ALEXANDER,BENARY,CZAPEK,+  (WEIZMANN(CERN))
BASSOMPI 67 PL 25B 440         BASSOMPIERRE, +              (CERN,BRUXELLES)
LEE      67 PR 159 1156        +MOEBS,ROF,SINCLAIR,VANDER VELDE       (MICH)

ANDERSON 70 PRL 25 699         +BLESER,BLIEDEN,COLLINS+          (BNL,CARN)

AMALDI   71 PL 34B 435         +BIANCASTELLI,BOSIO,+ (I SANITA ROMA+CERN)
ELLIS    71 PRL 27 442         +MAGLICH,NOREM,SANNES,SILVERMAN     (RUTG)
MORSE    71 PR D4 133          +OH,WALKER,CARROLL,LYNCH +      (WISC+TNTO)J

EDELSTEI 72 PR D5 1073         EDELSTEIN,CARRIGAN,HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD 72 NP B42 589         +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH)JP
OH       72 PL 42B 497         +FUNG,KERNAN,POE,SCHALK,SHEN          (UCR)JP

COOPER   74 NP B75 259         COOPER,SEIDL,VANDERVELDE              (MICH)

BRAUN    75 NP B95 481         +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
MUSGRAVE 75 NP B87 365         +PEETERS,SCREINER,WHITMORE,YUTA        (ANL)
STRACHMA 75 NP B98 120         STRACHMAN,BRAUN,GERBER,MAURER+ (LPNP+STRB)I
   ALSO  76 NP B107 330        STRACHMAN                             (LPNP)I
WEBB     75 PL 55B 331         +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)
   ALSO  75 PL 55B 335         +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)

ROUGE    77 PL 69B 115         +DE ROSNY,FLEURY,RIVET+    (LPNP+CDEF+LALO)
FERRER   78 NP B142 77         +BOUQUET,D.ALMAGNE+    (LALO+CERN+CDEF+EPOL)I,JP

                         PAPERS NOT REFERRED TO IN DATA CARDS

RUSHBROO 76 PRD 13 1835        RUSHBROOKE,RAJA,ANSORGE,CARTER,NEALE (CAVE)IJP
SOTIRIOU 76 NP B107 457        D.SOTIRIOU                          (CERN)IJP
BIEL     78 PRD 18 3079        +FERBEL,SLATTERY+         (ROCH+NWES+FNAL+SLAC)
   ALSO  76 PRL 36 504,507     BIEL,BLESER,FERBEL+       (ROCH+FNAL+SLAC+NWES)
CHADWICK 78 PRD 17 1713        +CARROLL,CHALOUPKA,BALLAM+   (SLAC+CIT+LBL)IJP
GOGGI2   78 NP B143 365        +CAVALLI-SFORZA,CONTA+            (CERN+PAVI)
GOGGI    79 NP B161 14         +CONTA,FRATERNALI,LIVAN+      (CERN+PAVI+TRST)
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N(1535)

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63  N*1/2(1535, JP=1/2-) I=1/2          S'11

    THIS RESONANCE IS WELL ESTABLISHED.
    IT  COUPLES STRONGLY TO THE ETA NUCLEON CHANNEL.
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                63  N*1/2(1535) MASS (MEV)

M          (1519.0)                  HENDRY    65 RVUE   ETA N + S11 PI N  9/66
M          (1570.0)                  MICHAEL   66 RVUE   FITS BAREYRE S11  7/66
M    N     (1557.0) OR  1565.0       UCHIYAMA- 66 RVUE   FITS N ETA DATA   9/66
M    N      FITTING GIVES TWO SOLUTIONS.  PROBLEMS MATCHING PI P PHASE SHIFT
M    1     (1535.0)                  BAREYRE   68 RVUE   PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1591.0)                  DONNACHI  68 RVUE   PHASE-SHIFT ANAL  6/68
M          (1535.0)    (10.0)        DELCOURT  69 CNTR   PHOTOPRODUCT.     8/69
M    6     (1534.0)                  AYED      70 IPWA                     1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1502.0)                  DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
M    7     (1500.)                   ALMEHED   72 IPWA                     2/72
M     2    (1551.)                   HICKS     73 MPWA   GAM P-ETA P       9/73
M     2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.   9/73
M     2  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.  9/73
M           1507. TO 1530.           CRAWFORD  75 DPWA   PI N PHOTOPROD.   1/76
M     L     1525. OR 1510.           LONGACRE  75 IPWA   PI N TO 2PI N    11/75
M     L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75
M          (1519.)                   AYED      76 IPWA                    11/77
M          (1501.)                   BARBOUR   76 DPWA   PI N PHOTOPROD.   1/76
M          (1500.)                   BERENDS   77 IPWA   PI-N PHOTOPROD.   1/78
M           1547.       6.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
M    8     (1520.)                   LONGACRE  77 IPWA   PI N TO 2PI N    11/77
M    8   ALL LONGACRETT PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M    8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                      11/77
M     E    (1511.)                   BARBOUR   78 DPWA   PI-N PHOTOPROD.   3/79
M     E  SUPERSEDES BARBOUR 76.                                            3/79
M          (1540.)     (20.)         CUTKOSKY  79 IPWA   PI N TO PI N     12/79
M           1526.       7.           HOEHLER   79 IPWA   PI N TO PI N     12/79
M          (1513.0)                  CRAWFORD  80 DPWA   PI N PHOTOPROD.  12/81*
M           1550.      40.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
M           . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)
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                63  N*1/2(1535) WIDTH (MEV)

W          (130.0)                   HENDRY    65 RVUE                     9/66
W          (130.0)                   MICHAEL   66 RVUE                     7/66
W    N     (155.0) OR  144.0         UCHIYAMA- 66 RVUE   SEE NOTE ON MASS  9/66
W    1     (155.0)                   BAREYRE   68 RVUE                    11/67
W    3     (268.0)       APPROX      DONNACHI  68 RVUE                     6/68
W          (120.0)                   DELCOURT  69 CNTR   PHOTOPRODUCT.     8/69
W    6     (96.0)                    AYED      70 IPWA                     1/71
W    4     (36.0)                    DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
W    7     (50.)                     ALMEHED   72 IPWA                     2/72
W     2    (134.)                    HICKS     73 MPWA   GAM P-ETA P       9/73
W           114. TO  167.            CRAWFORD  75 DPWA   PI N PHOTOPROD.   1/76
W     L     75. OR  100.             LONGACRE  75 IPWA   PI N TO 2PI N    11/75
W          (75.)                     AYED      76 IPWA                    11/77
W          (129.)                    BARBOUR   76 DPWA   PI N PHOTOPROD.   1/76
W          (57.)                     BERENDS   77 IPWA   PI-N PHOTOPROD.   1/78
W           139.       33.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
W    8     (135.)                    LONGACRE  77 IPWA   PI N TO 2PI N    11/77
W     E    (132.)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.   3/79
W          (90.)                     BAKER     79 DPWA  0 PI- P TO ETA N  12/79
W          (270.)      (50.)         CUTKOSKY  79 IPWA   PI N TO PI N     12/79
W           120.       20.           HOEHLER   79 IPWA   PI N TO PI N     12/79
W          (136.0)                   CRAWFORD  80 DPWA   PI N PHOTOPROD.  12/81*
W           240.       80.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
W           . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)
W       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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          63  N*1/2(1535) REAL PART OF POLE POSITION (MEV)              11/75

RE         (1496.)                   LONGACRE  75 IPWA   PI N TO 2PI N    11/75
RE          1519.       4.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
RE   8      1525. OR 1527.           LONGACRE  77 IPWA   PI N TO 2PI N    11/77
RE         (1465.)                   CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RE          1510.      50.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
RE          . . . . . . . . .
RE   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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          63  N*1/2(1535) -2*IMAG PART OF POLE POSITION (MEV)           11/75

IM         (103.)                    LONGACRE  75 IPWA   PI N TO 2PI N    11/75
IM          140.       32.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
IM   8      135. OR 123.             LONGACRE  77 IPWA   PI N TO 2PI N    11/77
IM         (256.)                    CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IM          260.       80.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
IM          . . . . . . . . .
IM   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)
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          63  N*1/2(1535) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER         20.        21.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
RER        (48.)                     CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RER         116.       46.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
RER         . . . . . . . . .
RER  AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)
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          63  N*1/2(1535) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         13.         8.           BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
IMR        (-67.)                    CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IMR         31.        92.           CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
IMR         . . . . . . . . .
IMR  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                63  N*1/2(1535) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1     N*1/2(1535) INTO PI N                              139+ 938
P2     N*1/2(1535) INTO N ETA                             939+ 548
P3     N*1/2(1535) INTO N PI PI                           938+ 139+ 139
P4     N*1/2(1535) INTO N EPSILON                         938+1300
P5     N*1/2(1535) INTO N*3/2(1232) PI                   1232+ 139
P6     N*1/2(1535) INTO N RHO                             938+ 769
P7     N*1/2(1535) INTO GAM P, HELICITY=1/2                 0+ 938
P8     N*1/2(1535) INTO GAM N, HELICITY=1/2                 0+ 939
P9     N*1/2(1535) INTO K LAMBDA                          497+1115
P10    N*1/2(1535) INTO N RHO,S=1/2,S-WAVE                938+ 769
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                63  N*1/2(1535) BRANCHING RATIOS

R1     N*1/2(1535) INTO (PI N)/TOTAL                          (P1)
R1          (0.68)                   HENDRY    65 RVUE                     9/66
R1          (0.32)                   MICHAEL   66 RVUE                     9/66
R1   N      (0.71) OR  0.28          UCHIYAMA- 66 RVUE   SEE NOTE ON MASS  9/66
R1          (0.31) OR  0.43          DAVIES    67 RVUE   PIP TO N ETA,B,C 11/67
R1   3      (0.696)                  DONNACHI  68 RVUE                     6/68
R1          (0.33)                   DELCOURT  69 CNTR                     8/69
R1   6      (0.397)                  AYED      70 IPWA                     1/71
R1   4      (0.36)                   DAVIES    70 RVUE   P-S ANAL  SOL A   8/69
R1   7      (0.25)                   ALMEHED   72 IPWA                     2/72
R1          (0.34)                   AYED      76 IPWA                    11/77
R1           0.297      0.026        BHANDARI  77 DPWA  0 USES ETA N CUSP  1/78
R1          (0.45)     (0.06)        CUTKOSKY  79 IPWA   PI N TO PI N     12/79
R1           0.38       0.04         HOEHLER   79 IPWA   PI N TO PI N     12/79
R1           0.50       0.10         CUTKOSKY  80 IPWA   PI N TO PI N      1/82*
R1          . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
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R2      N*1/2(1535) INTO (N ETA)/TOTAL   (SEE R8 ALSO.)  (P2)
R2           DOMINANT INEL DECAY      HENDRY    65 RVUE                          9/66
R2           (0.68)                   MICHAEL   66 RVUE                          9/66
R2  N        (0.29) OR  0.71          UCHIYAMA- 66 RVUE    SEE NOTE ON MASS     9/66
R2           (0.69) OR  0.45          DAVIES    67 RVUE    PI- TO N ETA,B,C    11/67
R2  B        (0.4)     (0.1)          DEANS     69 MPWA    T POLE+ RESON.       5/70
R2           (0.66)                   DELCOURT  69 MPWA                         8/69
R2  B        (0.69) OR  0.696         CARRERAS  70 MPWA    T POLE+ RESON.       5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R2      THE VALUES OF R2 LISTED ABOVE ARE INCOMPATIBLE WITH THE RESULTS
R2      OF DIEM ET AL. (70)
R2      THE BRANCHING RATIO INTO ETA NEUTRON FOUND BY BHANDARI 77 IS           12/79
R2      0.70 (R.BHANDARI, PRIV. COMM., 1979).                                  12/79

R3      N*1/2(1535) INTO (N*3/2(1232) PI)/TOTAL          (P5)
R3  D        (0.07)                   DIEM      70 IPWA    3 BODY ANALYSIS      1/71
R3  D     ASSUMING  R1= 0.34

R4      N*1/2(1535) INTO (N EPSILON)/TOTAL               (P4)
R4  D        (0.26)                   DIEM      70 IPWA    3 BODY ANALYSIS      1/71
R4  D     ASSUMING  R1= 0.34

R5      N*1/2(1535) INTO (N RHO )/TOTAL                  (P6)
R5  D        (0.20)                   DIEM      70 IPWA    3 BODY ANALYSIS      1/71
R5  D     ASSUMING  R1= 0.34

R6      N*1/2(1535) INTO GAMMA PROTON/TOTAL              (P7)                   9/73
R6   5        0.0042   0.0014         DEANS     72 MPWA    P ETA PHOTOPROD.     9/73
R6   5  BR=(DEANS72 RADIATIVE WIDTH)/(NOMINAL FULL WIDTH=100 MEV)               9/73
R6   5  THE HICKS75 ENTRY UNDER R7 IS A MORE RECENT RESULT BY SAME GROUP.       9/73

R7      N*1/2(1535) FROM GAMMA PROTON TO ETA PROTON      SQRT(P2*P7)            9/73
R7   2       (0.0366)                 HICKS     73 MPWA    GAM P-ETA P          9/73

R8      N*1/2(1535) FROM PI N INTO ETA N  (SEE R2 ALSO.) SQRT(P1*P2)            2/74
R8          (+0.43)                   LEMOIGNE  73 DPWA    1488 TO 1685 MEV     2/74
R8  A       (+0.48)                   FELTESSE  75 DPWA  O 1488 TO 1745 MEV    11/75
R8  A   SUPERSEDES LEMOIGNE 73, USES M AND W OF AYED 76.                       11/77
R8          (+0.33)                   BAKER     79 DPWA  O PI- P TO ETA N      12/79

R9      N*1/2(1535) FROM PI N TO K LAMBDA                SQRT(P1*P9)            4/75
R9 C        -0.691     0.214          DEVENISH  74         O FIXED T DISP REL   4/75
R9 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD.                4/75

R10     N*1/2(1535) FROM PI N TO N*3/2(1232) PI          SQRT(P1*P5)           11/75
R10  L       (0.0) OR -0.06           LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R10 8        (0.00)                   LONGACRE  77 IPWA    PI N TO 2PI N       11/77

R11     N*1/2(1535) FROM PI N TO N RHO,S=1/2,S-WAVE      SQRT(P1*P10)          11/75
R11  L      (+0.12)OR +0.09           LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R11 8       (+0.10)                   LONGACRE  77 IPWA    PI N TO 2PI N       11/77

R12     N*1/2(1535) FROM PI N TO N EPSILON               SQRT(P1*P4)           11/75
R12  L       (0.1) OR -0.09           LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R12 8       (-0.08)                   LONGACRE  77 IPWA    PI N TO 2PI N       11/77

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                63  N*1/2(1535) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1535) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1            0.042    0.023          DEVENISH  73 DPWA    PI N PHOTOPROD.      2/74
A1           (0.015)                  HEMMI1    73       * FWD PI0 PHTOPROD     2/74
A1           +0.053    0.020          MOORHOUS  73 DPWA    PI N PHOTOPROD.      2/73
A1            0.078    0.020          DEVENIS2  74 DPWA    PI N PHOTOPROD.      4/75
A1            0.056    0.020          KNIES     74 DPWA    PI N PHOTOPROD.      2/74
A1           +0.063    0.013          METCALF   74 DPWA    PI N PHOTOPROD.      2/74
A1            0.036    0.002          MOORHOUS  74 DPWA    PI N PHOTOPROD.      2/74
A1           +0.082    0.007          CRAWFORD  75 DPWA    PI N PHOTOPROD.      1/76
A1          (+0.062)                  KRIVETS   75 DPWA    PI-N PHOTOPROD.      1/78
A1          (+0.063)                  BARBOUR   76 DPWA    PI N PHOTOPROD.      1/76
A1           +0.070    0.004          FELLER    76 DPWA    PI N PHOTOPROD.      2/77
A1           +0.046    0.007          AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1    12/79
A1           +0.101    0.012          AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2    12/79
A1          (+0.034)                  BERENDS   77 IPWA    PI-N PHOTOPROD.      1/78
A1   E       +0.082    0.019          BARBOUR   78 DPWA    PI-N PHOTOPROD.      3/79
A1   N       (0.046)                  NOELLE    78         PI-N PHOTOPROD.      1/80
A1   N  CONVERTED TO OUR CONVENTIONS USING M=1.548, W=.073 FROM NOELLE 78.      1/80
A1            0.083    0.007          ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A1            0.080    0.007          ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A1            0.029    0.007          BRATASHEV 80 DPWA    PI N PHOTOPROD.    12/81*
A1            0.065    0.016          CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A1            0.0704   0.0091         ISHII     80 DPWA    P COMPTON SCAT     12/81*
A1             . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 4.1)

A2      N*1/2(1535) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2           -0.026    0.029          DEVENISH  73 DPWA    PI N PHOTOPROD.      2/74
A2           -0.048    0.021          MOORHOUS  73 DPWA    PI N PHOTOPROD.      2/73
A2 8         -0.031    0.024          ROSSI     73 DPWA  O GAM N TO PI- P       4/75
A2 8    CONVERTED TO OUR CONVENTIONS USING M AND W FROM ROSSI73 AND X=.36       4/75
A2 9        (-0.078)                  BENEVENT  74 DPWA  O GAM N TO PI- P       4/75
A2 9    CONVERTED TO OUR CONVENTIONS USING M=1520 MEV, W=80 MEV, X=.36          4/75
A2           -0.037    0.023          DEVENIS2  74 DPWA    PI N PHOTO-ROD.      4/75
A2           -0.052    0.005          KNIES     74 DPWA    PI N PHOTOPROD.      2/74
A2           -0.051    0.021          METCALF   74 DPWA    PI N PHOTOPROD.      2/74
A2           -0.027    0.009          MOORHOUS  74 DPWA    PI N PHOTOPROD.      2/74
A2           -0.088    0.011          CRAWFORD  75 DPWA    PI N PHOTOPROD.      1/76
A2          (-0.109)                  BARBOUR   76 DPWA    PI N PHOTOPROD.      1/76
A2   E       -0.112    0.034          BARBOUR   78 DPWA    PI-N PHOTOPROD.      3/79
A2   N      (-0.048)                  NOELLE    78         PI-N PHOTOPROD.      1/80
A2   N  CONVERTED TO OUR CONVENTIONS USING M=1.548, W=.073 FROM NOELLE 78.      1/80
A2           -0.075    0.019          ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A2           -0.075    0.018          ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A2           -0.098    0.026          CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A2           -0.011    0.017          TAKEDA    80 DPWA    PI N PHOTOPROD.    12/81*
A2           -0.062    0.003          FUJII     81 DPWA    PI N PHOTOPROD.    12/81*
A2             . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                       REFERENCES FOR N*1/2(1535)

HENDRY   65 PL 18 171         A W HENDRY, R G MOORHOUSE              (RHEL)
   REVIEWS EARLY PHASE-SHIFT-ANALYSIS RESULTS AND PI- P TO ETA N
   EXPERIMENTS. WE TAKE NUMBERS FROM THE SOLUTION USING BRANDSEN 65.
MICHAEL  66 PL 21 93          C MICHAEL                              (OXF)
UCHIYAMA 66 PR 149 1220       F UCHIYAMA-CAMPBELL, P K LOGAN         (ILL)IJP
DAVIES   67 NC 52A 1112       A T DAVIES, R G MOORHOUSE    (GLASGOW,RHEL)
BAREYRE  68 PR 165 1731       P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139        DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO 68 THESIS            R G KIRSOPP                           (EDIN)
DEANS    69 PR 185 1797       S DEANS, J WOOTEN          (UNIV S FLORIDA)
DELCOURT 69 PL 29B 75         DELCOURT,LEFRANCOIS,PEREZ-Y-JORBA,+  (ORSA)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35         B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359        A DAVIES                              (GLAS)
DIEM     70 KIEV CONF.        + SMADJA, CHAVANON, DELER, DOLBEAU+  (SACL)

ALMEHED  72 NP B40 157        +LOVELACE                       (LUND,RUTG)IJP
DEANS    72 PN 3 217          +JACOBS, LYONS, HICKS  (U S FL TAMPA+CARN)
DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 75         HEMMI,INAGAKI+        (KYOTO+SAGA+KEK+TOKY)IJP
HICKS    73 PRD 7 2614        +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LEMOIGNE 73 PURDUE CONF. 93   +GRANET,MARTY,AYED,BAREYRE,BORGEAUD,+(SACL)IJP
MOORHOUS 73 PL 43B 44         MOORHOUSE, OBERLACK            (GLAS+LBL)IJP
ROSSI    73 NC 13A 59         +PIAZZA,SUSINNO,+      (ROMA,FRAS,NAPL,PAVIA)IJP
    ALSO 71 LNC 2 1183        CARBONARA,FIORE,+      (NAPL,FRAS,PAVIA,ROMA)IJP

BENEVENT 74 NC 19A 529        BENEVENTANO,DANGELO,NOTARISTEFANI,+  (ROMA)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS 74 PRD 9 1           MOORHOUSE,OBERLACK,ROSENFELD    (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                        (GLAS)IJP
FELTESSE 75 NP B93 242        +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KRIVETS  75 SJNP 20 430       +MIROSHNICHENKO,NIKIFOROV,SANIN+    (KIEV)IJP
    ALSO 74 SJNP 19 112       KRIVETS,NIKIFOROV,SANIN,SHALATSKII  (KIEV)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795       LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921        AYED (THESIS)                       (SACL)IJP
BARBOUR  76 NP B111 358       I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP
FELLER   76 NP B104 219       +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77   +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BERENDS  77 NP B136 317       F.A.BERENDS,A.DONNACHIE         (LEID,MCHS)IJP
BHANDARI 77 PRD 15 192        R BHANDARI,Y-A CHAO                 (CARN)IJP
LONGACRE 77 NP B122 493       LONGACRE,DOLBEAU                    (SACL)IJP
    ALSO 76 NP B108 365       DOLBEAU,TRIANTIS,NEVEU,CADIET       (SACL)IJP

BARBOUR  78 NP B141 253       BARBOUR,CRAWFORD,PARSONS              (GLAS)
NOELLE   78 PTP 60 778        P. NOELLE                             (NAGO)
BAKER    79 NP B156 53        +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+ (RHEL)IJP
CUTKOSKY 79 PRD 20 2839       +FORSYTH,HENDRICK,KELLY         (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN        (KARLSRUHE)IJP
    ALSO 80  TORONTO CONF 3   R.KOCH                         (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93  I. ARAI                               (TOKY)
BRATASHE 80 NP B166 525       BRATASHEVSKIJ,GORBENKO,DEREBCHINSKIJ+(KHAR)
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK (CARN+LBL)IJP
ISHII    80 NP B165 189       ISHII,EGAWA,KATO,MIYACHI+        (KYOT+TOKY)
TAKEDA   80 NP B168 17        TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+      (TOKY)
FUJII    81 NP B187 53        FUJII,HAYASHII,IWATA,KAJIKAWA+        (TOKY)

                              PAPERS NOT REFERRED TO IN DATA CARDS

BAREYRE  65 PL 18 342         + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
BRANDSEN 65 PR 139 B1566      +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
    BASIS OF NUMBERS WE QUOTE FROM HENDRY 65.
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                            (LRL)
LOVELACE 67 HEIDELBERG C. 79  C LOVELACE                          (CERN)IJP
DONNACHI 69 NP 10B 433        A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598        +BAREYRE+VILLET                       (SACLAY)

       THE FOLLOWING ARTICLES DEAL WITH THE REACTIONS PI- P TO ETA N
   AND GAMMA P TO ETA P NEAR THRESHOLD. THE DATA AND THE THEORETICAL
   ARTICLES ARE USEFUL IN UNDERSTANDING THE BEHAVIOR OF THE S11 AMPLI-
   TUDE AS DETERMINED IN PI P PHASE-SHIFT ANALYSES. FURTHER REFERENCES
   MAY BE FOUND IN THEM.

        MAINLY EXPERIMENTAL --
BULOS    64 PRL 13 486        +        (BROWN,BRANDEIS,HARVARD,MIT,PADOVA) I
BACCI    66 NC 45A 983        +PENSO,SALVINI,MENCUCCINI,+  (ROMA,FRASCATI)IJP
JONES    66 PL 23 597         +BINNIE,DUANE,HORSEY,MASON,+     (LOIC,RHEL)
RICHARDS 66 PRL 16 1221       +CHIU,EANDI,HELMHOLZ,KENNEY,+ (LRL,HAWAII) IJ
PREPOST  67 PRL 18 82         R PREPOST, D LUNDQUIST, D QUINN  (STANFORD)
BLOOM    68 PRL 21 1100       +HEUSCH, PRESCOTT, ROCHESTER           (CIT)
BULOS    69 PR 187 1827       +LANDU,BORDNER,BASTIEN+(BOST+HARV+MIT+PENN)
HEUSCH   70 PRL 25 1381       +PRESCOTT,ROCHESTER,WINSTEIN           (CIT)
BINNIE   73 PRD 8 2789        +CAMILLERI,DEBENHAM,DUANE,+      (LOIC,SHMP)
        MAINLY THEORETICAL --
BALL     66 PR 149 1191       J S BALL                              (UCLA)
DOBSON   66 PR 146 1022       P N DOBSON                          (HAWAII)
MINAMI   66 PR 147 1123       S MINAMI                             (OSAKA)
DEANS    67 PR 161 1466       S R DEANS, W G HOLLADAY        (VANDERBILT)
LOGAN    67 PR 153 1634       R K LOGAN, F UCHIYAMA-CAMPBELL         (ILL)
MENCUCCI 67 NC 48A 579        C MENCUCCINI, A REALE             (FRASCATI)
MINAMI   67 PR 162 1619       S MINAMI                             (OSAKA)
MOSS     67 PR 163 1785       T A MOSS                               (LSU)
DEANS    68 PR 165 1886       S R DEANS, W G HOLLADAY        (VANDERBILT)
PAL      68 PR 167 1350       B K PAL                       (NPL NEW DELHI)
BALL     69 PR 177 2257       +GARG+SHAW                        (UCLA+UCI)
LEFIEVRE 70 NC 66A 349        +LERUSTE                              (COEF)
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N(1540) 109 N*1/2(1540, JP=3/2+) I=1/2 **P'_{13}** 11/77

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                109  N*1/2(1540) MASS (MEV)                                  11/77

M    8     (1540.)                    LONGACRE  77 IPWA    PI N TO 2PI N     11/77
M    8  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE  11/77
M    8  POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                          11/77

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                109  N*1/2(1540) WIDTH (MEV)                                 11/77

W    8     (200.)                     LONGACRE  77 IPWA    PI N TO 2PI N     11/77

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                    109  N*1/2(1540) REAL PART OF POLE POSITION (MEV)                 11/77

RE  8      1535. OR 1482.              LONGACRE  77 IPWA     PI N TO 2PI N    11/77

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                    109  N*1/2(1540) -2*IMAG PART OF POLE POSITION (MEV)              11/77

IM  8       207. OR 314.               LONGACRE  77 IPWA     PI N TO 2PI N    11/77

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                    109  N*1/2(1540) PARTIAL DECAY MODES                              11/77

                                                               DECAY MASSES
P1      N*1/2(1540) INTO PI N                                  139+ 938
P2      N*1/2(1540) INTO N RHO,S=1/2,P-WAVE                    938+ 769
P3      N*1/2(1540) INTO N RHO,S=3/2,P-WAVE                    938+ 769
P4      N*1/2(1540) INTO N*3/2(1232) PI,P-WAVE                1232+ 139
P5      N*1/2(1540) INTO N EPSILON                             938+1300

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                    109  N*1/2(1540) BRANCHING RATIOS                                 11/77

R1      N*1/2(1540) FROM PI N TO N RHO,S=1/2,P-WAVE       SQRT(P1*P2)            11/77
R1  8       (-0.08)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77

R2      N*1/2(1540) FROM PI N TO N RHO,S=3/2,P-WAVE       SQRT(P1*P3)            11/77
R2  8       (0.00)                     LONGACRE  77 IPWA     PI N TO 2PI N    11/77

R3      N*1/2(1540) FROM PI N TO N*3/2(1232) PI,P-WAVE    SQRT(P1*P4)            11/77
R3  8       (+0.11)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77

R4      N*1/2(1540) FROM PI N TO N EPSILON                SQRT(P1*P5)            11/77
R4  8       (0.00)                     LONGACRE  77 IPWA     PI N TO 2PI N    11/77

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                              REFERENCES FOR N*1/2(1540)

LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                        (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET           (SACL)IJP

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N(1650) 66 N*1/2(1650, JP=1/2-) I=1/2 **S_{11}**

THIS RESONANCE IS WELL ESTABLISHED.

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                    66  N*1/2(1650) MASS (MEV)

M         (1695.0)                      BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  9/66
M         (1700.0)                      MICHAEL   66 RVUE    FITS BAREYRE S11  7/66
M   G     (1710.0)                      BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M   G           WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M   3     (1710.0)                      DONNACHI  68 RVUE    PHASE-SHIFT ANAL  8/68
M         (1705.0)    (10.0)            ORITO     69 RVUE    K LAMBDA PS ANAL  8/69
M   6     (1683.0)                      AYED      70 IPWA                       1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1766.0)                      DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M         (1679.0)                      SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
M   A     (1685.0)                      WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A   THERE ARE 3 SIMILAR SOLUTIONS
M   7     (1670.)                       ALMEHED   72 IPWA                       2/72
M    2    (1699.)                       HICKS     73 MPWA    GAM P-ETA P       9/73
M    2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.         9/73
M    2  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.        9/73
M    1    (1860.)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M    1  S11 AMPLITUDE LARGE BUT NOT RESONANT IN SOLUTION 1 OF LANGBEIN73        9/73
M    1  DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF         1/78
M    1  WINNIK77 AROUND 1920 MEV.                                               1/78
M         (1675.)                       KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
M   L      1675. OR 1669.               LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.      11/75
M         (1673.)                       AYED      76 IPWA                      11/77
M         (1676.)                       BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M   D     (1700.)       (5.)            BAKER     77 IPWA  0 PI- P TO K LAM.   1/78
M   E     (1680.)                       BAKER     77 DPWA  0 PI- P TO K LAM.   1/78
M   D   THE TWO ENTRIES FOR BAKER 77 ARE FOR AN IPWA USING THE BARRELET         1/78
M   E   ZERO METHOD AND A CONVENTIONAL ENERGY-DEPENDENT ANALYSIS.               1/78
M   8     (1700.)                       LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M   8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE   11/77
M   8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                           11/77
M         (1680.)                       BAKER     78 DPWA  0 PI- P TO K LAM    3/79
M    9    (1694.)                       BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M    9  SUPERSEDES BARBOUR 76.                                                  3/79
M         (1640.)     130.)             CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M          1670.        8.              HOEHLER   79 IPWA    PI N TO PI N     12/79
M         (1688.0)                      CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M          1650.       30.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M         (1675.)                       LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*
M         (1672.)                       MUSETTE   80 IPWA  0 PI- P TO K LAM    1/82*
M   H     (1680.)                       SAXON     80 DPWA  0 PI- P TO K LAM   12/79
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    66  N*1/2(1650) WIDTH (MEV)

W         (240.0)                       MICHAEL   66 RVUE                       7/66
W   1     (260.0)                       BAREYRE   68 RVUE                      11/67
W   3     (300.0)                       DONNACHI  68 RVUE                       8/69
W         (106.0)     (15.0)            ORITO     69 RVUE                       8/69
W   6     (166.0)                       AYED      70 IPWA                       1/71
W   4     (404.0)                       DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W   4   SOL B GIVES 121 MEV                                                     2/73
W         (99.0)                        SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
W   A     (110.0)OR(140.0)              WAGNER    71 IPWA    PI-P TO K LAMB    1/71
W   7     (120.)                        ALMEHED   72 IPWA                       2/72
W    2    (195.)                        HICKS     73 MPWA    GAM P-ETA P       9/73
W    1    (200.)                        LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W         (170.)                        KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
W   L      150. OR  130.                LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W         (150.)                        AYED      76 IPWA                      11/77
W         (196.)                        BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W   D     (130.)      (10.)             BAKER     77 IPWA  0 PI- P TO K LAM.   1/78
W   E     (90.)                         BAKER     77 DPWA  0 PI- P TO K LAM.   1/78
W   8     (170.)                        LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W         (90.)                         BAKER     78 DPWA  0 PI- P TO K LAM    3/79
W    9    (193.)                        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W         (140.)      (40.)             CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W          180.        20.              HOEHLER   79 IPWA    PI N TO PI N     12/79
W         (163.0)                       CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W          150.        40.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W         (109.)                        LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*
W         (179.)                        MUSETTE   80 IPWA  0 PI- P TO K LAM    1/82*
W   H     (120.)                        SAXON     80 DPWA  0 PI- P TO K LAM   12/79
W            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                    66  N*1/2(1650) REAL PART OF POLE POSITION (MEV)                  11/75

RE        (1648.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE  8      1699. OR 1698.               LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE        (1633.)                       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE         1640.       20.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                    66  N*1/2(1650) -2*IMAG PART OF POLE POSITION (MEV)               11/75

IM        (117.)                        LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM  8      174. OR 173.                 LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM        (140.)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM         150.        30.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                    66  N*1/2(1650) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER       (3.)                          CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER        15.         25.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                    66  N*1/2(1650) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR       (-58.)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR        -53.        12.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                    66  N*1/2(1650) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(1650) INTO PI N                                  139+ 938
P2      N*1/2(1650) INTO N ETA                                 939+ 548
P3      N*1/2(1650) INTO LAMBDA K                             1115+ 497
P4      N*1/2(1650) INTO GAM P, HELICITY=1/2                     0+ 938
P5      N*1/2(1650) INTO GAM N, HELICITY=1/2                     0+ 939
P6      N*1/2(1650) INTO N PI PI                               938+ 139+ 139
P7      N*1/2(1650) INTO N EPSILON                             938+1300
P8      N*1/2(1650) INTO N RHO                                 938+ 769
P9      N*1/2(1650) INTO K SIGMA                               493+1189
P10     N*1/2(1650) INTO N RHO,S=1/2,S-WAVE                    938+ 769
P11     N*1/2(1650) INTO N RHO,S=3/2,D-WAVE                    938+ 769
P12     N*1/2(1650) INTO N*3/2(1232) PI                       1232+ 139

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                    66  N*1/2(1650) BRANCHING RATIOS

R1      N*1/2(1650) INTO (PI N)/TOTAL                                (P1)
R1          (1.0)           APPROX      MICHAEL   66 RVUE                       7/66
R1  3       (0.79)                      DONNACHI  68 RVUE                       8/69
R1  6       (0.642)                     AYED      70 IPWA                       1/71
R1  4       (0.56)                      DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
R1  7       (0.5)                       ALMEHED   72 IPWA                       2/72
R1          (0.54)                      AYED      76 IPWA                      11/77
R1          (0.60)     (0.05)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
R1           0.61       0.04            HOEHLER   79 IPWA    PI N TO PI N     12/79
R1           0.65       0.10            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1            . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*1/2(1650) FROM PI N TO K LAMBDA                     SQRT(P1*P3)       4/75
R2          (0.20)     (0.05)           ORITO     69 RVUE                       4/75
R2  A       (0.21)OR 0.23               WAGNER    71 IPWA    PI- P TO K LAMB   4/75
R2          -0.179      0.033           DEVENISH  74       0 FIXED T DISP REL  4/75
R2          (0.12)                      KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
R2  D       (-0.23)    (0.01)           BAKER     77 IPWA  0 PI- P TO K LAM.   1/78
R2  E       (-0.25)                     BAKER     77 DPWA  0 PI- P TO K LAM.   1/78
R2   F      (-0.25)                     BAKER     78 DPWA  0 PI- P TO K LAM    3/79
R2   F  THE (UNDETERMINED) OVERALL PHASE OF ALL COUPLINGS FROM BAKER78          3/79
R2   F  HAS BEEN CHANGED TO AGREE WITH PREVIOUS CONVENTIONS.                   3/79
R2  H       (-0.22)                     SAXON     80 DPWA  0 PI- P TO K LAM   12/79
R2  H   SUPERSEDES BAKER 78.                                                   12/79

R3      N*1/2(1650) INTO (LAMBDA K)/TOTAL                            (P3)
R3  B       (0.028)         APPROX.     RUSH      68 MPWA    T POLE + RESCN.   8/69
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4      N*1/2(1650) INTO (N ETA)/TOTAL                               (P2)
R4  B       (0.013)                     BOTKE     69 MPWA    T POLE + RESCN.  10/69
R4  B       (0.03)     (0.02)           DEANS     69 MPWA    T POLE + RESCN.   8/6.
R4  C       (0.19) OR 0.27              CARRERAS  70 MPWA    T POLE + RESON.   5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4  C   CARRERAS 70 USES REGGE POLES + RESONANCES. VALUES SUSPICIOUSLY LARG

R5      N*1/2(1650) FROM GAMMA PROTON TO K LAMBDA             SQRT(P3*P4)       9/73
R5          (0.002)OR LESS              ORITO2    69 CNTR    K LAM PHOTOPRO   10/71
R5          (0.0072)                    SCHORSCH  70 DPWA    K LAM PHOTOPRO.  10/71
R5          (0.0060)                    DEANS     72 MPWA    GAM P-K L*,SOL 3  9/73

R6      N*1/2(1650) FROM GAMMA PROTON TO ETA PROTON           SQRT(P2*P4)       9/73
R6   2      (0.0101)                    HICKS     73 MPWA    GAM P-ETA P       9/73

R7      N*1/2(1650) FROM PI N TO K SIGMA                      SQRT(P1*P9)       9/73
R7   1      (0.11)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
R7  5       (0.066)TO 0.137             DEANS     75 DPWA    PI N TO K SIGMA  11/75
R7  5   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                               11/75
R7          (0.20)                      KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
R7          (-0.254)                    LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*

R8      N*1/2(1650) FROM PI N TO N*3/2(1232) PI               SQRT(P1*P12)     11/75
R8  L       (-0.16)OR -0.15             LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R8  8       (-0.29)                     LONGACRE  77 IPWA    PI N TO 2PI N    11/77
R8  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
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R9     N*1/2(1650) FROM PI N TO N RHO,S=1/2,S-WAVE        SQRT(PI*P10)        11/75
R9   L     (0.23)OR +0.16             LONGACRE  75 IPWA     PI N TO 2PI N     11/75
R9   8     (-0.17)                    LONGACRE  77 IPWA     PI N TO 2PI N     11/77

R10    N*1/2(1650) FROM PI N TO N RHO,S=3/2,D-WAVE        SQRT(PI*P11)        11/77
R10 8      (-0.29)                    LONGACRE  77 IPWA     PI N TO 2PI N     11/77
R10 8  LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R11    N*1/2(1650) FROM PI N TO N EPSILON                 SQRT(PI*P7)         11/75
R11  L     (-0.23)OR -0.25            LONGACRE  75 IPWA     PI N TO 2PI N     11/75
R11  8     (0.00)                     LONGACRE  77 IPWA     PI N TO 2PI N     11/77

R12    N*1/2(1650) FROM PI N TO ETA N                     SQRT(PI*P2)         12/79
R12  I     (-0.09)                    BAKER     79 DPWA  0 PI- P TO ETA N     12/79
R12  I THIS COUPLING WAS FIXED DURING FITTING, BUT THE NEGATIVE SIGN          12/79
R12  I RELATIVE TO N(1535) IS WELL DETERMINED.                                12/79
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               66  N*1/2(1650) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1650) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1          0.024      0.033        DEVENISH  73 DPWA     PI N PHOTOPROD.     2/74
A1         +0.066      0.042        MOORHOUS  73 DPWA     PI N PHOTOPROD.     2/73
A1          0.029      0.018        DEVENIS2  74 DPWA     PI N PHOTOPROD.     4/75
A1          0.058      0.018        KNIES     74 DPWA     PI N PHOTOPROD.     2/74
A1         +0.012      0.015        METCALF   74 DPWA     PI N PHOTOPROD.     2/74
A1          0.054      0.005        MOORHOUS  74 DPWA     PI N PHOTOPROD.     2/74
A1         +0.044      0.018        CRAWFORD  75 DPWA     PI N PHOTOPROD.     1/76
A1         (+0.044)                 BARBOUR   76 DPWA     PI N PHOTOPROD.     1/76
A1         +0.068      0.009        FELLER    76 DPWA     PI N PHOTOPROD.     2/77
A1         +0.004      0.004        AZNAURYAN 77 DPWA     PI0 PHTPRD,SOL 1 12/79
A1         +0.003      0.004        AZNAURYAN 77 DPWA     PI0 PHTPRD,SOL 2 12/79
A1   9     +0.048      0.017        BARBOUR   78 DPWA     PI-N PHOTOPROD.     3/79
A1          0.065      0.005        ARAI      80 DPWA     PI N PHOTO FIT 1 12/81*
A1          0.061      0.005        ARAI      80 DPWA     PI N PHOTO FIT 2 12/81*
A1          0.031      0.017        CRAWFORD  80 DPWA     PI N PHOTOPROD.   12/81*
A1          . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 4.5)

A2     N*1/2(1650) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2          0.010      0.043        DEVENISH  73 DPWA     PI N PHOTOPROD.     2/74
A2         -0.072      0.066        MOORHOUS  73 DPWA     PI N PHOTOPROD.     2/73
A2         -0.006      0.031        DEVENIS2  74 DPWA     PI N PHOTOPROD.     4/75
A2         -0.015      0.035        KNIES     74 DPWA     PI N PHOTOPROD.     2/74
A2         -0.019      0.022        METCALF   74 DPWA     PI N PHOTOPROD.     2/74
A2         -0.027      0.009        MOORHOUS  74 DPWA     PI N PHOTOPROD.     2/74
A2         -0.103      0.010        CRAWFORD  75 DPWA     PI N PHOTOPROD.     1/76
A2         (-0.022)                 BARBOUR   76 DPWA     PI N PHOTOPROD.     1/76
A2   9     -0.045      0.024        BARBOUR   78 DPWA     PI-N PHOTOPROD.     3/79
A2          0.010      0.020        ARAI      80 DPWA     PI N PHOTO FIT 1 12/81*
A2          0.008      0.019        ARAI      80 DPWA     PI N PHOTO FIT 2 12/81*
A2         -0.068      0.040        CRAWFORD  80 DPWA     PI N PHOTOPROD.   12/81*
A2         -0.011      0.011        TAKEDA    80 DPWA     PI N PHOTOPROD.   12/81*
A2          0.004      0.004        FUJII     81 DPWA     PI N PHOTOPROD.   12/81*
A2          . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 3.6)

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                              REFERENCES FOR N*1/2(1650)

BRANDSEN 65 PL 19 420             +DONNELL, MOORHOUSE            (DURHAM, RHEL)IJP

MICHAEL  66 PL 21 93              C MICHAEL                              (OXF)

BAREYRE  68 PR 165 1731           P BAREYRE, C BRICMAN, G VILLET    (SACLAY)IJP
DONNACHI 68 PL 26B 161            A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
  ALSO   68 VIENNA 139            DONNACHIE  RAPPORTEUR.S TALK           (GLAS)
  ALSO   68 THESIS                R G KIRSOPP                            (EDIN)
RUSH     68 PR 173 1776           J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417           J C BOTKE                              (UCSB)
DEANS    69 PR 185 1797           S DEANS, J WOOTEN          (UNIV S FLORIDA)
ORITO    69 LNC 1 936             S ORITO,S SASAKI               (TOKYO-OSAKA)
ORITO2   69 INS J 113             S ORITO (THESIS)                      (TOKYO)

AYED     70 KIEV CONF             R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35             B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES   70 NP B21 359            A DAVIES                               (GLAS)
SCHORSCH 70 NP B25 179            +TIETGE,WEILNBOECK                     (MPIM)

WAGNER   71 NP B25 411            F WAGNER, C LOVELACE                   (CERN)

ALMEHED  72 NP B40 157            +LOVELACE                      (LUND,RUTG)IJP
DEANS    72 PRD 6 1906            DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53             DEVENISH,RANKIN,LYTH         (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614            +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251            LANGBEIN,WAGNER                    (MUNICH)IJP
MOORHOUS 73 PL 43B 44             MOORHOUSE, OBERLACK              (GLAS+LBL)IJP

DEVENISH 74 NP B81 330            DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227            DEVENISH,LYTH,RANKIN       (DESY,LANC+BONN)IJP
KNIES    74 PRD 9 2680            KNIES,MOORHOUSE,OBERLACK         (LBL+GLAS)IJP
METCALF  74 NP B76 253            W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1               MOORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125            R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90             +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1              +LINDQUIST,NELSON+   (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415            +ROSENFELD,LASINSKI,SMADJA+    (LBL,SLAC)IJP
  ALSO   78 PRD 17 1795           LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921            AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358           I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
FELLER   76 NP B104 219           +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77 EFI-264(5T)-77        +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BAKER    77 NP B126 365           +BLISSET,BLOODWORTH,BROOME,HART+      (RHEL)IJP
LONGACRE 77 NP B122 493           LONGACRE,DOLBEAU                      (SACL)IJP
  ALSO   76 NP B108 365           DOLBEAU,TRIANTIS,NEVEU,CADIET          (SACL)IJP

BAKER    78 NP B141 29            +BLISSET,BLOODWORTH,BROOME+       (RL+CAMB)IJP
BARBOUR  78 NP B141 253           BARBOUR,CRAWFORD,PARSONS               (GLAS)
BAKER    79 NP B156 93            +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839           +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                  +KAISER,KOCH,PIETARINEN        /KARLSRUHE IJP
  ALSO   80 TORONTO CONF 3        R.KOCH                          (KARLSRUHE)IJP
ARAI     80 TORONTO CONF 93       I. ARAI                                (TOKY)
CRAWFORD 80 TORONTO CONF 107      R.L.CRAWFORD                           (GLAS)
CUTKOSKY 80 TORONTO CONF 19       +FORSYTH,BABCOCK,KELLY,HENDRICK   (CARN+LBL)IJP
LIVANOS  80 TORONTO CONF 35       +BATON,COUTURES,KOCHOWSKI,NEVEU       (SACL)IJP
MUSETTE  80 NC 57A 37             M. MUSETTE                            (BRUX)IJP
SAXON    80 NP B162 522           +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP
TAKEDA   80 NP B168 17            TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+       (TOKY)
FUJII    81 NP B187 53            FUJII,HAYASHII,IWATA,KAJIKAWA+         (TOKY)

                                  PAPERS NOT REFERRED TO IN DATA CARDS

BAREYRE  65 PL 18 342             + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS C H JOHNSON                             (LRL)
DEANS    69 PR  177 2623          S R DEANS                     (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433            A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598            +BAREYRE+VILLET                      (SACLAY)
WINNIK   77 NP B128 66            +TOAFF,REVEL,GOLDBERG,BERNY           (HAIF)
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N(1675)

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 64  N*1/2(1675, JP=5/2-) I=1/2          D15

        THIS RESONANCE IS WELL ESTABLISHED.

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               64  N*1/2(1675) MASS (MEV)

M         (1650.0)         APPROX      BRANDSEN  65 RVUE    PHASE-SHIFT ANAL  7/66
M    1    (1680.0)                     BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1          WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3    (1679.0)                     DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M         (1674.0)                     DUKE      68 CNTR    PI-P EL + POL     6/68
M    6    (1675.0)                     AYED      70 IPWA                      1/71
M    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4    (1669.0)                     DAVIES    70 RVUE    P-S ANAL   SOL A  8/69
M    7    (1683.)                      ALMEHED   72 IPWA                      2/72
M          1652. TO 1687.              CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
M    L     1660. OR 1660.              LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M    L  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75
M         (1660.)                      AYED      76 IPWA                     11/77
M         (1687.)                      BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M    8    (1650.)                      LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M    8  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2. EXCEPT FOR THE POLE 11/77
M    8  POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                         11/77
M    5    (1680.)                      BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M    5  SUPERSEDES BARBOUR 76.                                              3/79
M         (1680.)      (15.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M          1679.         9.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M         (1685.0)                     CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M          1675.        10.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M    9    (1670.)                      SAXON     80 DPWA  0 PI- P TO K LAM   12/79
M          . . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               64  N*1/2(1675) WIDTH (MEV)

W    1    (135.0)                      BAREYRE   68 RVUE                     11/67
W    3    (173.0)                      DONNACHI  68 RVUE                      6/68
W    6    (143.0)                      AYED      70 IPWA                      1/71
W    4    (115.0)                      DAVIES    70 RVUE    SOL A AND B       8/69
W    7    (150.)                       ALMEHED   72 IPWA                      2/72
W          165. TO  185.               CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
W    L     145. OR  150.               LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W         (146.)                       AYED      76 IPWA                     11/77
W         (172.)                       BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W    8    (130.)                       LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W    5    (192.)                       BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W         (89.)                        BAKER     79 DPWA  0 PI- P TO ETA N   12/79
W         (180.)       (30.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W          120.         15.            HOEHLER   79 IPWA    PI N TO PI N     12/79
W         (191.0)                      CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W          160.         20.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W    9    (140.)                       SAXON     80 DPWA  0 PI- P TO K LAM   12/79
W          . . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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               64  N*1/2(1675) REAL PART OF POLE POSITION (MEV)          11/75

RE        (1663.)                      LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE   8     1649. OR 1650.              LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE        (1663.)                      CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE         1660.        10.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               64  N*1/2(1675) -2*IMAG PART OF POLE POSITION (MEV)       11/75

IM        (146.)                       LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM   8     127. OR 127.                LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM        (150.)                       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM         140.         10.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               64  N*1/2(1675) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (33.)                       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER         27.          5.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               64  N*1/2(1675) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-11.)                      CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR        -16.          5.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                64   N*1/2(1675) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      N*1/2(1675) INTO PI N                                   139+ 938
P2      N*1/2(1675) INTO N ETA                                  939+ 548
P3      N*1/2(1675) INTO LAMBDA K                              1115+ 497
P4      N*1/2(1675) INTO N*3/2(1232) PI                        1232+ 139
P5      N*1/2(1675) INTO N PI PI                                938+ 139+ 139
P6      N*1/2(1675) INTO GAM P, HELICITY=1/2                      0+ 938
P7      N*1/2(1675) INTO GAM P, HELICITY=3/2                      0+ 938
P8      N*1/2(1675) INTO GAM N, HELICITY=1/2                      0+ 939
P9      N*1/2(1675) INTO GAM N, HELICITY=3/2                      0+ 939
P10     N*1/2(1675) INTO SIGMA K                                493+1189
P11     N*1/2(1675) INTO N*3/2(1232) PI,D-WAVE                 1232+ 139
P12     N*1/2(1675) INTO N RHO,S=3/2,D-WAVE                     938+ 769
P13     N*1/2(1675) INTO N EPSILON                              938+1300

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                64   N*1/2(1675) BRANCHING RATIOS

R1      N*1/2(1675) INTO (PI N)/TOTAL                          (P1)
R1  1         (0.41)                  BAREYRE   58 RVUE                       11/67
R1  3         (0.391)                 DONNACHI  68 RVUE                        6/68
R1  6         (0.392)                 AYED      70 IPWA                        1/71
R1  4         (0.50)                  DAVIES    70 RVUE    P-S ANAL   SOL A    8/69
R1  7         (0.45)                  ALMEHED   72 IPWA                        2/72
R1            (0.41)                  AYED      76 IPWA                       11/77
R1            (0.35)    (0.06)        CUTKOSKY  79 IPWA    PI N TO PI N       12/79
R1             0.38      0.03         HOEHLER   79 IPWA    PI N TO PI N       12/79
R1             0.38      0.05         CUTKOSKY  80 IPWA    PI N TO PI N        1/82*
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2      N*1/2(1675) INTO (N ETA)/TOTAL                         (P2)
R2            (0.02) OR LESS          TRIPP     67 RVUE                        8/67
R2  B         (0.018)                 BOTKE     69 MPWA    T POLE + RESON.    10/69
R2  B         (0.006)  (0.004)        DEANS     69 MPWA    T POLE + RESON.     5/70
R2  B         (0.006)OR 0.012         CARRERAS  70 MPWA    T POLE + RESON.     5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1675) INTO (LAMBDA K)/TOTAL                      (P3)
R3            (0.016)OR LESS          TRIPP     67 RVUE                        8/67
R3  B         (0.001)OR LESS          RUSH      68 MPWA    T POLE + RESON.     8/69
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R3            (0.0028)OR LESS CL=.63  WAGNER    71 IPWA    PI-P TO K LAMB      1/71

R4      N*1/2(1675) INTO (N*3/2(1232) PI)/TOTAL                (P4)
R4 E 12600     0.63      0.1          BRODY     71  HBC    PI-P--2PI N,PWA     6/70
R4 E        ASSUMES ELASTIC BRANCHING RATIO 0.42+-0.04

R5      N*1/2(1675) FROM PI N TO K LAMBDA                     SQRT(P1*P3)          4/75
R5           -0.034     0.006         DEVENISH  74          O FIXED T DISP REL 4/75
R5      COUPLING TO LAMBDA K NOT REQUIRED IN THE ANALYSES OF BAKER77 AND           3/79
R5      BAKER78.                                                                   3/79
R5  9         (+0.036)                SAXON     80 DPWA  O PI- P TO K LAM     12/79
R5  9   SUPERSEDES BAKER 78.  COUPLING PHASE IS NEAR 90 DEGREES.                  12/79

R6      N*1/2(1675) FROM PI N TO ETA N                        SQRT(P1*P2)         11/75
R6  2         (0.0)OR (+0.009)        FELTESSE  75 DPWA  O 1488 TO 1745 MEV 11/75
R6  2   USES M AND W OF AYED 76.                                                  11/75
R6            (-0.07)                 BAKER     79 DPWA  O PI- P TO ETA N     12/79

R7      N*1/2(1675) FROM PI N TO K SIGMA                      SQRT(P1*P10)        11/75
R7  2       LESS THAN 0.003           DEANS     75 DPWA    PI N TO K SIGMA    11/75
R7  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                                  11/75
R7  2   DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77                 1/78
R7  2   AROUND 1920 MEV.                                                           1/78

R8      N*1/2(1675) FROM PI N TO N*3/2(1232) PI,D-WAVE   SQRT(P1*P11)             11/75
R8  1         (-0.45)OR -0.50         LONGACRE  75 IPWA    PI N TO 2PI N      11/75
R8  8         (-0.46)                 LONGACRE  77 IPWA    PI N TO 2PI N      11/77
R8  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R8  N         (-0.5)                  NOVOSELLE 78 IPWA    PI N TO 2PI N       3/79
R8  N   BW FIT TO LONGACRE 75 IPWA.                                                3/79

R9      N*1/2(1675) FROM PI N INTO N RHO,S=3/2,D-WAVE    SQRT(P1*P12)             11/77
R9  8         (+0.15)                 LONGACRE  77 IPWA    PI N TO 2PI N      11/77
R9  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R10     N*1/2(1675) FROM PI N INTO N EPSILON                  SQRT(P1*P13)        11/77
R10 8         (-0.03)                 LONGACRE  77 IPWA    PI N TO 2PI N      11/77

   SEE NOTE PRECEDING THE N*1/2(1680) INELASTIC DECAY MODE MEASUREMENTS.

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                64   N*1/2(1675) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(1675) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1             0.027     0.030        DEVENISH  73 DPWA    PI N PHOTOPROD.     2/74
A1            (0.023)                 HEMMI1    73       + FWD PI0 PHTOPROD    2/74
A1            +0.011     0.012        MOORHOUS  73 DPWA    PI N PHOTOPROD.     2/73
A1             0.019     0.021        DEVENIS2  74 DPWA    PI N PHOTOPROD.     4/75
A1             0.013     0.014        KNIES     74 DPWA    PI N PHOTOPROD.     2/74
A1            +0.010     0.013        METCALF   74 DPWA    PI N PHOTOPROD.     2/74
A1             0.019     0.007        MOORHOUS  74 DPWA    PI N PHOTOPROD.     2/74
A1            +0.027     0.009        CRAWFORD  75 DPWA    PI N PHOTOPROD.     1/76
A1           (+0.004)                 KRIVETS   75 DPWA    PI-N PHOTOPROD.     1/78
A1           (+0.009)                 BARBOUR   76 DPWA    PI N PHOTOPROD.     1/76
A1            +0.034     0.004        FELLER    76 DPWA    PI N PHOTOPROD.     2/77
A1            +0.034     0.003        AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1   12/79
A1            +0.071     0.002        AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2   12/79
A1  5         +0.022     0.010        BARBOUR   78 DPWA    PI-N PHOTOPROD.     3/79
A1             0.006     0.005        ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A1             0.006     0.004        ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A1             0.023     0.015        CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 6.2)

A2      N*1/2(1675) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2             0.036     0.030        DEVENISH  73 DPWA    PI N PHOTOPROD.     2/74
A2            +0.021     0.020        MOORHOUS  73 DPWA    PI N PHOTOPROD.     2/73
A2             0.014     0.004        DEVENIS2  74 DPWA    PI N PHOTOPROD.     4/75
A2             0.014     0.008        KNIES     74 DPWA    PI N PHOTOPROD.     2/74
A2            +0.042     0.024        METCALF   74 DPWA    PI N PHOTOPROD.     2/74
A2             0.016     0.002        MOORHOUS  74 DPWA    PI N PHOTOPROD.     2/74
A2            +0.015     0.006        CRAWFORD  75 DPWA    PI N PHOTOPROD.     1/76
A2           (+0.021)                 KRIVETS   75 DPWA    PI-N PHOTOPROD.     1/78
A2           (+0.021)                 BARBOUR   76 DPWA    PI N PHOTOPROD.     1/76
A2            +0.019     0.009        FELLER    76 DPWA    PI N PHOTOPROD.     2/77
A2            +0.019     0.010        AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1   12/79
A2            +0.002     0.021        AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2   12/79
A2  5         +0.015     0.006        BARBOUR   78 DPWA    PI-N PHOTOPROD.     3/79
A2             0.030     0.004        ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A2             0.029     0.004        ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A2             0.005     0.012        CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

A3      N*1/2(1675) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            -0.060     0.062        DEVENISH  73 DPWA    PI N PHOTOPROD.     2/74
A3            +0.010     0.040        MOORHOUS  73 DPWA    PI N PHOTOPROD.     2/73
A3            -0.029     0.023        DEVENIS2  74 DPWA    PI N PHOTOPROD.     4/75
A3            -0.043     0.006        KNIES     74 DPWA    PI N PHOTOPROD.     2/74
A3             0.004     0.015        METCALF   74 DPWA    PI N PHOTOPROD.     2/74
A3            -0.017     0.004        MOORHOUS  74 DPWA    PI N PHOTOPROD.     2/74
A3            -0.052     0.003        CRAWFORD  75 DPWA    PI N PHOTOPROD.     1/76
A3           (-0.058)                 BARBOUR   76 DPWA    PI N PHOTOPROD.     1/76
A3  5         -0.066     0.020        BARBOUR   78 DPWA    PI-N PHOTOPROD.     3/79
A3            -0.039     0.017        ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A3            -0.025     0.027        ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A3            -0.059     0.015        CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A3            -0.021     0.011        TAKEDA    80 DPWA    PI N PHOTOPROD.    12/81*
A3            -0.033     0.004        FUJII     81 DPWA    PI N PHOTOPROD.    12/81*
A3          . . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

A4      N*1/2(1675) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4            -0.072     0.022        DEVENISH  73 DPWA    PI N PHOTOPROD.     2/74
A4            -0.035     0.014        MOORHOUS  73 DPWA    PI N PHOTOPROD.     2/73
A4            -0.068     0.020        DEVENIS2  74 DPWA    PI N PHOTOPROD.     4/75
A4            -0.071     0.030        KNIES     74 DPWA    PI N PHOTOPROD.     2/74
A4            -0.009     0.029        METCALF   74 DPWA    PI N PHOTOPROD.     2/74
A4            -0.049     0.004        MOORHOUS  74 DPWA    PI N PHOTOPROD.     2/74
A4            -0.083     0.007        CRAWFORD  75 DPWA    PI N PHOTOPROD.     1/76
A4           (-0.080)                 BARBOUR   76 DPWA    PI N PHOTOPROD.     1/76
A4  5         -0.073     0.014        BARBOUR   78 DPWA    PI-N PHOTOPROD.     3/79
A4            -0.066     0.026        ARAI      80 DPWA    PI N PHOTO FIT 1   12/81*
A4            -0.071     0.022        ARAI      80 DPWA    PI N PHOTO FIT 2   12/81*
A4            -0.059     0.020        CRAWFORD  80 DPWA    PI N PHOTOPROD.    12/81*
A4            -0.030     0.012        TAKEDA    80 DPWA    PI N PHOTOPROD.    12/81*
A4            -0.069     0.004        FUJII     81 DPWA    PI N PHOTOPROD.    12/81*
A4          . . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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                    REFERENCES FOR N*1/2(1675)

BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP

TRIPP    67 NP 83 10           + LEITH, +      (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET      (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, P G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                           (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
      INSIGHTFUL QUALITATIVE ARGUMENTS CONCERNING EXISTENCE AND IJP.
RUSH     68 PR 173 1776        J E RUSH                        (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                             (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN            (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                              (GLAS)

BRODY    71 PL 34B 665         +CASHMORE+..+HERNDON+..           (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                  (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                       (LUND,RUTG)IJP

DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH      (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79          HEMMI,INAGAKI+       (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK          (LRL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,P L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242         +AYED,BAREYRE,BORGEAUD,DAVID,ERNWEIN+(SACL)IJP
KRIVETS  75 SJNP 20 430        +MIROSHNICHENKO,NIKIFOROV,SANIN+      (KIEV)IJP
    ALSO 74 SJNP 19 112        KRIVETS,NIKIFOROV,SANIN,SHALATSKII    (KIEV)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795        LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921         AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358        T. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
FELLER   76 NP B104 219        +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493        LONGACRE,DOLBEAU                      (SACL)IJP
    ALSO 76 NP B108 365        DOLBEAU,TRIANTIS,NEVEU,CADIET         (SACL)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS              (GLAS)
NOVOSELL 78 NP B137 509        D. E. NOVOSELLER                  (CAL TECH)IJP
    ALSO 78 NP B137 445        D. E. NOVOSELLER                  (CAL TECH)IJP

BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+   (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY           (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93   I. ARAI                               (TOKY)
CRAWFORD 80  TORONTO CONF 107  R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK   (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP
TAKEDA   80 NP B168 17         TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+      (TOKY)
FUJII    81 NP B187 53         FUJII,HAYASHII,IWATA,KAJIKAWA+        (TOKY)

                               PAPERS NOT REFERRED TO IN DATA CARDS

BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET         (SACLAY)IJP
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
JOHNSON  67 UCRL-17683 THESIS  C H JOHNSON                            (LRL)
DEANS    69 PRL 177 2623       S R DEANS                      (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                        (SACLAY)
BAKER    77 NP B126 365        +BLISSET,BLOODWORTH,BROOME,HART+      (RHEL)IJP
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY           (HAIF)I
BAKER    78 NP B141 29         +BLISSET,BLOODWORTH,BROWNE+       (RL+CAMB)IJP

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N(1680)    65  N*1/2(1680, JP=5/2+) I=1/2    F'15
           THIS RESONANCE IS WELL ESTABLISHED.

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                  65  N*1/2(1680) MASS (MEV)

M          (1680.0)                BRANDSEN  65 RVUE    PHASE SHIFT ANAL  7/66
M    1     (1690.0)                BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1687.0)                DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M          (1682.0)                DUKE      68 CNTR    PI-P EL + POL     6/68
M    6     (1682.0)                AYED      70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1685.0)                DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M    7     (1688.)                 ALMEHED   72 IPWA                      2/72
M           1674. TO 1676.         CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
M          (1685.)                 KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
M    L      1680. OR 1670.         LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M    L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75
M          (1679.)                 AYED      76 IPWA                     11/77
M          (1680.)                 BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M    8     (1660.)                 LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M    8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M    8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                     11/77
M    5     (1680.)                 BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M    5   SUPERSEDES BARBOUR 76.                                           3/79
M          (1680.)    (15.)        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M           1684.       3.         HOEHLER   79 IPWA    PI N TO PI N     12/79
M          (1692.0)                CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M           1680.      10.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M            . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                  65  N*1/2(1680) WIDTH (MEV)

W    1     (119.0)                 BAREYRE   68 RVUE                     11/67
W    3     (177.0)                 DONNACHI  68 RVUE                      6/68
W    6     (109.0)                 AYED      70 IPWA                      1/71
W    4     (104.0)                 DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W    7     (140.)                  ALMEHED   72 IPWA                      2/72
W           115. TO  124.          CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
W          (155.)                  KNASEL    75 DPWA  0 PI- P TO K0 LAM  11/75
W    L      125. OR  130.          LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W          (126.)                  AYED      76 IPWA                     11/77
W          (120.)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W    8     (150.)                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W    5     (119.)                  BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W          (120.)     (25.)        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W           128.        9.         HOEHLER   79 IPWA    PI N TO PI N     12/79
W          (121.0)                 CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W           120.       10.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W            . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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              65  N*1/2(1680) REAL PART OF POLE POSITION (MEV)        11/75

RE         (1688.)                 LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE   8      1656. OR 1653.         LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE         (1666.)                 CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE          1667.       5.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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              65  N*1/2(1680) -2*IMAG PART OF POLE POSITION (MEV)     11/75

IM         (132.)                  LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM   8      145. OR 143.           LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM         (112.)                  CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM          110.       10.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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              65  N*1/2(1680) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (31.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER         31.         2.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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              65  N*1/2(1680) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-15.)                  CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR         -14.        3.         CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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              65  N*1/2(1680) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1       N*1/2(1680) INTO PI N                         139+ 938
P2       N*1/2(1680) INTO N ETA                        939+ 548
P3       N*1/2(1680) INTO LAMBDA K                    1115+ 497
P4       N*1/2(1680) INTO N*3/2(1232) PI              1232+ 139
P5       N*1/2(1680) INTO N PI PI                      938+ 139+ 139
P6       N*1/2(1680) INTO GAM P, HELICITY=1/2            0+ 938
P7       N*1/2(1680) INTO GAM P, HELICITY=3/2            0+ 938
P8       N*1/2(1680) INTO GAM N, HELICITY=1/2            0+ 939
P9       N*1/2(1680) INTO GAM N, HELICITY=3/2            0+ 939
P10      N*1/2(1680) INTO N EPSILON                    938+1300
P11      N*1/2(1680) INTO N RHO                        938+ 769
P12      N*1/2(1680) INTO N*3/2(1232) PI,P-WAVE       1232+ 139
P13      N*1/2(1680) INTO N*3/2(1232) PI,F-WAVE       1232+ 139
P14      N*1/2(1680) INTO N RHO,S=3/2,P-WAVE           938+ 769
P15      N*1/2(1680) INTO N RHO,S=3/2,F-WAVE           938+ 769
P16      N*1/2(1680) INTO SIGMA K                      493+1189

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                  65  N*1/2(1680) BRANCHING RATIOS

R1     N*1/2(1680) INTO (PI N)/TOTAL                     (P1)
R1  1      (0.[illegible])         BAREYRE   68 RVUE                        11/67
R1  3      (0.[illegible]60)       DONNACHI  68 RVUE                         6/68
R1  6      (0.59[illegible])       AYED      70 IPWA                         1/71
R1  4      (0.54)                  DAVIES    70 RVUE       SOL A AND B       8/69
R1  7      (0.65)                  ALMEHED   72 IPWA                         2/72
R1         (0.59)                  AYED      76 IPWA                        11/77
R1         (0.62)    (0.06)        CUTKOSKY  79 IPWA    PI N TO PI N        12/79
R1          0.65      0.02         HOEHLER   79 IPWA    PI N TO PI N        12/79
R1          0.62      0.05         CUTKOSKY  80 IPWA    PI N TO PI N         1/82*
R1            . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

     MORE INFORMATION ON THE INELASTIC DECAY MODES OF THE 1690 MEV
     BUMP, AS SEEN IN PRODUCTION EXPERIMENTS, MAY BE FOUND BELOW

R2     N*1/2(1680) INTO (N ETA)/TOTAL                    (P2)
R2         (0.015)OR LESS          TRIPP     67 RVUE                         8/67
R2  B      (0.0004)                BOTKE     69 MPWA     T POLE + RESON.    10/69
R2  B      (0.003)  (0.002)        DEANS     69 MPWA     T POLE + RESON.     5/70
R2  B      (0.0005)OR 0.001        CARRERAS  70 MPWA     T POLE + RESON.     5/70
R2  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3     N*1/2(1680) INTO (N ETA)/(PI N)                   (P2)/(P1)
R3         (0.027)OR LESS          HEUSCH    66 RVUE +  PI0, ETA PHOTO       9/66

R4     N*1/2(1680) INTO (LAMBDA K)/TOTAL                 (P3)
R4         (0.0013)OR LESS         TRIPP     67 RVUE                         8/67
R4  B      (0.001)OR LESS          RUSH      68 MPWA     T POLE + RESON.     5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
R4         (0.001)OR LESS  CL=.63  WAGNER    71 IPWA    PI-P TO K LAMB       1/71

R5     N*1/2(1680) INTO (N*3/2(1232) PI)/TOTAL           (P4)
R5 E 12600  (0.13)   (0.04)  SOLN.A  BRODY   71  HBC    PI-P--2PI N/PWA      6/70
R5 E 12600  (0.39)   (0.10)  SOLN.B  BRODY   71  HBC    PI-P--2PI N/PWA      6/70
R5 E        ASSUMES ELASTIC BRANCHING RATIO 0.62+-0.06

R6     N*1/2(1680) FROM PI N TO K LAMBDA                 SQRT(P1*P3)         4/75
R6          -0.009    0.009        DEVENISH  74          0 FIXED T DISP REL  4/75
R6          (0.01)                 KNASEL    75 DPWA  0 PI- P TO K0 LAM     11/75
R6      COUPLING TO LAMBDA K NOT REQUIRED IN THE ANALYSES OF BAKER 77 AND   12/79
R6      SAXON 80.                                                           12/79

R7     N*1/2(1680) FROM PI N TO N EPSILON                SQRT(P1*P10)       11/75
R7  L      (-0.28)OR -0.30         LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R7  8      (-0.31)                 LONGACRE  77 IPWA    PI N TO 2PI N       11/77
R7  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R7  N      (-0.42)                 NOVOSELLE 78 IPWA    PI N TO 2PI N        3/79
R7  N   BW FIT TO LONGACRE 75 IPWA.                                          3/79

R8     N*1/2(1680) FROM PI N TO N*3/2(1232) PI,P-WAVE    SQRT(P1*P12)       11/75
R8  L      (+0.26)OR +0.25         LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R8  8      (+0.27)                 LONGACRE  77 IPWA    PI N TO 2PI N       11/77
R8  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R8  N      (+0.38)                 NOVOSELLE 78 IPWA    PI N TO 2PI N        3/79

R9     N*1/2(1680) FROM PI N TO N*3/2(1232) PI,F-WAVE    SQRT(P1*P13)       11/75
R9  L      (0.) OR (-0.08)         LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R9  8      (-0.07)                 LONGACRE  77 IPWA    PI N TO 2PI N       11/77
R9  N      (-0.05)                 NOVOSELLE 78 IPWA    PI N TO 2PI N        3/79

R10    N*1/2(1680) FROM PI N TO N RHO,S=3/2,P-WAVE       SQRT(P1*P14)       11/75
R10 L      (+0.27)OR +0.30         LONGACRE  75 IPWA    PI N TO 2PI N       11/75
R10 8      (+0.23)                 LONGACRE  77 IPWA    PI N TO 2PI N       11/77
R10 8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R10 N      (+0.34)                 NOVOSELLE 78 IPWA    PI N TO 2PI N        3/79

R11    N*1/2(1680) FROM PI N TO N RHO,S=3/2,F-WAVE       SQRT(P1*P15)       11/77
R11 8      (+0.15)                 LONGACRE  77 IPWA    PI N TO 2PI N       11/77
R11 8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.

R12    N*1/2(1680) FROM PI N TO K SIGMA                  SQRT(P1*P16)       11/75
R12 2      LESS THAN 0.001         DEANS     75 DPWA    PI N TO K SIGMA     11/75
R12 2   RANGE GIVEN IS FROM 3 OF 4 BEST SOLUTIONS, NOT PRESENT IN SLTN.1.  11/75
R12 2   DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77           1/78
R12 2   AROUND 1920 MEV.                                                     1/78

R13    N*1/2(1680) FROM PI N TO ETA N                    SQRT(P1*P2)        12/79
R13        NOT SEEN                BAKER     79 DPWA  0 PI- P TO ETA N      12/79

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              65  N*1/2(1680) PHOTON DECAY AMPLI(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(1680) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1           0.015     0.023       DEVENISH  73 DPWA    PI N PHOTOPROD.      2/74
A1         (-0.003)                HEMMI1    73       + FWD PI0 PHTOPROD     2/74
A1          -0.008     0.004       MOORHOUS  73 DPWA    PI N PHOTOPROD.      2/73
A1           0.027     0.019       DEVENIS2  74 DPWA    PI N PHOTOPROD.      4/75
A1          -0.016     0.014       KNIES     74 DPWA    PI N PHOTOPROD.      2/74
A1          -0.008     0.011       METCALF   74 DPWA    PI N PHOTOPROD.      2/74
A1          -0.024     0.003       MOORHOUS  74 DPWA    PI N PHOTOPROD.      2/74
A1          -0.013     0.002       CRAWFORD  75 DPWA    PI N PHOTOPROD.      1/76
A1         (+0.003)                KRIVETS   75 DPWA    PI-N PHOTOPROD.      1/78
A1         (-0.004)                BARBOUR   76 DPWA    PI N PHOTOPROD.      1/76
A1          -0.009     0.002       FELLER    76 DPWA    PI N PHOTOPROD.      2/77
A1          -0.007     0.002       AZNAURYAN 77 DPWA    PI0 PHTPRO.SOL 1    12/79
A1          +0.010     0.001       AZNAURYAN 77 DPWA    PI0 PHTPRD.SOL 2    12/79
A1  5       -0.005     0.015       BARBOUR   78 DPWA    PI-N PHOTOPROD.      3/79
A1          -0.028     0.003       ARAI      80 DPWA    PI N PHOTO FIT 1    12/81*
A1          -0.026     0.003       ARAI      80 DPWA    PI N PHOTO FIT 2    12/81*
A1          -0.018     0.014       CRAWFORD  80 DPWA    PI N PHOTOPROD.     12/81*
A1           . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 7.1)
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A2      N*1/2(1680) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2              0.146      0.031            DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A2             +0.100      0.012            MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A2              0.163      0.011            DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2              0.097      0.007            KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2              0.129      0.016            METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2              0.147      0.006            MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A2             +0.135      0.006            CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2            (+0.107)                      KRIVETS   75 DPWA    PI-N PHOTOPROD.    1/78
A2            (+0.132)                      BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2             +0.121      0.010            FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A2             +0.112      0.002            AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 1  12/79
A2             +0.114      0.002            AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 2  12/79
A2    5        +0.138      0.021            BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2              0.115      0.003            ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A2              0.122      0.003            ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A2              0.141      0.014            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A2                 . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

A3      N*1/2(1680) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3              0.035      0.049            DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A3             +0.017      0.014            MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A3              0.031      0.028            DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A3              0.023      0.005            KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A3              0.008      0.018            METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A3              0.023      0.003            MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A3             +0.021      0.001            CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A3            (+0.034)                      BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A3    5        +0.037      0.010            BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A3              0.026      0.005            ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A3              0.028      0.014            ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A3              0.044      0.012            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A3              0.025      0.010            TAKEDA    80 DPWA    PI N PHOTOPROD.   12/81*
A3              0.032      0.003            FUJII     81 DPWA    PI N PHOTOPROD.   12/81*
A3                 . . . . . . . . . .
A3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

A4      N*1/2(1680) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4             -0.018      0.039            DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A4             -0.005      0.018            MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A4             -0.021      0.028            DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A4              0.001      0.018            KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A4              0.00       0.030            METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A4             -0.041      0.004            MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A4             -0.015      0.004            CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A4            (-0.028)                      BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A4    5        -0.038      0.018            BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A4             -0.024      0.009            ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A4             -0.029      0.017            ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A4             -0.033      0.015            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A4             -0.035      0.012            TAKEDA    80 DPWA    PI N PHOTOPROD.   12/81*
A4             -0.023      0.005            FUJII     81 DPWA    PI N PHOTOPROD.   12/81*
A4                 . . . . . . . . . .
A4   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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REFERENCES FOR N*1/2(1680)

SEE A PREVIOUS EDITION (RMP 37, 633, 1965) FOR EARLIER REFERENCES.


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BRANDSEN 65 PL 19 420          +ODONNELL, MOORHOUSE          (DURHAM, RHEL)IJP
HEUSCH   66 PRL 17 1019        C A HEUSCH, C Y PRESCOTT, P F DASHEN  (CIT)
TRIPP    67 NP 83 10           + LEITH, +          (LRL,SLAC,CERN,HEID,SACLAY)

BAREYRE  68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK            (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                             (EDIN)
DUKE     68 PR 166 1448        +JONES,KEMP,MURPHY,THRESHER, +   (RHEL,OXF)IJP
RUSH     68 PR 173 1776        J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417        J C BOTKE                               (UCSB)
DEANS    69 PR 185 1797        S DEANS, J WOOTEN            (UNIV S FLORIDA)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES   70 NP B21 359         A DAVIES                                (GLAS)

BRODY    71 PL 34B 253         +CASHMORE+..+HERNDON+..            (SLAC+LRL)
WAGNER   71 NP B25 411         F WAGNER, C LOVELACE                    (CERN)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMII   73 PL 43B 79          HEMMI,INAGAKI+           (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44          MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN        (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125         R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1           +LINDQUIST,NELSON+        (CHIC,WUSL,OSU,ANL)IJP
KRIVETS  75 SJNP 20 430        +MIROSHNICHENKO,NIKIFOROV,SANIN+       (KIEV)IJP
    ALSO 74 SJNP 19 112        KRIVETS,NEKIFOROV,SANIN,SHALATSKII     (KIEV)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795        LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921         AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358        I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
FELLER   76 NP B104 219        +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493        LONGACRE,DOLBEAU                      (SACL)IJP
    ALSO 76 NP B108 365        DOLBEAU,TRIANTIS,NEVEU,CADIET         (SACL)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS                (GLAS)
NOVOSELL 78 NP B137 509        D. E. NOVOSELLER                  (CAL TECH)IJP
    ALSO 78 NP B137 445        D. E. NOVOSELLER                  (CAL TECH)IJP

BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+   (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY           (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN           /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                            (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93   I. ARAI                                 (TOKY)
CRAWFORD 80  TORONTO CONF 107  R.L.CRAWFORD                            (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLOODWORTH+           (RHEL+BRIS)IJP
TAKEDA   80 NP B168 17         TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+        (TOKY)
FUJII    81 NP B187 53         FUJII,HAYASHII,IWATA,KAJIKAWA+          (TOKY)
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PAPERS NOT REFERRED TO IN DATA CARDS


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CROUCH   65 DESY CONF II 21    +   (BROWN,CEA,HARVARD,MIT,PADOVA,WEIZMANN)
DERADO   65 ATHENS CONF 244    +KENNEY,LAMSA, +       (NOTRE DAME,KENTUCKY)
DUKE     65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
MERLO    66 P ROY SOC 289 489  J P MERLO, G VALLADAS                 (SACLAY)
ROBERTS  67 PREPRINT           R G ROBERTS                           (DURHAM)
BANNER   68 PR 166 1347        +DEIDEUF,FAYOUX,HAMEL, +        (SACLAY,CAEN)
     THE ABOVE PAPERS DISCUSS INELASTIC CHANNELS NEAR THE BUMP.
BAREYRE  65 PL 18 342          + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
DEANS    69 PRL 177 2623       S R DEANS                    (UNIV S FLORIDA)
DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP             (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE+VILLET                       (SACLAY)
BAKER    77 NP B126 365        +BLISSET,BLOODWORTH,BROOME,HART+      (RHEL)IJP
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY            (HAIFI)
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N(1700)

18 N*1/2(1700, JP=3/2-) I=1/2

D_{13}

THIS RESONANCE IS WELL ESTABLISHED.

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                 18  N*1/2(1700) MASS  (MEV)

M   3    (1730.)                        DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3    (1680.)                        KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3   WHERE MAX. ABSORPTION IS -DONNACHI, 2 .KIRSOPP EYEBALL FIT CERN 1     10/69
M   A    (1780.0)                       WAGNER    71 IPWA    PI-P TO K LAMB    1/71
M   A   D13 RESONATES CNLY IN ONE OUT OF 3 POSSIBLE SOL.
M        (1670.)                        DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
M   1    (1790.)                        LANGBEIN  73 IPWA    PI N-K SIG.SOL 1  5/73
M   1   NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                   9/73
M   1   DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF        1/78
M   1   WINNIK77 ARCUND 1920 MEV.                                              1/78
M   L     1710. OR 1710.                LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.     11/75
M        (1710.)                        AYED      76 IPWA                     11/77
M   D    (1670.)     (10.)              BAKER     77 IPWA  D PI- P TO K LAM.   1/78
M   E    (1690.)                        BAKER     77 DPWA  D PI- P TO K LAM.   1/78
M   D   THE TWO ENTRIES FOR BAKER 77 ARE FOR AN IPWA USING THE BARRELET        1/78
M   E   ZERO METHOD AND A CONVENTIONAL ENERGY-DEPENDENT ANALYSIS.              1/78
M   8    (1660.)                        LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M   8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE   11/77
M   8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                           11/77
M         1690. TO 1710.                BAKER     78 DPWA  0 PI- P TO K LAM    3/79
M   4    (1719.)                        BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M   6    (1880.)                        BAKER     79 DPWA  0 PI- P TO ETA N   12/79
M   6   THE HIGH MASS FOUND BY BAKER79 MAY BE INFLUENCED BY THE N(2080).      12/79
M        (1670.)     (25.)              CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M         1731.       15.               HOEHLER   79 IPWA    PI N TO PI N     12/79
M        (1709.0)                       CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M         1675.       25.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M   5    (1650.)                        SAXON     80 DPWA  0 PI- P TO K LAM   12/79
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

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                 18  N*1/2(1700) WIDTH (MEV)

W         (90.)                         DEANS     72 MPWA    GAM P-K LM,SOL D  9/73
W   L    (120.)                         LANGBEIN  73 IPWA    PI N-K SIG.SOL 1  9/73
W   L     100. OR  300.                 LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W        (100.)                         AYED      76 IPWA                     11/77
W   D     (90.)      (25.)              BAKER     77 IPWA  0 PI- P TO K LAM.   1/78
W   E    (100.)                         BAKER     77 DPWA  0 PI- P TO K LAM.   1/78
W   8    (600.)                         LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W          70. TO  100.                 BAKER     78 DPWA  0 PI- P TO K LAM    3/79
W   4    (126.)                         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W   6     (87.)                         BAKER     79 DPWA  0 PI- P TO ETA N   12/79
W         (80.)      (40.)              CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W         110.        30.               HOEHLER   79 IPWA    PI N TO PI N     12/79
W        (156.0)                        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W          90.        40.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W   5     (73.)                         SAXON     80 DPWA  0 PI- P TO K LAM   12/79
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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            18  N*1/2(1700) REAL PART OF POLE POSITION (MEV)        11/75

RE       (1710.)                        LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE  8     1616. OR 1613.                LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE       (1660.)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE        1660.       30.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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            18  N*1/2(1700) -2*IMAG PART OF POLE POSITION (MEV)     11/75

IM       (607.)                         LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM  8     577. OR 575.                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM        (76.)                         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM         90.        40.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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            18  N*1/2(1700) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (4.)                         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER         6.         3.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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            18  N*1/2(1700) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR       (-0.3)                        CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR         0.         5.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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      19  N*1/2(1700) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1    N*1/2(1700) INTO PI N                           139+ 938
P2    N*1/2(1700) INTO LAMBDA K                       1115+ 497
P3    N*1/2(1700) INTO GAM P,HELICITY=3/2             0+ 938
P4    N*1/2(1700) INTO GAM P,HELICITY=1/2             0+ 938
P5    N*1/2(1700) INTO GAM N,HELICITY=3/2             0+ 939
P6    N*1/2(1700) INTO GAM N,HELICITY=1/2             0+ 939
P7    N*1/2(1700) INTO K SIGMA                        493+1189
P8    N*1/2(1700) INTO N EPSILON                      938+1300
P9    N*1/2(1700) INTO N*3/2(1232) PI,S-WAVE          1232+ 139
P10   N*1/2(1700) INTO N*3/2(1232) PI,D-WAVE          1232+ 139
P11   N*1/2(1700) INTO N RHO,S=3/2,S-WAVE             938+ 769
P12   N*1/2(1700) INTO ETA N                          939+ 548

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      19  N*1/2(1700) BRANCHING RATIOS

R1    N*1/2(1700) FROM GAMMA PROTON TO K LAMBDA         SQRT((P3+P4)*P2)     9/73
R1       (0.0077)                    DEANS     72 MPWA    GAM P-K LM,SOL 0   9/73

R2    N*1/2(1700) FROM PI N TO K SIGMA                  SQRT(P1*P7)          9/73
R2  1    (0.10)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
R2  2    LESS THAN  .017             DEANS     75 DPWA    PI N TO K SIGMA   11/75
R2  2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                             11/75

R3    N*1/2(1700) INTO (PI N)/TOTAL                     (P1)
R3       (0.09)                      AYED      76 IPWA                      11/77
R3       (0.10)     (0.02)           CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R3        0.08       0.03            HOEHLER   79 IPWA    PI N TO PI N      12/79
R3        0.11       0.05            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R3       . . . . . . . . . .
R3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R4    N*1/2(1700) FROM PI N TO K LAMBDA                 SQRT(P1*P2)          4/75
R4       +0.026      0.019           DEVENISH  74           0 FIXED T DISP REL  4/75
R4  D    (-0.03)    (0.004)          BAKER     77 IPWA    0 PI- P TO K LAM.  1/78
R4  E    (-0.03)                     BAKER     77 DPWA    0 PI- P TO K LAM.  1/78
R4  9    (-0.04)                     BAKER     78 DPWA    0 PI- P TO K LAM   3/79
R4  9  THE (UNDETERMINED) OVERALL PHASE OF ALL COUPLINGS FROM BAKER78         3/79
R4  9  HAS BEEN CHANGED TO AGREE WITH PREVIOUS CONVENTIONS.                   3/79
R4  5    (-0.012)                    SAXON     80 DPWA    0 PI- P TO K LAM  12/79
R4  5  SUPERSEDES BAKER 78.                                                 12/79

R5    N*1/2(1700) FROM PI N TO N EPSILON                SQRT(P1*P8)         11/75
R5  L    (-0.2) OR -0.2              LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R5  8    (0.00)                      LONGACRE  77 IPWA    PI N TO 2PI N     11/77

R6    N*1/2(1700) FROM PI N TO N*3/2(1232) PI,S-WAVE    SQRT(P1*P9)         11/75
R6  L    (+0.15)OR +0.16             LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R6  8    (0.00)                      LONGACRE  77 IPWA    PI N TO 2PI N     11/77

R7    N*1/2(1700) FROM PI N TO N*3/2(1232) PI,D-WAVE    SQRT(P1*P10)        11/75
R7  L    (-0.10)OR -0.14             LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R7  8    (+0.12)                     LONGACRE  77 IPWA    PI N TO 2PI N     11/77

R8    N*1/2(1700) FROM PI N TO N RHO,S=3/2,S-WAVE       SQRT(P1*P11)        11/75
R8  L    (0.1 OR (-0.07)             LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R8  8    (+0.07)                     LONGACRE  77 IPWA    PI N TO 2PI N     11/77

R9    N*1/2(1700) FROM PI N TO ETA N                    SQRT(P1*P12)        12/79
R9       (0.065)                     BAKER     79 DPWA    0 PI- P TO ETA N  12/79

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      18  N*1/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
      REVIEW PRECEDING THE BARYON LISTINGS.

A1    N*1/2(1700) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1        -0.103     0.130           DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A1        -0.048     0.050           DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A1        -0.        0.040           KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A1         0.0       0.034           METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A1       (0.023)                     MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A1        -0.012     0.010           CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A1       (-0.005)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1        -0.014     0.025           FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A1        +0.078     0.008           AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1  12/79
A1        +0.038     0.005           AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2  12/79
A1  4     -0.033     0.021           BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1  4  SUPERSEDES BARBOUR 76.                                                3/79
A1        -0.028     0.007           ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A1        -0.029     0.006           ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A1        -0.024     0.019           CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A1       . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 5.2)

A2    N*1/2(1700) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2         0.055     0.065           DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A2        -0.006     0.014           DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2         0.030     0.040           KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2         0.0       0.029           METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2       (0.035)                     MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A2        -0.012     0.010           CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2       (-0.009)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2         0.0       0.014           FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A2        -0.066     0.007           AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1  12/79
A2        -0.048     0.007           AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2  12/79
A2  4     -0.014     0.025           BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2        -0.002     0.005           ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A2         0.014     0.005           ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A2        -0.017     0.014           CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A2       . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.8)

A3    N*1/2(1700) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3         0.013     0.222           DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A3        -0.021     0.098           DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A3        -0.076     0.040           KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A3         0.0       0.034           METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A3       (-0.015)                    MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A3        +0.081     0.015           CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A3       (+0.017)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A3  4     +0.050     0.042           BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A3        -0.052     0.039           ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A3        -0.055     0.030           ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A3         0.052     0.035           CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A3        -0.002     0.013           FUJII     81 DPWA    PI N PHOTOPROD.   12/81*
A3       . . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

A4    N*1/2(1700) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4        -0.088     0.087           DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A4        -0.026     0.067           DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A4         0.024     0.024           KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A4         0.0       0.044           METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A4       (0.028)                     MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A4        +0.107     0.025           CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A4       (+0.022)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A4  4     +0.035     0.030           BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A4        -0.037     0.036           ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A4        -0.035     0.024           ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A4         0.041     0.030           CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A4         0.018     0.018           FUJII     81 DPWA    PI N PHOTOPROD.   12/81*
A4       . . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                          REFERENCES FOR N*1/2(1700)

DONNACH2 68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS              R G KIRSOPP                           (EDIN)
WAGNER   71 NP B25 411          F WAGNER, C LOVELACE                  (CERN)
DEANS    72 PRD 6 1906          DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                     (MUNICH)IJP

DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                  (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                           (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+       (LBL+SLAC)IJP
    ALSO 78 PRD 17 1795         LONGACRE,LASINSKI,ROSENFELD+      (LBL+SLAC)

AYED     76 CEA-N-1921          AYED (THESIS)                          (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD           (GLAS)IJP
FELLER   76 NP B104 219         +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77     +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BAKER    77 NP B126 365         +BLISSET,BLOODWORTH,BROOME,HART+       (RHEL)IJP
LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                       (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET          (SACL)IJP

BAKER    78 NP B141 29          +BLISSET,BLOODWORTH,BROOME+       (RL+CAMB)IJP
BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS               (GLAS)

BAKER    79 NP B156 93          +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY            (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                            (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93    I. ARAI                                (TOKY)
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                             (GLAS)
CUTKOSKY 80  TORONTO CONF 19    +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522         +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP
FUJII    81 NP B187 53          FUJII,HAYASHII,IWATA,KAJIKAWA+        (TOKY)

                                PAPERS NOT REFERRED TO IN DATA CARDS

HERNDON  72 LBL 1065            +...ROSENFELD...+CASHMORE+...       (LBL+SLAC)
WINNIK   77 NP B128 66          +TOAFF,REVEL,GOLDBERG,BERNY           (HAIFI)
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1700 MEV REGION - PRODUCTION EXPERIMENTS

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      20  N*1/2(1700, JP=    ) I=1/2    PRODUCTION EXPERIMENTS

      SEE THE MINI-REVIEW PRECEDING THE N AND DELTA LISTINGS
      FOR DISCUSSION OF PRODUCTION EXPERIMENTS.

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      20  N*1/2(1700) MASS (MEV) (PROD. EXP.)

M          (1695.0)    (9.0)           A-BORELLI 67 HBC  +  PBAR P 5.7 BEV/C  8/67
M          (1734.0)   (21.0)           ALMEIDA   68 HBC  +  PP 10 BEV/C       9/69
M          (1730.0)   (18.0)           GALLOWAY  68 HBC     PI-P 6 GEV/C      8/69
M   I      (1712.0)    (6.0)           BARNES    69 HBC     K-P TO K-P 2PI    7/70
M   I      IJP CONSISTENT WITH S11(1650) OR P11(1710) IN FORMATION
M   A      (1667.0)    (5.0)           BENVENUTI 69 DBC   0 PI-D 2.26 GEV     5/70
M   A        J CONSISTENT WITH 5/2 OR 7/2
M   B  190(1693.)     (15.)            RHODE     69 HBC     PP 22 GEV/C      10/69
M   B  JP IS PROBABLY 5/2+
M          (1691.)     (4.)            ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M      177(1713.)     (10.)            CIMBA     70 HBC  +  PI+ P TO P+3PI    2/21
M       40(1763.)     (25.)            COOPER    70 HBC  +  LAMB. K PROD.     2/71
M      505(1730.0)    (15.0)           CPENNELL  70 HBC  +  PI-P,PI+P 6 GEV   1/71
M       60(1710.)                      KUZNETSOV 70 HLBC -  LAMB. K PROD.     2/71
M   A      (1719.0)    (6.0)           WILLMANN  70 HBC  +  PI+P 13. GEV      5/70
M   A        J CONSISTENT WITH 5/2 OR 7/2
M          (1694.0)    (8.0)           AMALDI    71 SAS     P P AT 24 GEV    10/71
M          (1730.)    (20.)            BALLAM    71 HBC  +- PI+-P AT 16GEV    2/72
M          (1700.)                     BEKETOV   71 HBC  +  PI- P 4.45GEV/C   3/72
M          (1711.)    (10.)            BOESEBEC  71 RVUE    PP,PI-P,K-P PROD  3/72
M          (1672.0)    (4.0)           ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M       80(1659.0)    (10.0)   80/120  MA        71 HBC  +  P P TO P N PI   10/71
M          (1700.0)   (10.0)           MORSE     71 HBC  +  PI-P   25 GEV/C   3/72
M           1670. TO 1730.             MORSE     71 HBC  +0 PI-P   7  GEV/C   3/72
M          (1720.)    (20.)            RUSHBROOKE71 HBC  +  PP TO P2PI 16GEV  2/72
M          (1690.3)    (4.5)           EDELSTEIN 72 MMS  +  PP 6 TO 30 GEV    1/73
M          (1668.0)   (19.0)   24/45   KARSHON   72 DBC  +  PO--PO2PI 7 GEV  12/72
M   C      (1715.0)    (5.0)           LAMSA     72 HBC  +  PI+-P 8TO18 GEV   1/73
M   C    ANALYSIS GIVES JP = 5/2+
M    2     (1660.)  (15.)              OH        72 DBC   0 PI-N TO PI-PI-P   2/73
M    2   DETERMINE J=5/2,F15 PROBABLE                                         2/73
M          (1720.)    (15.)            RONAT     72  HBC    PI+P TO 3PI P     2/73
M   3      (1920.)                     DAVIDSON  74 HBC   + PI-P TO PI- OM P 10/74
M   3    OMEGA PROTON ENHANCEMENT,MOMENTS ANALYSIS CONSISTENT WITH 2J=1 OR 3 10/74
M          (1732.)     (7.)            LICHTMAN  74 HBC  +  PI+P TO 3PI P     4/75
M          (1694.)    (10.)            LICHTMAN  74 HBC  +  PI-P TO 3PI P     4/75
M   5      (1810.)    (15.)            ATHERTD2  75 HBC     PBAR P 5.7 GEV    2/77
M   5    OMEGA PROTON ENHANCEMENT, MOMENTS ANALYSIS CONSISTENT WITH S STATE.  2/77
M   4      (1700.)                     BLOBEL    75 HBC  +  PP TO P(PI+PI-P)  1/76
M   4    PWA INDICATES PI+PI-P ENHANCEMENT IS PRIMARILY A                     1/76
M   4    P-WAVE P EPSILON SYSTEM WITH 1,JP=1/2,3/2-.                          1/76
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M          1660. TO 1670.          BRAUNI     75 HBC    PBAR P 5.7 GEV    11/75
M          (1691.)    (11.)        CAVALLI    75 SPEC + PP TO 2N*,W=23GV   1/76
M          (1691.)    (8.)         CAVALLI    75 SPEC + PP TO 2N*,W=31GV   1/76
M          (1715.)    (10.)        CAVALLI    75 SPEC + PP TO 2N*,W=53GV   1/76
M          (1686.)    (12.)        MUSGRAVE   75 HBC    K+ P TO K PI N    11/75
M          (1650.)                 STRACHMA   75  BC    NBAR (N PI)        1/76
M          (1678.)    (4.)         WEBB       75 ISR  + P P TO P N*        1/76
M          (1691.)    (4.)         ATHERTON   76 HBC    PBAR P 5.7 GEV     2/77
M          (1680.)    (25.)        APPLE      77 SPEC + P P TO P (P PI0)   1/78
M          (1660.)    (20.)        APPLE      77 SPEC + P P TO P (N PI+)   1/78
M          (1690.)    (10.)        HEINEN     77 HBC    K-P TO K- N**      1/78
M          (1679.)    (10.)        HEINEN     77 HBC  0 K-P TO KOBAR N*0   1/78
M  G       (1677.)    (2.)         ROUGE      77 OMEG 0 PI-P 9.12 GEV/C    1/78
M  G   BACKWARD PRODUCTION. PI- P --> (P PI-) PI0. CONSISTENT WITH JP=5/2+
M          (1710.)    (20.)        EKELOF     78 SPEC + P HE--P PI PI HE   1/78
M  H 2.5K(1680.)      (3.)         FERRER     78 OMEG 0 PI-P 9.12 GEV/C    3/79
M  H   BACKWARD PRODUCTION. PI- P --> (P PI-) PI+ PI-
M  I   185(1664.)     (15.)        FERRER     78 OMEG + PI-P 9.12 GEV/C    3/79
M  I   BACKWARD PRODUCTION. PI- P --> (P PI+ PI-) PI-. JP=5/2- FAVORED.
M       50(1714.)     (25.)        GODDARD    78 HBC  + PI+P TO LAM K PI   3/79
M  F       (1670.)                 OTTER      78 HBC  + K-P TO K- N**      1/78
M  F   FROM PARTIAL WAVE ANALYSIS OF P PI+ PI- SYSTEM. SHAPE OF            1/78
M  F   5/2-D(DELTA PI) WAVE IS COMPATIBLE WITH A BREIT-WIGNER.             1/78
M      410(1690.)     (6.)         APELDOORN 79 HBC  +- PBAR P 7.2 GEV/C 12/79
M      600(1688.)     (1.)         APELDOORN 80 HBC  +- PBAR P 12 GEV/C   2/82*
M      700(1639.)     (7.)         FUKUNAGA  80 HBC  + PI+P TO PI PI N    2/82*
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            20  N*1/2(1700) WIDTH (MEV) (PROD. EXP.)

W          (70.0)     (20.0)       A-BORELLI 67 HBC                        9/69
W          (140.0)    (57.0)       ALMEIDA    68 HBC  +                    9/69
W          (55.0)     (15.0)       GALLOWAY   68 HBC                       8/69
W  I       (70.0)     (15.0)       BARNES     69 HBC    K-P TO K-P 2PI     7/70
W  A       (105.0)    (16.0)       BENVENUTI  69 DBC  0                    5/70
W  B   190 (235.)     (50.)        RHODE      69 HBC    PP 22 GEV/C       10/69
W          (130.)     (10.)        ANDERSON   70 MMS  - PI- P TO PI- MMS   2/71
W      177 (65.)      (26.)        CIRBA      70 HBC  + PI+ P AT 5 GEV/C   2/71
W          (102.)     (40.)        COOPER     70 HBC  + PI+P, 5.5 GEV/C    2/71
W      505 (130.0)    (30.0)       CRENNELL   70 HBC  +                    1/71
W       60 (220.)                  KUZNETSOV 70 HLBC  - PI-P, 4 GEV/C      2/71
W  A       (63.0)     (12.0)       WILLMANN   70 HBC  +                    5/70
W          (152.0)    (15.0)       AMALDI     71 SAS    P P AT 24 GEV     10/71
W          (120.)     (50.)        BALLAM     71 HBC +- PI+-P AT 16GEV     2/72
W          (57.)      (15.)        BOESEBEC   71 RVUE   PP,PI-P,K-P PROD   3/72
W          (102.0)    (9.0)        ELLIS      71 CNTR   MMS PP 3.7 GEV/C 10/71
W       80 (94.0)     (20.0)  80/120 MA       71 HBC  + P P TO P N PI     10/71
W          (73.)      (20.)        MORSE      71 HBC  + PI-P   25 GEV/C   3/72
W          70. TO  120.            MORSE      71 HBC +0 PI-P  7   GEV/C    3/72
W          (123.)     (40.)        RUSHBROOKE71 HBC  + PP TO P2PI 16GEV    2/72
W          (133.0)    (26.0)       EDELSTEIN  72 MMS  + PP 6 TO 30 GEV     1/73
W          (169.0)    (64.0)       KARSHON    72 DBC  + PD--PD2PI 7 GEV   12/72
W          180.0)     APPROX.      LAMSA      72 HBC    PI P  18.5 GEV/C 12/72
W   2      (128.)     (40.)        OH         72 DBC  0 PI-N TO PI-PI-P    2/73
W          (60.)      (40.)        RONAT      72  HBC   PI+P TO 3PI P      2/73
W          (157.)     (12.)        ABE        74      + P+P->P+X.JCBN PK   4/75
W   3      (120.)                  DAVIDSON   74 HBC  + PI-P TO PI- OM P  10/74
W          (34.)      (14.)        LICHTMAN   74 HBC  + PI+P TO 3PI P      4/75
W          (48.)      (20.)        LICHTMAN   74 HBC  + PI-P TO 3PI P      4/75
W   5      (87.)      (20.)        ATHERTO2   75 HBC    PBAR P 5.7 GEV     2/77
W          (140.)                  BRAUNI     75 HBC    PBAR P 5.7 GEV    11/75
W          (188.)     (112.)       CAVALLI    75 SPEC + PP TO 2N*,W=23GV   1/76
W          (133.)     (38.)        CAVALLI    75 SPEC + PP TO 2N*,W=31GV   1/76
W          (100.)     (10.)        CAVALLI    75 SPEC + PP TO 2N*,W=53GV   1/76
W          (135.)     (20.)        MUSGRAVE   75 HBC    K+ P TO K PI N    11/75
W          (148.)     (16.)        WEBB       75 ISP  + P P TO P N*        1/76
W          (194.)     (10.)        ATHERTON   76 HBC    PBAR P 5.7 GEV     2/77
W          (150.)     (100.)       APPLE      77 SPEC + P P TO P (P PI0)   1/78
W          (150.)     (70.)        APPLE      77 SPEC + P P TO P (N PI+)   1/78
W          (120.)     (20.)        HEINEN     77 HBC  + K-P TO K- N**      1/78
W          (90.)      (30.)        HEINEN     77 HBC  0 K-P TO KOBAR N*0   1/78
W  G       (133.)     (6.)         ROUGE      77 OMEG 0 PI-P 9.12 GEV/C    1/78
W          (200.)                  EKELOF     78 SPEC + P HE--P PI PI HE   1/78
W  H 2.5K  (121.)     (7.)         FERRER     78 OMEG 0 PI-P 9.12 GEV/C    3/79
W  I   185 (121.)     (23.)        FERRER     78 OMEG + PI-P 9.12 GEV/C    3/79
W       50 (208.)     (50.)        GODDARD    78 HBC  + PI+P TO LAM K PI   3/79
W  F       (159.)                  OTTER      78 HBC  + K-P TO K- N**      1/78
W      410 (120.)     (10.)        APELDOORN 79 HBC  +- PBAR P 7.2 GEV/C 12/79
W      600 (221.)     (1.)         APELDOORN 80 HBC  +- PBAR P 12 GEV/C   2/82*
W      700 (96.)      (20.)        FUKUNAGA  80 HBC  + PI+P TO PI PI N    2/82*
   SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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            20  N*1/2(1700) PARTIAL DECAY MODES (PROD. EXP.)

                                                       DECAY MASSES
P1    N*1/2(1700) INTO PI N                            139+ 938
P2    N*1/2(1700) INTO N PI PI                         938+ 139+ 139
P3    N*1/2(1700) INTO N*3/2(1232) PI                  1232+ 139
P4    N*3/2(1700)+ INTO NEUTRON PI+                    539+ 139
P5    N*1/2(1700)+ INTO PROTON PI+ PI-                 938+ 139+ 139
P6    N*1/2(1700)+ INTO N*3/2(1232)++ PI-              1232+ 139
P7    N*1/2(1700) INTO N ETA                           939+ 548
P8    N*1/2(1700) INTO LAMBDA K                        1115+ 497
P9    N*1/2(1700) INTO SIGMA K                         1189+ 493
P10   N*1/2(1700) INTO OMEGA PROTON                    782+ 938
P11   N*1/2(1700) INTO RHOO PROTON                     769+ 938
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            20  N*1/2(1700) BRANCHING RATIOS (PROD. EXP.)

R1        N*1/2(1700) INTO (PI N)/(PI N*3/2(1232))         (P1)/(P3)
R1             (0.77) OR LESS              LEE        67 HBC    PI-P 3.6 GEV/C   11/67
R1   A         (9.0)  OR MORE              BENVENUTI  69 DBC  0                   5/70

R2        N*1/2(1700) INTO (N ETA)/(N PI + N PI PI)        (P7)/(P1+P2)
R2             (0.025)OR LESS              KRAEMER    64 DBC  + PI+D 1.2
R2             (0.042)OR LESS  CL=.95      A-BORELLI  67 HBC  + PBAR P 5.7 BEV/C  9/69

R3        N*1/2(1700) INTO (LAMBDA K)/(P PI+ PI-)          (P8)/(P5)
R3             (0.034)OR LESS              ALEXANDER  67 HBC  + PP 5.5 BEV/C     11/67
R3             (0.07) OR LESS  CL=.95      CIRBA      70 HBC    PI+P AT 5 GEV/C   2/71
R3             (0.01)                      BAKSAY     76 ISR  + PP--N*P           1/78

R4        N*1/2(1700) INTO (LAMBDA K)/(N PI + N PI PI)     (P8)/(P1+P2)
R4             (0.013)OR LESS  CL=.95      A-BORELLI  67 HBC  +                   8/67
R4               SEEN                      CHINOWSKY  68 HBC    PP TO K+ Y N      6/68
R4   I         LIMITS 0.075 TO 0.11        BARNES     69 HBC    K-P TO K-P 2PI    7/70
R4        25     0.025     0.005           CRENNELL   70 HBC  +                   1/71
R4   A         LESS THAN   0.025           WILLMANN   70 HBC    PI+P TO 3PI P     6/70
R4        25  SEEN. CONS. WITH J=1/2       MORSE      71 HBC  0 PI-P  7   GEV/C   3/72
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R5        N*1/2(1700) INTO (N PI)/(N PI PI)                (P1)/(P2)
R5             (1.26) OR LESS  CL=.95   A-BORELLI  67 HBC  +                      8/67
R5              0.025     0.13          CRENNELL   70 HBC  +                      1/71

R6        N*1/2(1700) INTO (N*3/2(1232) PI)/(N PI PI)      (P3)/(P2)
R6             NO EVIDENCE              A-BORELLI  67 HBC  +                      8/67
          SEE MERLO 66 FOR A REVIEW.

R7        N*1/2(1700) INTO (NEUTRON PI+)/(P PI+ PI-)       (P4)/(P5)
R7              0.67      0.40          ALEXANDER  67 HBC  + PP 5.5 BEV/C        11/67
R7              0.47      0.25          A-BORELLI  67 HBC    PBAR P 5.5 GEV/C     7/70
R7           . . . . . . . . . .
R7   AVG        0.53      0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R8        N*1/2(1700) INTO (N*3/2(1232)++ PI-)/(P PI+ PI-) (P6)/(P5)
R8              0.74      0.14          ALEXANDER  67 HBC  + PP 5.5 BEV/C        11/67
R8              1.0       0.3           ALMEIDA    68 HBC  + PP 10 BEV/C          9/66
R8             (0.83)                   KAYAS      68 HBC    PP 8.1 BEV/C        11/68
R8   I       LESS THAN    0.15          BARNES     69 HBC    K-P TO K-P 2PI       7/70
R8             (0.50) OR LESS  CL=.95   CIRBA      70 HBC    PI+P AT 5 GEV/C      2/71
R8             NO EVIDENCE              CRENNELL   70 HBC  +                      1/71
R8   A         (2.3)     (1.6)          WILLMANN   70 HBC    PI+P TO 3PI P        6/70
R8             (1.0)  OR MORE  CL=.95   BEKETOV    71 HBC  + DEL(1232)++ PI-      3/72
R8              0.75      0.75          BOESEBEC   71 RVUE   PP,PI-P,K-P PROD     3/72
R8              0.35      0.20          RUSHBROOKE71 HBC  + PP TO P2PI 16GEV      2/72
R8 C            0.65      0.15          LAMSA      72 HBC    PI P  18.5 GEV/C    12/72
R8             (0.40)                   BLOBEL     75 HBC  + PP TO P(PI+PI-PI-    1/78
R8              0.3       0.1           HEINEN     77 HBC  + K-P TO K- N**        1/78
R8              0.42      0.08          EKELOF     78 SPEC + P HE--P PI PI HE     1/78
R8           . . . . . . . . . .
R8   AVG        0.471     0.078   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)

R9        N*1/2(1700) INTO (SIG K)/(LAMB K)                (P9)/(P8)
R9           LESS THAN    0.20          COOPER     70 HBC  + PI+P, 5.5 GEV/C      2/71

R10       N*1/2(1700) INTO (PI N)+/(OMEGA PROTON)          (P1)/(P10)
R10        LESS THA   0.36 (90 PCT CL)  DAVIDSON   74 HBC   + PI-P TO PI- OM P   10/74

R11       N*1/2(1700) INTO (RHOO PROTON)/(OMEGA PROTON)    (P11)/(P10)
R11        LESS THAN 0.12 (90 PCT CL)   DAVIDSON   74 HBC   + PI-P TO PI- OM P   10/74

          SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                         REFERENCES FOR N*1/2(1700) (PROD. EXP.)

KRAEMER   64 PR 136 B496         +MADANSKY.+  (J HOPKINS.NWESTERN.WOODSTOCK) I

ALEXANDE 67 PR 154 1284          ALEXANDER.BENARY.CZAPEK.+  (WEIZMANN(CERN)I
A-BORELL 67 NC 47 232            ALLES-BORELLI.FRENCH,FRISK,MICHEJDA  (CERN)
LEE      67 PR 159 1156          +MOEBS,ROE,SINCLAIR,VANDER VELDE     (MICH)

ALMEIDA  68 PR 174 1638          +RUSHBROOKE, +              (CAVE.DESY(CERN)I
CHINOWSK 68 PR 165 1466          CHINOWSKY.KINSEY.KLEIN. +           (LRL.SLAC)
GALLOWAY 68 PL 27B 250           GALLOWAY,ALYEA,CRITTENDEN,PRICKETT,+  (IND)
KAYAS    68 NP B5 169            +GUYADER,SENE,YIOU,ALITTI,+  (ORSAY,SACLAY)

BARNES   69 PRL 23 1516          +BASSANO+CHUNG+EISNER+FLAMINIO+KINSON (BNL)IJ
BENVENUT 69 PR 187 1852          BENVENUTI, MARQUIT, OPPENHEIMER (MINN.COLO)
RHODE    69 PR 187 1844          RHODE, LEACOCK, KERNAN, JESPERSEN,+   (ISU)

ANDERSON 70 PRL 25.699           +BLESER,BLIEDEN,COLLINS++          (BNL.CARN)
CIRBA    70 NP B23.533           +VANDERHAGEN+    (EPOL,DURH,NIJM, TORI,BONN)
COOPER   70 NP B23,605           +MANNER,MUSGRAVE,POLLARD,VOYVODIC      (ANL)
CRENNELL 70 PRL 25 187           +LAI, LOUIE, SCARR, SIMS               (BNL)
KUZNETSOV70 SJNP 10.332          +MELNIKOV,RYLTSEVA,CHADRAA,BALINTP    (JINR)
WILLMANN 70 PRL 24 1260          +LAMSA,GAIDOS,EZELL                  (PURD)IJ

AMALDI   71 PL  34B 435          +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
BALLAM   71 PR D4 1946           +CHADWICK,GUIRAGOSSIAN,JOHNSON,++    (SLAC) I
BEKETOV  71 SJNP 13 605          +ZOMBKOVSKII,KONOVALOV,KRUCHININ,++  (ITEP)IJ
BOESEBEC 71 NP B33 445           BOESEBECK.GRAESSLER,KRAUS,+++      (ABRCHLV) I
ELLIS    71 PRL 27 442           +MAGLICH.NOREM,SANNES,SILVERMAN       (RUTG)
MA       71 PRL  26  333         +COLTON                            (MSU+LBL)I
MORSE    71 PR D4 133            +OH,WALKER.CARROLL.LYNCH +        (WISC+TNTO)I
RUSHBROO 71 PR D4 3273           RUSHBROOKE,WILLIAMS+BAREFORD++ (CAVE,LOIC) IJ

EDELSTEI 72 PR D5 1073           EDELSTEIN,CARRIGAN.HIEN,MCMAHON,+(CARN+BNL)
JOHNSTAD 72 NP B42 588           +MOLLERUD+...+JACOBSEN(BOHR,HELS,OSLO,STOH) IJP
KARSHON  72 NP B37 371           +YEKUTIELI.YAFFE.SHAPIRA.RONAT,+       (REHO) I
LAMSA    72 NP B37 364           +WILLMANN+..+GO,BISWAS+...      (PURD,NDAM) IJP
OH       72 PL 42B 497           +FUNG,KERNAN,POE.SCHALK,SHEN           (UCR)IJP
RONAT    72 NP B38 20            +EISENBERG.LYONS.SHAPIRA,TOAFF+        (REHO)

ABE      74 PL 53B 114           +ALSPECTOR,BOMBEROWITZ+        (RUTG,UPNJ,FSU)
DAVIDSON 74 PRL 32 855           DAVIDSON,OZTERBA,FIRESTONE,+  (CIT+BNL+LBL)I
LICHTMAN 74 NP B81 31            LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

ATHERTO2 75 NC 30A 505           ATHERTON,BAR-NIR,FRENCH,SKURA+  (CERN+PRAG)
BLOBEL   75 NP B97 201           +ESKREYS,FESEFELDT,FRANZ+  (BONN+HAMB+MPIM)IJP
BRAUNI   75 NP B95 481           +GERBER,MAURER,MICHALON,SCHIBY+ (STRB.LPNP)I
CAVALLI  75 LNC 14 353           CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
    ALSO 75 LNC 14 345+359       CAVALLI-SFORZA,CONTA+            (PAVIA+PRIN)
MUSGRAVE 75 NP B87 365           +PEETERS,SCREINER,WHITMORE,YUTA          (ANL)
STRACHMA 75 NP B98 120           STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WEBB     75 PL 55B 331           +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)
    ALSO 75 PL 55B 336           +TRILLING,TELEGDI+        (AACH+UCLA+UCR+CERN)

ATHERTON 76 NP B103 381          ATHERTON,FRENCH,SKURA,BOHM+      (CERN+PRAG)
BAKSAY   76 PL 61B 405           +BOHM,CHANG,ELLIS,FOETH+     (AACH+UCR+CERN)I

APPLE    77 LNC 18 167           +ASH,CHENG,COYNE,GROSSMAN+       (PRIN+PAVIA)
HEINEN   77 NP B122 443          +ENGELEN,KITTEL,METZGER+   (NIJM+AMST+CERN)IJP
ROUGE    77 PL 69B 115           +DE ROSNY,FLEURY,RIVET+    (LPNP+CDEF+LALO)IJP

EKELOF   78 NP B132 212          +HERZ,HAGBERG,KULLANDER+   (CERN+UPPS+LOUC)IJ
FERRER   78 NP B142 77           +BOUQUET,D.ALMAGNE+   (LALO+CERN+CDEF+EPOL)IJP
GODDARD  78 NP B134 49           +KEY,GORDON,LAI                   (TNTO+BNL)IJ
    ALSO 78 NP B138 265          +KEY,GORDON,LAI                   (TNTO+BNL)IJ
OTTER    78 NP B139 365          +RUDOLPH+         (AACH+BERL+CERN+LOIC+VIEN)IJP
APELDOOR 79 NP B156 111          VAN APELDOORN,HARTING,HOLTHUIZEN+       (AMST)
APELDOOR 80 NP B169 365          VAN APELDOORN,HARTING+(AMST+HELS+LIVP+STOH)
FUKUNAGA 80 NC 58A 199           +HAMATSU,HIROSE,KITAMURA,YAMAGATA      (TOKY)I

                         PAPERS NOT REFERRED TO IN DATA CARDS

MERLO    66 P ROY SOC 289 489 J P MERLO, G VALLADAS                    (SACLAY)
LISSAUER 72 PRD 6 1852           +FIRESTONE,GINESTET,GOLDHABER,TRILLING(LBL)IJP
ANTIPOV  75 NP B99 189           +ASCOLI,BAUD+          (CERN-IHEP BOSON SPEC)
LEDNICKY 75 PL 58B 89            R. LEDNICKY                             (JINR)
CARNEY   76 NP B110 248          +COLLEY,JONES,KENYON+ (BIRM+BRUX+CERN+MONS)IJP
DEKERRET 76 PL 63B 477,483       +NAGY,REGLER,BRANDT+    (CERN+HAMB+IPN+VIEN)
RUSHBROO 76 PRD 13 1635          RUSHBROOKE,RAJA,ANSORGE,CARTER,NEALE (CAVE)IJP
SOTIRIOU 76 NP B107 457          D.SOTIRIOU                            (CERN)IJP
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BACON     77 NC 42A 431        +BARNHAM,DORNAN,EASON,POLLOCK+        (LOIC)IJP
HARRIS    77 NP B119 189       +LUBATTI,MORIYASU,BINGHAM+             (WASH+UCB)
HOFMANN   77 NP B125 404       +IDSCHOK,SCHRODER,BLOBEL+   (BONN+DESY+MPIM)I
BIEL      78 PRD 18 3079       +FERBEL,SLATTERY+       (ROCH+NWES+FNAL+SLAC)
     ALSO 76 PRL 36 504,507    BIEL,BLESER,FERBEL+     (ROCH+FNAL+SLAC+NWES)
CHADWICK  78 PRD 17 1713       +CARROLL,CHALOUPKA,BALLAM+    (SLAC+CIT+LBL)IJP
GOGGI1    78 PL 79B 165        +CAVALLI-SFORZA,CONTA+               (CERN+PAVI)
     ALSO 77 PL 72B 261        GOGGI,MANTOVANI,CAVALLI-SFORZA+ (CERN+PAVI)
GOGGI2    78 NP B143 365       +CAVALLI-SFORZA,CONTA+               (CERN+PAVI)
IDSCHOK   78 NC 48A 355        +SCHRODER,BLOBEL,FRANZ+     (BONN+HAMB+MPIM)IJP
     ALSO 75 BLOBEL
MUHLEMAN  78 NP B193 189       MUHLEMANN,CARITHERS,FERBEL,LAM+ (ROCH+MCGI)
BAKKEN    79 NC 49A 465        +JACOBSEN,GENNOW+         (OSLO+STOH+HELS+ABO)
GOGGI     79 NP B161 14        +CONTA,FRATERNALI,LIVAN+    (CERN+PAVI+TRST)
LUCAS     79 PRD 19 43         P.M.LUCAS                                 (JHU)
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N(1710)

14 N*1/2(1710, JP=1/2+) I=1/2 P_{11}''

THIS RESONANCE IS WELL ESTABLISHED.

14 N*1/2(1710) MASS (MEV)

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M   3   (1751.0)                    DONNACHI  68 RVUE   PHASE-SHIFT ANAL   8/69
M       (1640.0)    (70.0)          ORITO     69 RVUE   K LAMBDA PS ANAL   8/69
M       (1700.0)                    ORITO2    69 CNTR   K LAM PHOTOPRO    10/71
M   6   (1645.0)                    AYED      70 IPWA                      1/71
M   6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4   (1770.0)                    DAVIES    70 RVUE   P-S ANAL  SOL A    6/69
M       (1809.0)                    SCHORSCH  70 DPWA   K LAM PHOTOPRO.   10/71
M   A   (1685.0)OR(1740.0)          WAGNER    71 IPWA   PI-P TO K LAMB     1/71
M   A  THERE ARE 3 SIMILAR SOLUTIONS
M   7   (1720.)                     ALMEHED   72 IPWA                      2/72
M    2  (1724.)                     HICKS     73 MPWA   GAM P-ETA P        9/73
M    2  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.    9/73
M    2  M AND W ARE FROM SOLUTION C2.BR=SQRT(G)/W WITH G FROM TABLE VII.   9/73
M   F   (1780.)                     LANGBEIN  73 IPWA   PI N-K SIG,SOL 1   9/73
M   F   (1780.)                     LANGBEIN  73 IPWA   PI N-K SIG,SOL 2   9/73
M   F   DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF    1/78
M   F   WINNIK77 AROUND 1920 MEV.                                          1/78
M       (1670.)                     KNASEL    75 DPWA 0 PI- P TO KO LAM   11/75
M    K    1730. OR 1710.            LONGACRE  75 IPWA   PI N TO 2PI N     11/75
M    K  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75
M       (1730.)                     AYED      76 IPWA                     11/77
M   D   (1625.)     (10.)           BAKER     77 IPWA 0 PI- P TO K LAM.    1/78
M   E   (1650.)                     BAKER     77 DPWA 0 PI- P TO K LAM.    1/78
M   D   THE TWO ENTRIES FOR BAKER 77 ARE FOR AN IPWA USING THE BARRELET    1/78
M   E   ZERO METHOD AND A CONVENTIONAL ENERGY-DEPENDENT ANALYSIS.          1/78
M   8   (1720.)                     LONGACRE  77 IPWA   PI N TO 2PI N     11/77
M   8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                       11/77
M         1650. TO 1680.            BAKER     78 DPWA 0 PI- P TO K LAM     3/79
M    9  (1721.)                     BARBOUR   78 DPWA   PI-N PHOTOPROD.    3/79
M       (1690.)                     BAKER     79 DPWA 0 PI- P TO ETA N    12/79
M       (1710.)     (60.)           CUTKOSKY  79 IPWA   PI N TO PI N      12/79
M         1723.        9.           HOEHLER   79 IPWA   PI N TO PI N      12/79
M       (1692.0)                    CRAWFORD  80 DPWA   PI N PHOTOPROD.   12/81*
M         1700.       50.           CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
M       (1695.)                     LIVANOS   80 DPWA   PI P TO K SIGMA    1/82*
M   C   (1730.)                     SAXON     80 DPWA 0 PI- P TO K LAM    12/79
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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14 N*1/2(1710) WIDTH (MEV)

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W   3   (327.0)                     DONNACHI  68 RVUE                      8/69
W       (313.0)    (50.0)           ORITO     69 RVUE                      8/69
W       (210.0)                     ORITO2    69 CNTR   K LAM PHOTOPRO    10/71
W   6    (50.0)                     AYED      70 IPWA                      1/71
W   4   (445.0)                     DAVIES    70 PVUE   SOL A              8/69
W       (280.0)                     SCHORSCH  70 DPWA   K LAM PHOTOPRO.   10/71
W   A   (160.0)OR(220.0)            WAGNER    71 IPWA   PI-P TO K LAMB     1/71
W   7   (160.)                      ALMEHED   72 IPWA                      2/72
W    2  (203.)                      HICKS     73 MPWA   GAM P-ETA P        9/73
W   F   (130.)                      LANGBEIN  73 IPWA   PI N-K SIG,SOL 1   9/73
W   F   (130.)                      LANGBEIN  73 IPWA   PI N-K SIG,SOL 2   9/73
W       (174.)                      KNASEL    75 DPWA 0 PI- P TO KO LAM   11/75
W    K  (165.) OR (75.)             LONGACRE  75 IPWA   PI N TO 2PI N     11/75
W       (164.)                      AYED      76 IPWA                     11/77
W   D   (169.)       (6.)           BAKER     77 IPWA 0 PI- P TO K LAM.    1/78
W   E    (95.)                      BAKER     77 DPWA 0 PI- P TO K LAM.    1/78
W   8   (120.)                      LONGACRE  77 IPWA   PI N TO 2PI N     11/77
W          90. TO  150.             BAKER     78 DPWA 0 PI- P TO K LAM     3/79
W    9  (167.)                      BARBOUR   78 DPWA   PI-N PHOTOPROD.    3/79
W        (97.)                      BAKER     79 DPWA 0 PI- P TO ETA N    12/79
W       (100.)      (50.)           CUTKOSKY  79 IPWA   PI N TO PI N      12/79
W        120.        15.            HOEHLER   79 IPWA   PI N TO PI N      12/79
W       (200.0)                     CRAWFORD  80 DPWA   PI N PHOTOPROD.   12/81*
W          90.       30.            CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
W       (253.)                      LIVANOS   80 DPWA   PI P TO K SIGMA    1/82*
W   C   (550.)                      SAXON     80 DPWA 0 PI- P TO K LAM    12/79
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
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14 N*1/2(1710) REAL PART OF POLE POSITION (MEV) 11/75

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RE      (1708.)                     LONGACRE  75 IPWA   PI N TO 2PI N     11/75
RE  8    1720. OR 1711.             LONGACRE  77 IPWA   PI N TO 2PI N     11/77
RE      (1692.)                     CUTKOSKY  79 IPWA   PI N TO PI N      12/79
RE       1690.       20.            CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
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14 N*1/2(1710) -2*IMAG PART OF POLE POSITION (MEV) 11/75

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IM       (17.)                      LONGACRE  75 IPWA   PI N TO 2PI N     11/75
IM  8    123. OR 115.               LONGACRE  77 IPWA   PI N TO 2PI N     11/77
IM       (88.)                      CUTKOSKY  79 IPWA   PI N TO PI N      12/79
IM        80.        20.            CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
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14 N*1/2(1710) REAL PART OF ELASTIC POLE RESIDUE (MEV)

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RER      (-9.)                      CUTKOSKY  79 IPWA   PI N TO PI N      12/79
RER       -9.        2.             CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
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14 N*1/2(1710) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

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IMR      (0.1)                      CUTKOSKY  79 IPWA   PI N TO PI N      12/79
IMR       1.         5.             CUTKOSKY  80 IPWA   PI N TO PI N       1/82*
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14 N*1/2(1710) PARTIAL DECAY MODES

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                                                    DECAY MASSES
P1   N*1/2(1710) INTO PI N                          139+ 938
P2   N*1/2(1710) INTO LAMBDA K                      1115+ 497
P3   N*1/2(1710) INTO N ETA                         939+ 548
P4   N*1/2(1710) INTO GAM P, HELICITY=1/2           0+ 938
P5   N*1/2(1710) INTO GAM N, HELICITY=1/2           0+ 939
P6   N*1/2(1710) INTO N PI PI                       938+ 139+ 139
P7   N*1/2(1710) INTO N EPSILON                     938+1300
P8   N*1/2(1710) INTO N RHO                         938+ 769
P9   N*1/2(1710) INTO K SIGMA                       493+1189
P10  N*1/2(1710) INTO N*3/2(1232) PI                1232+ 139
P11  N*1/2(1710) INTO N RHO,S=1/2,P-WAVE            938+ 769
P12  N*1/2(1710) INTO N RHO,S=3/2,P-WAVE            938+ 769
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14 N*1/2(1710) BRANCHING RATIOS

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R1      N*1/2(1710) INTO (PI N)/TOTAL                       (P1)
R1  3     (0.32)                  DONNACHI  68 RVUE                        8/69
R1  6     (0.14)                  AYED      70 IPWA                        1/71
R1  4     (0.43)                  DAVIES    70 RVUE   SOL A                8/69
R1  7     (0.2)                   ALMEHED   72 IPWA                        2/72
R1        (0.17)                  AYED      76 IPWA                       11/77
R1        (0.15)    (0.05)        CUTKOSKY  79 IPWA   PI N TO PI N        12/79
R1         0.12      0.04         HOEHLER   79 IPWA   PI N TO PI N        12/79
R1         0.20      0.04         CUTKOSKY  80 IPWA   PI N TO PI N         1/82*
R1           . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

R2      N*1/2(1710) FROM PI N TO K LAMBDA               SQRT(P1*P2)        4/75
R2        (0.06)    (0.03)        ORITO     69 RVUE                        4/75
R2  A     (0.16)OR  0.21          WAGNER    71        PI- P TO K LAMB      4/75
R2        -0.150     0.025        DEVENISH  74      0 FIXED T DISP REL     4/75
R2        (0.10)                  KNASEL    75 DPWA 0 PI- P TO KO LAM     11/75
R2  D     (-0.05)   (0.03)        BAKER     77 IPWA 0 PI- P TO K LAM.      1/78
R2  E     (-0.10)                 BAKER     77 DPWA 0 PI- P TO K LAM.      1/78
R2   9    (-0.12)                 BAKER     78 DPWA 0 PI- P TO K LAM       3/79
R2   9  THE (UNDETERMINED) OVERALL PHASE OF ALL COUPLINGS FROM BAKER78     3/79
R2   9  HAS BEEN CHANGED TO AGREE WITH PREVIOUS CONVENTIONS.               3/79
R2  C     (+0.14)                 SAXON     80 DPWA 0 PI- P TO K LAM      12/79
R2  C   SUPERSEDES BAKER 78.                                              12/79

R3      N*1/2(1710) INTO (LAMBDA K)/TOTAL                   (P2)
R3  B     (0.003)TO 0.065         RUSH      68 MPWA   T POLE + RESON.      8/69
R3  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R4      N*1/2(1710) INTO (N ETA)/TOTAL                      (P3)
R4  B     (0.19)                  BOTKE     69 MPWA   T POLE + RESON.     10/69
R4  B     (0.09)    (0.05)        DEANS     69 MPWA   T POLE + RESON.      5/70
R4  B     (0.015)OR 0.035         CARRERAS  70 MPWA   T POLE + RESON.      5/70
R4  B   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R5      N*1/2(1710) FROM GAMMA PROTON TO K LAMBDA       SQRT(P2*P4)        9/73
R5        (0.0027)                ORITO2    69 CNTR   K LAM PHOTOPRO      10/71
R5        (0.0088)                SCHORSCH  70 DPWA   K LAM PHOTOPRO.     10/71
R5        (0.0104)                DEANS     72 MPWA   GAM P-K LM,SOL D     9/73

R6      N*1/2(1710) FROM GAMMA PROTON TO ETA PROTON     SQRT(P3*P4)        9/73
R6   2    (0.0075)                HICKS     73 MPWA   GAM P-ETA P          9/73

R7      N*1/2(1710) FROM PI N TO K SIGMA                SQRT(P1*P9)        9/73
R7  F     (0.11)                  LANGBEIN  73 IPWA   PI N-K SIG,SOL 1     9/73
R7  F     (0.14)                  LANGBEIN  73 IPWA   PI N-K SIG,SOL 2     9/73
R7  1     (0.075)TO 0.203         DEANS     75 DPWA   PI N TO K SIGMA     11/75
R7  1   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75
R7        (-0.034)                LIVANOS   80 DPWA   PI P TO K SIGMA      1/82*

R8      N*1/2(1710) FROM PI N TO N*3/2(1232) PI         SQRT(P1*P10)      11/75
R8   K    (0.33)OR -0.20          LONGACRE  75 IPWA   PI N TO 2PI N       11/75
R8  8     (+0.17)                 LONGACRE  77 IPWA   PI N TO 2PI N       11/77

R9      N*1/2(1710) FROM PI N TO N RHO,S=1/2,P-WAVE     SQRT(P1*P11)      11/75
R9   K    (+0.32)OR +0.20         LONGACRE  75 IPWA   PI N TO 2PI N       11/75
R9  8     (-0.19)                 LONGACRE  77 IPWA   PI N TO 2PI N       11/77

R10     N*1/2(1710) FROM PI N TO N RHO,S=3/2,P-WAVE     SQRT(P1*P12)      11/77
R10 8     (-0.31)                 LONGACRE  77 IPWA   PI N TO 2PI N       11/77

R11     N*1/2(1710) FROM PI N TO N EPSILON              SQRT(P1*P7)       11/75
R11  K    (+0.18)OR +0.28         LONGACRE  75 IPWA   PI N TO 2PI N       11/75
R11 8     (+0.26)                 LONGACRE  77 IPWA   PI N TO 2PI N       11/77

R12     N*1/2(1710) FROM PI N TO ETA N                  SQRT(P1*P3)       11/75
R12 5     (+0.382)TO +0.383       FELTESSE  75 DPWA   0 1488 TO 1745 MEV  11/75
R12 5   USES M AND W OF AYED 76.  NOTE THAT THIS GIVES A BRANCHING        11/77
R12 5   RATIO TO ETA N OF ABOUT 80 PCT, IN STRONG DISAGREEMENT WITH      11/75
R12 5   EARLIER EXPERIMENTS.                                              11/75
R12       (0.22)                  BAKER     78 DPWA 0 PI- P TO ETA N      12/79
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14 N*1/2(1710) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
REVIEW PRECEDING THE BARYON LISTINGS.

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A1      N*1/2(1710) INTO GAM P, HELICITY=1/2 (GEV**-1/2)
A1         0.022     0.057        DEVENISH  73 DPWA   PI N PHOTOPROD.      2/74
A1        +0.026     0.028        MOORHOUS  73 DPWA   PI N PHOTOPROD.      2/73
A1        -0.014     0.021        DEVENIS2  74 DPWA   PI N PHOTOPROD.      4/75
A1         0.022     0.015        KNIES     74 DPWA   PI N PHOTOPROD.      2/74
A1        -0.068     0.024        METCALF   74 DPWA   PI N PHOTOPROD.      2/74
A1         0.016     0.025        MOORHOUS  74 DPWA   PI N PHOTOPROD.      2/74
A1        +0.062     0.007        CRAWFORD  75 DPWA   PI N PHOTOPROD.      1/76
A1        (+0.005)                BARBOUR   76 DPWA   PI N PHOTOPROD.      1/76
A1        +0.053     0.019        FELLER    76 DPWA   PI N PHOTOPROD.      2/77
A1   9    +0.001     0.039        BARBOUR   78 DPWA   PI-N PHOTOPROD.      3/79
A1   9  SUPERSEDES BARBOUR 76.                                             3/79
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A1          -0.009     0.006         ARAI       80 DPWA    PI N PHOTO FIT 1 12/81*
A1          -0.012     0.005         ARAI       80 DPWA    PI N PHOTO FIT 2 12/81*
A1           0.015     0.025         CRAWFORD   80 DPWA    PI N PHOTOPROD.  12/81*
A1           . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 3.A)

A2      N*1/2(1710) INTO GAM N, HELICITY=1/2 (GEV**-1/2)
A2          -0.028     0.067         DEVENISH   73 DPWA    PI N PHOTOPROD.   2/74
A2          +0.027     0.022         MOORHOUS   73 DPWA    PI N PHOTOPROD.   2/73
A2          -0.060     0.061         DEVENIS2   74 DPWA    PI N PHOTOPROD.   4/75
A2           0.027     0.015         KNIES      74 DPWA    PI N PHOTOPROD.   2/74
A2           0.048     0.045         METCALF    74 DPWA    PI N PHOTOPROD.   2/74
A2           0.057     0.022         MOORHOUS   74 DPWA    PI N PHOTOPROD.   2/74
A2          -0.020     0.016         CRAWFORD   75 DPWA    PI N PHOTOPROD.   1/76
A2          (-0.010)                 BARBOUR    76 DPWA    PI N PHOTOPROD.   1/76
A2    9     -0.028     0.045         BARBOUR    78 DPWA    PI-N PHOTOPROD.   3/79
A2           0.005     0.013         ARAI       80 DPWA    PI N PHOTO FIT 1 12/81*
A2           0.011     0.021         ARAI       80 DPWA    PI N PHOTO FIT 2 12/81*
A2          -0.017     0.020         CRAWFORD   80 DPWA    PI N PHOTOPROD.  12/81*
A2          -0.001     0.003         FUJII      81 DPWA    PI N PHOTOPROD.  12/81*
A2           . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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REFERENCES FOR N*1/2(1710)


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DONNACHI 68 PL 268 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                           (EDIN)
RUSH     68 PR 173 1776         J E RUSH                       (UNIV ALABAMA)

BOTKE    69 PR 180 1417         J C BOTKE                             (UCSB)
DEANS    69 PR 185 1797         S DEANS, J WOOTEN             (UNIV S FLORIDA)
ORITO    69 LNC 1 936           S ORITO,S SASAKI                (TOKYO-OSAKA)
ORITO2   69 INS J 113           S ORITO (THESIS)                      (TOKYO)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 168 35           B CARRERAS, A DONNACHIE         (DARE,MCHS)
DAVIES   70 NP B21 359          A DAVIES                              (GLAS)
SCHORSCH 70 NP  B25 179         +TIETGE,WEILNBOECK                    (MPIM)

WAGNER   71 NP B25 411          F WAGNER, C LOVELACE                  (CERN)

ALMEHED  72 NP B40 157          +LOVELACE                      (LUND,RUTG)IJP
DEANS    72 PRD 6 1906          DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP

DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH      (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614          +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN      (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK         (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
FELTESSE 75 NP B93 242          +AYED,BAREYRE,BORGEAUD,CAVID,ERNWEIN+(SACL)IJP
KNASEL   75 PRD 11 1            +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+        (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795         LONGACRE,LASINSKI,ROSENFELD+        (LBL,SLAC)

AYED     76 CEA-N-1921          AYED (THESIS)                        (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP
FELLER   76 NP B104 219         +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP
BAKER    77 NP B126 365         +BLISSET,B.OODWORTH,BROOME,HART+     (RHEL)IJP
LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                     (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET        (SACL)IJP

BAKER    78 NP B141 29          +BLISSET,BLOODWORTH,BROOME+     (RL+CAMB)IJP
BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS              (GLAS)

BAKER    79 NP B156 93          +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN        /KARLSRUHE IJP
  ALSO 80  TORONTO CONF 3       R.KOCH                          (KARLSRUHE)IJP

ARAI     80 TORONTO CONF 93     I. ARAI                               (TOKY)
CRAWFORD 80 TORONTO CONF 107    R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80 TORONTO CONF 19     +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
LIVANOS  80 TORONTO CONF 35     +BATON,COUTURES,KOCHOWSKI,NEVEU      (SACL)IJP
SAXON    80 NP B162 522         +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP
FUJII    81 NP B187 53          FUJII,HAYASHII,IWATA,KAJIKAWA+        (TOKY)

                    PAPERS NOT REFERRED TO IN DATA CARDS

DEANS    69 PR  177 2623        S R DEANS                     (UNIV S FLORIDA)
DONNACHI 69 NP 108 433          A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 558          +BAREYRE+VILLET                     (SACLAY)
WINNIK   77 NP B128 66          +TOAFF,REVEL,GOLDBERG,BERNY          (HAIFI)

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N(1720) — P''_{13}

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15  N*1/2(1720, JP=3/2+) I=1/2

THIS RESONANCE IS WELL ESTABLISHED.

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                 15  N*1/2(1720) MASS (MEV)

M    3      (1860.0)                 DONNACHI   68 RVUE    PHASE-SHIFT ANAL  6/68
M    X      (1863.0)      APPROX     LEA        69 CNTR    PI-P ELASTIC      8/69
M    X   SEE ALSO APLIN 71
M    6      (1766.0)                 AYED       70 IPWA                      1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M    4      (1844.0)                 DAVIES     70 RVUE    P-S ANAL  SOL A   8/69
M    A      (1800.0)                 WAGNER     71 IPWA    PI-P TO K LAMB    1/71
M    A   P13 RESONATES ONLY IN ONE OUT OF 3 POSSIBLE SOLUTIONS
M    7      (1850.)                  ALMEHED    72 IPWA                      2/72
M    1      (1833.)                  HICKS      73 MPWA    GAM P-ETA P       9/73
M    1   ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.     9/73
M    1   M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.    9/73
M           (1850.)                  KNASEL     75 OPWA  O PI- P TO KO LAM  11/75
M    L       1695. OR 1720.          LONGACRE   75 IPWA    PI N TO 2PI N    11/75
M    L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75
M           (169/.)                  AYED       76 IPWA                     11/77
M    D      (1/  .)      (10.)       BAKER      77 IPWA  O PI- P TO K LAM.   1/78
M    E      (1.  J.)                 BAKER      77 DPWA  O PI- P TO K LAM.   1/78
M    D   THE TWO ENTRIES FOR BAKER 77 ARE FOR AN IPWA USING THE BARRELET     1/78
M    E   ZERO METHOD AND A CONVENTIONAL ENERGY-DEPENDENT ANALYSIS.           1/78
M    8      (1750.)                  LONGACRE   77 IPWA    PI N TO 2PI N    11/77
M    8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M    8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                        11/77
M            1710. TO 1790.          BAKER      78 OPWA  O PI- P TO K LAM    3/79
M    5      (1809.)                  BARBOUR    78 OPWA    PI-N PHOTOPROD.   3/79
M           (1740.)      (80.)       CUTKOSKY   79 IPWA    PI N TO PI N     12/79
M            1710.        20.        HOEHLER    79 IPWA    PI N TO PI N     12/79
M           (1785.0)                 CRAWFORD   80 DPWA    PI N PHOTOPROD.  12/81*
M            1700.        50.        CUTKOSKY   80 IPWA    PI N TO PI N      1/82*
M    C      (1690.)                  SAXON      80 DPWA  O PI- P TO K LAM   12/79
M            . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 15  N*1/2(1720) WIDTH (MEV)

W    3      (296.00)                 DONNACHI   68 RVUE                      8/69
W    6      (182.0)                  AYED       70 IPWA                      1/71
W    4      (449.0)                  DAVIES     70 RVUE    SOL A             8/69
W    4   SOL B GIVES 3CT MEV                                                 2/73
W    A      (220.0)                  WAGNER     71 IPWA    PI-P TO K LAMB    1/71
W    7      (300.)                   ALMEHED    72 IPWA                      2/72
W    1      (250.)                   HICKS      73 MPWA    GAM P-ETA P       9/73
W           (327.)                   KNASEL     75 OPWA  O PI- P TO KO LAM  11/75
W    L       115. OR  150.           LONGACRE   75 IPWA    PI N TO 2PI N    11/75
W           (117.)                   AYED       76 IPWA                     11/77
W    D      (200.)       (50.)       BAKER      77 IPWA  O PI- P TO K LAM.   1/78
W    E      (500.)                   BAKER      77 DPWA  O PI- P TO K LAM.   1/78
W    8      (130.)                   LONGACRE   77 IPWA    PI N TO 2PI N    11/77
W            300. TO  400.           BAKER      78 DPWA  O PI- P TO K LAM    3/79
W    5      (285.)                   BARBOUR    78 DPWA    PI-N PHOTOPROD.   3/79
W           (447.)                   BAKER      79 OPWA  O PI- P TO ETA N   12/79
W           (210.)       (80.)       CUTKOSKY   79 IPWA    PI N TO PI N     12/79
W            190.         30.        HOEHLER    79 IPWA    PI N TO PI N     12/79
W           (308.0)                  CRAWFORD   80 DPWA    PI N PHOTOPROD.  12/81*
W            125.         70.        CUTKOSKY   80 IPWA    PI N TO PI N      1/82*
W    C      (120.)                   SAXON      80 DPWA  O PI- P TO K LAM   12/79
W            . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                 15  N*1/2(1720) REAL PART OF POLE POSITION (MEV)       11/75

RE          (1716.                   LONGACRE   75 IPWA    PI N TO 2PI N    11/75
RE   8       1745.  -   748.         LONGACRE   77 IPWA    PI N TO 2PI N    11/77
RE          (1702.)                  CUTKOSKY   79 IPWA    PI N TO PI N     12/79
RE           1680.        30.        CUTKOSKY   80 IPWA    PI N TO PI N      1/82*

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                 15  N*1/2(1720) -2*IMAG PART OF POLE POSITION (MEV)   11/75

IM          (124.)                   LONGACRE   75 IPWA    PI N TO 2PI N    11/75
IM   8       135. OR 123.            LONGACRE   77 IPWA    PI N TO 2PI N    11/77
IM          (158.)                   CUTKOSKY   79 IPWA    PI N TO PI N     12/79
IM           120.         40.        CUTKOSKY   80 IPWA    PI N TO PI N      1/82*

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                 15  N*1/2(1720) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER         (-6.)                    CUTKOSKY   79 IPWA    PI N TO PI N     12/79
RER          -8.          2.         CUTKOSKY   80 IPWA    PI N TO PI N      1/82*

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                 15  N*1/2(1720) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         (-8.)                    CUTKOSKY   79 IPWA    PI N TO PI N     12/79
IMR          -3.          4.         CUTKOSKY   80 IPWA    PI N TO PI N      1/82*

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                 15  N*1/2(1720) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      N*1/2(1720) INTO PI N                         139+ 938
P2      N*1/2(1720) INTO LAMBDA K                    1115+ 497
P3      N*1/2(1720) INTO N ETA                        939+ 548
P4      N*1/2(1720) INTO N PI PI                      938+ 139+ 139
P5      N*1/2(1720) INTO GAM P,HELICITY=3/2             0+ 938
P6      N*1/2(1720) INTO GAM P,HELICITY=1/2             0+ 938
P7      N*1/2(1720) INTO GAM N,HELICITY=3/2             0+ 939
P8      N*1/2(1720) INTO GAM N,HELICITY=1/2             0+ 939
P9      N*1/2(1720) INTO SIGMA K                      493+1189
P10     N*1/2(1720) INTO N RHO,S=1/2,P-WAVE           938+ 769
P11     N*1/2(1720) INTO N RHO,S=3/2,P-WAVE           938+ 769
P12     N*1/2(1720) INTO N*3/2(1232) PI,P-WAVE       1232+ 139
P13     N*1/2(1720) INTO N EPSILON                    938+1300

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                 15  N*1/2(1720) BRANCHING RATIOS

R1      N*1/2(1720) INTO (PI N)/TOTAL                         (P1)
R1   3      (0.21)                   DONNACHI   68 RVUE                      8/69
R1   6      (0.149)                  AYED       70 IPWA                      1/71
R1   4      (0.40)                   DAVIES     70 RVUE    SOL A             8/69
R1   7      (0.25)                   ALMEHED    72 IPWA                      2/72
R1          (0.14)                   AYED       76 IPWA                     11/77
R1          (0.15)       (0.05)      CUTKOSKY   79 IPWA    PI N TO PI N     12/79
R1           0.14         0.03       HOEHLER    79 IPWA    PI N TO PI N     12/79
R1           0.10         0.04       CUTKOSKY   80 IPWA    PI N TO PI N      1/82*
R1           . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*1/2(1720) INTO (LAMBDA K)/TOTAL                     (P2)
R2   8      (0.014)TO 0.16           RUSH       68 MPWA    T POLE + RESON.   8/69
R2   8   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3      N*1/2(1720) INTO (N ETA)/TOTAL                        (P3)
R3   8      (0.0364)                 BOTKE      69 MPWA    T POLE + RESON.  10/69
R3   8      (0.003)  (0.003)         DEANS      69 MPWA    T POLE + RESON.   5/70
R3   8      (0.030)OR 0.094          CARRERAS   70 MPWA    T POLE + RESON.   5/70
R3   8   PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING
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R4      N*1/2(1720) FROM PI N TO K LAMBDA                    SQRT(P1*P2)         4/75
R4  A         (0.12)                 WAGNER     71 IPWA    PI- P TO K LAMB    4/75
R4           -0.067     0.033        DEVENISH   74       D FIXED T DISP REL   4/75
R4            (0.13)                 KNASEL     75 DPWA  0 PI- P TO KO LAM   11/75
R4  D        (-0.06)   (0.02)        BAKER      77 IPWA  0 PI- P TO K LAM.    1/78
R4  E        (-0.09)                 BAKER      77 DPWA  0 PI- P TO K LAM.    1/78
R4   9       (-0.09)                 BAKER      78 DPWA  0 PI- P TO K LAM     3/79
R4   9  THE (UNDETERMINED) OVERALL PHASE OF ALL COUPLINGS FROM BAKER78         3/79
R4   9  HAS BEEN CHANGED TO AGREE WITH PREVIOUS CONVENTIONS.                   3/79
R4  C        (-0.11)                 SAXON      80 DPWA  0 PI- P TO K LAM    12/79
R4  C   SUPERSEDES BAKER 78.                                                  12/79

R5      N*1/2(1720) FROM GAMMA PROTON TO K LAMBDA           SQRT((P5+P6)*P2)    9/73
R5            (0.0082)               DEANS      72 MPWA    GAM P-K LM,SOL D

R6      N*1/2(1720) FROM GAMMA PROTON TO ETA PROTON         SQRT((P5+P6)*P3)    9/73
R6   1        (0.0052)               HICKS      73 MPWA    GAM P-ETA P        9/73

R7      N*1/2(1720) FROM PI N TO K SIGMA                     SQRT(P1*P9)        11/75
R7  2       (0.051)TO 0.087          DEANS      75 DPWA    PI N TO K SIGMA   11/75
R7  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                              11/75
R7  2   DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77              1/78
R7  2   AROUND 1920 MEV.                                                        1/78

R8      N*1/2(1720) FROM PI N TO N RHO,S=1/2,P-WAVE          SQRT(P1*P10)       11/75
R8   L       (-0.35)OR -0.40         LONGACRE   75 IPWA    PI N TO 2PI N     11/75
R8  8        (+0.26)                 LONGACRE   77 IPWA    PI N TO 2PI N     11/77

R9      N*1/2(1720) FROM PI N TO N RHO,S=3/2,P-WAVE          SQRT(P1*P11)       11/77
R9  8        (-0.15)                 LONGACRE   77 IPWA    PI N TO 2PI N     11/77

R10     N*1/2(1720) FROM PI N TO N*3/2(1232)PI,P-WAVE        SQRT(P1*P12)       11/77
R10 8        (+0.17)                 LONGACRE   77 IPWA    PI N TO 2PI N     11/77

R11     N*1/2(1720) FROM PI N TO N EPSILON                   SQRT(P1*P13)       11/77
R11 8        (+0.19)                 LONGACRE   77 IPWA    PI N TO 2PI N     11/77

R12     N*1/2(1720) FROM PI N TO ETA N                       SQRT(P1*P3)        12/79
R12          (-0.08)                 BAKER      79 DPWA  0 PI- P TO ETA N    12/79
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15 N*1/2(1720) PHOTON DECAY AMPL(GEV**-1/2)

FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-REVIEW PRECEDING THE BARYON LISTINGS.

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A1      N*1/2(1720) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1           -0.022     0.094        DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A1            0.025     0.034        DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A1           -0.004     0.032        KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A1            0.0       0.025        METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A1           +0.022     0.012        CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A1          (+0.086)                 BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1           +0.122     0.018        AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 1 12/79
A1           +0.054     0.012        AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 2 12/79
A1   5       +0.111     0.047        BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1   5  SUPERSEDES BARBOUR 76.                                               3/79
A1            0.051     0.009        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A1            0.071     0.010        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A1            0.038     0.050        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1            . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.1)

A2      N*1/2(1720) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2           -0.001     0.106        DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A2           -0.087     0.057        DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2           -0.006     0.030        KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2            0.0       0.022        METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2           -0.016     0.016        CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2          (-0.060)                 BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2           +0.034     0.015        AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 1 12/79
A2            0.000     0.016        AZNAURYAN 77 DPWA    PIO PHTPRD,SOL 2 12/79
A2   5       -0.063     0.032        BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2           -0.058     0.010        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A2           -0.011     0.011        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A2           -0.014     0.040        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2            . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

A3      N*1/2(1720) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3            0.132     0.173        DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A3            0.013     0.045        DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A3            0.014     0.014        KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A3            0.0       0.050        METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A3           -0.037     0.022        CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A3          (-0.020)                 BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A3   5       +0.007     0.020        BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A3           -0.019     0.033        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A3            0.001     0.038        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A3           -0.003     0.034        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A3            . . . . . . . . . .
A3  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A4      N*1/2(1720) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4            0.080     0.133        DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A4           -0.083     0.090        DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A4           -0.008     0.025        KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A4            0.0       0.044        METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A4           -0.038     0.015        CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A4          (+0.046)                 BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A4   5       +0.051     0.051        BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A4           -0.139     0.039        ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A4           -0.134     0.044        ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A4            0.018     0.028        CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A4            . . . . . . . . . .
A4  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
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REFERENCES FOR N*1/2(1720)


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DONNACHI 68 PL 26B 161        A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
   ALSO  68 VIENNA 139        DONNACHIE  RAPPORTEUR,S TALK            (GLAS)
   ALSO  68 THESIS            R G KIRSOPP                             (EDIN)
RUSH     68 PR 173 1776       J E RUSH                        (UNIV ALABAMA)

BOTKE    69 PR 180 1417       J C BOTKE                               (UCSB)
DEANS    69 PR 185 1797       S DEANS, J WOOTEN            (UNIV S FLORIDA)
LEA      69 PL 29B 584        LEA,OADES,MARD,COMAN,+  (RHEL,BRISTOL,DARE)

AYED     70 KIEV CONF         R AYED,P BAREYRE, G VILLET          (SACL)IJP
CARRERAS 70 NP 16B 35         B CARRERAS, A DONNACHIE          (DARE,MCHS)
DAVIES   70 NP B21 359        A DAVIES                               (GLAS)

WAGNER   71 NP B25 411        F WAGNER, C LOVELACE                   (CERN)

ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
DEVENISH 73 PL 47B 53         DEVENISH,RANKIN,LYTH     (LOUC+BONN+LANC)IJP
HICKS    73 PRD 7 2614        +DEANS,JACOBS,LYONS+ (CARN+ORN+SOUTH FLA.)IJP

DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEVENIS2 74 PL 52B 227        DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253        W J METCALF,R L WALKER                 (CIT)IJP

CRAWFORD 75 NP B97 125        R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
KNASEL   75 PRD 11 1          +LINDQUIST,NELSON+      (CHIC,WUSL,OSU,ANL)IJP
LONGACRE 75 PL 55B 415        +ROSENFELD,LASINSKI,SMADJA+      (LBL,SLAC)IJP
   ALSO  78 PRD 17 1795       LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921        AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358       I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP

AZNAURYA 77 EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BAKER    77 NP B126 365       +BLISSET,BLOODWORTH,BROOME,HART+      (RHEL)IJP
LONGACRE 77 NP B122 493       LONGACRE,DOLBEAU                      (SACL)IJP
   ALSO  76 NP B108 365       DOLBEAU,TRIANTIS,NEVEU,CADIET         (SACL)IJP

BAKER    78 NP B141 29        +BLISSET,BLOODWORTH,BROOME+        (RL+CAMB)IJP
BARBOUR  78 NP B141 253       BARBOUR,CRAWFORD,PARSONS                  (GLAS)

BAKER    79 NP B156 93        +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+   (RHEL)IJP
CUTKOSKY 79 PRD 20 2839       +FORSYTH,HENDRICK,KELLY           (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN            (KARLSRUHE)IJP
   ALSO  80 TORONTO CONF 3    R.KOCH                             (KARLSRUHE)IJP

ARAI     80 TORONTO CONF 93   I. ARAI                                  (TOKY)
CRAWFORD 80 TORONTO CONF 107  R.L.CRAWFORD                             (GLAS)
CUTKOSKY 80 TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK   (CARN+LBL)IJP
SAXON    80 NP B162 522       +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

DEANS    69 PR 177 2623       S R DEANS                     (UNIV S FLORIDA)
DONNACHI 69 NP B10 433        A DONNACHIE, R KIRSOPP              (GLAS+EDIN)

AYED     70 PL 31B 598        +BAREYRE,VILLET                        (SACLAY)
APLIN    71 NP B32 253        +COWAN,GIBSON,GILMORE++         (RHEL,BRISTOL)
MA       76 PRD 13 3027       E. MA,G. L. SHAW                   (OREG+UCI)IJP
WINNIK   77 NP B128 66        +TOAFF,REVEL,GOLDBERG,BERNY             (HAIF)
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N(1990) — 17 N*1/2(1990, JP=7/2+) I=1/2 — F_{17}

17 N*1/2(1990) MASS (MEV)

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M    3      (1983.0)                   DONNACHI  68 RVUE    PHASE-SHIFT ANAL
M    3      (1995.)                    KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M    3   WHERE MAX. ABSORPTION IS -DONNACHI. 2 ,KIRSOPP EYEBALL FIT CERN :  10/69
M    X      (2000.0)        APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M    X   SEE ALSO APLIN 71
M    7      (2000.)                    ALMEHED   72 IPWA                      2/72
M     H     (1970.)                    HICKS     73 MPWA    GAM P-ETA P       9/73
M     H  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.     9/73
M     H  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.    9/73
M     1     (1960.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M     1  NOT SEEN IN SOLUTION 2 OF LANGBEIN73                                 9/73
M     1  DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF     1/78
M     1  WINNIK77 AROUND 1920 MEV.                                            1/78
M           (2049.)                    AYED      76 IPWA                     11/77
M           (1999.)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M           (1970.)    (80.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M            2005.     150.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M           (2019.0)                   CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M            1970.      50.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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17 N*1/2(1990) WIDTH (MEV)

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W    3      (225.0)                    DONNACHI  68 RVUE                      8/69
W    3      (250.)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
W    7      (200.)                     ALMEHED   72 IPWA                      2/72
W     H     (300.)                     HICKS     73 MPWA    GAM P-ETA P       9/73
W     1     (170.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W           (119.)                     AYED      76 IPWA                     11/77
W           (216.)                     BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W           (325.)     (150.)          CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W            350.      100.            HOEHLER   79 IPWA    PI N TO PI N     12/79
W           (295.0)                    CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W            350.      120.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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17 N*1/2(1990) REAL PART OF POLE POSITION (MEV)

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RE          (1899.)                    CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE           1900.      30.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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17 N*1/2(1990) -2*IMAG PART OF POLE POSITION (MEV)

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IM          (208.)                     CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM           260.       60.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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17 N*1/2(1990) REAL PART OF ELASTIC POLE RESIDUE (MEV)

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RER          (3.)                      CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER           5.         4.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                 17  N*1/2(1990) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          (-6.)                       CUTKOSKY  79 IPWA    PI N TO PI N       12/79
IMR           -8.         4.             CUTKOSKY  80 IPWA    PI N TO PI N        1/82*

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                 17  N*1/2(1990) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1       N*1/2(1990) INTO PI N                                 139+ 938
P2       N*1/2(1990) INTO N PI PI                              938+ 139+ 139
P3       N*1/2(1990) INTO N ETA                                939+ 548
P4       N*1/2(1990) INTO LAMBDA K                             1115+ 497
P5       N*1/2(1990) INTO GAM P,HELICITY=3/2                   0+ 938
P6       N*1/2(1990) INTO GAM P,HELICITY=1/2                   0+ 938
P7       N*1/2(1990) INTO GAM N,HELICITY=3/2                   0+ 939
P8       N*1/2(1990) INTO GAM N,HELICITY=1/2                   0+ 939
P9       N*1/2(1990) INTO K SIGMA                              493+1189

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                 17  N*1/2(1990) BRANCHING RATIOS

R1       N*1/2(1990) INTO (PI N)/TOTAL                        (P1)
R1  3         (0.09)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7         (0.15)                     ALMEHED   72 IPWA                       2/72
R1            (0.06)                     AYED      76 IPWA                      11/77
R1            (0.06)     (0.02)          CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R1             0.04       0.02           HOEHLER   79 IPWA    PI N TO PI N      12/79
R1             0.06       0.02           CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R1              . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2       N*1/2(1990) INTO (N ETA)/TOTAL                       (P3)
R2  B         (0.02)     (0.02)          DEANS     69 MPWA    T POLE + RESON.    5/70
R2  B  PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3       N*1/2(1990) FROM GAMMA PROTON TO K LAMBDA            SQRT((P5+P6)*P4)   9/73
R3             0.0034                    DEANS     72 MPWA    GAM P-K LM,SOL D   9/73

R4       N*1/2(1990) FROM GAMMA PROTON TO ETA PROTON          SQRT((P5+P6)*P3)   9/73
R4  H         (0.0045)                   HICKS     73 MPWA    GAM P-ETA P        9/73

R5       N*1/2(1990) FROM PI N TO K SIGMA                     SQRT(P1*P9)        9/73
R5  1         (0.06)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
R5  2         (0.010)TO 0.023            DEANS     75 DPWA    PI N TO K SIGMA   11/75
R5  2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                                 11/75

R6       N*1/2(1990) FROM PI N TO K LAMBDA                    SQRT(P1*P4)        4/75
R6           -0.021       0.033          DEVENISH  74         D FIXED T DISP REL 4/75
R6          NOT SEEN                     SAXON     80 DPWA    0 PI- P TO K LAM  12/79

R7       N*1/2(1990) FROM PI N TO ETA N                       SQRT(P1*P3)       12/79
R7           (-0.043)                    BAKER     79 DPWA    0 PI- P TO ETA N  12/79

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                 17  N*1/2(1990) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1       N*1/2(1990) INTO GAM P, HELICITY=1/2  (GEV**-1/2)                       1/76
A1           (+0.011)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1           (0.040)                     BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1             0.001      0.040          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

A2       N*1/2(1990) INTO GAM P, HELICITY=3/2  (GEV**-1/2)                       1/76
A2           (-0.008)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2           (+0.004)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2             0.004      0.025          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

A3       N*1/2(1990) INTO GAM N, HELICITY=1/2  (GEV**-1/2)                       1/76
A3           (-0.099)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A3           (-0.069)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A3            -0.078      0.030          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

A4       N*1/2(1990) INTO GAM N, HELICITY=3/2  (GEV**-1/2)                       1/76
A4           (-0.070)                    BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A4           (-0.072)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A4            -0.116      0.045          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

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                          REFERENCES FOR N*1/2(1990)

DONNACH1 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS             R G KIRSOPP                          (EDIN)

DEANS    69 PR 185 1797        S DEANS, J WOOTEN              (UNIV S FLORIDA)
LEA      69 PL 29B 584         LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

ALMEHED  72 NP B40 157         +LOVELACE                            (RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251         LANGBEIN,WAGNER                    (MUNICH)IJP

DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP

AYED     76 CEA-N-1921         AYEO (THESIS)                        (SACL)IJP
BARBOUR  76 NP B111 358        I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS             (GLAS)

BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN         /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                          (KARLSRUHE)IJP

CRAWFORD 80  TORONTO CONF 107  R.L.CRAWFORD                         (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

DEANS    69 PR  177 2623       S R DEANS                      (UNIV S FLORIDA)
AYED     70 PL 31B 598         +BAREYRE,VILLET                      (SACLAY)
APLIN    71 NP  B32 253        +COWAN,GIBSON,GILMORE++       (RHEL,BRISTOL)
MA       76 PRD 13 3027        E. MA,G. L. SHAW                 (OREG+UCI)IJP
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY          (HAIF)I

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N(2000) F_{15}

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          06  N*1/2(2000, JP=5/2+) I=1/2

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                 06  N*1/2(2000) MASS (MEV)

M  7        (2175.)                     ALMEHED   72 IPWA                          2/72
M           (1930.)                     DEANS     72 MPWA    GAM P-K LM,SOL D     9/73
M  1        (1970.)                     LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
M  1  NOT SEEN IN SOLUTION 1 OF LANGBEIN73                                        9/73
M           (2125.)                     AYED      76 IPWA                         11/77
M            1882.      10.             HOEHLER   79 IPWA    PI N TO PI N         12/79

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                 06  N*1/2(2000) WIDTH (MEV)

W  7        (150.)                      ALMEHED   72 IPWA                          2/72
W           (112.)                      DEANS     72 MPWA    GAM P-K LM,SOL D     9/73
W  1        (170.)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
W           (157.)                      AYED      76 IPWA                         11/77
W             95.       20.             HOEHLER   79 IPWA    PI N TO PI N         12/79

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                 06  N*1/2(2000) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1       N*1/2(2000) INTO PI N                                   139+ 939
P2       N*1/2(2000) INTO LAMBDA K                               1115+ 497
P3       N*1/2(2000) INTO GAM P,HELICITY=3/2                     0+ 938
P4       N*1/2(2000) INTO GAM P,HELICITY=1/2                     0+ 938
P5       N*1/2(2000) INTO GAM N,HELICITY=3/2                     0+ 939
P6       N*1/2(2000) INTO GAM N,HELICITY=1/2                     0+ 939
P7       N*1/2(2000) INTO K SIGMA                                493+1189
P8       N*1/2(2000) INTO ETA N                                  939+ 548

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                 06  N*1/2(2000) BRANCHING RATIOS

R1       N*1/2(2000) INTO (PI N)/TOTAL                          (P1)
R1  7         (0.25)                    ALMEHED   72 IPWA                          2/72
R1            (0.08)                    AYED      76 IPWA                         11/77
R1             0.04       0.02          HOEHLER   79 IPWA    PI N TO PI N         12/79

R2       N*1/2(2000) FROM GAMMA PROTON TO K LAMBDA          SQRT((P3+P4)*P2)       9/73
R2            (0.0022)                  DEANS     72 MPWA    GAM P-K LM,SOL D     9/73

R3       N*1/2(2000) FROM PI N TO K SIGMA                   SQRT(P1*P7)            9/73
R3  1         (0.05)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2     9/73
R3  2         (0.022)                   DEANS     75 DPWA    PI N TO K SIGMA     11/75
R3  2  VALUE GIVEN IS FROM SOLUTION 1, NOT PRESENT IN SOLUTIONS 2,3,4.           11/75

R4       N*1/2(2000) FROM PI N TO K LAMBDA                  SQRT(P1*P2)           12/79
R4          NOT SEEN                    SAXON     80 DPWA    0 PI- P TO K LAM    12/79

R5       N*1/2(2000) FROM PI N TO ETA N                     SQRT(P1*P8)           12/79
R5           (+0.03)                    BAKER     79 DPWA    0 PI- P TO ETA N    12/79

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                       REFERENCES FOR N*1/2(2000)

ALMEHED  72 NP B40 157        +LOVELACE                           (RUTG)IJP
DEANS    72 PRD 6 1906        DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                   (MUNICH)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP
AYED     76 CEA-N-1921        AYED (THESIS)                       (SACL)IJP

BAKER    79 NP B156 93        +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+ (RHEL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN        /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3   R.KOCH                        (KARLSRUHE)IJP

SAXON    80 NP B162 522       +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                       PAPERS NOT REFERRED TO IN DATA CARDS

MA       76 PRD 13 3027       E. MA,G. L. SHAW                (OREG+UCI)IJP

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N(2080) D_{13}

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          16  N*1/2(2080, JP=3/2-) I=1/2

          THERE IS SOME EVIDENCE THAT TWO RESONANCES EXIST IN
          THIS WAVE BETWEEN 1800 AND 2200 MEV (SEE CUTKOSKY 79
          AND CUTKOSKY 80).  BOTH ARE LISTED HERE AWAITING
          INDEPENDENT CONFIRMATION OF THE LOWER MASS STATE.

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                 16  N*1/2(2080) MASS (MEV)

M   3      (2057.0)                    DONNACH1  68 RVUE    PHASE-SHIFT ANAL  6/69
M   3      (2030.)                     DONNACH2  68 RVUE    PHAS.SHIFT-CERN1 10/69
M   3      (2040.)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
M   3  WHERE MAX. ABSORPTION IS -DONNACH1, 2  ,KIRSOPP EYEBALL FIT CERN I    10/69
M   X      (2030.)          APPROX     LEA       69 CNTR    PI-P ELASTIC      8/69
M   X  SEE ALSO APLIN 71
M   7      (2075.)                     ALMEHED   72 IPWA                       2/72
M   1      (2090.)                     HICKS     73 MPWA    GAM P-ETA P        9/73
M   1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.        9/73
M   1  M AND W ARE FROM SOLUTION C2.BR=SQRT(G)/W WITH G FROM TABLE VII.       9/73
M          (2029.)                     AYED      76 IPWA                      11/77
M   L      (1830.)      (50.)          CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M   H      (2100.)      (80.)          CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M  LH  CUTKOSKY79 FINDS A LOWER MASS D13 RESONANCE, AS WELL AS ONE IN THIS   12/79
M  LH  MASS REGION. BOTH ARE LISTED HERE, AND LABELED L AND H FOR LOW AND    12/79
M  LH  HIGH, AWAITING CONFIRMATION OF THE LOWER MASS STATE.                  12/79
M           2081.       20.            HOEHLER   79 IPWA    PI N TO PI N      12/79
M   A       1880.      100.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M   B       2060.       80.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M  AB  CUTKOSKY 80 AGAIN FINDS A LOWER MASS D13 RESONANCE, AS WELL AS ONE     1/82*
M  AB  IN THIS MASS REGION.  BOTH ARE LISTED HERE, LABELED A AND B FOR   L
M  AB  THE LOWER AND HIGHER STATES.                                           1/82*
M   4      (1900.)                     SAXON     80 DPWA  0 PI- P TO K LAM   12/79
M           . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    16  N*1/2(2080) WIDTH (MEV)

W           (293.0)                  DONNACHI   68 RVUE                          8/69
W     3     (290.)                   DONNACH2   68 RVUE     PHAS.SHIFT-CERN1   10/69
W     3     (240.)                   KIRSOPP    68 RVUE     PHASE SHIFT ANAL   10/69
W     7     (150.)                   ALMEHED    72 IPWA                         2/72
W     1     (224.)                   HICKS      73 MPWA     GAM P-ETA P         9/73
W           (116.)                   AYED       76 IPWA                        11/77
W     L     (125.)    (50.)          CUTKOSKY   79 IPWA     PI N TO PI N       12/79
W     H     (300.)   (100.)          CUTKOSKY   79 IPWA     PI N TO PI N       12/79
W           265.       40.           HOEHLER    79 IPWA     PI N TO PI N       12/79
W     A     180.       60.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
W     B     300.      100.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
W     4     (240.)                   SAXON      80 DPWA   0 PI- P TO K LAM     12/79
W                . . . . . . . . .
W     AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

                    16  N*1/2(2080) REAL PART OF POLE POSITION  (MEV)

RE    L     (1818.)                  CUTKOSKY   79 IPWA     PI N TO PI N       12/79
RE    H     (2053.)                  CUTKOSKY   79 IPWA     PI N TO PI N       12/79
RE    A     1880.     100.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
RE    B     2050.      70.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
RE               . . . . . . . . .
RE    AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

                    16  N*1/2(2080) -2*IMAG PART OF POLE POSITION  (MEV)

IM    L     (122.)                   CUTKOSKY   79 IPWA     PI N TO PI N       12/79
IM    H     (308.)                   CUTKOSKY   79 IPWA     PI N TO PI N       12/79
IM    A     160.       80.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
IM    B     200.       60.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
IM               . . . . . . . . .
IM    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

                    16  N*1/2(2080) REAL PART OF ELASTIC POLE RESIDUE (MEV)

REP   L      (3.)                    CUTKOSKY   79 IPWA     PI N TO PI N       12/79
REP   H     (24.)                    CUTKOSKY   79 IPWA     PI N TO PI N       12/79
RER   A      -2.       14.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
RER   B      30.       20.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
RER              . . . . . . . . .
RER   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

                    16  N*1/2(2080) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR   L     (-3.)                    CUTKOSKY   79 IPWA     PI N TO PI N       12/79
IMR   H     (-10.)                   CUTKOSKY   79 IPWA     PI N TO PI N       12/79
IMR   A      10.        5.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
IMR   B       0.       52.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
IMR              . . . . . . . . .
IMR   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

                    16  N*1/2(2080) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1       N*1/2(2080) INTO PI N                            139+ 938
P2       N*1/2(2080) INTO N PI PI                         938+ 139+ 139
P3       N*1/2(2080) INTO N ETA                           939+ 548
P4       N*1/2(2080) INTO LAMBDA K                       1115+ 497
P5       N*1/2(2080) INTO GAM P,HELICITY=3/2                0+ 938
P6       N*1/2(2080) INTO GAM P,HELICITY=1/2                0+ 938
P7       N*1/2(2080) INTO GAM N,HELICITY=3/2                0+ 939
P8       N*1/2(2080) INTO GAM N,HELICITY=1/2                0+ 939
P9       N*1/2(2080) INTO SIGMA K                         493+1189

                    16  N*1/2(2080) BRANCHING RATIOS

R1       N*1/2(2080) INTO (PI N)/TOTAL                    (P1)
R1    3     (0.26)                   DONNACH2   68 RVUE     PHAS.SHIFT-CERN1   10/69
R1    3     (0.15)                   KIRSOPP    68 RVUE     PHASE SHIFT ANAL   10/69
R1    7     (0.3)                    ALMEHED    72 IPWA                         2/72
R1          (0.10)                   AYED       76 IPWA                        11/77
R1    L     (0.06)    (0.03)         CUTKOSKY   79 IPWA     PI N TO PI N       12/79
R1    H     (0.13)    (0.05)         CUTKOSKY   79 IPWA     PI N TO PI N       12/79
R1           0.06      0.02          HOEHLER    79 IPWA     PI N TO PI N       12/79
R1    A      0.10      0.04          CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
R1    B      0.14      0.07          CUTKOSKY   80 IPWA     PI N TO PI N        1/82*
R1               . . . . . . . . .
R1    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2       N*1/2(2080) INTO (N ETA)/TOTAL                   (P3)
R2 B        (0.1   OR 0.009          CARRERAS   70 MPWA     T POLE + RESON.     5/70
R2 B     PARAMETRIZATION USED COULD BE IN DANGER OF DOUBLE COUNTING

R3       N*1/2(2080) FROM GAMMA PROTON TO K LAMBDA        SQRT((P5+P6)*P4)    9/73
R3          (0.0070)                 DEANS      72 MPWA     GAM P-K LN,SOL D    9/73

R4       N*1/2(2080) FROM GAMMA PROTON TO ETA PROTON      SQRT((P5+P6)*P3)    9/73
R4    1     (0.0037)                 HICKS      73 MPWA     GAM P-ETA P         9/73

R5       N*1/2(2080) FROM PI N TO K SIGMA                 SQRT(P1*P9)        11/75
R5 2        (0.014)TO 0.037          DEANS      75 DPWA     PI N TO K SIGMA    11/75
R5 2     RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75
R5 2     DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77           1/78
R5 2     AROUND 1920 MEV.                                                     1/78

R6       N*1/2(2080) FROM PI N TO K LAMBDA                SQRT(PI*P4)        12/79
R6 4        (+0.03)                  SAXON      80 DPWA   0 PI- P TO K LAM   12/79
R6 4     COUPLING PHASE IS NEAR -90 DEGREES. THIS IS THE ONLY D13 RESONANCE  12/79
R6 4     ABOVE THE N*1/2(1700,3/2-) REQUIRED IN THE SAXON80 ANALYSIS.        12/79

R7       N*1/2(2080) FROM PI N TO ETA N                   SQRT(P1*P3)        12/79
R7          NOT SEEN                 BAKER      79 DPWA   0 PI- P TO ETA N   12/79
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                    16  N*1/2(2080) PHOTON DECAY AMPL(GEV**-1/2)

   FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
   REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*1/2(2080) INTO GAM P, HELICITY=1/2   (GEV**-1/2)
A1          0.026      0.052          DEVENIS2   74 DPWA     PI N PHOTOPROD.     4/75

A2     N*1/2(2080) INTO GAM P, HELICITY=3/2   (GEV**-1/2)
A2          0.128      0.057          DEVENIS2   74 DPWA     PI N PHOTOPROD.     4/75

A3     N*1/2(2080) INTO GAM N, HELICITY=1/2   (GEV**-1/2)
A3          0.053      0.083          DEVENIS2   74 DPWA     PI N PHOTOPROD.     4/75

A4     N*1/2(2080) INTO GAM N, HELICITY=3/2   (GEV**-1/2)
A4          0.100      0.141          DEVENIS2   74 DPWA     PI N PHOTOPROD.     4/75

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                    REFERENCES FOR N*1/2(2080)

DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
DONNACH2 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK          (GLAS)
KIRSOPP  68 THESIS             R G KIRSOPP                           (EDIN)

LEA      69 PL 29B 584         LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,OARE)

CARRERAS 70 NP 16B 35          B CARRERAS, A DONNACHIE          (OARE,MCHS)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
AYED     76 CEA-N-1921         AYED (THESIS)                         (SACL)IJP

BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY           (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          (KARLSRUHE IJP
    ALSO 80 TORONTO CONF 3     R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY 80 TORONTO CONF 19    +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

DONNACHI 69 NP 10B 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED     70 PL 31B 598         +BAREYRE,VILLET                       (SACLAY)
APLIN    71 NP B32 253         +COWAN,GIBSON,GILMORE++          (RHEL,BRISTOL)
MA       76 PRD 13 3027        E. MA,G. L. SHAW                   (OREG+UCI)IJP
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY               (HAIF)
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N(2100) S_{11}

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04  N*1/2(2100, JP=1/2-) I=1/2

ANY STRUCTURE IN THIS WAVE ABOVE 1800 MEV IS LISTED
HERE

                    04  N*1/2(2100) MASS (MEV)

M           (2070.)                  ROYCHOUD   71 DPWA                         3/72
M     7     (2100.)                  ALMEHED    72 IPWA                         2/72
M           (2280.)                  AYED       76 IPWA                        11/77
M           1880.      20.           HOEHLER    79 IPWA     PI N TO PI N       12/79
M           2180.      80.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) WIDTH (MEV)

W     7     (200.)                   ALMEHED    72 IPWA                         2/72
W           (320.)                   AYED       76 IPWA                        11/77
W            95.       30.           HOEHLER    79 IPWA     PI N TO PI N       12/79
W           350.      100.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) REAL PART OF POLE POSITION  (MEV)

RE          2150.                    CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) -2*IMAG PART OF POLE POSITION  (MEV)

IM          350.      100.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) REAL PART OF ELASTIC POLE RESIDUE (MEV)

REM          40.       20.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR           0.       60.           CUTKOSKY   80 IPWA     PI N TO PI N        1/82*

                    04  N*1/2(2100) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1       N*1/2(2100) INTO PI N                            139+ 938
P2       N*1/2(2100) INTO LAMBDA K                       1115+ 497
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                    04  N*1/2(2100) BRANCHING RATIOS

R1     N*1/2(2100) INTO (PI N)/TOTAL                         (P11
R1  7          (0.5)                   ALMEHED   72 IPWA                   2/72
R1             (0.15)                  AYED      76 IPWA                  11/77
R1              0.09      0.05         HOEHLER   79 IPWA    PI N TO PI N  12/79
R1              0.18      0.08         CUTKOSKY  80 IPWA    PI N TO PI N   1/82*

R2     N*1/2(2100) FROM PI N TO K LAMBDA              SQRT(P1*P2)         12/79
R2         NOT SEEN                    SAXON     80 DPWA  0 PI- P TO K LAM 12/79

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                         REFERENCES FOR N*1/2(2100)

ROYCHOUD 71 NP B27 125        R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP
ALMEHED  72 NP B40 157        +LOVELACE                       (LUND,RUTG)IJP
AYED     76 CEA-N-1921        AYED (THESIS)                        (SACL)IJP

HOEHLER  79 HANDBOOK OF PI-N SCATTERING. PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522       +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

MA       76 PRD 13 3027       E. MA,G. L. SHAW                  (OREG+UCI)IJP

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N(2100) → 132 N*1/2(2100, JP=1/2+) I=1/2 P_{11}

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                    132  N*1/2(2100) MASS (MEV)

M          2050.       20.             HOEHLER   79 IPWA    PI N TO PI N   1/82*
M          2125.       75.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    132  N*1/2(2100) WIDTH (MEV)

W          200.        30.             HOEHLER   79 IPWA    PI N TO PI N   1/82*
W          260.       100.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    132  N*1/2(2100) REAL PART OF POLE POSITION  (MEV)

RE         2120.       40.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*

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                    132  N*1/2(2100) -2*IMAG PART OF POLE POSITION  (MEV)

IM         240.        80.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*

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                    132  N*1/2(2100) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER         11.         7.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*

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                    132  N*1/2(2100) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          8.         6.             CUTKOSKY  80 IPWA    PI N TO PI N   1/82*

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                    132  N*1/2(2100) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*1/2(2100) INTO PI N                           139+ 938

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                    132  N*1/2(2100) BRANCHING RATIOS

R1     N*1/2(2100) INTO (PI N)/TOTAL                    (P1)
R1             0.10      0.04         HOEHLER   79 IPWA    PI N TO PI N   1/82*
R1             0.12      0.03         CUTKOSKY  80 IPWA    PI N TO PI N   1/82*
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                         REFERENCES FOR N*1/2(2100)

HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

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2100 MEV REGION - PRODUCTION EXPERIMENTS

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                    114  N*1/2(2100, JP=   ) I=1/2     PRODUCTION EXPERIMENTS

                    RESONANCE-LIKE BUMP OBSERVED IN PP TO P(N PI+) AT CERN
                    ISR (DE KERRET 76). THE ENHANCEMENT SHOWS UP MORE
                    CLEARLY WHEN EVENTS CORRESPONDING TO TRANSVERSAL DECAYS
                    OF THE (N PI+) SYSTEM ARE SELECTED, CONTRARY TO WHAT
                    WOULD BE EXPECTED FOR A DIFFRACTIVE-LIKE EFFECT.

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                    114  N*1/2(2100) MASS (MEV) (PROD. EXPERIMENTS)

M          (2100.)                     DE KERRET 76 ISR  +  P(N PI+)E**=45GEV  1/78

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                    114  N*1/2(2100) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     N*1/2(2100) INTO PI N                           139+ 493

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                   REFERENCES FOR N*1/2(2100) PROD. EXPERIMENTS

DEKERRET 76 PL 63B 477,+83    +NAGY,REGLER,BRANDT+    (CERN+HAMB+IPN+VIEN)

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N(2190) — 71 N*1/2(2190, JP=7/2-) I=1/2 G_{17}

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                    THIS RESONANCE IS WELL ESTABLISHED.

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                    71  N*1/2(2190) MASS (MEV)

M          (2190.0)                    DIODENS   63 CNTR    PI+- P TOTKL
M          (2210.0)                    HOHLER    64 RVUE    DATA + DISP REL
M          (2190.0)        APPROX      YOKOSAWA  66 CNTR    PI- P DSIG + POL   7/66
M    3     (2265.0)                    DONNACHI  68 RVUE    PHASE-SHIFT ANAL   6/68
M          (2000.0)        APPROX      LEA       69 CNTR    PI-P ELASTIC       8/69
M           2180.      25.             ANDERSON  70 MMS  -  PI- P TO PI- MMS   2/71
M    6     (2158.0)                    AYED      70 IPWA                       1/71
M    6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (2260.0)                    HULL      70 MPWA    SMALL ANGLE PI-P   1/71
M          (2160.0)   (50.0)           AMALDI    71 CNTR    P P AT 24 GEV     10/71
M          (2160.)                     BRANSDEN  71 DPWA                       3/72
M          (2200.)                     ROYCHOUD  71 DPWA                       3/72
M    7     (2225.)                     ALMEHED   72 IPWA                       2/72
M          (2190.)                     OTT       72 NPWA  0 PI-P BKWD ELSTC    2/73
M     1    (2208.)                     HICKS     73 MPWA    GAM P-ETA P        9/73
M     1  ONLY STATES FROM TABLE VII OF HICKS73 ARE INCLUDED IN LISTINGS.       9/73
M     1  M AND W ARE FROM SOLUTION C2,BR=SQRT(G)/W WITH G FROM TABLE VII.      9/73
M          (2208.)    (20.)            ABE       74      +  P+P->P+X,JCBN PK   4/75
M          (2141.)                     AYED      76 IPWA                      11/77
M          (2117.)                     BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
M           2140.      40.             HENDRY    78 MPWA    PI N TO PI N      12/79
M          (2140.)                     BAKER     79 DPWA  0 PI- P TO ETA N    12/79
M          (2150.)   (100.)            CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M           2140.      12.             HOEHLER   79 IPWA    PI N TO PI N      12/79
M          (2098.0)                    CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
M           2200.      70.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M          (2180.)                     SAXON     80 DPWA  0 PI- P TO K LAM    12/79
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    71  N*1/2(2190) WIDTH (MEV)

W          (200.0)                     DIODENS   63 CNTR
W          (200.0)                     HOHLER    64 RVUE                       7/66
W          (220.0)         APPROX      YOKOSAWA  66 CNTR                       7/66
W    3     (258.0)                     DONNACHI  68 RVUE                       6/66
W           275.       70.             ANDERSON  70 MMS  -  PI- P TO PI- MMS   2/71
W    6     (325.0)                     AYED      70 IPWA                       1/71
W          (239.0)                     HULL      70 MPWA    SMALL ANGLE PI-P   1/71
W    7     (150.)                      ALMEHED   72 IPWA                       2/72
W     1    (193.)                      HICKS     73 MPWA    GAM P-ETA P        9/73
W          (243.)                      AYED      76 IPWA                      11/77
W          (220.)                      BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
W           270.       50.             HENDRY    78 MPWA    PI N TO PI N      12/79
W          (319.)                      BAKER     79 DPWA  0 PI- P TO ETA N    12/79
W          (300.)    (100.)            CUTKOSKY  79 IPWA    PI N TO PI N      12/79
W           330.       30.             HOEHLER   79 IPWA    PI N TO PI N      12/79
W          (238.0)                     CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
W           500.      150.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W          (80.)                       SAXON     80 DPWA  0 PI- P TO K LAM    12/79
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                    71  N*1/2(2190) REAL PART OF POLE POSITION  (MEV)

RE         (2111.)                     CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RE          2100.      50.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    71  N*1/2(2190) -2*IMAG PART OF POLE POSITION  (MEV)

IM         (308.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IM          400.      160.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    71  N*1/2(2190) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (24.)                       CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RER         22.        14.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    71  N*1/2(2190) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-12.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR         -13.       20.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    71  N*1/2(2190) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     N*1/2(2190) INTO PI N                           139+ 938
P2     N*1/2(2190) INTO LAMBDA K                      1115+ 493
P3     N*1/2(2190) INTO N PI PI                        938+ 139+ 139
P4     N*1/2(2190) INTO GAM P,HELICITY=3/2               0+ 938
P5     N*1/2(2190) INTO GAM P,HELICITY=1/2               0+ 938
P6     N*1/2(2190) INTO GAM N,HELICITY=3/2               0+ 939
P7     N*1/2(2190) INTO GAM N,HELICITY=1/2               0+ 939
P8     N*1/2(2190) INTO ETA N                          548+ 939
P9     N*1/2(2190) INTO SIGMA K                        493+1189

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                    71  N*1/2(2190) BRANCHING RATIOS

R1      N*1/2(2190) INTO (PI N)/TOTAL                          (P1)
R1            (0.3)         APPROX      DIODENS   63 CNTR                        7/66
R1            (0.3)         APPROX      YOKOSAWA  66 CNTR                        7/66
R1   3        (0.349)                   DONNACHI  68 RVUE                        6/68
R1   6        (0.150)                   AYED      70 IPWA                        1/71
R1            (0.09)                    HULL      70 MPWA   SMALL ANGLE PI-P     1/71
R1   7        (0.35)                    ALMEHED   72 IPWA                        2/72
R1            (0.25)                    OTT       72 MPWA  0 PI-P BKWD ELSTC     2/73
R1            (0.16)                    AYED      76 IPWA                       11/77
R1             0.16       0.04          HENDRY    78 MPWA    PI N TO PI N       12/79
R1            (0.16)     (0.07)         CUTKOSKY  79 IPWA    PI N TO PI N       12/79
R1             0.14       0.02          HOEHLER   79 IPWA    PI N TO PI N       12/79
R1             0.12       0.06          CUTKOSKY  80 IPWA    PI N TO PI N        1/82*
R1           . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*1/2(2190) FROM GAMMA PROTON TO K LAMBDA         SQRT((P4+P5)*P2)       9/73
R2           (0.0161)                   DEANS     72 MPWA   GAM P-K LM,SOL D     9/73

R3      N*1/2(2190) FROM GAMMA PROTON TO ETA PROTON       SQRT((P4+P5)*P8)       9/73
R3           (0.0094)                   HICKS     73 MPWA   GAM P-ETA P          9/73

R4      N*1/2(2190) FROM PI N TO K SIGMA                  SQRT(P1*P9)           11/75
R4   4       (0.014)TO 0.019            DEANS     75 DPWA   PI N TO K SIGMA     11/75
R4   4  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                                11/75
R4   4  DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77               1/78
R4   4  AROUND 1920 MEV.                                                         1/78

R5      N*1/2(2190) FROM PI N TO K LAMBDA                 SQRT(P1*P2)           12/79
R5          (-0.02)                     SAXON     80 DPWA  0 PI- P TO K LAM     12/79

R6      N*1/2(2190) FROM PI N TO ETA N                    SQRT(P1*P8)           12/79
R6          (+0.052)                    BAKER     79 DPWA  0 PI- P TO ETA N     12/79

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                    71  N*1/2(2190) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*1/2(2190) INTO GAM P, HELICITY=1/2  (GEV**-1/2)
A1          (-0.030)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.      3/79
A1          (-0.055)                    CRAWFORD  80 DPWA   PI N PHOTOPROD.     12/81*

A2      N*1/2(2190) INTO GAM P, HELICITY=3/2  (GEV**-1/2)
A2          (+0.180)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.      3/79
A2           (0.081)                    CRAWFORD  80 DPWA   PI N PHOTOPROD.     12/81*

A3      N*1/2(2190) INTO GAM N, HELICITY=1/2  (GEV**-1/2)
A3          (-0.085)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.      3/79
A3          (-0.042)                    CRAWFORD  80 DPWA   PI N PHOTOPROD.     12/81*

A4      N*1/2(2190) INTO GAM N, HELICITY=3/2  (GEV**-1/2)
A4          (+0.007)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.      3/79
A4          (-0.126)                    CRAWFORD  80 DPWA   PI N PHOTOPROD.     12/81*

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                        REFERENCES FOR N*1/2(2190)

DIODENS  63 PRL 10 262         +JENKINS, KYCIA, RILEY                 (BNL) I
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE             (KARLSRUHE) I
YOKOSAWA 66 PRL 16 714         +SUWA,HILL,ESTERLING, BOOTH         (ANL,CHIC) JP

DONNACHI 68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR.S TALK             (GLAS)
    ALSO 68 THESIS             R G KIRSOPP                              (EDIN)

LEA      69 PL 29B 584         LEA,OADES,WARD,COWAN,+  (RHEL,BRISTOL,DARE)

ANDERSON 70 PRL 25,699         +BLESER,BLIEDEN,COLLINS++         (BNL,CARN)
AYED     70 KIEV CONF          P AYED,P BAREYRE, G VILLET            (SACL)IJP
HULL     70 PR D2 1763         J HULL, R LEACOCK                         (ISU)

AMALDI   71 PL  34B 435        +BIANCASTELLI,BOSIO,+  (I SANITA ROMA+CERN)
BRANSDEN 71 NP B26 511         +OGDEN                                (DURH)IJP
    ALSO 70 NP B16 461         ROYCHOUDHURY,PERRIN,BRANSDEN          (DURH)IJP
ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN         (DURH)IJP

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
DEANS    72 PRD 6 1906         DEANS,JACOBS, LYONS,MONTGOMERY (SOUTH FLA.)IJP
OTT      72 PL 42B 133         +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
    ALSO 72 MCGILL THESIS    J.VAVRA                                 (MCGI) JP
HICKS    73 PRD 7 2614         +DEANS,JACOBS,LYONS+ (CARN+ORNL+SOUTH FLA.)IJP

ABE      74 PL 53B 114         +ALSPECTOR,BOMBEROWITZ+      (RUTG,UPNJ,FSU)
DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
AYED     76 CEA-N-1921         AYED (THESIS)                         (SACL)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS                 (GLAS)
HENDRY   78 PRL 41 222         ARCHIBALD W. HENDRY                 (IND+LBL)IJP
BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY             (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                             (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                        PAPERS NOT REFERRED TO IN DATA CARDS

BARGER   66 PRL 16 913         V BARGER, D CLINE                      (WISC) P
CARROLL  66 PRL 16 288         +CORBETT,DAMERELL,MIDDLEMAS, +   (RHEL,OXF)J-L
CARROLL  66 PRL 17 1274        +CORBETT,DAMERELL,MIDDLEMAS, +   (RHEL,OXF)J-L
    ERRATUM CHANGING THE RATHER WEAK DETERMINATION OF J-L TO +L        (2+)
KORMANYO 66 PRL 16 709         KORMANYOS,KRISCH,OFALLON, +       (MICH,ANL) P
BUSZA    67 NC 52A 331         +DAVIS,DUFF,HEYMANN, +       (LOUC,WESTFIELD)
AYED     70 PL 31B 558         +BAREYRE,VILLET                        (SACLAY)
MA       76 PRD 13 3027        E. MA,G. L. SHAW                   (OREG+UCI)IJP
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY              (HAIF)

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N(2200) 05 N*1/2(2200, JP=5/2-) I=1/2 **D''_{15}**

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                    05  N*1/2(2200) MASS (MEV)

M    7     (2100.)                     ALMEHED   72 IPWA                       2/72
M          (2076.)                     AYED      76 IPWA                      11/77
M    E     (1870.)                     BAKER     77 DPWA  0 PI- P TO K LAM.    1/78
M    E  IN ADDITION TO THE LISTED PARAMETERS OBTAINED IN A DPWA, BAKER 77      1/78
M    E  SEE A POSSIBLE EFFECT ABOVE 2000 MEV IN AN IPWA.                       1/78
M           2228.       30.            HOEHLER   79 IPWA    PI N TO PI N      12/79
M           2180.       80.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M          (1920.)                     SAXON     80 DPWA  0 PI- P TO K LAM    12/79

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                    05  N*1/2(2200) WIDTH (MEV)

W    7      (150.)                     ALMEHED   72 IPWA                       2/72
W           (206.)                     AYED      76 IPWA                      11/77
W    E       (53.)                     BAKER     77 DPWA  0 PI- P TO K LAM.    1/78
W            310.       50.            HOEHLER   79 IPWA    PI N TO PI N      12/79
W            400.      100.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W           (220.)                     SAXON     80 DPWA  0 PI- P TO K LAM    12/79

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                    05  N*1/2(2200) REAL PART OF POLE POSITION  (MEV)

RE          2100.       60.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    05  N*1/2(2200) -2*IMAG PART OF POLE POSITION  (MEV)

IM           360.       90.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    05  N*1/2(2200) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER            0.       17.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    C5  N*1/2(2200) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          -20.       10.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                    05  N*1/2(2200) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1      N*1/2(2200) INTO PI N                                     139+ 938
P2      N*1/2(2200) INTO LAMBDA K                                1115+ 497
P3      N*1/2(2200) INTO ETA N                                    939+ 548

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                    C5  N*1/2(2200) BRANCHING RATIOS

R1      N*1/2(2200) INTO (PI N)/TOTAL                        (P1)
R1   7        (0.2)                    ALMEHED   72 IPWA                       2/72
R1            (0.09)                   AYED      76 IPWA                      11/77
R1             0.07       0.02         HOEHLER   79 IPWA    PI N TO PI N      12/79
R1             0.10       0.03         CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

R2      N*1/2(2200) FROM PI N TO LAMBDA K                SQRT(P1*P2)
R2   E       (-0.06)                   BAKER     77 DPWA  0 PI- P TO K LAM.    1/78
R2           (-0.05)                   SAXON     80 DPWA  0 PI- P TO K LAM    12/79

R3      N*1/2(2200) FROM PI N TO  TA N                   SQRT(P1*P3)          12/79
R3           (0.066)                   BAKER     79 DPWA  0 PI- P TO ETA N    12/79

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                        REFERENCES FOR N*1/2(2200)

ALMEHED  72 NP B40 157         +LOVELACE                        (LUND,RUTG)IJP
AYED     76 CEA-N-1921         AYED (THESIS)                         (SACL)IJP
BAKER    77 NP B126 365        +BLISSET,BLOODWORTH,BROOME,HART+      (RHEL)IJP

BAKER    79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON    80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                        PAPERS NOT REFERRED TO IN DATA CARDS

MA       76 PRD 13 3027        E. MA,G. L. SHAW                   (OREG+UCI)IJP

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2200 MEV REGION - PRODUCTION EXPERIMENTS

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                    111  N*1/2(2200, JP=?) I=1/2      PRODUCTION EXPERIMENTS

                     WE LIST HERE BUMPS OBSERVED IN THE RANGE 1900-2500 MEV.

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                    111  N*1/2(2200) MASS (MEV)  (PROD. EXP.)

M           2160.       50.            AMALDI    71 SAS  +  P P TO P MM         1/78
M           2120.       30.            APPLE     77 SPEC +  P P TO P (P PI0)    1/78
M           2362.       20.            APPLE     77 SPEC +  P P TO P (N PI+)    1/78
M    D   45 1930.       20.            SUGAHARA  79 HBC  +0 PI-P AT 4.5 GEV    12/79
M    D   34 2120.       10.            SUGAHARA  79 HBC  +0 PI-P AT 4.5 GEV    12/79
M    D  SEEN IN N*3/2(1232) PI PI (NOT RHO)
M    R  176(2200.)                     SUGAHARA  79 HBC  +  PI-P AT 4.5 GEV    12/79
M    R  N*3/2(1232) RHO IS DOMINANT.  IDENTIFIED WITH G17(2190).
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 7.7)

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               111  N*1/2(2200) WIDTH (MEV)  (PROD. EXP.)

W            125.       70.             APPLE     77 SPEC +  P P TO P (P PI0)  1/78
W             75.       50.             APPLE     77 SPEC +  P P TO P (N PI+)  1/78
W   D     45  160.      30.             SUGAHARA  79 HBC  +0 PI-P AT 4.5 GEV  12/79
W   D     34   20.      30.             SUGAHARA  79 HBC  +0 PI-P AT 4.5 GEV  12/79
W              . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED ABOVE.

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                         REFERENCES FOR N*1/2(2200)

AMALDI    71 PL 34B 435         +BIANCASTELLI,BOSIO,MATTHIAE+    (SANI+CERN)
APPLE     77 LNC 18 167         +ASH,CHENG,COYNE,GROSSMAN+       (PRIN+PAVIA)
SUGAHARA  79 NC 52A 373         +SUZUKI,FUKAWA,KABE,KICHIMI,OCHIAI+     (KEK)

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N(2220)

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  90  N*1/2(2220, JP=9/2+) I=1/2
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      THIS RESONANCE IS WELL ESTABLISHED.

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               90  N*1/2(2220) MASS (MEV)

M          (2200.)    APPROX.          BUSZA     67 CSPK    LEG.POLYN.ANAL.    2/71
M    6     (2221.0)                    AYED      70 IPWA                       1/71
M    6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M          (2245.0)                    HULL      70 MPWA    SMALL ANGLE PI-P   1/71
M          (2249.)                     AYED      76 IPWA                      11/77
M           2300.      100.            HENDRY    78 MPWA    PI N TO PI N      12/79
M          (2050.)                     BAKER     79 DPWA  0 PI- P TO ETA N    12/79
M          (2750.)                     CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M           2205.       10.            HOEHLER   79 IPWA    PI N TO PI N      12/79
M           2230.       80.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M              . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               90  N*1/2(2220) WIDTH (MEV)

W    6     (258.0)                     AYED      70 IPWA                       1/71
W          (329.0)                     HULL      70 MPWA    SMALL ANGLE PI-P   1/71
W          (347.)                      AYED      76 IPWA                      11/77
W           450.       150.            HENDRY    78 MPWA    PI N TO PI N      12/79
W          (450.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
W           365.        30.            HOEHLER   79 IPWA    PI N TO PI N      12/79
W           500.       150.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W              . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               90  N*1/2(2220) REAL PART OF POLE POSITION  (MEV)

RE         (2180.)                     CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RE          2160.       80.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               90  N*1/2(2220) -2*IMAG PART OF POLE POSITION  (MEV)

IM         (400.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IM          480.       100.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               90  N*1/2(2220) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (37.)                       CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RER         32.         20.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               90  N*1/2(2220) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-21.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR         -32.        20.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               90  N*1/2(2220) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2220) INTO PI N                              139+ 938
P2     N*1/2(2220) INTO N ETA                             939+ 548
P3     N*1/2(2220) INTO LAMBDA K                         1115+ 497

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               90  N*1/2(2220) BRANCHING RATIOS

R1     N*1/2(2220) INTO (PI N)/TOTAL                      (P1)
R1   6     (0.140)                     AYED      70 IPWA                       1/71
R1         (0.15)                      HULL      70 MPWA    SMALL ANGLE PI-P   1/71
R1         (0.20)                      AYED      76 IPWA                      11/77
R1          0.1.      0.04             HENDRY    78 MPWA    PI N TO PI N      12/79
R1         (0.20)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R1          0.18      0.015            HOEHLER   79 IPWA    PI N TO PI N      12/79
R1          0.15      0.03             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R1             . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

R2     N*1/2(2220) FROM PI N TO K LAMBDA                   SQRT(P1*P3)        12/79
R2         NOT SEEN                    SAXON     80 DPWA  0 PI- P TO K LAM    12/79

R3     N*1/2(2220) FROM PI N TO ETA N                      SQRT(P1*P2)        12/79
R3         (0.034)                     BAKER     79 DPWA  0 PI- P TO ETA N    12/79

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                         REFERENCES FOR N*1/2(2220)

BUSZA     67 NC 52A 331         +DAVIS,DUFF,HEYMANN,NIMMON +    (LOUC+LOWC)
AYED      70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
HULL      70 PR D2 1783         J HULL, R LEACOCK                    (TSU)
AYED      76 CEA-N-1921         AYED (THESIS)                       (SACL)IJP
HENDRY    78 PRL 41 222         ARCHIBALD W. HENDRY             (IND+LBL)IJP
    ALSO  80  TORONTO CONF 113  ARCHIBALD W. HENDRY                  (IND)IJP

BAKER     79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY  79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY         (CARN+LBL)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN          (KARLSRUHE)IJP
    ALSO  80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY  80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON     80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS

AYED      70 PL 31B 598         +BAREYRE,VILLET                       (SACLAY)
MA        76 PRD 13 3027        E. MA,G. L. SHAW                  (OREG+UCI)IJP

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N(2250)

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  113  N*1/2(2250, JP=9/2-) I=1/2
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G_{19}

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      THIS RESONANCE IS WELL ESTABLISHED.

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               113  N*1/2(2250) MASS (MEV)

M          (2133.)                     AYED      76 IPWA                       1/78
M           2200.      100.            HENDRY    78 MPWA    PI N TO PI N      12/79
M          (2200.)                     CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M           2268.       15.            HOEHLER   79 IPWA    PI N TO PI N      12/79
M           2250.       80.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M              . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               113  N*1/2(2250) WIDTH (MEV)

W          (193.)                      AYED      76 IPWA                       1/78
W           350.       100.            HENDRY    78 MPWA    PI N TO PI N      12/79
W          (330.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
W           300.        40.            HOEHLER   79 IPWA    PI N TO PI N      12/79
W           480.       120.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W              . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               113  N*1/2(2250) REAL PART OF POLE POSITION  (MEV)

RE         (2160.)                     CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RE          2150.       50.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               113  N*1/2(2250) -2*IMAG PART OF POLE POSITION  (MEV)

IM         (290.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IM          350.       100.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               113  N*1/2(2250) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (15.)                       CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RER         13.          7.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               113  N*1/2(2250) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-7.)                       CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR         -15.         6.            CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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               113  N*1/2(2250) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     N*1/2(2250) INTO PI N                              139+ 938
P2     N*1/2(2250) INTO LAMBDA K                         1115+ 497
P3     N*1/2(2250) INTO ETA N                             939+ 548

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               113  N*1/2( 250) BRANCHING RATIOS

R1     N*1/2(2250) INTO (PI N)/TOTAL                      (P1)
R1         (0.09)                      AYED      76 IPWA                       1/78
R1          0.09      0.02             HENDRY    78 MPWA    PI N TO PI N      12/79
R1         (0.10)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R1          0.10      0.02             HOEHLER   79 IPWA    PI N TO PI N      12/79
R1          0.10      0.02             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R1             . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2     N*1/2(2250) FROM PI N TO K LAMBDA                   SQRT(P1*P2)        12/79
R2         NOT SEEN                    SAXON     80 DPWA  0 PI- P TO K LAM    12/79

R3     N*1/2(2250) FROM PI N TO ETA N                      SQRT(P1*P3)        12/79
R3         (-0.043)                    BAKER     79 DPWA  0 PI- P TO ETA N    12/79

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                         REFERENCES FOR N*1/2(2250)

AYED      76 CEA-N-1521         AYED (THESIS)                       (SACL)IJP
HENDRY    78 PRL 41 222         ARCHIBALD W. HENDRY             (IND+LBL)IJP
    ALSO  80  TORONTO CONF 113  ARCHIBALD W. HENDRY                  (IND)IJP

BAKER     79 NP B156 93         +BROWN,CLARK,DAVIES,DEPAGTER,EVANS+  (RHEL)IJP
CUTKOSKY  79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY         (CARN+LBL)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN          (KARLSRUHE)IJP
    ALSO  80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CUTKOSKY  80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
SAXON     80 NP B162 522        +BAKER,BELL,BLISSETT,BLOODWORTH+(RHEL+BRIS)IJP

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N(2600) — I_{111}

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120  N*1/2(2600, JP=11/2-) I=1/2

                    120  N*1/2(2600) MASS  (MEV)

M          2700.     100.              HENDRY    78 MPWA    PI N TO PI N     12/79
M          2577.      50.              HOEHLER   79 IPWA    PI N TO PI N     12/79
M                 . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

                    120  N*1/2(2600) WIDTH  (MEV)

W           900.     100.              HENDRY    78 MPWA    PI N TO PI N     12/79
W           400.     100.              HOEHLER   79 IPWA    PI N TO PI N     12/79
W                 . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 3.5)

                    120  N*1/2(2600) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(2600) INTO PI N                                  139+ 938

                    120  N*1/2(2600) BRANCHING RATIOS

R1      N*1/2(2600) INTO (PI N)/TOTAL                        (P1)              12/79
R1           0.08      0.02             HENDRY    78 MPWA    PI N TO PI N      12/79
R1           0.05      0.01             HOEHLER   79 IPWA    PI N TO PI N      12/79
R1                . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)
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                              REFERENCES FOR N*1/2(2600)

HENDRY   78 PRL 41 222         ARCHIBALD W. HENDRY                  (IND+LBL)IJP
   ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                     (IND)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3     P.KOCH                            (KARLSRUHE)IJP
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2650 MEV REGION - MISCELLANEOUS EXPERIMENTS

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                    72  N*1/2(2650,          ) I=1/2   PRODUCTION EXPERIMENTS

                    ROYCHOUDHURY 71 CLAIM F15(2400) AND G19(2400) TO BE
                    POSSIBLE RESONANCES. BRANSDEN 71 FIND THE POSSIBLE
                    RESONANT CANDIDATES S11(2520) AND H19(2590).  RECENT
                    PI N PWA*S ESTABLISH THE EXISTENCE OF A JP=11/2- STATE
                    IN THIS REGION, BUT THE POSSIBILITY THAT THERE
                    ARE ALSO OTHER STATES REMAINS. SEE THE MINI-REVIEW
                    PRECEDING THE N AND DELTA LISTINGS.

                    72  N*1/2(2650) MASS (MEV) (PROD. EXP.)

M        (2700.0)                      ALVAREZ   64 CNTR    PI PHOTOPROD.
M        (2660.0)                      HOHLER    64 RVUE    DATA + DISP REL
M        (2600.0)       APPROX         WAHLIG    64 OSPK  0 PI-P CH EX
M        (2633.0)                      BARGER    66 FIT     TOTAL + CH EX     11/67
M         2649.0     10.0              CITRON    66 CNTR    PI+- P TOTAL       7/66

                    72  N*1/2(2650) WIDTH (MEV) (PROD. EXP.)

W        (100.0)                       ALVAREZ   64 CNTR
W        (200.0)                       HOHLER    64 RVUE                       7/66
W        (425.0)                       BARGER    66 FIT     TOTAL + CH EX     11/67
W         363.0      20.0              CITRON    66 CNTR                       7/66

                    72  N*1/2(2650) PARTIAL DECAY MODES (PROD. EXP.)

                                                               DECAY MASSES
P1      N*1/2(2650) INTO PI N                                  139+ 938
P2      N*1/2(2650) INTO LAMBDA K                             1115+ 497
P3      N*1/2(2650) INTO N PI PI                               938+ 139+ 139

                    72  N*1/2(2650) BRANCHING RATIOS (PROD. EXP.)

R1      N*1/2(2650) INTO (PI N)/TOTAL                        (P1)
R1    ONLY (J+1/2)*( PI N/TOTAL) MEASURED FOR THIS STATE
R1  B        (0.456)  (0.018)          BARGER    66 RVUE    TOTAL + CH EXC.  11/67
R1            0.436    0.028           CITRON    66 CNTR    TOTAL CROSS-SEC. 11/67
R1  B        (0.30)                    BARGER    67 RVUE    USES KORMANYOS67 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D        (0.24)                    DIKMEN    67 RVUE    USES KORMANYOS66 11/67
R1  D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.06)                    KORMANYOS 67 CNTR    PI-P AT 180 DEG. 11/67
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                         REFERENCE. FOR N*1/2(2650) (PROD. EXP.)

ALVAREZ  64 PRL 12 710         +BAR-YAM,KERN,LUCKEY,OSBORNE, +   (MIT,CEA)
HOHLER   64 PL 12 149          G HOHLER, J GIESECKE           (KARLSRUHE) I
WAHLIG   64 PRL 13 103         +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
BARGER   66 PR 151 1123        V BARGER, M OLSSON                   (WISC)
CITRON   66 PR 144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, + (BNL) I
BARGER   67 PR 155 1792        V BARGER, D CLINE                  (WISC) P
DIKMEN   67 PRL 18 798         F N DIKMEN                           (MICH)
KORMANYO 67 PR 164 1661        KORMANYOS, KRISCH, OFALLON, +   (MICH,ANL) P

                         PAPERS NOT REFERRED TO IN DATA CARDS

BAACKE   67 NC 51A 761         J BAACKE, M YVERT          (KARLSRUHE,ORSAY)J-L
DOLEN    68 PR 166 1768        R DOLEN, D HORN, C SCHMID                 (CIT)
WAHLIG   68 PR 168 1515        M A WAHLIG, I MANNELLI               (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

BRANSDEN 71 NP B26 511         +OGDEN                               (DURH)IJP
   ALSO 70 NP B16 461          ROYCHOUDHURY,PERRIN,BRANSDEN         (DURH)IJP
ROYCHOUD 71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP
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N(2700) — K_{113} →

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121  N*1/2(2700, JP=13/2+) I=1/2

                    121  N*1/2(2700) MASS  (MEV)

M          3000.     100.              HENDRY    78 MPWA    PI N TO PI N     12/79
M          2612.      45.              HOEHLER   79 IPWA    PI N TO PI N     12/79
M                 . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 3.5)

                    121  N*1/2(2700) WIDTH  (MEV)

W           900.     150.              HENDRY    78 MPWA    PI N TO PI N     12/79
W           350.      50.              HOEHLER   79 IPWA    PI N TO PI N     12/79
W                 . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 3.5)

                    121  N*1/2(2700) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(2700) INTO PI N                                  139+ 938

                    121  N*1/2(2700) BRANCHING RATIOS

R1      N*1/2(2700) INTO (PI N)/TOTAL                        (P1)              12/79
R1           0.07      0.02             HENDRY    78 MPWA    PI N TO PI N      12/79
R1           0.04      0.01             HOEHLER   79 IPWA    PI N TO PI N      12/79
R1                . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)
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                              REFERENCES FOR N*1/2(2700)

HENDRY   78 PRL 41 222         ARCHIBALD W. HENDRY                  (IND+LBL)IJP
   ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                     (IND)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3     P.KOCH                            (KARLSRUHE)IJP
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N(2800) — G''_{19} →

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122  N*1/2(2800, JP=9/2-) I=1/2

                    122  N*1/2(2800) MASS  (MEV)

M          2792.     100.              HOEHLER   79 IPWA    PI N TO PI N     12/79

                    122  N*1/2(2800) WIDTH  (MEV)

W           240.     100.              HOEHLER   79 IPWA    PI N TO PI N     12/79

                    122  N*1/2(2800) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      N*1/2(2800) INTO PI N                                  139+ 938

                    122  N*1/2(2800) BRANCHING RATIOS

R1      N*1/2(2800) INTO (PI N)/TOTAL                        (P1)              12/79
R1           0.02      0.015            HOEHLER   79 IPWA    PI N TO PI N      12/79
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                              REFERENCES FOR N*1/2(2800)

HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3     R.KOCH                            (KARLSRUHE)IJP
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>3000 MEV REGION - FORMATION EXPERIMENTS

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              128  N*1/2(>3000) I=1/2

               WE LIST HERE I=1/2 RESONANCES WITH MASS GREATER THAN
               ABOUT 3.0 GEV WHICH HAVE BEEN SEEN IN A SINGLE PARTIAL
               WAVE ANALYSIS ONLY.  ALL RESONANCES WHICH HAVE BEEN
               OBSERVED IN >1 ANALYSIS AT ABOUT THE SAME MASS ARE
               GIVEN A SEPARATE LISTING WITH THE APPROPRIATE QUANTUM
               NUMBERS.

              128  N*1/2(>3000) MASS  (MEV)

M         3500.    200.          HENDRY   78 MPWA   PI N  L115    12/79
M         3900.    200.          HENDRY   78 MPWA   PI N  M117    12/79
M         4100.    200.          HENDRY   78 MPWA   PI N  N119    12/79
M         . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

              128  N*1/2(>3000) WIDTH  (MEV)

W         1300.    200.          HENDRY   78 MPWA   PI N  L115    12/79
W         1600.    200.          HENDRY   78 MPWA   PI N  M117    12/79
W         1900.    330.          HENDRY   78 MPWA   PI N  N119    12/79
W         . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

              128  N*1/2(>3000) PARTIAL DECAY MODES

                                                   DECAY MASSES
P1     N*1/2(>3000) INTO PI N                      139+ 938

              128  N*1/2(>3000) BRANCHING RATIOS

R1     N*1/2(>3000) INTO (PI N)/TOTAL                     (P1)          12/79
R1          0.055    0.02        HENDRY   78 MPWA   PI N  L115    12/79
R1          0.040    0.015       HENDRY   78 MPWA   PI N  M117    12/79
R1          0.030    0.015       HENDRY   78 MPWA   PI N  N119    12/79
R1        . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

                         REFERENCES FOR N*1/2(>3000)

HENDRY   78 PRL 41 222      ARCHIBALD W. HENDRY              (IND+LBL)IJP
    ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                (IND)IJP
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N(3030) BUMPS

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73  N*1/2(3030, JP=     ) I=1/2  PRODUCTION EXPERIMENTS

              73  N*1/2(3030) MASS (MEV) (PROD. EXP.)

M        (3080.0)                HOHLER   64 RVUE   DATA + DISP REL   7/66
M        (3030.0)                CITRON   66 CNTR   PI+- P TOTAL      7/66

              73  N*1/2(3030) WIDTH (MEV) (PROD. EXP.)

W         (400.0)                CITRON   66 CNTR                     7/6

              73  N*1/2(3030) PARTIAL DECAY MODES (PROD. EXP.)

                                                   DECAY MASSES
P1     N*1/2(3030) INTO PI N                       139+ 938
P2     N*1/2(3030) INTO N PI PI                    938+ 139+ 139

              73  N*1/2(3030) BRANCHING RATIOS (PROD. EXP.)

R1     N*1/2(3030) INTO (PI N)/TOTAL                      (P1)
R1    ONLY (J+1/2)*(PI N/TOTAL) MEASURED FOR THIS STATE
R1  B       (0.088)  (0.016)     BARGER   66 RVUE   TOTAL + CH EXC.  11/67
R1          (0.048)              CITRON   66 CNTR   TOTAL CRDS.SEC.  11/67
R1  B       (0.12)               BARGER   67 CNTR   USES KORMANYOS66 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D       (0.016)              DIKMEN   67 RVUE   USES KORMANYOS67 11/67
R1  D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES

                   REFERENCES FOR N*1/2(3030) (PROD. EXP.)

HOHLER   64 PL 12 149       G HOHLER, J GIESECKE             (KARLSRUHE) I
BARGER   66 PR 151 1123     V BARGER, M OLSSON                    (WISC)
CITRON   66 PR 144 1101     +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER   67 PR 155 1792     V BARGER, D CLINE                     (WISC) P
DIKMEN   67 PRL 18 798      F N DIKMEN                            (MICH)

                   PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO 67 PR 164 1661     KORMANYOS, KRISCH, OFALLON, +   (MICH,ANL) P
DOLEN    68 PR 166 1768     R DOLEN, D HORN, C SCHMID             (CIT)
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N?(3245) BUMPS →

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74  N* /2(3245, JP=     )        PRODUCTION EXPERIMENTS

EXISTENCE NOT CONCLUSIVELY ESTABLISHED.  I-SPIN
NOT DETERMINED, BUT THE NARROW WIDTH PRECLUDES
IDENTIFICATION WITH THE N*3/2(3230).
OMITTED FROM TABLE.

              74  N* /2(3245) MASS (MEV) (PROD. EXP.)

M         3245.0    10.0        KORMANYOS 67 CNTR   PI-P 180 DEG EL   6/68

              74  N* /2(3245) WIDTH (MEV) (PROD. EXP.)

W         (35.0)  OR LESS       KORMANYOS 67 CNTR                     6/68

              74  N* /2(3245) PARTIAL DECAY MODES (PROD. EXP.)

                                                   DECAY MASSES
P1     N* /2(3245) INTO PI N                       139+ 938

              74  N* /2(3245) BRANCHING RATIOS (PROD. EXP.)

R1     N* /2(3245) INTO (PI N)/TOTAL                      (P1)
R1    J IS NOT KNOWN.  FOLLOWING IS (J+1/2)*(PI N)/TOTAL
R1          (0.37)              KORMANYOS 67 CNTR                     6/68

                   REFERENCES FOR N* /2(3245) (PROD. EXP.)

KORMANYO 67 PR 164 1661     KORMANYOS, KRISCH, OFALLON, +   (MICH,ANL) P
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N(3690) BUMPS →

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75  N*1/2(3690, JP=     ) I=1/2  PRODUCTION EXPERIMENTS

A BUMP SEEN IN THE INVARIANT MASS OF A VERY COMPLI-
CATED STATE (N + SEVEN PIS), SO AS EVIDENCE FOR
A NEW RESONANCE IT IS NOT CONCLUSIVE.  NOT INCLUDED
IN TABLE.

              75  N*1/2(3690) MASS (MEV) (PROD. EXP.)

M         3690.0    10.0        BARTKE    67 HBC  +  PI+P 8 PRONGS    8/67

              75  N*1/2(3690) WIDTH (MEV) (PROD. EXP.)

W           50.0    30.0        BARTKE    67 HBC  +                   8/67

              75  N*1/2(3690) PARTIAL DECAY MODES (PROD. EXP.)

                                                   DECAY MASSES
P1     N*1/2(3690) INTO N + 7 PIS

                   REFERENCES FOR N*1/2(3690) (PROD. EXP.)

BARTKE   67 PL 24B 118      +CZYZEWSKI,DANYSZ,+          (CRACOW,ORSAY) I
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N?(3755) BUMPS →

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76  N* /2(3755, JP=     )        PRODUCTION EXPERIMENTS

A SMALL PEAK IN THE (P P PBAR) INVARIANT MASS FROM
8.4 BEV/C PI+ P TO PI+ P P PBAR EVENTS.  AS EVIDENCE
FOR A NEW RESONANCE IT IS NOT CONCLUSIVE.  OMITTED
FROM TABLE.

              76  N* /2(3755) MASS (MEV) (PROD. EXP.)

M         3755.0     8.0        EHRLICH   68 HBC  +  PI+ P P PBAR     6/68

              76  N* /2(3755) WIDTH (MEV) (PROD. EXP.)

W           40.0    20.0        EHRLICH   68 HBC  +                   6/68

              76  N* /2(3755) PARTIAL DECAY MODES (PROD. EXP.)

                                                   DECAY MASSES
P1     N* /2(3755) INTO PI+ P P PBAR               139+ 938+ 938+ 938

                   REFERENCES FOR N* /2(3755) (PROD. EXP.)

EHRLICH  68 PRL 20 686      R EHRLICH,R J PLANO,J B WHITTAKER (RUTGERS)
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S=0 I=3/2 NUCLEON STATES (Δ)

Δ(1232) — P_{33}

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33  N*3/2(1232, JP=3/2+) I=3/2

THIS RESONANCE IS WELL ESTABLISHED.
SEE CARTER 71 AND CARTER 73 FOR PI N CROSS-SECTION
DATA IN THIS REGION.
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                    33  N*3/2(1232)  MASS (MEV)

M        (1236.)                    ROPER      65 DPWA ++0 PHASE SHIFT AN.
M        (1235.)                    ALMEHED    72 IPWA                    2/72
M   3    (1243.3)  (1241.7)         CHENG      73         FIT CARTER 71   2/74
M   3  THE TWO ENTRIES ARE FROM TWO DIFFERENT PARAMETRIZATIONS OF THE     2/74
M   3  RESONANCE CONTRIBUTION TO THE P33 PHASE SHIFT.                     2/74
M        (1230.4)                   TSCHANG    73         FIT CARTER71 P33 1/74
M        (1231.)                    AYED       76 IPWA                   11/77
M         1233.     2.              HOEHLER    79 IPWA    PI N TO PI N   12/79
M        (1231.6)                   CRAWFORD   80 DPWA    PI N PHOTOPROD. 12/81*
M         1232.     3.              CUTKOSKY   80 IPWA    PI N TO PI N    1/82*
M              . . . . . . . . . .
M      AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

M++       1236.0    0.55            OLSSON     65 RVUE ++ TOTAL-SIGMA DATA
M++ 2     1231.0    1.5             CARTER     71 MPWA ++ PI+P SIG. TOTAL  1/74
M++ 1     1231.1    0.2             CARTER     73 IPWA ++ PI N 88-310 MEV  9/73
M++       1231.1    0.2             PEDRONI    78 DPWA ++ PI N 70-370 MEV  3/82*
M++       1230.9    0.3             KOCH       80 IPWA ++ PI N TO PI N     1/82*
M++       1230.6    0.2             ZIDELL     80 DPWA ++ PI N  0-350 MEV  1/82*
M++ 1  EXPERIMENTAL QUANTITY-SEE CARTER73 FOR COULOMB BARRIER CORRECTIONS  9/73
M++ 2  EXPERIMENTAL QUANTITY-SEE CARTER71 FOR COULOMB BARRIER CORRECTIONS  1/74
M++            . . . . . . . . . .
M++    AVERAGE MEANINGLESS (SCALE FACTOR = 4.6)

M+       (1231.8)                   BERENDS    75 IPWA +  GAM P TO PI NUC  4/75
M+        1230.6    1.8             CRAWFORD   75 DPWA    PI N PHOTOPROD.  1/76
M+       (1231.7)                   BARBOUR    76 DPWA    PI N PHOTOPROD.  1/76
M+  4    (1231.2)                   BARBOUR    78 DPWA    PI-N PHOTOPROD.  3/79
M+  4  SUPERSEDES BARBOUR 76.                                              3/79
M+        1234.9    1.4             MIROSHNIC  79      +  FIT PHOTOPROD.  12/79
M+             . . . . . . . . . .
M+     AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)

M0        1236.45   0.65            OLSSON     65 RVUE  0
M0        1232.9    0.6             CARTER     71 MPWA  0 PI-P SIG. TOTAL  1/71
M0        1233.8    0.2             PEDRONI    78 DPWA  0 PI N 70-370 MEV  3/82*
M0        1233.6    0.5             KOCH       80 IPWA  0 PI N TO PI N     1/82*
M0        1232.5    0.3             ZIDELL     80 DPWA  0 PI N  0-350 MEV  1/82*
M0             . . . . . . . . . .
M0     AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)
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                    33  N*3/2(1232) WIDTH (MEV)

W        (120.)                     ROPER      65 DPWA ++0 PHASE SHIFT AN.
W        (129.)                     ALMEHED    72 IPWA                    2/72
W   3    (152.2)   (145.8)          CHENG      73         FIT CARTER 71   2/74
W        (120.)                     TSCHANG    73         FIT CARTER71 P33 1/74
W        (109.)                     AYED       76 IPWA                   11/77
W         116.      5.              HOEHLER    79 IPWA    PI N TO PI N   12/79
W        (111.2)                    CRAWFORD   80 DPWA    PI N PHOTOPROD. 12/81*
W         120.      5.              CUTKOSKY   80 IPWA    PI N TO PI N    1/82*
W              . . . . . . . . . .
W      AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

W++       120.0     2.0             OLSSON     65 RVUE ++
W++ 2     111.1     1.8             CARTER     71 MPWA ++ PI+P SIG. TOTAL  1/74
W++ 1     111.5     0.4             CARTER     73 IPWA ++ PI N 88-310 MEV  9/73
W++       111.3     0.5             PEDRONI    78 DPWA ++ PI N 70-370 MEV  3/82*
W++       111.0     1.0             KOCH       80 IPWA ++ PI N TO PI N     1/82*
W++       113.2     0.3             ZIDELL     80 DPWA ++ PI N  0-350 MEV  1/82*
W++            . . . . . . . . . .
W++    AVERAGE MEANINGLESS (SCALE FACTOR = 2.5)

W+        120.2     3.9             CRAWFORD   75 DPWA    PI N PHOTOPROD.  1/76
W+       (117.4)                    BARBOUR    76 DPWA    PI N PHOTOPROD.  1/76
W+  4    (111.0)                    BARBOUR    78 DPWA    PI-N PHOTOPROD.  3/79
W+        131.1     2.4             MIROSHNIC  79      +  FIT PHOTOPROD.  12/79
W+             . . . . . . . . . .
W+     AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

W0        119.6     2.4             OLSSON     65 RVUE  0
W0        114.7     3.0             CARTER     71 MPWA  0 PI-P SIG TOT.    1/71
W0        117.9     0.9             PEDRONI    78 DPWA  0 PI N 70-370 MEV  3/82*
W0        113.0     1.5             KOCH       80 IPWA  0 PI N TO PI N     1/82*
W0        121.3     0.4             ZIDELL     80 DPWA  0 PI N  0-350 MEV  1/82*
W0             . . . . . . . . . .
W0     AVERAGE MEANINGLESS (SCALE FACTOR = 4.3)
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                    33  (N*0) - (N*++) MASS DIFFERENCE (MEV)

D   R    (0.45)    (0.85)           OLSSON     65 RVUE
D   R  REDUNDANT WITH DATA IN MASS LISTING.
D   2     1.3       1.9             CARTER     71 MPWA ++ PI+-P SIG. TOTAL 1/74
D   1     1.4       0.4             CARTER     73 IPWA    PI N 88-310 MEV  9/73
D   P    (2.7)     (0.3)            PEDRONI    78 DPWA    PI N 70-370 MEV  3/82*
D   P  USING PI+-D AS WELL, PEDRONI 78 DETERMINE (M- - M++)+(M0 - M+)/3 =  3/82*
D   P  4.6+-0.2 MEV.                                                       3/82*
D              . . . . . . . . . .
D      AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    33  (N*0) - (N*++) WIDTH DIFFERENCE (MEV)              9/73

WD  2     6.5       2.2             CARTER     71 MPWA ++ PI+-P SIG. TOTAL 1/74
WD  1    10.3       1.3             CARTER     73 IPWA    PI N 88-310 MEV  9/73
WD        6.6       1.0             PEDRONI    78 DPWA    PI N 70-370 MEV  3/82*
WD             . . . . . . . . . .
WD     AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)
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                    33  N*3/2(1232) REAL PART OF POLE POSITION (MEV)

RE  M    (1214.)                    MICHAEL    67                              2/74
RE  M  FIT INCLUDES OLSSON 65 PARAMETERS PLUS SCATTERING LENGTH PLUS 6
RE  M  PHASE SHIFT VALUES FOR TPI=120 TO 492 MEV.
RE       (1211.)                    BALL       72                              2/73
RE  P     1211.6    0.7             PDG        72             FIT DELTA 33     2/73
RE  P  ERROR EST. FROM FITS WITH SOMEWHAT VARYING ASSUMPTIONS
RE  3    (1210.7)  (1210.7)         CHENG      73             FIT CARTER 71    2/74
RE        1214.5   10.              NOGOVA     73             FIT ALMEHED72    2/74
RE       (1213.)                    SPEARMAN   74             FIT ZERO TRJCTRY 4/75
RE        1210.     1.              CUTKOSKY   80 IPWA        PI N TO PI N     1/82*
RE             . . . . . . . . . .
RE     AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)

R++ U     1211.5    0.6             BALL       75         ++ FIT CARTER 73    11/75
R++ U     1210.9    0.8             LICHTENB   75         ++ FIT CARTER 73    11/75
R++ C     1209.6    0.5             VASAN      76         ++ FIT CARTER 73     1/76
R++ C  FROM FITS TO COULOMB-BARRIER-CORRECTED CARTER 73 PHASE SHIFT.           3/79
R++ U    (1210.5)TO(1210.8)         VASAN      76         ++ FIT CARTER 73     1/76
R++ U  FROM FITS TO CARTER 73 NUCLEAR PHASE SHIFT WITHOUT COULOMB BARRIER      3/79
R++ U  CORRECTIONS.                                                            3/79
R++ Z     1210.4    0.17            ZIDELL     78         ++ FIT ZIDELL 76     3/79
R++ Z  FIT TO ZIDELL 78 NUCLEAR PHASE SHIFT WITHOUT COULOMB                    3/79
R++ Z  BARRIER CORRECTIONS.                                                    3/79
R++ Y     1210.70   0.16            ZIDELL     80 DPWA ++ PI N  0-350 MEV      1/82*
R++ Y  FIT TO ZIDELL 80 NUCLEAR PHASE SHIFTS.                                  1/82*
R++            . . . . . . . . . .
R++    AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

RE+       1208.     2.              CAMPBELL   76          + FIT PHOTOPROD.    2/77
RE+       1206.9+-0.9 TO 1210.5+-1.8 MIROSHNIC 79          + FIT PHOTOPROD.   12/79

RE0 U    (1211.6)                   BALL       75          0 FIT CARTER 73    11/75
RE0 U     1210.9    1.4             LICHTENB   75          0 FIT CARTER 73    11/75
RE0 C     1210.75   0.6             VASAN      76          0 FIT CARTER 73     1/76
RE0 U    (1210.2)                   VASAN      76          0 FIT CARTER 73     1/76
RE0 Z     1209.5    0.41            ZIDELL     78          0 FIT ZIDELL 76     3/79
RE0 Y     1210.30   0.36            ZIDELL     80 DPWA  0 PI N  0-350 MEV      1/82*
RE0            . . . . . . . . . .
RE0    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)
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                    33  N*3/2(1232) -IMAG PART OF POLE POSITION (MEV)

IM  M    (52.)                      MICHAEL    67                              2/74
IM       (50.)                      BALL       72                              2/73
IM  P     49.5      1.8             PDG        72             FIT DELTA 33     2/73
IM  3    (50.7)    (50.6)           CHENG      73             FIT CARTER 71    2/74
IM        48.6      5.              NOGOVA     73             FIT ALMEHED72    2/74
IM       (49.)                      SPEARMAN   74             FIT ZERO TRJCTRY 4/75
IM        50.       1.              CUTKOSKY   80 IPWA        PI N TO PI N     1/82*
IM             . . . . . . . . . .
IM     AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

I++ U     50.1      0.6             BALL       75         ++ FIT CARTER 73    11/75
I++ U     49.6      0.75            LICHTENB   75         ++ FIT CARTER 73    11/75
I++ C     50.4      0.5             VASAN      76         ++ FIT CARTER 73     1/76
I++ U    (49.9)TO (50.0)            VASAN      76         ++ FIT CARTER 73     1/76
I++ Z     49.745    0.14            ZIDELL     78         ++ FIT ZIDELL 76     3/79
I++ Y     49.61     0.12            ZIDELL     80 DPWA ++ PI N  0-350 MEV      1/82*
I++            . . . . . . . . . .
I++    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

IM+       53.       2.              CAMPBELL   76          + FIT PHOTOPROD.    2/77
IM+       55.6+-1.0 TO 58.3+-1.1    MIROSHNIC  79          + FIT PHOTOPROD.   12/79

IM0 U    (53.0)                     BALL       75          0 FIT CARTER 73    11/75
IM0 U     53.25     1.75            LICHTENB   75          0 FIT CARTER 73    11/75
IM0 C     52.8      0.6             VASAN      76          0 FIT CARTER 73     1/76
IM0 U    (52.9)TO (53.1)            VASAN      76          0 FIT CARTER 73     1/76
IM0 Z     52.45     0.2             ZIDELL     78          0 FIT ZIDELL 78     3/79
IM0 Y     54.0      0.26            ZIDELL     80 DPWA  0 PI N  0-350 MEV      1/82*
IM0            . . . . . . . . . .
IM0    AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)
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                    33  N*3/2(1232) ABSOLUTE VALUE OF ELASTIC
                                    POLE RESIDUE (MEV)

ABS      (53.)                      BALL       73             FIT DELTA 33     9/73
ABS       53.       2.              CUTKOSKY   80 IPWA        PI N TO PI N     1/82*

A++ C    (52.4)TO (53.2)            VASAN      76         ++ FIT CARTER 73     1/76
A++ U    (52.1)TO (52.4)            VASAN      76         ++ FIT CARTER 73     1/76

A80 C    (54.8)TO (55.0)            VASAN      76         ++ FIT CARTER 73     1/76
A80 U    (55.2)TO (55.3)            VASAN      76         ++ FIT CARTER 73     1/76
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                    33  N*3/2(1232) PHASE OF ELASTIC POLE RESIDUE (RADIANS)

PH       (-0.81)                    BALL       73             FIT DELTA 33     9/73
PH        -0.82     0.02            CUTKOSKY   80 IPWA        PI N TO PI N     1/82*

P++ C    (-0.822)TO -0.833          VASAN      76         ++ FIT CARTER 73     1/76
P++ U    (-0.823)TO -0.830          VASAN      76         ++ FIT CARTER 73     1/76

PH0 C    (-0.840)TO -0.847          VASAN      76         ++ FIT CARTER 73     1/76
PH0 U    (-0.848)TO -0.856          VASAN      76         ++ FIT CARTER 73     1/76
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                    33  N*3/2(1232) PHASE OF M1+(3/2) PHOTOPRODUCTION
                                    MULTIPOLE AMPLITUDE POLE RESIDUE

M1P    INFORMATION ON THE PHASE (AND MAGNITUDE) OF THE M1+(3/2) MULTIPOLE  12/79
M1P    AMPLITUDE POLE RESIDUE IS CONTAINED IMPLICITLY IN THE PAPER OF      12/79
M1P    MIROSHNICHENKO 79.  THEY FIND THAT THE PHASE IS CONSISTENT WITH     12/79
M1P    BEING EQUAL TO THAT OF THE ELASTIC POLE RESIDUE.                    12/79
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                    33  N*3/2(1232) MAGNETIC MOMENT  (NUCLEAR MAGNETONS)

MM       (+4.7)TO (+6.7)            NEFKENS    78             PI P TO PI P GAM 12/79
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                    33  N*3/2(1232) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      N*3/2(1232) INTO N PI                                  938+ 139
P2      N*3/2(1232) INTO N GAMMA                               938+   0
P3      N*3/2(1232) INTO N PI PI                               938+ 139+ 139
P4      N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2               0+ 938
P5      N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2               0+ 938

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                    33  N*3/2(1232) BRANCHING RATIOS

R1      N*3/2(1232) INTO (N GAMMA)/(N PI) (PERCENT)         (P2)/(P1)
R1              0.55      0.02          DALITZ    66 RVUE                    7/60
R1              0.53      0.025         BERENDS   71 IPWA   PHOTOPROD. ANAL. 10/71
R1             . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*3/2(1232)0 INTO (N PI)/TOTAL                      (P1)
R2   2          (0.99)                  CARTER    71 MPWA ++ PI+-P SIG. TOTAL  1/74
R2              (1.)                    AYED      76 IPWA                     11/77
R2              (1.)                    HOEHLER   79 IPWA    PI N TO PI N     12/79
R2              (1.)                    CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                    33  N*3/2(1232) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1232) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1            -0.144      0.014         DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A1            -0.142      0.006         MOORHOUS  73 DPWA    PI N PHOTOPROD.   2/73
A1            -0.138      0.004         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A1            -0.140      0.006         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A1            -0.142      0.001         MOORHOUS  74 DPWA    PI N PHOTOPROD.   2/74
A1            -0.130      0.002         CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A1           (-0.139)                   KRIVETS   75 DPWA    PI-N PHOTOPROD.   1/78
A1           (-0.129)                   BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A1            -0.141      0.004         FELLER    76 DPWA    PI N PHOTOPROD.   2/77
A1            -0.136      0.002         AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1 12/79
A1            -0.139      0.002         AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2 12/79
A1   4        -0.142      0.007         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A1   N       (-0.140)                   NOELLE    78         PI-N PHOTOPROD.   1/80
A1   N  CONVERTED TO OUR CONVENTIONS USING M=1.232, W=.110 FROM NOELLE 78.     1/80
A1            -0.147      0.001         ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A1            -0.145      0.001         ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A1            -0.136      0.006         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1             . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 3.4)

A2      N*3/2(1232) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2            -0.262      0.015         DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A2            -0.259      0.016         MOORHOUS  73 DPWA    PI N PHOTOPROD.   2/73
A2            -0.253      0.002         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A2            -0.254      0.007         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A2            -0.261      0.001         MOORHOUS  74 DPWA    PI N PHOTOPROD.   2/74
A2            -0.248      0.002         CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A2           (-0.253)                   KRIVETS   75 DPWA    PI-N PHOTOPROD.   1/78
A2           (-0.251)                   BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A2            -0.256      0.003         FELLER    76 DPWA    PI N PHOTOPROD.   2/77
A2            -0.255      0.002         AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1 12/79
A2            -0.256      0.002         AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 2 12/79
A2   4        -0.271      0.010         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A2   N       (-0.247)                   NOELLE    78         PI-N PHOTOPROD.   1/80
A2   N  CONVERTED TO OUR CONVENTIONS USING M=1.232, W=.110 FROM NOELLE 78.     1/80
A2            -0.264      0.002         ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A2            -0.261      0.002         ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A2            -0.247      0.010         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2             . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                         REFERENCES FOR N*3/2(1232)

OLSSON    65 PRL 14 118        M G OLSSON                          (WISC)
ROPER     65 PR 138 B190       L D ROPER, R M WRIGHT, B T FELD   (LRL+MIT)IJP

DALITZ    66 PR 146 1180       DALITZ,SUTHERLAND                   (OXFORD)
     CONTAINS REFERENCES TO EARLIER WORK ON DELTA PHOTOPRODUCTION.

MICHAEL   67 PR 156 1677       MICHAEL                             (RHEL)IJP
BERENDS   71 NP  B30 575       +WEAVER                       (CEA,MIT,TUFT)
CARTER    71 NP B26 445        +WILLIAMS, BUGG, BUSSEY, DANCE  (CAVE,RHEL)

ALMEHED   72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
BALL      72 PRL 28 1143       +CAMPBELL,LEE,SHAW            (UTAH,BOIS,UCI)
POG       72 PL 39B 1C3        SODING,BARTELS,+  (DESY+LBL+BRAN+CERN+HELS)IJP
BALL      73 PRD 7 2789        BALL,LEE,SHAW                    (UTAH+UCI)IJP
CARTER    73 NP B58 378        CARTER,BUGG,CARTER   (CAVENDISH+QUEEN MARY)IJP
CHENG     73 PRD 7 2249        CHENG,LICHTENBERG                     (IND)IJP
DEVENISH  73 PL 47B 53         DEVENISH,RANKIN,LYTH      (LOUC+BONN+LANC)IJP
MOORHDUS  73 PL 43B 44         MOORHOUSE, OBERLACK              (GLAS+LBL)IJP
NOGOVA    73 NP B61 445        NOGOVA,PISUT(IP SLOVAK ACAD SCI,COMENIUS U)IJP
    ALSO  73 NP B61 438        NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
    ALSO  73 NP B65 544        NOGOVA,PISUT+(IP SLOVK ACAD SCI,COMENIUS U)IJP
TSCHANG   73 NP B59 445        TSCHANG,PARKINSON        (FLOR+GAINESVILLE)IJP

KNIES     74 PRD 9 2680        KNIES,MOORHOUSE,OBERLACK         (LBL,GLAS)IJP
METCALF   74 NP B76 253        W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS  74 PRD 9 1           MOORHOUSE,OBERLACK,ROSENFELD     (GLAS+LBL)IJP
SPEARMAN  74 PRD 10 1660       T D SPEARMAN        (TRINITY COLLEGE,DUBLIN)

BALL      75 PRD 11 1171       J S BALL,R L GOBLE                   (UTAH)IJP
BERENDS   75 NP B84 342        BERENDS,DONNACHIE                (LEID,MCHS)
CRAWFORD  75 NP B97 125        R L CRAWFORD                         (GLAS)IJP
KRIVETS   75 SJNP 20 430       +MIROSHNICHENKO,NIKIFOROV,SANIN+     (KIEV)IJP
    ALSO  74 SJNP 19 112       KRIVETS,NIKIFOROV,SANIN,SHALATSKII   (KIEV)IJP
LICHTENB  75 LNC 12 616        O B LICHTENBERG                       (IND)IJP

AYED      76 CEA-N-1921        AYED (THESIS)                        (SACL)IJP
BARBOUR   76 NP B111 358       I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP
CAMPBELL  76 PRD 14 2431       CAMPBELL,SHAW,BALL          (BOIS+UCI+UTAH)IJP
FELLER    76 NP B104 219       +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP
VASAN     76 NP B106 535       S. S. VASAN                          (CARN)IJP
    ALSO  76 NP B106 526       S. S. VASAN                          (CARN)IJP

AZNAURYA  77  EFI-264(57)-77   +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BARBOUR   78 NP B141 253       BARBOUR,CRAWFORD,PARSONS             (GLAS)
NEFKENS   78 PRD 18 3911       +ARMAN,BALLAGH,GLODIS,HADDOCK+  (UCLA+CATH)IJP
NOELLE    78 PTP 60 778        P. NOELLE                            (NAGO)
PEDRONI   78 NP A300 321       +GABATHULER,DOMINGO,HIRT+ (SIN,GREN,KARL,+)IJP
ZIDELL    78 LNC 21 140        V.S.ZIDELL,R.A.ARNDT,L.D.ROPER        (VPI)IJP

HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN          (KARLSRUHE )JP
    ALSO  80  TORONTO CONF 3   R.KOCH                          (KARLSRUHE)IJP
MIROSHNI  79 SJNP 29 94        MIROSHNICHENKO,NIKIFOROV,SANIN+   (KHARKOV)IJP

ARAI      80  TORONTO CONF 93  I. ARAI                              (TOKY)
CRAWFORD  80  TORONTO CONF 107 R.L.CRAWFORD                         (GLAS)
CUTKOSKY  80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK (CARN+LBL)IJP
KOCH      80 NP A336 331       R. KOCH, E. PIETARINEN               (KARL)IJP
ZIDELL    80 PR D21 1255       V.S.ZIDELL,,R.A.ARNDT,L.D.ROPER       (VPI)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

DONNACHI  68 PL 26B 161        DONNACHIE,LOVELACE,KIPSOPP           (CERN)
FONDA     73 PRD 8 353         FONDA,GHIRARDI,SHAW    (ICTP-TRIESTE+IRSF)IJP
HENYEY    74 PR D9 302         HENYEY,KANE                          (MICH)IJP
OLSSON    74 LNC 10 333        OLSSON                               (CERN)IJP
PFEIL     74 NP B73 166        PFEIL,ROLLNIK,STANKOWSKI             (BONN)
SUZUKI    74 NP B68 413        SUZUKI,KUROKAWA,KONDO                (TOKYO)

GANENKO   75 SJNP 22 522       +KRIVETS,MIROSHNICHENKO,NIKIFOROV+   (KIEV)IJP
NIGRO     75 NP B84 201        NIGRO,SPILLANTINI,VALENTE        (PADO,FRAS)
GANENKO1  76 SJNP 24 284       +KRIVETS,MIROSHNICHENKO,NIKIFOROV+   (KIEV)IJP
GANENKO2  76 SJNP 24 594       +GORBENKO,KRIVETS,KOLESNIKOV+        (KIEV)IJP
ZABEV     76 SJNP 24 70        ZABEV,KUZNETSOV,STUKOV               (TMSK)IJP
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1232 MEV REGION - PRODUCTION EXPERIMENTS

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                    81  N*3/2(1232, JP=3/2+) I=3/2   PRODUCTION EXPERIMENTS

                    SEE THE MINI-REVIEW PRECEDING THE N AND DELTA LISTINGS
                    FOR A DISCUSSION OF PRODUCTION EXPERIMENTS.

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                    81  N*3/2(1232) MASS (MEV) (PROD. EXP.)

M             1217.       8.              ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
M             1227.0      7.0             ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
M             . . . . . . . . . .
M    AVG      1222.7      5.3       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

M++          (1232.0)    (6.0)            FERRO-LUZ 65 HBC  ++ K+P TO K0 P PI+
M++          (1236.0)                     DEANS     66 RVUE ++ PI+P TOTAL        7/66
M++          (1233.4)    (4.4)            GIDAL     66 DBC  ++ D D TO NN(NN) PI  7/66
M++          (1224.0)    (2.0)            HABER     70 DBC     K-D TO 4 BOD(P)   7/70
M++           1236.0      2.0             COLTON    72 HBC  ++ PP TO PI+PN 7GEV  1/73
M++           1226.0      2.0             COLTON    72 HBC  ++  TO PI+PI-PP      1/73
M++           1222.0      3.0             COLTON    72 HBC  ++ TO PI+PI-PI0PP    1/73
M++           1226.0      2.0             COLTON    72 HBC  ++ TO PI+PI-PI-PN    1/73
M++          (1231.)     (3.)             LEWIS     73 HBC  ++ K+ P TO K P 2PI   1/76
M++           1219.       5.              LICHTMAN  74 HBC  ++ PI+P TO 3PI P     4/75
M++           1213.       3.              LICHTMAN  74 HBC  ++ PI-P TO 3PI P     4/75
M++          (1224.)      5. TO 10.       BRAUN2    75  BC     PBAR P AND D,5.7 11/75
M++           1224. TO 1228.              ATHERTON  76 HBC     PBAR P 5.7 GEV    2/77
M++       2K  1226.       3.              GOGGI2    78 ISP  ++ PP TO DELTA P PI  1/80
M++      840  1225.       2.              APELDOORN 79 HBC  ++ PBAR P 7.2 GEV/C 12/79
M++    N 600  1220.       3.              ALLEN     80 HBC  ++ NU P TO MU-P PI+  2/82*
M++  N  NEGLIGIBLE BACKGROUND.
M++           . . . . . . . . . .
M++  AVG      1225.6      2.1       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.5)

M+            1224. TO 1230.              BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75
M+   1        1256.      15.              APPLE     77 SPEC +  P P TO P (N PI+)  1/78
M+   1  NOT SEEN IN P P TO P (P PI0).                                            1/78

M0            1231.      11.              COOPER    74 HBC   0 D P CEX           4/75
M0           (1230.)                      BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75
M0           (1220.)      5. TO 10.       BRAUN2    75  BC     PBAR P AND D,5.7 11/75

M-           (1241.3)    (5.1)            GIDAL     66 DBC  -                    7/66
M-            1239.0      5.0             COLTON    72 HBC  -  TO PI+PI-PI-PN    1/73

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                    81  (N*-) - (N*++) MASS DIFFERENCE (MEV) (PROD. EXP.)

D              7.9        6.8             GIDAL     66 DBC
D        TK    5.9        3.1             DAKHNO    81 DBC     PI+-N TO PI+PI-N  2/82*
D             . . . . . . . . . .
D    AVG       6.2        2.8       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                    81  N*3/2(1232) WIDTH (MEV) (PROD. EXP.)

W             115.        5.              ANDERSON  70 MMS  -  PI- P TO PI- MMS  2/71
W             105.0       7.0             ELLIS     71 CNTR    MMS PP 3.7 GEV/C 10/71
W             141.       11.              MUSGRAVE  75 HBC     K+ P TO K PI N   11/75
W             . . . . . . . . . .
W    AVG      115.2       7.5       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.0)

W++          (125.0)    (30.0)            FERRO-LUZ 65 HBC  ++
W++          (121.0)                      DEANS     66 RVUE ++                   7/66
W++          (124.0)    (14.0)            GIDAL     66 DBC  ++                   7/66
W++          (120.0)     (8.0)            HABER     70 DBC     K-D TO 4 BOD(P)   7/70
W++           115.0       6.0             COLTON    72 HBC  ++ PP TO PI+PN 7GEV  1/73
W++           127.0       5.0             COLTON    72 HBC  ++  TO PI+PI-PP      1/73
W++           122.0       9.0             COLTON    72 HBC  ++ TO PI+PI-PI0PP    1/73
W++           106.0       7.0             COLTON    72 HBC  ++ TO PI+PI-PI-PN    1/73
W++          (146.)     (10.)             LEWIS     73 HBC  ++ K+ P TO K P 2PI   1/76
W++           166.       14.              LICHTMAN  74 HBC  ++ PI+P TO 3PI P     4/75
W++           134.        7.              LICHTMAN  74 HBC  ++ PI-P TO 3PI P     4/75
W++          (110.)      10. TO 20.       BRAUN2    75  BC     PBAR P AND D,5.7 11/75
W++            96. TO   113.              ATHERTON  76 HBC     PBAR P 5.7 GEV    2/77
W++       2K  113.       16.              GOGGI2    78 ISP  ++ PP TO DELTA P PI  1/80
W++      840  100.        5.              APELDOORN 79 HBC  ++ PBAR P 7.2 GEV/C 12/79
W++    N 600   95.        7.              ALLEN     80 HBC  ++ NU P TO MU-P PI+  2/82*
W++           . . . . . . . . . .
W++  AVG      115.1       5.5       AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.4)

W+            110. TO   130.              BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75
W+   1         20.       60.       20.    APPLE     77 SPEC +  P P TO P (N PI+)  1/78

W0            109.       32.       25.    COOPER    74 HBC   0 D P CEX           4/75
W0           (120.)                       BRAUN1    75 HBC     PBAR P 5.7 GEV   11/75
W0           (120.)      10. TO 20.       BRAUN2    75  BC     PBAR P AND D,5.7 11/75

W-           (149.0)    (18.0)            GIDAL     66 DBC  -                    7/66
W-            237.0      22.0             COLTON    72 HBC  -  TO PI+PI-PI-PN    1/73

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                              REFERENCES FOR N*3/2(1232) (PROD. EXP.)

FERRO-LU 65 NC 36 1101        FERRO-LUZZI,GEORGE, +                     (CERN)
DEANS    66 PREPRINT          S R DEANS, W G HOLLADAY            (VANDERBILT)
GIDAL    66 PR 141 1261       G GIDAL, A KERNAN, S KIM                   (LRL)

ANDERSON 70 PRL 25 699        +BLESER,BLIEDEN,COLLINS++           (BNL,CARN)
HABER    70 NP 17B 289        +SHAPIRA,MERRILL,MONARI++         (SABRE COLL)
ELLIS    71 PRL 27 442        +MAGLICH,NOREN,SANNES,SILVERMAN         (RUTG)
COLTON   72 PR D6 95          E COLTON, A KIRSCHBAUM                   (LBL)
LEWIS    73 NP B60 283        +ALLEN,JACOBS,DANYSZ,ISLAM+(LOWC+LOIC+CDEF)

COOPER   74 NP B79 259        COOPER,SEIDL,VANDERVELDE                (MICH)
LICHTMAN 74 NP B81 31         LICHTMAN,BISWAS,CASON,KENNEY,MCGAHAN+(NDAM)I

BRAUN1   75 NP B95 481        +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
BRAUN2   75 NP 395 5C3        +GERBER,MAURER,MICHALON,SCHIBY+ (STRB,LPNP)I
MUSGRAVE 75 NP B87 36F        +PEETERS,SCREINER,WHITMORE,YUTA          (ANL)

ATHERTON 76 NP B103 381       ATHERTON,FRENCH,SKURA,BOHM+     (CERN+PRAG)I
APPLE    77 LNC 18 167        +ASH,CHENG,COYNE,GROSSMAN+       (PRIN+PAVIA)
GOGG12   78 NP B143 365       +CAVALLI-SFORZA,CONTA+             (CERN+PAVI)
APELDOOR 79 NP B156 111       VAN APELDOORN,HARTING,HOLTHUIZEN+       (AMST)
ALLEN    80 NP B176 269       +BLIETSCHAU+         (AACH+BONN+CERN+MPIM+OXF)
DAKHNO   81 PL 104B 23        +KOPTEV,KRAVTSOV,LOBACHEV,MAKAROV+      (LENI)

                              PAPERS NOT REFERRED TO IN DATA CARDS

ALEXANDE 73 NP B52 221        ALEXANDER,BENARY+(TEL-AVIV+HEIDELBERG+DESY)
BEAUPRE  73 NP B66 93                 (AACH+BERL+BONN+CERN+NDAM+PENN+TOHO)I
BERLAND  74 NP B75 93         BERLAND,HABER,HODOUS,HULSIZER,+         (MIT)I
    ALSO 74 PL 51B 187        BERLAND,HABER,HODOUS,HULSIZER,+         (MIT)I
ATHERTON 75 NC 30A 505        ATHERTON,BAR-NIR,FRENCH,SKURA+  (CERN+PRAG)I
STRACHMA 75 NP B98 120        STRACHMAN,BRAUN,GERBER,MAURER+  (LPNP+STRB)I
WALTER   79 ZPHY C3 89        +BECKER+     (BERL+AACH+CERN+SERP+SACL+VIEN)
BALAND   80 ZPHY C3 187       +POIRET+(MONS+SERP+SACL+ALMA-ATA+MOSU+BELG)

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Δ(1550) — P′31

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110  N*3/2(1550, JP=1/2+) I=3/2                                        11/77

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                 110  N*3/2(1550) MASS (MEV)                            11/77

M   8    (1550.)                 LONGACRE  77 IPWA    PI N TO 2PI N     11/77
M   6  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8  POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                      11/77
M        (1525.)                 BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79
M        (1506.0)                CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

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                 110  N*3/2(1550) WIDTH (MEV)                           11/77

W   8    (110.)                  LONGACRE  77 IPWA    PI N TO 2PI N     11/77
W        (40.)                   BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79
W        (137.0)                 CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

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                 110  N*3/2(1550) REAL PART OF POLE POSITION (MEV)      11/77

RE  8     1554. OR 1553.         LONGACRE  77 IPWA    PI N TO 2PI N     11/77

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                 110  N*3/2(1550) -2*IMAG PART OF POLE POSITION (MEV)   11/77

IM  8     105. OR 104.           LONGACRE  77 IPWA    PI N TO 2PI N     11/77

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                 110  N*3/2(1550) PARTIAL DECAY MODES                   11/77

                                                      DECAY MASSES
P1     N*3/2(1550) INTO PI N                          139+ 938
P2     N*3/2(1550) INTO N*3/2(1232) PI               1232+ 139
P3     N*3/2(1550) INTO N RHO,S=3/2                   938+ 769

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                 110  N*3/2(1550) BRANCHING RATIOS                      11/77

R1     N*3/2(1550) FROM PI N TO N*3/2(1232) PI         SQRT(P1*P2)      11/77
R1  8      (+0.11)               LONGACRE  77 IPWA    PI N TO 2PI N     11/77
R1          0.13     0.05        BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79

R2     N*3/2(1550) FROM PI N TO N RHO,S=3/2            SQRT(P1*P3)      11/77
R2  8      (+0.08)               LONGACRE  77 IPWA    PI N TO 2PI N     11/77
R2          0.17     0.05        BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79

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                 110  N*3/2(1550) PHOTON DECAY AMPL(GEV**-1/2)

       FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1550) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1        (0.013)                CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

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                              REFERENCES FOR N*3/2(1550)

LONGACRE 77 NP B122 493       LONGACRE,DOLBEAU                     (SACL)IJP
    ALSO 76 NP B108 365       DOLBEAU,TRIANTIS,NEVEU,CADIET        (SACL)IJP
BARNHAM  80 NP B168 243       BARNHAM,GLICKMAN,MIER-JEDRZEJOWICZ+    (LOIC)
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                           (GLAS)

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Δ(1600) — P″33

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19  N*3/2(1600, JP=3/2+) I=3/2

    RECENT ANALYSES INDICATE AT LEAST ONE P33 RESONANCE
    IN THE 1500-1900 MEV REGION, ALTHOUGH THERE IS SOME
    DISAGREEMENT ON ITS MASS AND WIDTH.  IN ADDITION TO
    THE STATE LISTED, THE ANALYSIS OF BARNHAM 80 IS
    CONSISTENT WITH THE PRESENCE OF ANOTHER P33 RESONANCE
    WITH MASS 1600 MEV AND WIDTH 80 MEV.

    SEE ALSO THE N*3/2(1920,JP=3/2+) LISTINGS.

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                 19  N*3/2(1600) MASS (MEV)

M   3    (1690.)                 DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
M   3    (1690.)                 KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M   3  WHERE MAX. ABSORPTION IS -DONNACH1, 2 ,KIRSOPP EYEBALL FIT CERN 1  10/69
M   6    (1801.0)                AYED      70 IPWA                    1/71
M   6  ENER. DEP. FIT OF ARGAND DIAGRAM
M   7    (1680.)                 ALMEHED   72 IPWA                    2/72
M    L    1900. OR 1640.         LONGACRE  75 IPWA   PI N TO 2PI N   11/75
M    L THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.  11/75
M        (1909.)                 AYED      76 IPWA                   11/77
M   8    (1560.)                 LONGACRE  77 IPWA   PI N TO 2PI N   11/77
M   8  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8  POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                   11/77
M        (1640.)    (50.)        CUTKOSKY  79 IPWA   PI N TO PI N    12/79
M         1522.      13.         HOEHLER   79 IPWA   PI N TO PI N    12/79
M    4   (1690.)                 BARNHAM   80 IPWA ++ PI N TO 2PI N  12/79
M         1600.      50.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
M         . . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

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                 19  N*3/2(1600) WIDTH (MEV)

W   3    (281.)                  DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
W   3    (240.)                  KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W   6    (598.0)                 AYED      70 IPWA                    1/71
W   7    (220.)                  ALMEHED   72 IPWA                    2/72
W    L    205. OR  300.          LONGACRE  75 IPWA   PI N TO 2PI N   11/75
W        (204.)                  AYED      76 IPWA                   11/77
W   8    (180.)                  LONGACRE  77 IPWA   PI N TO 2PI N   11/77
W        (370.)     (70.)        CUTKOSKY  79 IPWA   PI N TO PI N    12/79
W         220.       40.         HOEHLER   79 IPWA   PI N TO PI N    12/79
W    4   (250.)                  BARNHAM   80 IPWA ++ PI N TO 2PI N  12/79
W         300.      100.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
W         . . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
         SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                 19  N*3/2(1600) REAL PART OF POLE POSITION (MEV)     11/75

RE       (1609.)                 LONGACRE  75 IPWA   PI N TO 2PI N   11/75
RE  8     1541. OR 1542.         LONGACRE  77 IPWA   PI N TO 2PI N   11/77
RE       (1547.)                 CUTKOSKY  79 IPWA   PI N TO PI N    12/79
RE        1550.      40.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                 19  N*3/2(1600) -2*IMAG PART OF POLE POSITION (MEV)  11/75

IM       (323.)                  LONGACRE  75 IPWA   PI N TO 2PI N   11/75
IM  8     178. OR 178.           LONGACRE  77 IPWA   PI N TO 2PI N   11/77
IM       (230.)                  CUTKOSKY  79 IPWA   PI N TO PI N    12/79
IM        200.       60.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                 19  N*3/2(1600) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER      (-18.)                  CUTKOSKY  79 IPWA   PI N TO PI N    12/79
RER       -15.        6.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
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                 19  N*3/2(1600) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR      (-11.)                  CUTKOSKY  79 IPWA   PI N TO PI N    12/79
IMR         8.        8.         CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                 19  N*3/2(1600) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1     N*3/2(1600) INTO PI N                          139+ 938
P2     N*3/2(1600) INTO K SIGMA                       493+1189
P3     N*3/2(1600) INTO N*3/2(1232) PI,P-WAVE        1232+ 139
P4     N*3/2(1600) INTO N*3/2(1232) PI,F-WAVE        1232+ 139
P5     N*3/2(1600) INTO N RHO,S=1/2,P-WAVE            938+ 769
P6     N*3/2(1600) INTO N RHO,S=3/2,P-WAVE            938+ 769
P7     N*3/2(1600) INTO N*1/2(1440) PI               1440+ 139

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                 19  N*3/2(1600) BRANCHING RATIOS

R1     N*3/2(1600) INTO (PI N)/TOTAL                        (P1)
R1  3      (0.10)                DONNACH2  68 RVUE   PHAS.SHIFT-CERN1 10/69
R1  3      (0.08)                KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1  6      (0.135)               AYED      70 IPWA                    1/71
R1  7      (0.11)                ALMEHED   72 IPWA                    2/72
R1         (0.19)                AYED      76 IPWA                   11/77
R1         (0.20)    (0.04)      CUTKOSKY  79 IPWA   PI N TO PI N    12/79
R1          0.21      0.06       HOEHLER   79 IPWA   PI N TO PI N    12/79
R1          0.18      0.04       CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
R1         . . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2     N*3/2(1600) INTO (K SIGMA)/TOTAL                     (P2)
R2  1      (0.0002)OR LESS       FEUERBACH 70 RVUE   PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.
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R3      N*3/2(1600) FROM PI N TO K SIGMA                 SQRT(P1*P2)        11/75
R3  2        (0.006)TO 0.042          DEANS     75 DPWA    PI N TO K SIGMA  11/75
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                             11/75
R3  2   DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77            1/78
R3  2   AROUND 1920 MEV.                                                       1/78

R4      N*3/2(1600) FROM PI N TO N*3/2(1232) PI,P-WAVE   SQRT(P1*P3)        11/75
R4   L       (-0.36)OR -0.30          LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R4   8       (-0.34)                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77
R4   8  LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R4   N       (0.3)                    NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R4   N  BW FIT TO LONGACRE 75 IPWA, PHASE IS NEAR -90 DEGREES.                3/79
R4   N       (0.27)                   NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R4   N  BW FIT TO NOVOSELLER 78 IPWA, PHASE IS NEAR -90 DEGREES. THIS FIT   12/79
R4   N  ASSUMES THE MASS IS NEAR 1900 MEV.                                  12/79
R4   4       -0.24      0.05          BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79
R4   4  THE COUPLING SIGNS (WHERE DETERMINED) OF BARNHAM 79 HAVE BEEN       12/79
R4   4  CHANGED TO AGREE WITH THE CONVENTION OF LONGACRE 77.                12/79

R5      N*3/2(1600) FROM PI N TO N*3/2(1232) PI,F-WAVE   SQRT(P1*P4)        11/77
R5  8        (+0.07)                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77

R6      N*3/2(1600) FROM PI N TO N RHO,S=1/2,P-WAVE      SQRT(P1*P5)        11/77
R6  8        (-0.10)                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77

R7      N*3/2(1600) FROM PI N TO N RHO,S=3/2,P-WAVE      SQRT(P1*P6)        11/77
R7  8        (-0.10)                  LONGACRE  77 IPWA    PI N TO 2PI N    11/77

R8      N*3/2(1600) FROM PI N TO N*1/2(1440) PI          SQRT(P1*P7)        12/79
R8   4       -0.23      0.04          BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79

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               19  N*3/2(1600) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES. SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1600) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           0.016      0.055         DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A1          -0.033      0.037         DEVENIS2  74 DPWA    PI N PHOTOPROD.   4/75
A1           0.003      0.015         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A1           0.0        0.038         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A1           0.0        0.020         FELLER    76 DPWA    PI N PHOTOPROD.   2/77
A1          +0.006      0.018         AZNAURYAN 77 DPWA    PI0 PHTPRD,SOL 1 12/79
A1          -0.119      0.014         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2 12/79
A1           0.000      0.030         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A1           0.005      0.020         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1           . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

A2      N*3/2(1600) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2           0.074      0.064         DEVENISH  73 DPWA    PI N PHOTOPROD.   2/74
A2           0.008      0.046         DEVENIS2  74 DPWA    PI N PHOTOPROD.   4/75
A2          -0.034      0.022         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A2           0.0        0.033         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A2           0.0        0.015         FELLER    76 DPWA    PI N PHOTOPROD.   2/77
A2          -0.133      0.042         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1 12/79
A2          -0.088      0.037         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2 12/79
A2           0.000      0.045         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A2          -0.069      0.020         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2           . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                        REFERENCES FOR N*3/2(1600)

DONNACH2 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
KIRSOPP  68 THESIS             R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF          R AYED,P BAREYRE, G VILLET           (SACL)IJP
FEUERBAC 70 NP 168 85          FEUERBACHER+HOLLADAY            (VANDERBILT)
ALMEHED  72 NP B40 157         +LOVELACE                       (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53          DEVENISH,RANKIN,LYTH       (LOUC+BONN+LANC)IJP

DEVENIS2 74 PL 52B 227         DEVENISH,LYTH,RANKIN       (DESY-LANC,BONN)IJP
KNIES    74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF  74 NP B76 253         W J METCALF,R L WALKER               (CIT)IJP

DEANS    75 NP B96 90          +MITCHELL,MONTGOMERY,+       (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795        LONGACRE,LASINSKI,ROSENFELD+     (LBL,SLAC)

AYED     76 CEA-N-1921         AYED (THESIS)                        (SACL)IJP
FELLER   76 NP B104 219        +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493        LONGACRE,DOLBEAU                     (SACL)IJP
    ALSO 76 NP B108 365        DOLBEAU,TRIANTIS,NEVEU,CADIET        (SACL)IJP

BARBOUR  78 NP B141 253        BARBOUR,CRAWFORD,PARSONS             (GLAS)
NOVOSELL 78 NP B137 509        D. E. NOVOSELLER                 (CAL TECH)IJP
    ALSO 78 NP B137 445        D. E. NOVOSELLER                 (CAL TECH)IJP

CUTKOSKY 79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN         /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3    R.KOCH                          (KARLSRUHE)IJP

BARNHAM  80 NP B168 243        BARNHAM,GLICKMAN,MIER-JEDRZEJOWICZ+  (LOIC)
CRAWFORD 80  TORONTO CONF 107  R.L.CRAWFORD                         (GLAS)
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

                               PAPERS NOT REFERRED TO IN DATA CARDS

AYED     70 PL 31B 596         +BAREYRE,VILLET                     (SACLAY)
BOWLER   70 NP 17B 331         +CASHMORE                        (U. OXFORD)
WINNIK   77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY          (HAIF)I

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Δ(1620) **S_{31}**

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82  N*3/2(1620, JP=1/2-) I=3/2
    THIS RESONANCE IS WELL ESTABLISHED.

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               82  N*3/2(1620) MASS (MEV)

M          (1640.0)   (12.0)          DEVLIN    65 CNTR    PI+- P TOTAL
M    1     (1695.0)                   BAREYRE   68 RVUE    PHASE-SHIFT ANAL 11/67
M    1            WHERE CROSS SECTION IS GREATEST - EYEBALL FIT
M    3     (1635.0)                   DONNACHI  68 RVUE    PHASE-SHIFT ANAL  6/68
M    6     (1614.0)                   AYED      70 IPWA                      1/71
M    6  ENER. DEP. FIT OF ARGAND DIAGRAM
M    4     (1617.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   6/69
M    7     (1620.)                    ALMEHED   72 IPWA                      2/72
M           1622. TO 1688.            CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
M     L     1625. OR 1600.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M     L THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75
M          (1623.)                    AYED      76 IPWA                     11/77
M          (1680.)                    BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
M    8     (1580.)                    LONGACRE  77 IPWA    PI N TO 2PI N    11/77
M    8  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M    8  POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                         11/77
M    2     (1662.)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M    2  SUPERSEDES BARBOUR 76.                                               3/79
M          (1620.)    (20.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M           1610.       7.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M    5     (1620.)                    BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79
M    A     (1712.8)    (6.)           CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M    B     (1786.7)    (2.)           CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M    AB CHEW 80 REPORTS TWO S31 RESONANCES AT SOMEWHAT HIGHER MASSES THAN    1/82*
M    AB OTHER ANALYSES.  BOTH ARE LISTED HERE, LABELED A AND B FOR LOWER     1/82*
M    AB AND HIGHER STATES.                                                   1/82*
M          (1657.0)                   CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M           1620.      20.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M          . . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               82  N*3/2(1620) WIDTH (MEV)

W    1      (250.0)                   BAREYRE   68 RVUE                     11/67
W    3      (177.0)                   DONNACHI  68 RVUE                      6/68
W    6      (142.0)                   AYEO      70 IPWA                      1/71
W    4      (141.0)                   DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
W    7      (140.)                    ALMEHED   72 IPWA                      2/72
W            125. TO  214.            CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
W     L      160. OR  150.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W           (161.)                    AYED      76 IPWA                     11/77
W           (246.)                    BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
W    8      (120.)                    LONGACRE  77 IPWA    PI N TO 2PI N    11/77
W    2      (180.)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W           (140.)     (20.)          CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W            139.       18.           HOEHLER   79 IPWA    PI N TO PI N     12/79
W    5      (120.)                    BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79
W    A      (228.3)    (18.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W    B       (30.)     (6.4)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W           (161.0)                   CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W            140.       20.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W     SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W          . . . . . . . . . .
W  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               82  N*3/2(1620) REAL PART OF POLE POSITION (MEV)         11/75

RE          (1583.)                   LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE   8       1575. OR 1572.           LONGACRE  77 IPWA    PI N TO 2PI N    11/77
RE          (1597.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE           1600.       15.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               82  N*3/2(1620) -2*IMAG PART OF POLE POSITION (MEV)      11/75

IM          (143.)                    LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM   8       119. OR 128.             LONGACRE  77 IPWA    PI N TO 2PI N    11/77
IM          (120.)                    CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM           120.        20.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               82  N*3/2(1620) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER          (-6.)                    CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER           -5.        5.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               82  N*3/2(1620) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          (-15.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR           -14.       3.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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               82  N*3/2(1620) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*3/2(1620) INTO PI N                              139+ 938
P2      N*3/2(1620) INTO N PI PI                           938+ 139+ 139
P3      N*3/2(1620) INTO GAM NUCLEON, HELICITY=1/2           0+ 938
P4      N*3/2(1620) INTO N*3/2(1232) PI                   1232+ 139
P5      N*3/2(1620) INTO N RHO                             938+ 769
P6      N*3/2(1620) INTO N RHO,S=1/2,S-WAVE                938+ 769
P7      N*3/2(1620) INTO N RHO,S=3/2,D-WAVE                938+ 769
P8      N*3/2(1620) INTO N*1/2(1440) PI                   1440+ 139

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                  82  N*3/2(1620) BRANCHING RATIOS

R1      N*3/2(1620) INTO (PI N)/TOTAL                         (P1)
R1  3        (0.284)                  DONNACH1  68 RVUE                      6/68
R1  6        (0.317)                  AYED      70 IPWA                      1/71
R1  4        (0.28)                   DAVIES    70 RVUE     P-S ANAL  SOL A  8/69
R1  7        (0.35)                   ALMEHED   72 IPWA                      2/72
R1           (0.32)                   AYED      76 IPWA                     11/77
R1           (0.25)    (0.04)         CUTKOSKY  79 IPWA     PI N TO PI N    12/79
R1            0.35      0.06          HOEHLER   79 IPWA     PI N TO PI N    12/79
R1  A        (0.60)                   CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1  B        (0.36)                   CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1            0.25      0.03          CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
R1           . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R2      N*3/2(1620) FROM PI N TO N*3/2(1232) PI          SQRT(P1*P4)        11/75
R2  L       (+0.40)OR +0.40           LONGACRE  75 IPWA     PI N TO 2PI N   11/75
R2  8       (+0.39)                   LONGACRE  77 IPWA     PI N TO 2PI N   11/77
R2  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R2  5        +0.33      0.06          BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79
R2  5   THE COUPLING SIGNS (WHERE DETERMINED) OF BARNHAM 80 HAVE BEEN        12/79
R2  5   CHANGED TO AGREE WITH THE CONVENTION OF LONGACRE 77.                 12/79

R3      N*3/2(1620) FROM PI N TO N RHO,S=1/2,S-WAVE      SQRT(P1*P6)        11/75
R3  L        (0.18)OR -0.28           LONGACRE  75 IPWA     PI N TO 2PI N   11/75
R3  8       (-0.08)                   LONGACRE  77 IPWA     PI N TO 2PI N   11/77
R3  5        -0.40      0.10          BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79

R4      N*3/2(1620) FROM PI N TO N RHO,S=3/2,D-WAVE      SQRT(P1*P7)        11/77
R4  8       (+0.13)                   LONGACRE  77 IPWA     PI N TO 2PI N   11/77

R5      N*3/2(1620) FROM PI N TO N*1/2(1440) PI          SQRT(P1*P8)        12/79
R5  5         0.11      0.05          BARNHAM   80 IPWA ++ PI N TO 2PI N    12/79

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                  82  N*3/2(1620) PHOTON DECAY AMPL(GEV**-1/2)

     FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1620) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           0.004     0.033          DEVENISH  73 DPWA     PI N PHOTOPROD.    2/74
A1          (0.113)                   HEMMI1    73        + FWD PI0 PHTOPROD   2/74
A1          +0.090     0.076          MOORHOUS  73 DPWA     PI N PHOTOPROD.    2/73
A1          -0.10      0.017          DEVENIS2  74 DPWA     PI N PHOTOPROD.    4/75
A1           0.033     0.015          KNIES     74 DPWA     PI N PHOTOPROD.    2/74
A1           0.105     0.038          METCALF   74 DPWA     PI N PHOTOPROD.    2/74
A1           0.078     0.066          MOORHOUS  74 DPWA     PI N PHOTOPROD.    2/74
A1          +0.044     0.027          CRAWFORD  75 DPWA     PI N PHOTOPROD.    1/76
A1         (+0.058)                   KRIVETS   75 DPWA     PI-N PHOTOPROD.    1/78
A1         (+0.055)                   BARBOUR   76 DPWA     PI N PHOTOPROD.    1/76
A1          -0.005     0.016          FELLER    76 DPWA     PI N PHOTOPROD.    2/77
A1          -0.014     0.030          AZNAURYAN 77 DPWA     PI0 PHTPRO,SOL 1  12/79
A1           0.000     0.014          AZNAURYAN 77 DPWA     PI0 PHTPRO,SOL 2  12/79
A1    2     +0.034     0.028          BARBOUR   78 DPWA     PI-N PHOTOPROD.    3/79
A1          -0.022     0.007          ARAI      80 DPWA     PI N PHOTO FIT 1  12/81*
A1          -0.026     0.008          ARAI      80 DPWA     PI N PHOTO FIT 2  12/81*
A1           0.021     0.020          CRAWFORD  80 DPWA     PI N PHOTOPROD.   12/81*
A1           0.126     0.021          TAKEDA    80 DPWA     PI N PHOTOPROD.   12/81*
A1           . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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                         REFERENCES FOR N*3/2(1620)

DEVLIN   65 PRL 14 1031         T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I

BAREYRE  68 PR 165 1731         P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
DONNACH1 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET           (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                              (GLAS)

ALMEHED  72 NP B40 157          +LOVELACE                       (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH        (LOUC+BONN+LANC)IJP
HEMMI1   73 PL 43B 79           HEMMI,INAGAKI+         (KYOTO+SAGA+KEK+TOKY)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK               (GLAS+LBL)IJP

DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                 (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD      (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                          (GLAS)IJP
KRIVETS  75 SJNP 20 430         +MIROSHNICHENKO,NIKIFOROV,SANIN+      (KIEV)IJP
    ALSO 74 SJNP 19 112         KRIVETS,NIKIFOROV,SANIN,SHALATSKII    (KIEV)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795         LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921          AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
FELLER   76 NP B104 219         +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77  EFI-264(57)-77     +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                      (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET         (SACL)IJP

BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS              (GLAS)
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY           (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                           (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93    I. ARAI                               (TOKY)
BARNHAM  80 NP B168 243         BARNHAM,GLICKMAN,MIER-JEDRZEJOWICZ+   (LOIC)
CHEW     80  TORONTO CONF 123   D.M.CHEW                              ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107   R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80  TORONTO CONF 19    +FORSYTH,BABCOCK,KELLY,HENDRICK   (CARN+LBL)IJP
TAKEDA   80 NP B168 17          TAKEDA,ARAI,FUJII,IKEDA,IWASAKI+      (TOKY)

                                PAPERS NOT REFERRED TO IN DATA CARDS

CARRUTHE 60 PRL 4 303           P CARRUTHERS                       (CORNELL) I
DEVLIN   62 PR 125 690          T J DEVLIN, B J MOYER, V PEREZ-MENDEZ (LRL) I
HELLAND  64 PR 134 B1062        +DEVLIN,HAGGE,LONGO,MOYER,WOOD         (LRL) I
BAREYRE  65 PL 18 342           + BRICMAN, STIRLING, VILLET        (SACLAY)IJP
JOHNSON  67 UCRL-17683 THESIS   C H JOHNSON                            (LRL)
DONNACHI 69 NP B10 433          A DONNACHIE, R KIRSOPP           (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                      (SACLAY)
BOWLER   70 NP B17 331          +CASHMORE                         (U. OXFORD)
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP

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Δ(1700)

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 10  N*3/2(1700, JP=3/2-) I=3/2     D'33
 THIS RESONANCE IS WELL ESTABLISHED.

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                  10  N*3/2(1700) MASS (MEV)

M   3     (1691.0)                    DONNACH1  68 RVUE     PHASE-SHIFT ANAL  8/69
M   6   ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1649.0)                    DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
M   7     (1700.)                     ALMEHED   72 IPWA                       2/72
M          1612. TO 1624.             CRAWFORD  75 DPWA     PI N PHOTOPROD.   1/76
M         (1600.)     (10.)           GAIDOS    75 HBC  ++ PI+P TO N* 2PI    1/76
M   L      1725. OR 1680.             LONGACRE  75 IPWA     PI N TO 2PI N    11/75
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.   11/75
M         (1723.)                     AYED      76 IPWA                      11/77
M         (1629.)                     BARBOUR   76 DPWA     PI N PHOTOPROD.   1/76
M   8     (1600.)                     LONGACRE  77 IPWA     PI N TO 2PI N    11/77
M   8   ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8   POSITION WHICH IS FROM SOLUTIONS S1 AND C1.                          11/77
M   5     (1629.)                     BARBOUR   78 DPWA     PI-N PHOTOPROD.   3/79
M   5   SUPERSEDES BARBOUR 76.                                                3/79
M         (1730.)     (30.)           CUTKOSKY  79 IPWA     PI N TO PI N     12/79
M          1680.       70.            HOEHLER   79 IPWA     PI N TO PI N     12/79
M   9     (1650.)                     BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79
M         (1718.4)    (13.1)   (13.)  CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
M         (1622.0)                    CRAWFORD  80 DPWA     PI N PHOTOPROD.  12/81*
M          1710.       30.            CUTKOSKY  80 IPWA     PI N TO PI N      1/82*
M         (1723.)                     LIVANOS   80 DPWA     PI P TO K SIGMA   1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                  10  N*3/2(1700) WIDTH (MEV)

W   3     (269.0)                     DONNACH1  68 RVUE                       8/69
W   6     (258.0)                     AYED      70 IPWA                       1/71
W   4     (188.0)                     DAVIES    70 RVUE     SOL A             8/69
W   7     (260.)                      ALMEHED   72 IPWA                       2/72
W          210. TO 268.               CRAWFORD  75 DPWA     PI N PHOTOPROD.   1/76
W         (180.)      (35.)    (20.)  GAIDOS    75 HBC  ++ PI+P TO N* 2PI    1/76
W   L      190. OR 240.               LONGACRE  75 IPWA     PI N TO 2PI N    11/75
W         (192.)                      AYED      76 IPWA                      11/77
W         (222.)                      BARBOUR   76 DPWA     PI N PHOTOPROD.   1/76
W   8     (200.)                      LONGACRE  77 IPWA     PI N TO 2PI N    11/77
W   5     (216.)                      BARBOUR   78 DPWA     PI-N PHOTOPROD.   3/79
W         (300.)      (100.)          CUTKOSKY  79 IPWA     PI N TO PI N     12/79
W          230.        80.            HOEHLER   79 IPWA     PI N TO PI N     12/79
W   9     (160.)                      BARNHAM   80 IPWA ++ PI N TO 2PI N     12/79
W         (193.3)     (26.)           CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
W         (209.0)                     CRAWFORD  80 DPWA     PI N PHOTOPROD.  12/81*
W          280.        80.            CUTKOSKY  80 IPWA     PI N TO PI N      1/82*
W         (192.)                      LIVANOS   80 DPWA     PI P TO K SIGMA   1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
        SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                  10  N*3/2(1700) REAL PART OF POLE POSITION (MEV)       11/75

RE        (1681.)                     LONGACRE  75 IPWA     PI N TO 2PI N    11/75
RE  8      1600. OR 1594.             LONGACRE  77 IPWA     PI N TO 2PI N    11/77
RE        (1691.)                     CUTKOSKY  79 IPWA     PI N TO PI N     12/79
RE         1675.       25.            CUTKOSKY  80 IPWA     PI N TO PI N      1/82*

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                  10  N*3/2(1700) -2*IMAG PART OF POLE POSITION (MEV)    11/75

IM        (245.)                      LONGACRE  75 IPWA     PI N TO 2PI N    11/75
IM  8      208. OR 201.               LONGACRE  77 IPWA     PI N TO 2PI N    11/77
IM        (292.)                      CUTKOSKY  79 IPWA     PI N TO PI N     12/79
IM         220.        40.            CUTKOSKY  80 IPWA     PI N TO PI N      1/82*

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                  10  N*3/2(1700) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (24.)                      CUTKOSKY  79 IPWA     PI N TO PI N     12/79
RER         12.        3.             CUTKOSKY  80 IPWA     PI N TO PI N      1/82*

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                  10  N*3/2(1700) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR        (-2.)                      CUTKOSKY  79 IPWA     PI N TO PI N     12/79
IMR         -4.        5.             CUTKOSKY  80 IPWA     PI N TO PI N      1/82*

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                  10  N*3/2(1700) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      N*3/2(1700) INTO PI N                             139+ 938
P2      N*3/2(1700) INTO N PI PI                          938+ 139+ 139
P3      N*3/2(1700) INTO K SIGMA                          493+1189
P4      N*3/2(1700) INTO GAM NUCLEON, HELICITY=1/2          0+ 938
P5      N*3/2(1700) INTO GAM NUCLEON, HELICITY=3/2          0+ 938
P6      N*3/2(1700) INTO N*3/2(1232) PI                  1232+ 139
P7      N*3/2(1700) INTO N*3/2(1232) PI,S-WAVE           1232+ 139
P8      N*3/2(1700) INTO N*3/2(1232) PI,D-WAVE           1232+ 139
P9      N*3/2(1700) INTO N RHO,S=3/2,S-WAVE               938+ 769
P10     N*3/2(1700) INTO N RHO,S=1/2,D-WAVE               938+ 769
P11     N*3/2(1700) INTO N RHO,S=3/2,D-WAVE               938+ 769

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                  10  N*3/2(1700) BRANCHING RATIOS

R1      N*3/2(1700) INTO (PI N)/TOTAL                         (P1)
R1  3        (0.14)                   DONNACH1  68 RVUE                      8/69
R1  6        (0.217)                  AYED      70 IPWA                      1/71
R1  4        (0.12)                   DAVIES    70 RVUE     SOL A            8/69
R1  7        (0.16)                   ALMEHED   72 IPWA                      2/72
R1           (0.17)                   AYED      76 IPWA                     11/77
R1           (0.12)    (0.04)         CUTKOSKY  79 IPWA     PI N TO PI N    12/79
R1            0.20      0.03          HOEHLER   79 IPWA     PI N TO PI N    12/79
R1           (0.16)                   CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
A1            0.12      0.03          CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
R1           . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)
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R2      N*3/2(1700) INTO (K SIGMA)/TOTAL                        (P3)
R2  1       (0.00002)OR LESS             FEUERBACH 70 RVUE     PI P TO K+ SIG+    7/70
R2  1       ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1       MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1700) FROM PI N TO N*3/2(1232) PI,S-WAVE    SQRT(P1*P7)         11/75
R3  L       (-0.25)OR -0.24              LONGACRE  75 IPWA    PI N TO 2PI N      11/75
R3  8       (-0.30)                      LONGACRE  77 IPWA    PI N TO 2PI N      11/77
R3  8   LONGACRE 77 CONSIDER THIS COUPLING TO BE WELL DETERMINED.
R3  9       -0.18       0.04             BARNHAM   80 IPWA ++ PI N TO 2PI N      12/79
R3  9   THE COUPLING SIGNS (WHERE DETERMINED) OF BARNHAM 80 HAVE BEEN           12/79
R3  9   CHANGED TO AGREE WITH THE CONVENTION OF LONGACRE 77.                    12/79

R4      N*3/2(1700) FROM PI N TO N*3/2(1232) PI,D-WAVE    SQRT(P1*P8)         11/75
R4  L       (0.1 OR (-0.10)              LONGACRE  75 IPWA    PI N TO 2PI N      11/75
R4  8       (-0.05)                      LONGACRE  77 IPWA    PI N TO 2PI N      11/77
R4  9       0.14        0.04             BARNHAM   80 IPWA ++ PI N TO 2PI N      12/79

R5      N*3/2(1700) FROM PI N TO N RHO,S=3/2,S-WAVE       SQRT(P1*P9)         11/75
R5  L       (0.20)OR +0.30               LONGACRE  75 IPWA    PI N TO 2PI N      11/75
R5  8       (-0.04)                      LONGACRE  77 IPWA    PI N TO 2PI N      11/77

R6      N*3/2(1700) FROM PI N TO K SIGMA                  SQRT(P1*P3)         11/75
R6  2       (0.001)TO 0.011              DEANS     75 DPWA    PI N TO K SIGMA    11/75
R6  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                                11/75
R6  2   DEANS75 DISAGREES WITH PI+ P TO K+ SIGMA+ DATA OF WINNIK77                1/78
R6  2   AROUND 1920 MEV.                                                          1/78
R6          (.002)                       LIVANOS   80 DPWA    PI P TO K SIGMA     1/82*

R7      N*3/2(1700) FROM PI N TO N RHO,S=1/2,D-WAVE       SQRT(P1*P10)        12/79
R7  9       -0.17       0.05             BARNHAM   80 IPWA ++ PI N TO 2PI N      12/79

R8      N*3/2(1700) FROM PI N TO N RHO,S=3/2,D-WAVE       SQRT(P1*P11)        12/79
R8  9       0.18        0.07             BARNHAM   80 IPWA ++ PI N TO 2PI N      12/79

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                 10  N*3/2(1700) PHOTON DECAY AMPL(GEV**-1/2)

       FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1700) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          0.036       0.052            DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A1          +0.068      0.042            MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A1          0.054       0.029            DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A1          0.078       0.009            KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A1          0.0         0.048            METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A1          0.041       0.028            MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A1          +0.101      0.011            CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A1          (+0.120)                     BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1          +0.072      0.033            FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A1          +0.147      0.013            AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1  12/79
A1          +0.136      0.013            AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2  12/79
A1  5       +0.130      0.037            BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1          0.112       0.006            ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A1          0.130       0.006            ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A1          0.123       0.022            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

A2      N*3/2(1700) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2          0.110       0.039            DEVENISH  73 DPWA    PI N PHOTOPROD.    2/74
A2          +0.022      0.052            MOORHOUS  73 DPWA    PI N PHOTOPROD.    2/73
A2          0.072       0.014            DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2          0.070       0.009            KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2          0.0         0.041            METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2          0.021       0.020            MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A2          +0.116      0.024            CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2          (+0.117)                     BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2          +0.087      0.023            FELLER    76 DPWA    PI N PHOTOPROD.    2/77
A2          +0.053      0.003            AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1  12/79
A2          +0.022      0.003            AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2  12/79
A2  5       +0.098      0.036            BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2          0.047       0.007            ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A2          0.050       0.007            ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A2          0.102       0.015            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A2          . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.6)

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REFERENCES FOR N*3/2(1700)


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DONNACHI 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139          DONNACHIE  RAPPORTEUR'S TALK           (GLAS)
    ALSO 68 THESIS              R G KIRSOPP                            (EDIN)

AYED     70 KIEV CONF           R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359          A DAVIES                               (GLAS)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY              (VANDERBILT)

ALMEHED  72 NP B40 157          +LOVELACE                        (LUND,RUTG)IJP
DEVENISH 73 PL 47B 53           DEVENISH,RANKIN,LYTH         (LOUC+BONN+LANC)IJP
MOORHOUS 73 PL 43B 44           MOORHOUSE, OBERLACK                (GLAS+LBL)IJP

DEVENIS2 74 PL 52B 227          DEVENISH,LYTH,RANKIN          (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680          KNIES,MOORHOUSE,OBERLACK           (LBL,GLAS)IJP
METCALF  74 NP B76 253          W J METCALF,R L WALKER                  (CIT)IJP
MOORHOUS 74 PRD 9 1             MOORHOUSE,OBERLACK,ROSENFELD       (GLAS+LBL)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                           (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP
GAIDOS   75 PRD 12 2565         GAIDOS,MILLER                          (PURD)IJP
LONGACRE 75 PL 55B 415          +ROSENFELD,LASINSKI,SMADJA+         (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795         LONGACRE,LASINSKI,ROSENFELD+        (LBL,SLAC)

AYED     76 CEA-N-1921          AYED (THESIS)                          (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD           (GLAS)IJP
FELLER   76 NP B104 219         +FUKUSHIMA,HORIKAWA,KAJIKAWA+(NAGOYA+OSAKA)IJP

AZNAURYA 77 EFI-264(57)-77      +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493         LONGACRE,DOLBEAU                       (SACL)IJP
    ALSO 76 NP B108 365         DOLBEAU,TRIANTIS,NEVEU,CADIET          (SACL)IJP

BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS               (GLAS)
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY            (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN            /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                             (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93  I. ARAI                                  (TOKY)
BARNHAM  80 NP B168 243         BARNHAM,GLICKMAN,MIER-JEDRZEJOWICZ+     (LOIC)
CHEW     80  TORONTO CONF 123 D.M.CHEW                                 ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                             (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK     (CARN+LBL)IJP
LIVANOS  80  TORONTO CONF 35  +BATON,COUTURES,KOCHOWSKI,NEVEU          (SACL)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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DONNACHI 69 NP 10B 433          A DONNACHIE, R KIRSOPP                (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE,VILLET                          (SACLAY)
BOWLER   70 NP 17B 331          +CASHMORE                           (U. OXFORD)
WINNIK   77 NP B128 66          +TOAFF,REVEL,GOLDBERG,BERNY              (HAIFA)
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Δ(1900) 30 N*3/2(1900, JP=1/2-) I=3/2 **S_{31}** 9/73

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                 THIS EFFECT IS SEEN IN BOTH ELASTIC AND PI N TO K SIGMA
                 CHANNELS.

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                 30  N*3/2(1900) MASS (MEV)                                  9/73

M   2       (1920.)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
M   2       (1870.)                      LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
M   2   DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF          1/78
M   2   WINNIK77 AROUND 1920 MEV.                                                1/78
M           (2001.)                      AYED      76 IPWA                      11/77
M           (1850.)     (35.)            CUTKOSKY  79 IPWA    PI N TO PI N      12/79
M           1908.       30.              HOEHLER   79 IPWA    PI N TO PI N      12/79
M           (1918.5)    (23.)            CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
M           (1803.0)                     CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
M           1890.       50.              CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 30  N*3/2(1900) WIDTH (MEV)                                 9/73

W   2       (140.)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
W   2       (160.)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
W           (307.)                       AYED      76 IPWA                      11/77
W           (130.)      (40.)            CUTKOSKY  79 IPWA    PI N TO PI N      12/79
W           140.        40.              HOEHLER   79 IPWA    PI N TO PI N      12/79
W           (93.5)      (54.)            CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
W           (137.0)                      CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
W           170.        50.              CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
          SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                 30  N*3/2(1900) REAL PART OF POLE POSITION  (MEV)

RE          (1844.)                      CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RE          1870.       40.              CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                 30  N*3/2(1900) -2*IMAG PART OF POLE POSITION  (MEV)

IM          (142.)                       CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IM          180.        50.              CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                 30  N*3/2(1900) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER         (7.)                         CUTKOSKY  79 IPWA    PI N TO PI N      12/79
RER         9.          4.               CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                 30  N*3/2(1900) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         (-1.)                        CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR         3.          7.               CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                 30  N*3/2(1900) PARTIAL DECAY MODES                         9/73

                                                          DECAY MASSES
P1      N*3/2(1900) INTO PI N                            139+ 938
P2      N*3/2(1900) INTO K SIGMA                         493+1189

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                 30  N*3/2(1900) BRANCHING RATIOS                            9/73

R1      N*3/2(1900) FROM PI N TO K SIGMA                  SQRT(P1*P2)         9/73
R1  2       (0.11)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
R1  2       (0.12)                       LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
R1  1       (0.076)                      DEANS     75 DPWA    PI N TO K SIGMA   11/75
R1  1   VALUE GIVEN IS FROM SOLUTION 1, NOT PRESENT IN SOLUTIONS 2,3,4.         11/75

R2      N*3/2(1900) INTO (PI N)/TOTAL                           (P1)
R2          (0.08)                       AYED      76 IPWA                      11/77
R2          (0.08)      (0.03)           CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R2          0.08        0.04             HOEHLER   79 IPWA    PI N TO PI N      12/79
R2          (0.28)                       CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
R2          0.10        0.03             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R2          . . . . . . . . . .
R2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 30  N*3/2(1900) PHOTON DECAY AMPL(GEV**-1/2)

       FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1900) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          (-0.006)TO -0.025            CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*

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REFERENCES FOR N*3/2(1900)


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LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                      (MUNICH)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP
AYED     76 CEA-N-1921          AYED (THESIS)                          (SACL)IJP
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CUTKOSKY 79 PRD 20 2839       +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CHEW     80  TORONTO CONF 123 D.M.CHEW                              ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

WINNIK   77 NP B128 66        +TOAFF,REVEL,GOLDBERG,BERNY           (HAIF)I

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Δ(1905)   F35

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11  N*3/2(1905, JP=5/2+) I=3/2

THIS RESONANCE IS WELL ESTABLISHED.

CUTKOSKY 80 FINDS A HIGHER MASS F35 RESONANCE IN
ADDITION TO THIS STATE.  BOTH RESONANCES ARE
LISTED HERE.

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               11  N*3/2(1905) MASS (MEV)

M   3     (1913.0)                  DONNACHI  68 RVUE    PHASE-SHIFT ANAL  8/69
M   6     (1837.0)                  AYED      70 IPWA                      1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4     (1841.0)                  DAVIES    70 RVUE    P-S ANAL  SOL A   8/69
M   7     (1875.)                   ALMEHED   72 IPWA                      2/72
M   1      1890. TO 1986.           MEHTANI   72 DPWA    PI+P TO PI+PIOP   9/73
M   5     (1890.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
M   5     (1890.)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
M   5   DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF    1/78
M   5   WINNIK77 AROUND 1920 MEV.                                          1/78
M   L      1870. OR 1830.           LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M   L   THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75. 11/75
M         (1869.)                   AYED      76 IPWA                     11/77
M         (1885.)     (27.)         CUTKOSKY  76 IPWA                     11/77
M   B     (1892.)                   BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M         (1920.)     (30.)         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M          1905.       20.          HOEHLER   79 IPWA    PI N TO PI N     12/79
M         (1787.)     (6.)    (5.7) CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M         (1880.0)                  CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M   A      1910.       30.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M   B      2200.      125.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M  AB   CUTKOSKY 80 FINDS A HIGHER MASS F35 RESONANCE AS WELL AS THE ONE IN 1/82*
M  AB   THIS MASS REGION.  BOTH ARE LISTED HERE, LABELED A AND B FOR LOWER  1/82*
M  AB   AND HIGHER MASS STATES, AWAITING CONFIRMATION FOR THE HIGHER STATE. 1/82*
M         (1869.)                   LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               11  N*3/2(1905) WIDTH (MEV)

W   3     (350.0)                   DONNACHI  68 RVUE                      8/69
W   6     (198.0)                   AYED      70 IPWA                      1/71
W   4     (136.0)                   DAVIES    70 RVUE    SOL A             8/69
W   7     (250.)                    ALMEHED   72 IPWA                      2/72
W   1      273. TO 322.             MEHTANI   72 DPWA    PI+P TO PI+PIOP   9/73
W   5     (180.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
W   5     (140.)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
W   L      255. OR  220.            LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W         (255.)                    AYED      76 IPWA                     11/77
W         (310.)      (90.)         CUTKOSKY  76 IPWA                     11/77
W   B     (159.)                    BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W         (340.)      (80.)         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W          260.        20.          HOEHLER   79 IPWA    PI N TO PI N     12/79
W         (66.)       (24.)   (16.) CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W         (193.0)                   CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W   A      400.       100.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W   B      400.       125.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W         (255.)                    LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)
          SEE NOTES ACCOMPANYING MASSES QUOTED AS FOR N*1/2(1910)

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               11  N*3/2(1905) REAL PART OF POLE POSITION (MEV)       11/75

RE        (1813.)                   LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE        (1825.)     (12.)         CUTKOSKY  76 IPWA                     11/77
RE        (1865.)                   CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE  A      1830.       40.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
RE  B      2150.      100.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
RE         . . . . . . . . . .
RE  AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)

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               11  N*3/2(1905) -2*IMAG PART OF POLE POSITION (MEV)    11/75

IM        (193.)                    LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM        (250.)      (36.)         CUTKOSKY  76 IPWA                     11/77
IM        (266.)                    CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM  A      280.        60.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
IM  B      350.       100.          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
IM         . . . . . . . . . .
IM  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               11  N*3/2(1905) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER       (11.5)      (3.5)         CUTKOSKY  76 IPWA                     11/77
RER       (20.)                     CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER A      16.         8.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
RER B     -14.        13.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
RER        . . . . . . . . . .
RER AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

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               11  N*3/2(1905) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR       (-11.)      (5.)          CUTKOSKY  76 IPWA                     11/77
IMR       (-5.)                     CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IMR A     -19.         8.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
IMR B       8.        22.           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
IMR        . . . . . . . . . .
IMR AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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               11  N*3/2(1905) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      N*3/2(1905) INTO PI N                             139+ 938
P2      N*3/2(1905) INTO N PI PI                          938+ 139+ 139
P3      N*3/2(1905) INTO K SIGMA                          493+1189
P4      N*3/2(1905) INTO N*3/2(1232) PI                  1232+ 139
P5      N*3/2(1905) INTO GAM NUCLEON, HELICITY=1/2          0+ 938
P6      N*3/2(1905) INTO GAM NUCLEON, HELICITY=3/2          0+ 938
P7      N*3/2(1905) INTO N RHO                            938+ 769
P8      N*3/2(1905) INTO N*3/2(1232) PI,P-WAVE           1232+ 139
P9      N*3/2(1905) INTO N*3/2(1232) PI,F-WAVE           1232+ 139
P10     N*3/2(1905) INTO N RHO,S=3/2,P-WAVE               938+ 769

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               11  N*3/2(1905) BRANCHING RATIOS

R1      N*3/2(1905) INTO (PI N)/TOTAL                      (P1)
R1  3      (0.16)                   DONNACHI  68 RVUE                      8/69
R1  6      (0.147)                  AYED      70 IPWA                      1/71
R1  4      (0.20)                   DAVIES    70 RVUE    SOL A             8/69
R1  7      (0.18)                   ALMEHED   72 IPWA                      2/72
R1         (0.14)                   AYED      76 IPWA                     11/77
R1         (0.140)   (0.008)        CUTKOSKY  76 IPWA                     11/77
R1         (0.15)    (0.02)         CUTKOSKY  79 IPWA    PI N TO PI N     12/79
R1          0.15      0.02          HOEHLER   79 IPWA    PI N TO PI N     12/79
R1         (0.11)                   CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1  A       0.08      0.03          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1  B       0.07      0.04          CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1         . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

R2      N*3/2(1905) INTO (K SIGMA)/TOTAL                   (P3)
R2  1      (0.008)OR LESS           FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1905) INTO (SIGMA K)*(PI N)/TOTAL**2         (P3*P1)
R3         (0.0016)OR LESS          KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71

R4      N*3/2(1905) FROM PI N TO N*3/2(1232) PI            SQRT(P1*P4)
R4  1     0.19 TO 0.23              MEHTANI   72 DPWA    PI+P TO PI+PIOP   9/73
R4  1   MOSTLY F WAVE DECAY                                                9/73

R5      N*3/2(1905) FROM PI N TO K SIGMA                   SQRT(P1*P3)     9/73
R5  5      (0.06)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 1  9/73
R5  5      (0.06)                   LANGBEIN  73 IPWA    PI N-K SIG,SOL 2  9/73
R5  2      (0.021)TO 0.054          DEANS     75 DPWA    PI N TO K SIGMA  11/75
R5  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75
R5         (-0.013)                 LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*

R6      N*3/2(1905) FROM PI N TO N*3/2(1232) PI,F-WAVE   SQRT(P1*P9)      11/75
R6  L      (-0.12)OR -0.20          LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R6  M      (-0.17)                  NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R6  M   BW FIT TO LONGACRE 75 IPWA.                                        3/79
R6  N      (-0.06)                  NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R6  N   BW FIT TO NOVOSELLER 78 IPWA.                                      3/79

R7      N*3/2(1905) FROM PI N TO N RHO,S=3/2,P-WAVE       SQRT(P1*P10)    11/75
R7  L      (-0.28)OR -0.33          LONGACRE  75 IPWA    PI N TO 2PI N    11/75
R7  M      (-0.26)                  NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R7  9      (-0.11)TO -0.33          NOVOSELLE 78 IPWA    PI N TO 2PI N     3/79
R7  9   BW FIT TO NOVOSELLER 78 IPWA, PHASE IS NEAR 90 DEGREES.           12/79

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               11  N*3/2(1905) PHOTON DECAY AMPL(GEV**-1/2)

    FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
  REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1905) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          0.019     0.027         DEVENISZ  74 DPWA    PI N PHOTOPROD.   4/75
A1          0.042     0.016         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A1         +0.047     0.067         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A1         -0.003     0.009         CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A1        (+0.035)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A1         -0.001     0.012         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1 12/79
A1         +0.063     0.018         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2 12/79
A1  B      +0.033     0.018         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A1          0.022     0.010         ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A1          0.031     0.009         ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A1          0.024     0.014         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1  B   SUPERSEDES BARBOUR 76.                                             3/79
A1         . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

A2      N*3/2(1905) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2          0.078     0.020         DEVENISZ  74 DPWA    PI N PHOTOPROD.   4/75
A2         -0.022     0.020         KNIES     74 DPWA    PI N PHOTOPROD.   2/74
A2         -0.028     0.066         METCALF   74 DPWA    PI N PHOTOPROD.   2/74
A2         -0.021     0.036         CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A2        (-0.013)                  BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A2         -0.094     0.027         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 1 12/79
A2         -0.101     0.018         AZNAURYAN 77 DPWA    PI0 PHTPRO,SOL 2 12/79
A2  B      -0.055     0.019         BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A2         -0.029     0.007         ARAI      80 DPWA    PI N PHOTO FIT 1 12/81*
A2         -0.045     0.006         ARAI      80 DPWA    PI N PHOTO FIT 2 12/81*
A2          0.072     0.035         CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2         . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 2.6)

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                          REFERENCES FOR N*3/2(1905)

DONNACHI 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139       DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS           R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY            (VANDERBILT)
KALMUS   70 PR D2 1824       G KALMUS, G BORREANI, J LOUIE          (LRL)

ALMEHED  72 NP B40 157       +LOVELACE                       (LUND,RUTG)IJP
MEHTANI  72 PRL 29 1634      +FUNG, KERNAN, SCHALK, +          (UCR +LBL)
LANGBEIN 73 NP B53 251       LANGBEIN,WAGNER                      (MUNICH)IJP
DEVENIS2 74 PL 52B 227       DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680       KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253       W J METCALF,R L WALKER                 (CIT)IJP

CRAWFORD 75 NP B97 125       R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90        +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP
LONGACRE 75 PL 55B 415       +ROSENFELD,LASINSKI,SMADJA+       (LBL,SLAC)IJP
    ALSO 78 PRD 17 1795      LONGACRE,LASINSKI,ROSENFELD+      (LBL,SLAC)

AYED     76 CEA-N-1921       AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358      I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
CUTKOSKY 76 PRL 37 645       CUTKOSKY,HENDRICK,KELLY            (CARN+LBL)IJP
    ALSO 76 OXFORD CONF. 49  CUTKOSKY,HENDRICK,CHAO+       (CARN+LBL+BRIS)IJP
AZNAURYA 77  EFI-264(57)-77  +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP

BARBOUR  78 NP B141 253      BARBOUR,CRAWFORD,PARSONS              (GLAS)
NOVOSELL 78 NP B137 509      D. E. NOVOSELLER                  (CAL TECH)IJP
    ALSO 78 NP B137 445      D. E. NOVOSELLER                  (CAL TECH)IJP

CUTKOSKY 79 PRD 20 2839      +FORSYTH,HENDRICK,KELLY            (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING. PHYSIK DATEN VOL.12-1
                             +KAISER,KOCH,PIETARINEN            /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3  R.KOCH                            (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93  I. ARAI                              (TOKY)
CHEW     80  TORONTO CONF 123 D.M.CHEW                             ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                         (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
LIVANOS  80  TORONTO CONF 35  +BATON,COUTURES,KOCHOWSKI,NEVEU      (SACL)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

AYED     70 PL 31B 598       +BAREYRE+VILLET                      (SACLAY)
WINNIK   77 NP B128 66       +TOAFF,REVEL,GOLDBERG,BERNY           (HAIF))
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Δ(1910) — P_{31}

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12  N*3/2(1910, JP=1/2+) I = 3/2

THIS RESONANCE IS WELL ESTABLISHED.
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                  12  N*3/2(1910) MASS (MEV)

M   3    (1934.0)                   DONNACHI  68 RVUE     PHASE-SHIFT ANAL  8/69
M   6    (1783.0)                   AYED      70 IPWA                       1/71
M   6  FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4    (1914.0)                   DAVIES    70 RVUE     P-S ANAL  SOL A   8/69
M   7    (1900.)                    ALMEHED   72 IPWA                       2/72
M   9    (1980.)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
M   9    (1950.)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
M   9  DEANS75 AND LANGBEIN73 DISAGREE WITH PI- P TO K+ SIGMA+ DATA OF      1/78
M   9  WINNIK77 AROUND 1920 MEV.                                            1/78
M        (1789.)                    AYED      76 IPWA                      11/77
M        (1940.)     (30.)          CUTKOSKY  76 IPWA                      11/77
M   8    (1790.)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77
M   8  ALL LONGACRE77 PARAMETERS ARE FROM SOLUTION S2, EXCEPT FOR THE POLE 11/77
M   8  POSITION WHICH IS FROM SOLUTIONS S1 AND L1.                         11/77
M    5   (1899.)                    BARBOUR   78 DPWA     PI-N PHOTOPROD.   3/79
M        (1920.)     (50.)          CUTKOSKY  79 IPWA     PI N TO PI N     12/79
M         1888.       20.           HOEHLER   79 IPWA     PI N TO PI N     12/79
M   A    (1715.2)    (21.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M   B    (1778.4)    (9.0)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M   C    (1960.1)    (21.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M   D    (2121.4)    (13.)    (14.3) CHEW     80 BPWA ++ PI+P TO PI+P      1/82*
M  AB  CHEW 80 REPORTS FOUR RESONANCES IN THE P31 WAVE.  ALL ARE LISTED    1/82*
M  CD  HERE LABELED A-D.                                                   1/82*
M        (1921.0)                   CRAWFORD  80 DPWA     PI N PHOTOPROD. 12/81*
M         1910.       40.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
M        (1930.)                    LIVANOS   80 DPWA     PI P TO K SIGMA  1/82*
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                  12  N*3/2(1910) WIDTH (MEV)

W   3     (339.0)                   DONNACHI  68 RVUE                       8/69
W   6     (308.0)                   AYED      70 IPWA                       1/71
W   4     (290.)                    DAVIES    70 RVUE     SOL A             8/69
W   7     (200.)                    ALMEHED   72 IPWA                       2/72
W   9     (190.)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
W   9     (170.)                    LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
W         (221.)                    AYED      76 IPWA                      11/77
W         (380.)     (130.)         CUTKOSKY  76 IPWA                      11/77
W   8     (170.)                    LONGACRE  77 IPWA     PI N TO 2PI N    11/77
W    5    (230.)                    BARBOUR   78 DPWA     PI-N PHOTOPROD.   3/79
W         (300.)     (100.)         CUTKOSKY  79 IPWA     PI N TO PI N     12/79
W          280.       50.           HOEHLER   79 IPWA     PI N TO PI N     12/79
W   A      (93.3)    (55.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W   B      (23.0)    (29.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W   C     (152.9)    (60.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W   D     (172.2)    (37.)          CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W         (351.0)                   CRAWFORD  80 DPWA     PI N PHOTOPROD. 12/81*
W          225.       50.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
W         (222.)                    LIVANOS   80 DPWA     PI P TO K SIGMA  1/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
          SEE NOTES ACCOMPANYING MASSES QUOTED
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                  12  N*3/2(1910) REAL PART OF POLE POSITION (MEV)

RE       (1363.)      (15.)         CUTKOSKY  76 IPWA                      11/77
RE  8     1792. OR 1801.            LONGACRE  77 IPWA     PI N TO 2PI N    11/77
RE       (1971.)                    CUTKOSKY  79 IPWA     PI N TO PI N     12/79
RE        1880.       30.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
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                  12  N*3/2(1910) -2*IMAG PART OF POLE POSITION (MEV)

IM        (250.)     (34.)          CUTKOSKY  76 IPWA                      11/77
IM  8      172. OR 165.             LONGACRE  77 IPWA     PI N TO 2PI N    11/77
IM        (200.)                    CUTKOSKY  79 IPWA     PI N TO PI N     12/79
IM         200.       40.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
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                  12  N*3/2(1910) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER       (-4.)      (5.)           CUTKOSKY  76 IPWA                      11/77
RER       (-0.6)                    CUTKOSKY  79 IPWA     PI N TO PI N     12/79
RER         0.       10.            CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
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                  12  N*3/2(1910) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR       (-27.)     (5.)           CUTKOSKY  76 IPWA                      11/77
IMR       (-18.)                    CUTKOSKY  79 IPWA     PI N TO PI N     12/79
IMR        -20.       4.            CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
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                  12  N*3/2(1910) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1      N*3/2(1910) INTO PI N                          139+ 938
P2      N*3/2(1910) INTO N PI PI                       938+ 139+ 139
P3      N*3/2(1910) INTO K SIGMA                       493+1189
P4      N*3/2(1910) INTO N*3/2(1232) PI                1232+ 139
P5      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2        0+ 938
P6      N*3/2(1910) INTO N RHO,S=3/2                   938+ 769
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                  12  N*3/2(1910) BRANCHING RATIOS

R1      N*3/2(1910) INTO (PI N)/TOTAL                          (P1)
R1  3       (0.30)                  DONNACHI  68 RVUE                       8/69
R1  6       (0.128)                 AYED      70 IPWA                       1/71
R1  4       (0.18)                  DAVIES    70 RVUE     SOL A             8/69
R1  7       (0.33)                  ALMEHED   72 IPWA                       2/72
R1          (0.16)                  AYED      76 IPWA                      11/77
R1          (0.225)   (0.025)       CUTKOSKY  76 IPWA                      11/77
R1          (0.19)    (0.04)        CUTKOSKY  79 IPWA     PI N TO PI N     12/79
R1           0.24      0.06         HOEHLER   79 IPWA     PI N TO PI N     12/79
R1  A       (0.18)                  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1  B       (0.20)                  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1  C       (0.17)                  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1  D       (0.40)                  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1           0.19      0.03         CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      N*3/2(1910) INTO (K SIGMA)/TOTAL                       (P3)
R2  1       (0.008)OR LESS          FEUERBACH 70 RVUE     PI P TO K+ SIG+   7/70
R2  1     ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1     MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1910) FROM PI N TO K SIGMA                       SQRT(P1*P3)      9/73
R3  9       (0.11)                  LANGBEIN  73 IPWA     PI N-K SIG,SOL 1  9/73
R3  9       (0.15)                  LANGBEIN  73 IPWA     PI N-K SIG,SOL 2  9/73
R3  2       (0.082)TO 0.184         DEANS     75 DPWA     PI N TO K SIGMA  11/75
R3  2  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75
R3          (-0.019)                LIVANOS   80 DPWA     PI P TO K SIGMA  1/82*

R4      N*3/2(1910) FROM PI N TO N*3/2(1232) PI                SQRT(P1*P4)     11/77
R4  8       (-0.06)                 LONGACRE  77 IPWA     PI N TO 2PI N    11/77

R5      N*3/2(1910) FROM PI N TO N RHO,S=3/2                   SQRT(P1*P6)     11/77
R5  8       (-0.29)                 LONGACRE  77 IPWA     PI N TO 2PI N    11/77
R5   N      (-0.17)                 NOVOSELLE 78 IPWA     PI N TO 2PI N     3/79
R5   N  EVIDENCE FOR THIS COUPLING IS WEAK. SEE NOVOSELLER 78. THIS        12/79
R5   N  COUPLING ASSUMES THE MASS IS NEAR 1920 MEV.                        12/79
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                  12  N*3/2(1910) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1910) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1           0.000     0.025        DEVENIS2  74 DPWA     PI N PHOTOPROD.   4/75
A1           0.010     0.012        KNIES     74 DPWA     PI N PHOTOPROD.   2/74
A1          -0.032     0.065        METCALF   74 DPWA     PI N PHOTOPROD.   2/74
A1          -0.009     0.013        CRAWFORD  75 DPWA     PI N PHOTOPROD.   6/76
A1         (-0.031)                 BARBOUR   76 DPWA     PI N PHOTOPROD.   1/76
A1          +0.040     0.013        AZNAURYAN 77 DPWA     PI0 PHTPRD.SOL 1 12/79
A1          +0.039     0.012        AZNAURYAN 77 DPWA     PI0 PHTPRD.SOL 2 12/79
A1   5      -0.035     0.021        BARBOUR   78 DPWA     PI-N PHOTOPROD.   3/79
A1   5  SUPERSEDES BARBOUR 76.                                              3/79
A1          -0.012     0.005        ARAI      80 DPWA     PI N PHOTO FIT 1 12/81*
A1          -0.031     0.004        ARAI      80 DPWA     PI N PHOTO FIT 2 12/81*
A1          -0.005     0.030        CRAWFORD  80 DPWA     PI N PHOTOPROD.  12/81*
A1          . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)
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                          REFERENCES FOR N*3/2(1910)

DONNACHI 68 PL 26B 161       A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
    ALSO 68 VIENNA 139       DONNACHIE  RAPPORTEUR'S TALK          (GLAS)
    ALSO 68 THESIS           R G KIRSOPP                           (EDIN)

AYED     70 KIEV CONF        R AYED,P BAREYRE, G VILLET            (SACL)IJP
DAVIES   70 NP B21 359       A DAVIES                              (GLAS)
FEUERBAC 70 NP 16B 85        FEUERBACHER+HOLLADAY            (VANDERBILT)

ALMEHED  72 NP B40 157       +LOVELACE                       (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251       LANGBEIN,WAGNER                      (MUNICH)IJP

DEVENIS2 74 PL 52B 227       DEVENISH,LYTH,RANKIN         (DESY,LANC,BONN)IJP
KNIES    74 PRD 9 2680       KNIES,MOORHOUSE,OBERLACK          (LBL,GLAS)IJP
METCALF  74 NP B76 253       W J METCALF,R L WALKER                 (CIT)IJP

CRAWFORD 75 NP B97 125       R L CRAWFORD                          (GLAS)IJP
DEANS    75 NP B96 90        +MITCHELL,MONTGOMERY,+         (SFLA,ALABAMA)IJP

AYED     76 CEA-N-1921       AYED (THESIS)                         (SACL)IJP
BARBOUR  76 NP B111 358      I. M. BARBOUR,R. L. CRAWFORD          (GLAS)IJP
CUTKOSKY 76 PRL 37 645       CUTKOSKY,HENDRICK,KELLY            (CARN+LBL)IJP
    ALSO 76 OXFORD CONF. 49  CUTKOSKY,HENDRICK,CHAO+       (CARN+LBL+BRIS)IJP
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AZNAURYA 77  EFI-264(57)-77   +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
LONGACRE 77 NP B122 493       LONGACRE,DOLBEAU                     (SACL)IJP
   ALSO 76 NP B108 365        DOLBEAU,TRIANTIS,NEVEU,CADIET        (SACL)IJP

BARBOUR  78 NP B141 253       BARBOUR,CRAWFORD,PARSONS              (GLAS)
NOVOSELL 78 NP B137 509       D. E. NOVOSELLER                 (CAL TECH)IJP
   ALSO 78 NP B137 445        D. E. NOVOSELLER                 (CAL TECH)IJP
CUTKOSKY 79 PRD 20 2839       +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

ARAI     80  TORONTO CONF 93  I. ARAI                               (TOKY)
CHEW     80  TORONTO CONF 123 D.M.CHEW                            ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                          (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK (CARN+LBL)IJP
LIVANOS  80  TORONTO CONF 35  +BATON,COUTURES,KOCHOWSKI,NEVEU      (SACL)IJP

                      PAPERS NOT REFERRED TO IN DATA CARDS

CARYANN  65 PR 138 B433       CARAYANNOPOULOS,TAUTFEST,WILLMANN     (PURD)
  A PARTIAL WAVE ANALYSIS OF PI+P TO SIGMA+ K+
AYEO     70 PL 31B 598        +BAREYRE+VILLET                     (SACLAY)
WINNIK   77 NP B128 66        +TOAFF,REVEL,GOLDBERG,BERNY          (HAIF))

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Δ(1920) — 117 N*3/2(1920, JP=3/2+) I=3/2 — P_{33}

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         EARLY ANALYSES FOUND EVIDENCE FOR A P33 RESONANCE NEAR
         2160 MEV; THERE MAY HAVE BEEN CONFUSION WITH OTHER
         RESONANCES IN THAT REGION (SEE LISTING FOR N*3/2(2160)).
         RECENT ANALYSES FIND THE MASS IS CLOSER TO 1920 MEV.

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                     117  N*3/2(1920) MASS  (MEV)

M   3    (2160.)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M        (2120.)                    ROYCHOUD  71 DPWA                     3/72
M   T    (2150.)                    ALMEHED   72 IPWA                     2/72
M    I   (1980.)                    LANGBEIN  73 IPWA   PI N-K SIG.SOL 1  9/73
M    I  NOT SEEN IN SOLUTION 2 OF LANGBEIN73                              9/73
M    I  DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF   1/78
M    I  WINNIK77 AROUND 1920 MEV.                                         1/78
M        (1960.)    (80.)           CUTKOSKY  79 IPWA   PI N TO PI N     12/79
M         1868.      10.            HOEHLER   79 IPWA   PI N TO PI N     12/79
M   A    (1955.)    (13.)           CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
M   B    (2065.)    (13.6)  (12.9)  CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
M   AB  CHEW 80 REPORTS TWO P33 RESONANCES IN THIS MASS REGION.  BOTH ARE 1/82*
M   AB  LISTED HERE, LABELED A AND B FOR LOWER AND HIGHER STATES.        1/82*
M         1920.      80.            CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
M        (1904.)                    LIVANOS   80 DPWA   PI P TO K SIGMA  1/82*
M        . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                     117  N*3/2(1920) WIDTH  (MEV)

W   3    (260.)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W   7    (200.)                     ALMEHED   72 IPWA                     2/72
W    1   (190.)                     LANGBEIN  73 IPWA   PI N-K SIG.SOL I  9/73
W        (300.)    (100.)           CUTKOSKY  79 IPWA   PI N TO PI N     12/79
W         220.      90.             HOEHLER   79 IPWA   PI N TO PI N     12/79
W   A    (98.3)    (35.)            CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
W   B    (162.0)   (44.)            CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
W        (204.)                     LIVANOS   80 DPWA   PI P TO K SIGMA  1/82*
W         300.     100.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
W        . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                     117  N*3/2(1920) REAL PART OF POLE POSITION  (MEV)

RE       (1933.)                    CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RE        1900.     80.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     117  N*3/2(1920) -2*IMAG PART OF POLE POSITION  (MEV)

IM       (280.)                     CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IM        300.     100.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     117  N*3/2(1920) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER      (-19.)                     CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RER       -21.      7.              CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     117  N*3/2(1920) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR      (-27.)                     CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IMR       -12.     11.              CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     117  N*3/2(1920) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1    N*3/2(1920) INTO PI N                           139+ 938
P2    N*3/2(1920) INTO K SIGMA                        493+1189

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                     117  N*3/2(1920) BRANCHING RATIOS

R1    N*3/2(1920) INTO (PI N)/TOTAL                  (P1)                 12/79
R1  3    (0.25)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
R1  7    (0.3)                     ALMEHED   72 IPWA                     2/72
R1       (0.17)    (0.04)          CUTKOSKY  79 IPWA   PI N TO PI N     12/79
R1        0.14      0.04           HOEHLER   79 IPWA   PI N TO PI N     12/79
R1  A    (0.24)                    CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
R1  B    (0.19)                    CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
R1        0.20      0.05           CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
R1       . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2    N*3/2(1920) FROM PI N TO K SIGMA                SQRT(P1*P2)          12/79
R2  .       (0.08)                 LANGBEIN  73 IPWA   PI N-K SIG.SOL 1  9/73
R2  5       (0.048)TO 0.120        DEANS     75 DPWA   PI N TO K SIGMA  11/75
R2  5  RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                          11/75
R2         -0.049)                 LIVANOS   80 DPWA   PI P TO K SIGMA  1/82*

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                     REFERENCES FOR N*3/2(1920)

KIRSOPP  68 THESIS            R G KIRSOPP                           (EDIN)
ROYCHOUD 71 NP B27 125        R K ROYCHOUDHURY,B H BRANSDEN      (DURH)IJP

ALMEHED  72 NP B40 157        +LOVELACE                      (LUND,RUTG)IJP
LANGBEIN 73 NP B53 251        LANGBEIN,WAGNER                    (MUNICH)IJP
DEANS    75 NP B96 90         +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP

CUTKOSKY 79 PRD 20 2839       +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                              +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3    R.KOCH                           (KARLSRUHE)IJP

CHEW     80  TORONTO CONF 123 D.M.CHEW                            ( LBL)IJP
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK (CARN+LBL)IJP
LIVANOS  80  TORONTO CONF 35  +BATON,COUTURES,KOCHOWSKI,NEVEU      (SACL)IJP

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Δ(1930) — 13 N*3/2(1930, JP=5/2-) I=3/2 — D_{35}

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         THIS RESONANCE IS WELL ESTABLISHED.

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                     13  N*3/2(1930) MASS (MEV)

M   3    (1954.0)                   DONNACHI  68 RVUE   PHASE-SHIFT ANAL  6/66
M   3    (1970.)                    KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
M   X    (1950.0)       APPROX      LEA       69 CNTR   PI-P ELASTIC      8/69
M   X   SEE ALSO APLIN 70
M   3   WHERE MAX. ABSORPTION IS -DONNACHI, 2 ,KIRSOPP EYEBALL FIT CERN I 10/69
M   7    (2200.)                    ALMEHED   72 IPWA                     2/72
M    I   (1960.)                    LANGBEIN  73 IPWA   PI N-K SIG.SOL 2  9/73
M    I  NOT SEEN IN SOLUTION 1 OF LANGBEIN73                              9/73
M    I  DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF   1/78
M    I  WINNIK77 AROUND 1920 MEV.                                         1/78
M        (1894.)                    AYED      76 IPWA                    11/77
M        (1925.)    (20.)           CUTKOSKY  76 IPWA                    11/77
M   4    (2074.)                    BARBOUR   78 DPWA   PI-N PHOTOPROD.   3/79
M        (1930.)    (20.)           CUTKOSKY  79 IPWA   PI N TO PI N     12/79
M         1901.      15.            HOEHLER   79 IPWA   PI N TO PI N     12/79
M        (1910.)    (15.)   (17.2)  CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
M        (2000.0)                   CRAWFORD  80 DPWA   PI N PHOTOPROD. 12/81*
M         1940.      30.            CUTKOSKY  90 IPWA   PI N TO PI N     1/82*
M        (1889.)                    LIVANOS   80 DPWA   PI P TO K SIGMA  1/82*
M        . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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                     13  N*3/2(1930) WIDTH (MEV)

W   3    (311.0)                    DONNACHI  68 RVUE                     8/69
W   3    (400.)                     KIRSOPP   68 RVUE   PHASE SHIFT ANAL 10/69
W   7    (600.)                     ALMEHED   72 IPWA                     2/72
W    1   (150.)                     LANGBEIN  73 IPWA   PI N-K SIG.SOL 2  9/73
W        (121.)                     AYED      76 IPWA                    11/77
W        (350.)    (100.)           CUTKOSKY  76 IPWA                    11/77
W   4    (462.)                     BARBOUR   78 DPWA   PI-N PHOTOPROD.   3/79
W        (280.)    (90.)            CUTKOSKY  79 IPWA   PI N TO PI N     12/79
W         195.      60.             HOEHLER   79 IPWA   PI N TO PI N     12/79
W        (174.8)   (17.)    (16.)   CHEW      80 BPWA ++ PI+P TO PI+P    1/82*
W        (442.0)                    CRAWFORD  80 DPWA   PI N PHOTOPROD. 12/81*
W         320.      60.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*
W        (121.)                     LIVANOS   80 DPWA   PI P TO K SIGMA  1/82*
W        . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)
         SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                     13  N*3/2(1930) REAL PART OF POLE POSITION (MEV)

RE       (1860.)   (15.)            CUTKOSKY  76 IPWA                    11/77
RE       (1908.)                    CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RE        1890.     50.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     13  N*3/2(1930) -2*IMAG PART OF POLE POSITION (MEV)

IM       (276.)    (40.)            CUTKOSKY  76 IPWA                    11/77
IM       (226.)                     CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IM        260.      60.             CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     13  N*3/2(1930) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER      (12.)     (3.)             CUTKOSKY  76 IPWA                    11/77
RER      (13.)                      CUTKOSKY  79 IPWA   PI N TO PI N     12/79
RER       17.       7.              CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     13  N*3/2(1930) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR      (-15.)    (4.)             CUTKOSKY  76 IPWA                    11/77
IMR      (2.)                       CUTKOSKY  79 IPWA   PI N TO PI N     12/79
IMR       -6.      12.              CUTKOSKY  80 IPWA   PI N TO PI N     1/82*

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                     13  N*3/2(1930) PARTIAL DECAY MODES

                                                      DECAY MASSES
P1    N*3/2(1930) INTO PI N                           139+ 938
P2    N*3/2(1930) INTO K SIGMA                        493+1189

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                 13  N*3/2(1930) BRANCHING RATIOS

R1      N*3/2(1930) INTO (PI N)/ TOTAL                      (P1)
R1  3       (0.154)                    DONNACHI  68 RVUE    PHASE SHIFT ANA. 10/69
R1  3       (0.12)                     KIRSOPP   68 RVUE    PHASE SHIFT ANAL 10/69
R1  7       (0.25)                     ALMEHED   72 IPWA                      2/72
R1          (0.08)                     AYED      76 IPWA                     11/77
R1          (0.133)   (0.013)          CUTKOSKY  76 IPWA                     11/77
R1          (0.12)    (0.03)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
R1           0.04      0.03            HOEHLER   79 IPWA    PI N TO PI N     12/79
R1          (0.11)                     CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
R1           0.14      0.04            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1             . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

R2      N*3/2(1930) INTO (K SIGMA)/TOTAL                    (P2)
R2  1       (0.013)   (0.01)           FEUERBACH 70 RVUE    PI P TO K+ SIG+   7/70
R2  1      ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2  1      MODEL USED MAY DOUBLE COUNT.

R3      N*3/2(1930) FROM PI N TO K SIGMA                    SQRT(P1*P2)       9/73
R3   1      (0.08)                     LANGBEIN  73 IPWA    PI N-K SIG.SOL 2  9/73
R3  2       (0.018)TO 0.035            DEANS     75 DPWA    PI N TO K SIGMA  11/75
R3  2   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                             11/75
R3         (-0.031)                    LIVANOS   80 DPWA    PI P TO K SIGMA   1/82*

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                 13  N*3/2(1930) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES, SEE MINI-
    REVIEW PRECEDING THE BARYON LISTINGS.

A1      N*3/2(1930) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)                1/76
A1          +0.003     0.016           CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A1         (-0.085)                    BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A1   4      -0.062     0.064           BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A1   4  SUPERSEDES BARBOUR 76.                                                3/79
A1          -0.038     0.047           CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A1             . . . . . . . . . .
A1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

A2      N*3/2(1930) INTO GAM NUCLEON, HELICIYT=3/2 (GEV**-1/2)                1/76
A2          -0.010     0.032           CRAWFORD  75 DPWA    PI N PHOTOPROD.   1/76
A2         (+0.066)                    BARBOUR   76 DPWA    PI N PHOTOPROD.   1/76
A2   4      +0.019     0.054           BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
A2          -0.023     0.080           CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
A2             . . . . . . . . . .
A2  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                          REFERENCES FOR N*3/2(1930)

DONNACHI 68 PL 26B 161          A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
KIRSOPP  68 THESIS              R G KIRSOPP                          (EDIN)

LEA      69 PL 29B 5E4          LEA,DADES,MARO,COWAN,+   (RHEL,BRISTOL,DARE)
FEUERBAC 70 NP 16B 85           FEUERBACHER+HOLLADAY           (VANDERBILT)
ALMEHED  72 NP B40 157          +LOVELACE                     (LUND,RUTG)IJP

LANGBEIN 73 NP B53 251          LANGBEIN,WAGNER                    (MUNICH)IJP

CRAWFORD 75 NP B97 125          R L CRAWFORD                         (GLAS)IJP
DEANS    75 NP B96 90           +MITCHELL,MONTGOMERY,+      (SFLA,ALABAMA)IJP

AYED     76 CEA-N-1921          AYED (THESIS)                        (SACL)IJP
BARBOUR  76 NP B111 358         I. M. BARBOUR,R. L. CRAWFORD         (GLAS)IJP
CUTKOSKY 76 PRL 37 645          CUTKOSKY,HENDRICK,KELLY          (CARN+LBL)IJP
    ALSO 76 OXFORD CONF. 49     CUTKOSKY,HENDRICK,CHAO+     (CARN+LBL+BRIS)IJP

BARBOUR  78 NP B141 253         BARBOUR,CRAWFORD,PARSONS                 (GLAS)
CUTKOSKY 79 PRD 20 2839         +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN           /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                          (KARLSRUHE)IJP

CHEW     80  TORONTO CONF 123 D.M.CHEW                            ( LBL)IJP
CRAWFORD 80  TORONTO CONF 107 R.L.CRAWFORD                        (GLAS)
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
LIVANOS  80  TORONTO CONF 35  +BATON,COUTURES,KOCHOWSKI,NEVEU      (SACL)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

DONNACHI 69 NP B10 433          A DONNACHIE, R KIRSOPP            (GLAS+EDIN)
AYED     70 PL 31B 598          +BAREYRE+VILLET                       (SACLAY)
APLIN    71 NP B32 253          +COWAN,GIBSON,GILMORE++       (RHEL,BRISTOL)
WINNIK   77 NP B12. 66          +TOAFF,REVEL,GOLDBERG,BERNY           (HAIFI:

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Δ(1940)

136 N*3/2(1940, JP=3/2-) I=3/2

D_{33}''

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                 136  N*3/2(1940) MASS (MEV)

M         1940.      100.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M        (2058.1)   (34.5)             CHEW      80 BPWA ++ PI+P TO PI+P      1/82*

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                 136  N*3/2(1940) WIDTH (MEV)

W         200.       100.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W        (198.4)    (45.5)             CHEW      80 BPWA ++ PI+P TO PI+P      1/82*

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                 136  N*3/2(1940) REAL PART OF POLE POSITION (MEV)

RE        1990.      100.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 136  N*3/2(1940) -2*IMAG PART OF POLE POSITION (MEV)

IM        200.        60.              CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 136  N*3/2(1940) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        -6.        5.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 136  N*3/2(1940) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         6.        5.               CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 136  N*3/2(1940) PARTIAL DECAY M[illegible]S

                                                        DECAY MASSES
P1      N*3/2(1940) INTO PI N                           139+ 938

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                 136  N*3/2(1940) BRANCHING RATIOS

R1      N*3/2(1940) INTO (PI N)/TOTAL                       (P1)
R1          0.05       0.02            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1         (0.16)                      CHEW      80 BPWA ++ PI+P TO PI+P      1/82*

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                          REFERENCES FOR N*3/2(1940)

CHEW     80  TORONTO CONF 123 D.M.CHEW                            ( LBL)IJP
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

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Δ(1950)

83 N*3/2(1950, JP=7/2+) I=3/2

F_{37}'

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                 THIS RESONANCE IS WELL ESTABLISHED.

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                 83  N*3/2(1950) MASS (MEV)

M          (1920.0)                    DUKE      65 CNTR    PI-P EL + POL     6/68
M          (1950.0)        APPROX      YOKOSAWA  66 CNTR    PI- P DSIG + PLL  7/66
M   1      (1975.0)                    BARE[illegible]  68 RVUE    PHASE-SHIFT ANAL 11/67
M   1          WHERE CROSS SECTION IS GREA[illegible]T - EYEBALL FIT
M   3      (1946.0)                    DONNACHI  [illegible] RVUE    PHASE-SHIFT ANAL  6/68
M   6      (1931.0)                    AYED      70 IPWA                      1/71
N   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M   4      (1935.0)                    DAVIES    70 RVUE    P-S ANAL   SOL A  8/67
M          (1950.0)   (30.0)           KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71
M          (1930.)                     ROYCHOUD  71 DPWA                      3/72
M   7      (1925.)                     ALMEHED   72 IPWA                      2/72
M    2      1920 TO 1951               MEHTANI   72 MPWA    PI+P TO PI+PIOP   9/73
M    K      1930. OR 1925.             LONGACRE  75 IPWA    PI N TO 2PI N    11/75
M    K  THE 2 SETS OF PARAMETERS ARE FROM METHODS 1 AND 2 OF LONGACRE 75.    11/75
M          (1928.)                     AYED      76 IPWA                     11/77
M          (1945.)      (7.)           CUTKOSKY  76 IPWA                     11/77
M    8     (1912.)                     BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
M          (1950.)     (20.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
M           1913.        8.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M          (1855.)     (11.)    (10.)  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M          (1902.0)                    CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
M           1950.       15.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M              . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

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                 83  N*3/2(1950) WIDTH (MEV)

W          (170.0)                     DUKE      65 CNTR                      7/66
W          (200.0)         APPROX      YOKOSAWA  66 CNTR                      7/66
W   1      (180.0)                     BAREYRE   68 RVUE                     11/67
W   3      (221.0)                     DONNACH1  68 RVUE                      6/68
W   6      (197.0)                     AYED      70 IPWA                      1/71
W   4      (221.0)                     DAVIES    70 RVUE    SOL A             8/69
W          (300.0)    (60.0)           KALMUS    70 DPWA    PI+P TO K+ SIG+   1/71
W   7      (200.)                      ALMEHED   72 IPWA                      2/72
W    2     234 TO 269                  MEHTANI   72 MPWA    PI+P TO PI+PIOP   9/73
W    K      235. OR  240.              LONGACRE  75 IPWA    PI N TO 2PI N    11/75
W          (237.)                      AYED      76 IPWA                     11/77
W          (305.)      (40.)           CUTKOSKY  76 IPWA                     11/77
W    8     (198.)                      BARBOUR   78 DPWA    PI-N PHOTOPROD.   3/79
W          (340.)      (60.)           CUTKOSKY  79 IPWA    PI N TO PI N     12/79
W           224.        10.            HOEHLER   79 IPWA    PI N TO PI N     12/79
W          (157.2)     (22.)    (19.)  CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W          (225.0)                     CRAWFORD  80 DPWA    PI N PHOTOPROD.  12/81*
W           340.        50.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W              . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
      SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

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                 83  N*3/2(1950) REAL PART OF POLE POSITION (MEV)        11/75

RE         (1924.)                     LONGACRE  75 IPWA    PI N TO 2PI N    11/75
RE         (1915.)                     VASAN2    76         FIT AYED 76      11/77
RE         (1895.)     (10.)           CUTKOSKY  76 IPWA                     11/77
RE         (1892.)                     CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RE          1890.       15.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 83  N*3/2(1950) -2*IMAG PART OF POLE POSITION (MEV)     11/75

IM         (258.)                      LONGACRE  75 IPWA    PI N TO 2PI N    11/75
IM         (220.)                      VASAN2    76         FIT AYED 76      11/77
IM         (260.)      (24.)           CUTKOSKY  76 IPWA                     11/77
IM         (248.)                      CUTKOSKY  79 IPWA    PI N TO PI N     12/79
IM          260.        40.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 83  N*3/2(1950) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER        (50.)       (6.)            CUTKOSKY  76 IPWA                     11/77
RER        (43.)                       CUTKOSKY  79 IPWA    PI N TO PI N     12/79
RER         42.         7.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*

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                 E3  N*3/2(1950) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         (-25.)      (9.)          CUTKOSKY  76 IPWA                      11/77
IMR         (-24.)                    CUTKOSKY  79 IPWA    PI N TO PI N      12/79
IMR          -27.        7.           CUTKOSKY  80 IPWA    PI N TO PI N       1/82*

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                 E3  N*3/2(1950) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1     N*3/2(1950) INTO PI N                                139+ 938
P2     N*3/2(1950) INTO SIGMA K                            1189+ 493
P3     N*3/2(1950) INTO N*3/2(1232) PI                     1232+ 139
P4     N*3/2(1950) INTO Y*1(1385) K                        1385+ 493
P5     N*3/2(1950) INTO N*3/2(1232) RHO                    1232+ 769
P6     N*3/2(1950) INTO NEUTRON PI+ PI+                     939+ 139+ 139
P7     N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)        1232+ 139+ 139
P8     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2             0+ 938
P9     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2             0+ 938
P10    N*3/2(1950) INTO N RHO                               938+ 769
P11    N*3/2(1950) INTO N*3/2(1232) PI,F-WAVE              1232+ 139
P12    N*3/2(1950) INTO N*3/2(1232) PI,H-WAVE              1232+ 139
P13    N*3/2(1950) INTO N RHO,S=3/2,F-WAVE                  938+ 769

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                 R3  N*3/2(1950) BRANCHING RATIOS

R1     N*3/2(1950) INTO (PI N)/TOTAL                          (P1)
R1          (0.41)                    DUKE      65 CNTR    VERY ENERGY DEP    7/66
R1          (0.4)         APPROX      YOKOSAWA  66 CNTR                       7/66
R1   1      (0.57)                    BAREYRE   68 RVUE                      11/67
R1   3      (0.386)                   DONNACHI  68 RVUE                       6/68
R1   6      (0.496)                   AYED      70 IPWA                       1/71
R1   4      (0.51)                    DAVIES    70 RVUE    SOL A              8/69
R1   7      (0.4)                     ALMEHED   72 IPWA                       2/72
R1          (0.41)                    AYED      76 IPWA                      11/77
R1          (0.396)   (0.010)         CUTKOSKY  76 IPWA                      11/77
R1          (0.40)    (0.02)          CUTKOSKY  79 IPWA    PI N TO PI N      12/79
R1           0.38      0.02           HOEHLER   79 IPWA    PI N TO PI N      12/79
R1          (0.44)                    CHEW      80 PPWA ++ PI+P TO PI+P       1/82*
R1           0.39      0.04           CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R1             . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
       SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.

R2     N*3/2(1950) INTO (SIGMA K)*(PI N)/TOTAL**2            (P2*P1)
R2             SEEN                   BORREANI  68 HBC     PI+P 1.35-1.66    10/69
R2   1      (0.004)   (0.008)         FEUERBACH 70 RVUE    PI P TO K+ SIG+    7/70
R2   1    ASSUME MASS, WIDTH, X(ELAST) OF DONNACHIE 68
R2   1    MODEL USED MAY DOUBLE COUNT.
R2           0.006     0.0013         KALMUS    70 DPWA    PI+P TO K+ SIG+    1/71

R3     N*3/2(1950) FROM PI N TO N*3/2(1232) PI               SQRT(P1*P3)
R3   2      0.3    0.48               MEHTANI   72 MPWA    PI+P TO PI+PIOP    9/73
R3   2  MOSTLY F WAVE DECAY                                                   9/73

R4     N*3/2(1950) FROM PI N TO SIGMA K                      SQRT(P1*P2)      9/73
R4          (0.04)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 1   9/73
R4          (0.05)                    LANGBEIN  73 IPWA    PI N-K SIG,SOL 2   9/73
R4   5      (0.022)TO 0.040           DEANS     75 DPWA    PI N TO K SIGMA   11/75
R4   5   RANGE GIVEN IS FROM FOUR BEST SOLUTIONS.                            11/75
R4   5   DEANS75 AND LANGBEIN73 DISAGREE WITH PI+ P TO K+ SIGMA+ DATA OF      1/78
R4   5   WINNIK77 AROUND 1920 MEV.                                            1/78

R5     N*3/2(1950) FROM PI N TO N*3/2(1232) PI,F-WAVE    SQRT(P1*P11)        11/75
R5   K     (-0.25)OR -0.32            LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R5   M      (0.21)                    NOVOSELLE 78 IPWA    PI N TO 2PI N      3/79
R5   M   BW FIT TO LONGACRE 75 IPWA. PHASE IS NEAR -60 DEGREES.               3/79
R5   N      (0.38)                    NOVOSELLE 78 IPWA    PI N TO 2PI N      3/79
R5   N   BW FIT TO NOVOSELLER 78 IPWA. PHASE IS NEAR -60 DEGREES.             3/79

R6     N*3/2(1950) FROM PI N TO N RHO,S=3/2,F-WAVE        SQRT(P1*P13)       11/75
R6   K      (0.18)OR -0.24            LONGACRE  75 IPWA    PI N TO 2PI N     11/75
R6   P      (0.24)                    NOVOSELLE 78 IPWA    PI N TO 2PI N      3/79
R6   P   BW FIT TO LONGACRE 75 IPWA, PHASE IS NEAR 120 DEGREES.               3/79
R6   Q      (0.43)                    NOVOSELLE 78 IPWA    PI N TO 2PI N      3/79
R6   Q   BW FIT TO NOVOSELLER 78 IPWA, PHASE IS NEAR 120 DEGREES.             3/79

    MORE INFORMATION ON INELASTIC DECAY MODES OF BUMPS, SEEN IN PRODUCTION
    EXPERIMENTS AROUND 1950 MEV, MAY BE FOUND IN THE NEXT ENTRY

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                 E3  N*3/2(1950) PHOTON DECAY AMPL(GEV**-1/2)

      FOR DEFINITION OF GAMMA-NUCLEON DECAY AMPLITUDES. SEE MINI-
     REVIEW PRECEDING THE BARYON LISTINGS.

A1     N*3/2(1950) INTO GAM NUCLEON, HELICITY=1/2 (GEV**-1/2)
A1          -0.088     0.025          DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A1          -0.070     0.012          KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A1          -0.059     0.029          METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A1         (-0.080)                   MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A1          -0.053     0.005          CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A1         (-0.076)                   BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A1          -0.078     0.008          AZNAURYAN 77 DPWA    PIO PHTPRO,SOL 1  12/79
A1          -0.132     0.015          AZNAURYAN 77 DPWA    PIO PHTPRO,SOL 2  12/79
A1   8      -0.058     0.013          BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A1   8  SUPERSEDES BARBOUR 76.                                                3/79
A1          -0.091     0.005          ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A1          -0.083     0.005          ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A1          -0.067     0.014          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A1             . . . . . . . . . .
A1   AVERAGE MEANINGLESS (SCALE FACTOR = 2.6)

A2     N*3/2(1950) INTO GAM NUCLEON, HELICITY=3/2 (GEV**-1/2)
A2          -0.080     0.021          DEVENIS2  74 DPWA    PI N PHOTOPROD.    4/75
A2          -0.078     0.010          KNIES     74 DPWA    PI N PHOTOPROD.    2/74
A2           0.093     0.024          METCALF   74 DPWA    PI N PHOTOPROD.    2/74
A2         (-0.180)                   MOORHOUS  74 DPWA    PI N PHOTOPROD.    2/74
A2          -0.038     0.014          CRAWFORD  75 DPWA    PI N PHOTOPROD.    1/76
A2         (-0.065)                   BARBOUR   76 DPWA    PI N PHOTOPROD.    1/76
A2          -0.160     0.016          AZNAURYAN 77 DPWA    PIO PHTPRO,SOL 1  12/79
A2          -0.169     0.015          AZNAURYAN 77 DPWA    PIO PHTPRO,SOL 2  12/79
A2   8      -0.075     0.020          BARBOUR   78 DPWA    PI-N PHOTOPROD.    3/79
A2          -0.101     0.005          ARAI      80 DPWA    PI N PHOTO FIT 1  12/81*
A2          -0.100     0.005          ARAI      80 DPWA    PI N PHOTO FIT 2  12/81*
A2          -0.082     0.017          CRAWFORD  80 DPWA    PI N PHOTOPROD.   12/81*
A2             . . . . . . . . . .
A2   AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

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                        REFERENCES FOR N*3/2(1950)

DUKE      65 PRL 15 468         +JONES,KEMP,MURPHY,PRENTICE, +   (RHEL,OXF)IJP
YOKOSAWA  66 PRL 16 714         +SUWA, HILL, ESTERLING, BOOTH    (ANL,CHIC)IJP

BAREYRE   68 PR 165 1731        P BAREYRE, C BRICMAN, G VILLET     (SACLAY)IJP
BORREANI  68 UCPL 18350          BORREANI,KALMUS                         (LRL)
DONNACHI  68 PL 26B 161         A DONNACHIE, R G KIRSOPP, C LOVELACE (CERN)IJP
     ALSO 68 VIENNA 139         DONNACHIE  RAPPORTEUR'S TALK            (GLAS)
     ALSO 68 THESIS             R G KIRSOPP                             (EDIN)

AYED      70 KIEV CONF          R AYED,P BAREYRE, G VILLET          (SACL)IJP
DAVIES    70 NP B21 359         A DAVIES                                (GLAS)
FEUERBAC  70 NP 16B 85          FEUERBACHER+HOLLADAY             (VANDERBILT)
KALMUS    70 PR D2 1824         G KALMUS, G BORREANI, J LOUIE            (LRL)

ROYCHOUD  71 NP B27 125         R K ROYCHOUDHURY,B H BRANSDEN       (DURH)IJP

ALMEHED   72 NP B40 157         +LOVELACE                      (LUND,RUTG)IJP
MEHTANI   72 PRL 29 1634        +FUNG, KERNAN, SCHALK, +         (UCR +LBL)
LANGBEIN  73 NP B53 251         LANGBEIN,WAGNER                   (MUNICH)IJP

DEVENIS2  74 PL 52B 227         DEVENISH,LYTH,RANKIN       (DESY,LANC,BONN)IJP
KNIES     74 PRD 9 2680         KNIES,MOORHOUSE,OBERLACK        (LBL,GLAS)IJP
METCALF   74 NP B76 253         W J METCALF,R L WALKER               (CIT)IJP
MOORHOUS  74 PRD 9 1            MOORHOUSE,OBERLACK,ROSENFELD    (GLAS+LBL)IJP

CRAWFORD  75 NP B97 125         R L CRAWFORD                        (GLAS)IJP
DEANS     75 NP B96 90          +MITCHELL,MONTGOMERY,+        (SFLA,ALABAMA)IJP
LONGACRE  75 PL 55B 415         +ROSENFELD,LASINSKI,SMADJA+     (LBL,SLAC)IJP
     ALSO 78 PRD 17 1795        LONGACRE,LASINSKI,ROSENFELD+       (LBL,SLAC)

AYED      76 CEA-N-1921         AYED (THESIS)                       (SACL)IJP
BARBOUR   76 NP B111 358        I. M. BARBOUR,R. L. CRAWFORD        (GLAS)IJP
CUTKOSKY  76 PRL 37 645         CUTKOSKY,HENDRICK,KELLY         (CARN+LBL)IJP
     ALSO 76 OXFORD CONF. 49    CUTKOSKY,HENDRICK,CHAO+    (CARN+LBL+BRIS)IJP
VASAN2    76 NP B106 526        S. S. VASAN                         (CARN)IJP

AZNAURYA  77  EFI-264(57)-77    +AKOPOV,BAGDASARYAN (YEREVAN PHYSICS INST.)IJP
BARBOUR   78 NP B141 253        BARBOUR,CRAWFORD,PARSONS                (GLAS)
NOVOSELL  78 NP B137 509        D. E. NOVOSELLER                (CAL TECH)IJP
     ALSO 78 NP B137 445        D. E. NOVOSELLER                (CAL TECH)IJP

CUTKOSKY  79 PRD 20 2839        +FORSYTH,HENDRICK,KELLY         (CARN+LBL)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN         /KARLSRUHE IJP
     ALSO 80  TORONTO CONF 3    R.KOCH                          (KARLSRUHE)IJP

ARAI      80  TORONTO CONF 93   I. ARAI                                 (TOKY)
CHEW      80  TORONTO CONF 123  D.M.CHEW                             ( LBL)IJP
CRAWFORD  80  TORONTO CONF 107  R.L.CRAWFORD                            (GLAS)
CUTKOSKY  80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK (CARN+LBL)IJP

                        PAPERS NOT REFERRED TO IN DATA CARDS

HOHLER    63 NP 48 470          G HOHLER, G EBEL                   (KARLSRUHE) I
LAYSON    63 NC 27 724          W M LAYSON                            (CERN) IJ
AUVIL     64 NC 33 473          P AUVIL, C LOVELACE                 (LOIC)IJP
HELLAND   64 PR 134 B1062       +DEVLIN,HAGGE,LONGO,MOYER,WOOD        (LRL) IJ
HOHLER    64 PL 12 149          G HOHLER, J GIESECKE               (KARLSRUHE) I
HOLLADAY  65 PR 139 B1348       W G HOLLADAY                     (VANDERBILT)
JOHNSON   67 UCRL-17683 THESIS  C H JOHNSON                              (LRL)
DONNACHI  69 NP 108 433         A DONNACHIE, R KIRSOPP              (GLAS+EDIN)
AYED      70 PL 31B 598         +BAREYRE+VILLET                        (SACLAY)
AYED      74 PRIVATE COMMCTN.   AYED,BAREYRE                        (SACL)IJP
     ALSO 73 AIX CONFERENCE     AYED,BAREYRE                        (SACL)IJP
WINNIK    77 NP B128 66         +TOAFF,REVEL,GOLDBERG,BERNY            (HAIF)I

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1950 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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              70  N*3/2(1950, JP=    ) I=3/2   PRODUCTION EXPERIMENTS

              SEE THE MINI-REVIEW PRECEDING THE N AND DELTA LISTINGS
              FOR A DISCUSSION OF PRODUCTION EXPERIMENTS

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              70  N*3/2(1950) MASS (MEV) (PROD. EXP.)

M          (1922.0)      APPROX      COOL      56 CNTR    PI+ P TOTAL        7/66
M          (1912.0)   (15.0)         BRISSON   61 CNTR    PI+ P TOTAL        7/66
M          (1900.0)    (9.0)         DEVLIN    65 CNTR    PI+ P TOTAL
M    N     (2080.0)   (12.0)         YOON      67 HBC  +  3 BEV/C PI-P       8/67
M    N      THIS BUMP IS NOT SEEN BY CHUNG 68 AT 3.2 GEV/C
M          (1860.0)                  COLTON    72 HBC  ++ PP TO PI+PN 7GEV   1/73
M          (1895.)    (15.)          COLLEY    74 HBC  ++ K+P TO K+PPI+PI- 10/74
M          (1890.)      5. TO 10.    BRAUN2    75  BC     PBAR P AND 0.5.7 11/75
M    C     (1981.)     (6.)          CHUNG     75 HBC  ++ PI+ P AND K+ P     1/76
M    C   MOST PROBABLE JP ASSIGNMENT IS 7/2+.                                1/76
M          (1880.)    (10.)          GAIDOS    75 HBC  ++ PI+P TO N* 2PI     1/76
M    B  540(1871.)    (22.)          ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C   3/79
M    B   BEST SIGNAL IS SEEN IN THE P PI+ SPECTRUM FROM THE                  3/79
M    B   P PI+ PI+ PI- FINAL STATE                                           3/79
M    D  600 1849. TO 1893.           ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C   3/79
M    D   FROM OTHER N PI, N PI PI AND SIGMA K CHANNELS                       3/79
M       150(1880.)    (30.)          APELDOORN 79 HBC  ++ PBAR P 7.2 GEV/C 12/79

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              70  N*3/2(1950) WIDTH (MEV) (PROD. EXP.)

W           (256.0)   (39.0)         DEVLIN    65 CNTR
W            (40.0)   (20.0)         YOON      67 HBC  +                     8/67
W           (180.0)                  COLTON    72 HBC  ++ PP TO PI+PN 7GEV   1/73
W           (230.)    (50.)          COLLEY    74 HBC  ++ K+P TO K+PPI+PI- 10/74
W           (120.)     10. TO 20.    BRAUN2    75  BC     PBAR P AND 0.5.7 11/75
W    C      (219.)    (23.)          CHUNG     75 HBC  ++ PI+ P AND K+ P     1/76
W           (180.)    (30.)          GAIDOS    75 HBC  ++ PI+P TO N* 2PI     1/76
W    B  540 (205.)    (43.)          ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C   3/79
W    D  600  114. TO  273.           ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C   3/79
W       150 (270.)    (70.)          APELDOORN 79 HBC  ++ PBAR P 7.2 GEV/C 12/79
          SEE THE NOTES ACCOMPANYING THE MASSES QUOTED ABOVE

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             70  N*3/2(1950) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1     N*3/2(1950) INTO PI N                                  139+ 938
P2     N*3/2(1950) INTO SIGMA K                              1189+ 493
P3     N*3/2(1950) INTO N*3/2(1232) PI                       1232+ 139
P4     N*3/2(1950) INTO Y*1(1385) K                          1385+ 493
P5     N*3/2(1950) INTO N*3/2(1232) RHO                      1232+ 769
P6     N*3/2(1950) INTO NEUTRON PI+ PI+                       939+ 139+ 139
P7     N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)          1232+ 139+ 139
P8     N*3/2(1950) INTO PROTON PI+ PI0                        938+ 139+ 139
P9     N*3/2(1950) INTO PI PI N                               139+ 139+ 938

             70  N*3/2(1950) BRANCHING RATIOS (PROD. EXP.)

R1     N*3/2(1950) INTO (PI N)/TOTAL                      (P1)
R1          (0.57)    (0.12)       DEVLIN    65 CNTR
R1          (0.48)    (0.15)       ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C  1/78

R2     N*3/2(1950) INTO (SIGMA K)/(PI N)                  (P2)/(P1)
R2          0.059     0.024        CHINOWSKY 68 HBC  ++ PP TO P SIG K    11/68

R3     N*3/2(1950) INTO N*3/2(1232) PI PI (NOT RHO)       (P7)
R3          SEEN                   CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R3          SEEN                   BOGGILD   70  HBC    PP TO N3PI(NTRL)  6/70

R4     N*3/2(1950) INTO (PI N)/(N*3/2(1232) PI)           (P1)/(P3)
R4          (0.55) OR LESS         LEE       67 HBC     PI-P 3.63 BEV/C  11/67

R5     N*3/2(1950) INTO ((PI N)*(NEUTRON PI+ PI+))/TOTAL**2
R5                                                        (P1*P6)
R5          0.05      0.013        GALLOWAY  68 RVUE ++ PI+P TO N 2PI+    6/68

R6     N*3/2(1950) INTO (Y*1(1385) K)/(PI N)              (P4)/(P1)
R6          0.035     0.015        CHINOWSKY 68 HBC  ++ PP TO P LAM K PI 11/68

R7     N*3/2(1950) INTO (N*3/2(1232) RHO)/(PI N)          (P5)/(P1)
R7          (0.45)    APPROX       CHINOWSKY 68 HBC  ++ PP TO (P 3PI) N  11/68
R7     THIS INCLUDES CORRECTION FOR UNSEEN DECAY (ISPIN FACTOR 5/3).

R8     N*3/2(1950) INTO (N*3/2(1232) RHO)/TOTAL           (P5)
R8          SEEN                   YOON      67 HBC  +                    8/67
R8          NOT SEEN               BOGGILD   70  HBC    PP TO N3PI(NTRL)  6/70

R9     N*3/2(1950) INTO (PROTON PI+ PI0)/TOTAL            (P8)
R9          (0.26)    (0.07)       ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C  1/78

R10    N*3/2(1950) INTO (NEUTRON PI+ PI+)/TOTAL           (P6)
R10         (0.24)    (0.07)       ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C  1/78

R11    N*3/2(1950) INTO (SIGMA K)/TOTAL                   (P2)
R11         (0.03)    (0.01)       ZEMANY    78 HBC  ++ PI+P  10.3 GEV/C  3/79

R12    N*3/2(1950) INTO (PI PI N)/(PI N + PI PI N)        (P9)/(P1+P9)
R12 D       (0.35)    (0.08)       GAIDOS    75 HBC  ++ PI+P TO N* 2PI     1/78
R12 D   ASSUMING (PI PI N) IS ALL N*3/2(1232) PI, WHICH AGREES WITH DATA   1/78
R12 R       (0.30)    (0.07)       GAIDOS    75 HBC  ++ PI+P TO N* 2PI     1/78
R12 R   ASSUMING (PI PI N) IS ALL RHO PI                                   1/78
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                    REFERENCES FOR N*3/2(1950) (PROD. EXP.)

COOL      56 PR 103 1082         R COOL, O PICCIONI, D CLARK          (BNL) I
BRISSON   61 NC 19 210           +DETOEUF,FALK-VATRANT,VAN ROSSUM,+ (SACLAY) I
DEVLIN    65 PRL 14 1031         T J DEVLIN,J SOLOMON,G BERTSCH  (PRINCETON) I
LEE       67 PR 159 1156         +MOEBS,ROE,SINCLAIR,VANDER VELDE      (MICH)
YOON      67 PL 24B 307          +BERENYI,KEY,PRENTICE, +      (TORONTO,WISC)

CHINOWSK  68 PR 171 1421         CHINOWSKY,CONDON,KINSEY,KLEIN,+  (LRL,SLAC)
CHUNG     68 PR 165 1491         S U CHUNG,DAHL,KIRZ,MILLER            (LRL)
GALLOWAY  68 PL 26B 394          K F GALLOWAY                     (INDIANA) I

BOGGILD   70 NP B16 503          +KOREA-AHO+JACOBSEN+ (BOHR+ HELS+OSLO+STOH)
COLTON    72 PR D6 95            E COLTON, A KIRSCHBAUM                (LBL)
COLLEY    74 NP B69 205          COLLEY,HUQ,JOBES,KINSON,MILNE,+ (BIRM+GLAS)I

BRAUN2    75 NP B95 503          +GERBER,MAURER,MICHALON,SCHIEY+ STRB,LPNP I
CHUNG     75 PL 57B 384          +PROTOPOPESCU,EISNER+   (BNL+CASE+LBL+UCSC)IJP
   ALSO   75 PRD 12 693          CHUNG,PROTOPOPESCU,EISNER+  (BNL+CASE+UCSC)IJP
GAIDOS    75 PRD 12 2565         GAIDOS,MILLER                          (PURD)IJP

ZEMANY    78 NP B137 365         +BEAUFAYS,GODDARD,KEY+      (TNTO+PURD+BNL)IJP
   ALSO   78 NP B139 265         GODDARD,KEY,GORDON,LAI           (TNTO+BNL)
   ALSO   78 PRD 17 2986         KENNEDY,ZEMANY,BEAUFAYS,KEY,LUSTE+   (TNTO)
APELDOOR  79 NP B156 111         VAN APELDOORN,HARTING,HOLTHUIZEN+    (AMST)

                    PAPERS NOT REFERRED TO IN DATA CARDS

DEUTSCHM  75 NP B95 397          DEUTSCHMANN+(AACH+BONN+BERL+CERN+CRAC+HEID)
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Δ(2150)

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137  N*3/2(2150, JP=1/2-)  I=3/2                    S31

             137  N*3/2(2150) MASS (MEV)

M            2150.      100.          CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
M    A      (2047.4)    (27.0)        CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M    B      (2203.2)    (8.4)         CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
M    AB  CHEW 80 REPORTS TWO S31 RESONANCES IN THIS MASS REGION LABELED      1/82*
M    AB  A AND B FOR LOWER AND HIGHER STATES.                                1/82*

             137  N*3/2(2150) WIDTH (MEV)

W            200.       100.          CUTKOSKY  80 IPWA     PI N TO PI N     1/82*
W    A      (121.6)    (62.1)         CHEW      80 BPWA ++ PI+P TO PI+P      1/82*
W    B      (120.5)    (45.1)         CHEW      80 BPWA ++ PI+P TO PI+P      1/82*

             137  N*3/2(2150) REAL PART OF POLE POSITION (MEV)

RE           2140.      80.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*

             1:7  N*3/2(2150) -2*IMAG PART OF POLE POSITION (MEV)

IM           200.       80.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*

             137  N*3/2(2150) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER          4.         10.           CUTKOSKY  80 IPWA     PI N TO PI N     1/82*

             137  N*3/2(2150) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          -6.        6.            CUTKOSKY  80 IPWA     PI N TO PI N     1/82*

             137  N*3/2(2150) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     N*3/2(2150) INTO PI N                                 139+ 938

             137  N*3/2(2150) BRANCHING RATIOS

R1     N*3/2(2150) INTO (PI N)/TOTAL                   (P1)
R1          0.08      0.02          CUTKOSKY  80 IPWA     PI N TO PI N      1/82*
R1   A     (0.41)                   CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
R1   B     (0.37)                   CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
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                    REFERENCES FOR N*3/2(2150)

CHEW      80 TORONTO CONF 123 D.M.CHEW                                (LBL)IJP
CUTKOSKY  80 TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
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Δ(2160)

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5  N*3/2(2160,      )  I=3/2

EARLY ANALYSES FOUND EVIDENCE FOR A RESONANCE
NEAR THIS MASS IN THE P33 PARTIAL WAVE.  THESE
RESULTS ARE NOW INCLUDED WITH THE LISTING FOR
N*3/2(1930, JP=3/2+).  IN ADDITION, ROYCHOUDHURY 71
FIND POSSIBLE EVIDENCE FOR P31, D33, AND D35
RESONANCES IN THIS MASS REGION.  IN A SIMILAR ANALYSIS
BRANSDEN 71 FOUND SOME EVIDENCE FOR S31, D33, AND D35
RESONANCES IN THIS REGION. VON SCHLIPPE 72 SUGGESTS A G39. A PRONOUNCED
SHARP DIP IS OBSERVED IN PI+ P BACKWARD SCATTERING AT 2200 MEV BY
REY 74.  DUAL INTERFERENCE MODEL ANALYSIS OF MA 75 FINDS SIGNAL FOR
P33, P31, AND D35, BUT NOT FOR G39.

             9  N*3/2(2160) MASS (MEV)

M    4      (2196.)    (46.)    (41.)   REY       74 MPWA ++ PI+ P 180 DEG CS 10/74
M    4   BAKER 74 AND REY 74 FIND NEGATIVE PARITY (SPIN UNDETERMINED).

             9  N*3/2(2160) WIDTH (MEV)

W    4      (302.)     (143.)           REY       74 MPWA ++ PI+ P 180 DEG CS 10/74

             9  N*3/2(2160) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1     N*3/2(2160) INTO PI N                                 139+ 938
P2     N*3/2(2160) INTO K SIGMA                              493+1189

             9  N*3/2(2160) BRANCHING RATIOS

R1     N*3/2(2160) INTO (PI N)/TOTAL                   (P1)
R1   4   REY74 FINDS (J+1/2)X=.81+/-(.54/.39)                                 10/74
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                    REFERENCES FOR N*3/2(2160)

REY       74 PRL 32 908          REY,LENNOX,POIRIER,PRETZL      (NDAM+MFIM)IP
   ALSO   74 PRL 33 250          REY,LENNOX,POIRIER,PRETZL      (NDAM+MPIM)IP
   ALSO   75 PRD 11 1777         LENNOX,POIRIER,REY,SANDER+  (NDAM+FNAL+ANL)IP

                    PAPERS NOT REFERRED TO IN DATA CARDS

DONNACHI  69 NP B8 433           A DONNACHIE,R KIRSOPP              (GLAS+EDIN)
BRANSDEN  71 NP B26 511          +OGDEN                               (DURH)IJP
   ALSO   70 NP B16 461          ROYCHOUDHURY,PERRIN,BRANSDEN         (DURH)IJP
ROYCHOUD  71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN        (DURH)IJP
VON SCHL  72 LNC 4 767           VON SCHLIPPE                         (LOWC)IJP
BAKER     74 PRL 32 251          BAKER,EARTLY,PRETAL,PRUSS,+ (FNAL+ANL+NDAM)P
MA        75 PRD 11 1832         MA,SHAW                         (UCSB,SLAC)IJP
WINNIK    77 NP B128 66          +TOAFF,REVEL,GOLDBERG,BERNY            (HAIF)I
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Δ(2200)

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135  N*3/2(2200, JP=7/2-)  I=3/2                    G37

             135  N*3/2(2200) MASS (MEV)

M          2280.      80.            HENDRY    78 MPWA    PI N TO PI N      1/82*
M         (2200.)                    CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
M          2215.      60.            HOEHLER   79 IPWA    PI N TO PI N      1/82*
M          2200.      80.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M          . . . . . . . . . .
M     AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    135  N*3/2(2200) WIDTH (MEV)

W          400.      150.             HENDRY    78 MPWA    PI N TO PI N      1/82*
W         (350.)                      CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
W          400.      100.             HOEHLER   79 IPWA    PI N TO PI N      1/82*
W          450.      100.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W                 . . . . . . . . .
W  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    135  N*3/2(2200) REAL PART OF POLE POSITION  (MEV)

RE        (2094.)                     CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
RE         2100.      50.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    135  N*3/2(2200) -2*IMAG PART OF POLE POSITION  (MEV)

IM         (294.)                     CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
IM          340.      80.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    135  N*3/2(2200) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER          12.)                     CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
RER           3.       5.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    135  N*3/2(2200) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          (-7.)                    CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
IMR           -8.      3.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    135  N*3/2(2200) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      N*3/2(2200) INTO PI N                                   139+ 938
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                    135  N*3/2(2200) BRANCHING RATIOS

R1      N*3/2(2200) INTO (PI N)/TOTAL                      (P1)
R1          0.09       0.02           HENDRY    78 MPWA    PI N TO PI N      1/82*
R1         (0.05)                     CUTKOSKY  79 IPWA    PI N TO PI N      1/82*
R1          0.05       0.02           HOEHLER   79 IPWA    PI N TO PI N      1/82*
R1          0.06       0.02           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1               . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                          REFERENCES FOR N*3/2(2200)

HENDRY    78 PRL 41 222          ARCHIBALD W. HENDRY              (IND+LBL)IJP
   ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                     (IND)IJP
CUTKOSKY 79 PRD 20 2839          +FORSYTH,HENDRICK,KELLY          (CARN+LBL)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                 +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3       R.KOCH                            (KARLSRUHE)IJP

CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
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Δ(2300) 123 N*3/2(2300, JP=9/2+) I=3/2 **H_{39}**

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                    123  N*3/2(2300) MASS  (MEV)

M          2450.     100.             HENDRY    78 MPWA    PI N TO PI N      12/79
M          2217.      80.             HOEHLER   79 IPWA    PI N TO PI N      12/79
M        (2204.5)    (3.4)            CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
M          2400.     125.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
M                 . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)
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                    123  N*3/2(2300) WIDTH  (MEV)

W           500.     200.             HENDRY    78 MPWA    PI N TO PI N      12/79
W           300.     100.             HOEHLER   79 IPWA    PI N TO PI N      12/79
W          (32.3)    (1.0)            CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
W           425.     150.             CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
W                 . . . . . . . . .
W  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    123  N*3/2(2300) REAL PART OF POLE POSITION  (MEV)

RE          2370.     80.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    123  N*3/2(2300) -2*IMAG PART OF POLE POSITION  (MEV)

IM           420.     160.            CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    123  N*3/2(2300) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER            9.      4.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    123  N*3/2(2300) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR           -3.      5.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    123  N*3/2(2300) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      N*3/2(2300) INTO PI N                                   139+ 938
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                    123  N*3/2(2300) BRANCHING RATIOS

R1      N*3/2(2300) INTO (PI N)/TOTAL                      (P1)              12/79
R1          0.08       0.02           HENDRY    78 MPWA    PI N TO PI N      12/79
R1          0.03       0.02           HOEHLER   79 IPWA    PI N TO PI N      12/79
R1         (0.05)                     CHEW      80 BPWA ++ PI+P TO PI+P       1/82*
R1          0.06       0.02           CUTKOSKY  80 IPWA    PI N TO PI N       1/82*
R1               . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.3)
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                          REFERENCES FOR N*3/2(2300)

HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                 +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3       R.KOCH                            (KARLSRUHE)IJP

CHEW      80  TORONTO CONF 123 D.M.CHEW                              ( LBL)IJP
CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
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Δ(2350) 134 N*3/2(2350, JP=5/2-) I=3/2 **D''_{35}**

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                    134  N*3/2(2350) MASS  (MEV)

M          2305.      26.             HOEHLER   79 IPWA    PI N TO PI N      1/82*
M          2400.     125.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M                 . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    134  N*3/2(2350) WIDTH  (MEV)

W           300.      70.             HOEHLER   79 IPWA    PI N TO PI N      1/82*
W           400.     150.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
W                 . . . . . . . . .
W  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                    134  N*3/2(2350) REAL PART OF POLE POSITION  (MEV)

RE          2400.    125.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    134  N*3/2(2350) -2*IMAG PART OF POLE POSITION  (MEV)

IM           400.    150.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    134  N*3/2(2350) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER            5.     17.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    134  N*3/2(2350) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          -14.     10.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
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                    134  N*3/2(2350) PARTIAL DECAY MODES

                                                                DECAY MASSES
P1      N*3/2(2350) INTO PI N                                   139+ 938
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                    134  N*3/2(2350) BRANCHING RATIOS

R1      N*3/2(2350) INTO (PI N)/TOTAL                      (P1)
R1          0.04       0.02           HOEHLER   79 IPWA    PI N TO PI N      1/82*
R1          0.20       0.10           CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
R1               . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                          REFERENCES FOR N*3/2(2350)

HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                 +KAISER,KOCH,PIETARINEN          /KARLSRUHE IJP
   ALSO 80  TORONTO CONF 3       R.KOCH                            (KARLSRUHE)IJP

CUTKOSKY 80  TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP
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Δ(2400) 133 N*3/2(2400, JP=7/2+) I=3/2 **F''_{37}**

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                    133  N*3/2(2400) MASS  (MEV)

M          2425.      60.             HOEHLER   79 IPWA    PI N TO PI N      1/82*
M          2350.     100.             CUTKOSKY  80 IPWA    PI N TO PI N      1/82*
M                 . . . . . . . . .
M  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                 133  N*3/2(2400) WIDTH (MEV)

W          330.      80.            HOEHLER    79 IPWA     PI N TO PI N       1/82*
W          333.     100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
W          . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 133  N*3/2(2400) REAL PART OF POLE POSITION  (MEV)

RE         2350.    100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 133  N*3/2(2400) -2*IMAG PART OF POLE POSITION  (MEV)

IM          260.    100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 133  N*3/2(2400) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER           0.     13.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 133  N*3/2(2400) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR         -12.      6.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 133  N*3/2(2400) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(2400) INTO PI N                                139+ 938

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                 133  N*3/2(2400) BRANCHING RATIOS

R1      N*3/2(2400) INTO (PI N)/TOTAL                     (P1)
R1           0.07      0.04         HOEHLER    79 IPWA     PI N TO PI N       1/82*
R1           0.08      0.04         CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
R1        . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                          REFERENCES FOR N*3/2(2400)

HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN            /KARLSRUHE 1JP
    ALSO 80   TORONTO CONF 3   R.KOCH                             (KARLSRUHE)IJP

CUTKOSKY 80   TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

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Δ(2400)   124   N*3/2(2400, JP=9/2-) I=3/2   **G_{39}**

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                 124  N*3/2(2400) MASS  (MEV)

M         (2170.)                   AYED       76 IPWA                       11/77
M          2200.    100.            HENDRY     78 MPWA     PI N TO PI N      12/79
M          2468.     50.            HOEHLER    79 IPWA     PI N TO PI N      12/79
M          2300.    100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
M          . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)

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                 124  N*3/2(2400) WIDTH  (MEV)

W         (205.)                    AYED       76 IPWA                       11/77
W          450.     200.            HENDRY     78 MPWA     PI N TO PI N      12/79
W          480.     100.            HOEHLER    79 IPWA     PI N TO PI N      12/79
W          333.     100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
W          . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 124  N*3/2(2400) REAL PART OF POLE POSITION  (MEV)

RE         2260.     60.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 124  N*3/2(2400) -2*IMAG PART OF POLE POSITION  (MEV)

IM          320.    160.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 124  N*3/2(2400) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER           7.      4.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 124  N*3/2(2400) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          -3.      3.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 124  N*3/2(2400) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(2400) INTO PI N                                139+ 938

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                 124  N*3/2(2400) BRANCHING RATIOS

R1      N*3/2(2400) INTO (PI N)/TOTAL                     (P1)               12/79
R1          (0.04)                  AYED       76 IPWA                       11/77
R1           0.10      0.03         HENDRY     78 MPWA     PI N TO PI N      12/79
R1           0.06      0.03         HOEHLER    79 IPWA     PI N TO PI N      12/79
R1           0.05      0.02         CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
R1         . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                          REFERENCES FOR N*3/2(2400)

AYED      76 CEA-N-1921            AYED (THESIS)                        (SACL)IJP
HENDRY    78 PRL 41 222            ARCHIBALD W. HENDRY               (IND+LBL)IJP
    ALSO 80   TORONTO CONF 113 ARCHIBALD W. HENDRY                      (IND)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                               +KAISER,KOCH,PIETARINEN            /KARLSRUHE 1JP
    ALSO 80   TORONTO CONF 3   R.KOCH                             (KARLSRUHE)IJP

CUTKOSKY 80   TORONTO CONF 19   +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

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Δ(2420)   84   N*3/2(2420, JP=11/2+) I=3/2   **H_{311}**

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          THIS RESONANCE IS WELL ESTABLISHED.

          BOTH ROYCHOUDHURY 71 AND BRANSDEN 71 SEE A POSSIBLE
          RESONANT F35 IN THIS MASS REGION. IN ADDITION BRANSDEN
          71 FIND A RESONANT P33 AT 2600 MEV.

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                 84  N*3/2(2420) MASS (MEV)

M   6     (2312.0)                  AYED       70 IPWA                        1/71
M   6   FROM ENER. DEP. FIT OF ARGAND DIAGRAM
M         (2400.)                   BRANSDEN   71 DPWA                        3/72
M         (2400.)                   ROYCHOUD   71 DPWA                        3/72
M         (2440.)                   OTT        72 MPWA  0 PI-P BKWD ELSTC     2/73
M   1     (2604.)      (63.)        REY        74 MPWA ++ PI+ P 180 DEG CS 10/74
M         (2392.)                   AYED       76 IPWA                       11/77
M          2400.     60.            HENDRY     78 MPWA     PI N TO PI N      12/79
M          2416.     17.            HOEHLER    79 IPWA     PI N TO PI N      12/79
M         (2358.)     (9.)          CHEW       80 BPWA ++ PI+P TO PI+P        1/82*
M          2400.    125.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
M          . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 84  N*3/2(2420) WIDTH (MEV)

W   6     (347.0)                   AYED       70 IPWA                        1/71
W   1     (484.)      (79.)         REY        74 MPWA ++ PI+ P 180 DEG CS 10/74
W         (289.)                    AYED       76 IPWA                       11/77
W          460.     100.            HENDRY     78 MPWA     PI N TO PI N      12/79
W          340.      28.            HOEHLER    79 IPWA     PI N TO PI N      12/79
W         (202.2)    (45.)          CHEW       80 BPWA ++ PI+P TO PI+P        1/82*
W          450.     150.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
W          . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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                 84  N*3/2(2420) REAL PART OF POLE POSITION  (MEV)

RE         2360.    100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 84  N*3/2(2420) -2*IMAG PART OF POLE POSITION  (MEV)

IM          420.    100.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 84  N*3/2(2420) REAL PART OF ELASTIC POLE RESIDUE (MEV)

RER          16.      8.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 84  N*3/2(2420) IMAG PART OF ELASTIC POLE RESIDUE (MEV)

IMR          -9.     11.            CUTKOSKY   80 IPWA     PI N TO PI N       1/82*

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                 84  N*3/2(2420) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(2420) INTO PI N                                139+ 938
P2      N*3/2(2420) INTO SIGMA K                            1197+ 493

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                 84  N*3/2(2420) BRANCHING RATIOS

R1      N*3/2(2420) INTO (PI N)/TOTAL                     (P1)
R1  6       (0.113)                 AYED       70 IPWA                        1/71
R1  7       (0.4)                   OTT        72 MPWA  0 PI-P BKWD ELSTC     2/73
R1  1       (0.157)  (0.070)  (0.035)REY       74 MPWA ++ PI+ P 180 DEG CS 10/74
R1  1   REY 74 DETERMINES (J+1/2)X ONLY, WE HAVE DIVIDED BY 6.               10/74
R1          (0.05)                  AYED       76 IPWA                       11/77
R1           0.11      0.02         HENDRY     78 MPWA     PI N TO PI N      12/79
R1           0.08      0.015        HOEHLER    79 IPWA     PI N TO PI N      12/79
R1          (0.22)                  CHEW       80 BPWA ++ PI+P TO PI+P        1/82*
R1           0.08      0.03         CUTKOSKY   80 IPWA     PI N TO PI N       1/82*
R1         . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                              REFERENCES FOR N*3/2(2420)

AYED      70 KIEV CONF          R AYED,P BAREYRE, G VILLET              (SACL)IJP

BRANSDEN 71 NP B26 511          +OGDEN                                  (DURH)IJP
    ALSO 70 NP B16 461          ROYCHOUDHURY,PERRIN,BRANSDEN            (DURH)IJP
ROYCHOUD 71 NP B27 125          R K ROYCHOUDHURY,B H BRANSDEN           (DURH)IJP
DTT      72 PL 42B 133          +TRISCHUK,VAVRA,RICHARDS,+ (MCGI,STLO,IOWA)IJP
    ALSO 72 MCGILL THESIS       J. VAVRA                                (MCGI) JP

REY      74 PRL 32 908          REY,LENNOX,POIRIER,PRETZL          (NDAM+MPIM)IP
    ALSO 74 PRL 33 250          REY,LENNOX,POIRTER,PRETZL          (NDAM+MPIM)IP
    ALSO 75 PRD 11 1777         LENNOX,POIRIER,REY,SANDER+   (NDAM+FNAL+ANL)IP

AYED     76 CEA-N-1921          AYED (THESIS)                           (SACL)IJP
HENDRY   78 PRL 41 222          ARCHIBALD W. HENDRY                  (IND+LBL)IJP
   ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                         (IND)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN            /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                             (KARLSRUHE)IJP

CHEW     80  TORONTO CONF 123 D.M.CHEW                                 ( LBL)IJP
CUTKOSKY 80  TORONTO CONF 19  +FORSYTH,BABCOCK,KELLY,HENDRICK  (CARN+LBL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

BELLAMY  67 PRL 19 476          +BUCKLEY,DOBINSON, +        (WESTFIELD,LOUC) JP

AYED     70 PL 31B 598          +BAREYRE+VILLET                          (SACLAY)

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2420 MEV REGION - PRODUCTION AND σ_{TOTAL} EXP'TS

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               69  N*3/2(2420, JP=    ) I=3/2   PRODUCTION EXPERIMENTS

               SEE THE MINI-REVIEW PRECEDING THE N AND DELTA LISTINGS
               FOR A DISCUSSION OF PRODUCTION EXPERIMENTS.

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               69  N*3/2(2420) MASS (MEV) (PROD. EXP.)

M         (2360.0)                      DIODENS   63 CNTR    PI+ P TOTAL
M         (2520.0)  (40.0)              ALVAREZ   64 CNTR    PI PHOTOPROD.      7/66
M         (2440.0)                      HOHLER    64 RVUE    DATA + DISP REL
M         (2400.0)         APPROX       WAHLIG    64 OSPK  O PI-P CH EX
M    B    (2452.0)                      BARGER    66 RVUE    TOTAL + CH EX     11/67
M    B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
M    B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
M          2423.0    10.0               CITRON    66 CNTR    PI+ P TOTAL        7/66

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               69  N*3/2(2420) WIDTH (MEV) (PROD. EXP.)

W          (200.0)                      DIODENS   63 CNTR
W          (245.0)                      HOHLER    64 RVUE                       7/66
W    B     (275.0)                      BARGER    66 RVUE    TOTAL + CH EX     11/67
W           310.0     20.0              CITRON    66 CNTR                       7/66

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               69  N*3/2(2420) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      N*3/2(2420) INTO PI N                                  139+ 938
P2      N*3/2(2420) INTO SIGMA K                              1197+ 493
P3      N*3/2(2420) INTO N*3/2(1232) PI                       1232+ 139
P4      N*3/2(2420) INTO NEUTRON PI+ PI+                       939+ 139+ 139

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               69  N*3/2(2420) BRANCHING RATIOS (PROD. EXP.)

R1      N*3/2(2420) INTO (PI N)/TOTAL                           (P1)
R1           (0.067)        APPROX      DIDDENS   63 CNTR    ASSUMING J=11/2    7/66
R1            0.113    0.0036           CITRON    66 CNTR    ASSUMING J=11/2    7/66
R1   B       (0.12)                     BARGER    67 FIT     ASSUMING J=11/2   11/67
R1   D       (0.163)                    DIKMEN    67 FIT     ASSUMING J=11/2   11/67
R1   D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.06)                     KORMANYOS 67 CNTR    ASSUMING J=11/2   11/67

R2      N*3/2(2420) INTO (PI N)*(NEUTRON PI+ PI+)/(TOTAL**2)
R2                                                      (P1*P4)
R2            0.0195   0.0048           GALLOWAY  68 RVUE                       6/68

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                              REFERENCES FOR N*3/2(2420) (PROD. EXP.)

DIDDENS  63 PRL 10 262          +JENKINS, KYCIA, RILEY                   (BNL) I
ALVAREZ  64 PRL 12 710          +BAR-YAM,KERN,LUCKEY,OSBORNE, +   (MIT,CEA)
HOHLER   64 PL 12 149           G HOHLER, J GIESECKE             (KARLSRUHE) I
WAHLIG   64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +   (MIT)
BARGER   66 PR 151 1123         V BARGER, M OLSSON                       (WISC)
CITRON   66 PR 144 1101         +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I

BARGER   67 PR 155 1792         V BARGER, D CLINE                       (WISC) P
DIKMEN   67 PRL 18 798          F N DIKMEN                              (MICH)
KORMANYO 67 PR 164 1661         KORMANYOS, KRISCH, OFALLON, +     (MICH,ANL) P
GALLOWAY 68 PL 26B 334          K F GALLOWAY                          (INDIANA) I

                              PAPERS NOT REFERRED TO IN DATA CARDS

BAACKE   67 NC 51A 761          J BAACKE, M VVERT            (KARLSRUHE,ORSAY)J-L
DOBROWOL 67 PL 24B 293          DOBROWOLSKI,GUSKOV,LIKHACHEV, +     (DUBNA) P
DOLEN    68 PR 166 1768         R DOLEN, D HORN, C SCHMID              (CIT)
WAHLIG   68 PR 168 1515         M A WAHLIG, I MANNELLI           (MIT,PISA)
    FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
    CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
    COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.

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>2500 MEV REGION - FORMATION EXPERIMENTS

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               127  N*3/2(>2500) I=3/2

               WE LIST HERE I=3/2 RESONANCES WITH MASS GREATER THAN
               ABOUT 2.5 GEV WHICH HAVE BEEN SEEN IN A SINGLE PARTIAL
               WAVE ANALYSIS ONLY.  ALL RESONANCES WHICH HAVE BEEN
               OBSERVED IN >1 ANALYSIS AT ABOUT THE SAME MASS ARE
               GIVEN A SEPARATE LISTING WITH THE APPROPRIATE QUANTUM
               NUMBERS.

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               127  N*3/2(>2500) MASS  (MEV)

M          2850.     150.             HENDRY    78 MPWA    PI N  I311         12/79
M          3200.     200.             HENDRY    78 MPWA    PI N  K313         12/79
M          3300.     200.             HENDRY    78 MPWA    PI N  L317         12/79
M          3700.     200.             HENDRY    78 MPWA    PI N  M319         12/79
M          4100.     300.             HENDRY    78 MPWA    PI N  N321         12/79
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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               127  N*3/2(>2500) WIDTH  (MEV)

W           700.     200.             HENDRY    78 MPWA    PI N  I311         12/79
W          1000.     300.             HENDRY    78 MPWA    PI N  K313         12/79
W          1100.     300.             HENDRY    78 MPWA    PI N  L317         12/79
W          1300.     400.             HENDRY    78 MPWA    PI N  M319         12/79
W          1600.     500.             HENDRY    78 MPWA    PI N  N321         12/79
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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               127  N*3/2(>2500) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(>2500) INTO PI N                                 139+ 938

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               127  N*3/2(>2500) BRANCHING RATIOS

R1      N*3/2(>2500) INTO (PI N)/TOTAL                      (P1)              12/79
R1          0.06      0.02            HENDRY    78 MPWA    PI N  I311         12/79
R1          0.045     0.02            HENDRY    78 MPWA    PI N  K313         12/79
R1          0.03      0.01            HENDRY    78 MPWA    PI N  L317         12/79
R1          0.025     0.01            HENDRY    78 MPWA    PI N  M319         12/79
R1          0.018     0.01            HENDRY    78 MPWA    PI N  N321         12/79
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                         REFERENCES FOR N*3/2(>2500)

HENDRY   78 PRL 41 222          ARCHIBALD W. HENDRY                  (IND+LBL)IJP
    ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                        (IND)IJP

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Δ(2750) → 125 N*3/2(2750, JP=13/2-) I=3/2 **I_{313}**

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               125  N*3/2(2750) MASS  (MEV)

M          2650.     100.             HENDRY    78 MPWA    PI N TO PI N     12/79
M          2794.      80.             HOEHLER   79 IPWA    PI N TO PI N     12/79
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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               125  N*3/2(2750) WIDTH  (MEV)

W           500.     100.             HENDRY    78 MPWA    PI N TO PI N     12/79
W           350.     100.             HOEHLER   79 IPWA    PI N TO PI N     12/79
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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               125  N*3/2(2750) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      N*3/2(2750) INTO PI N                                  139+ 938

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               125  N*3/2(2750) BRANCHING RATIOS

R1      N*3/2(2750) INTO (PI N)/TOTAL                       (P1)              12/79
R1          0.05      0.01            HENDRY    78 MPWA    PI N TO PI N     12/79
R1          0.04      0.015           HOEHLER   79 IPWA    PI N TO PI N     12/79
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                         REFERENCES FOR N*3/2(2750)

HENDRY   78 PRL 41 222          ARCHIBALD W. HENDRY                  (IND+LBL)IJP
    ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                        (IND)IJP
HOEHLER  79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                +KAISER,KOCH,PIETARINEN            /KARLSRUHE IJP
    ALSO 80  TORONTO CONF 3     R.KOCH                             (KARLSRUHE)IJP

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Δ(2850) BUMPS

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85  N*3/2(2850, JP=     ) I=3/2  PRODUCTION EXPERIMENTS

               85  N*3/2(2850) MASS (MEV) (PROD. EXP.)

M         (2870.0)                 HOHLER    64 RVUE    DATA + DISP REL
M         (2700.0)       APPROX    WAHLIG    64 CSPK  0 PI-P CH EX
M         (2850.0)                 BARDADIN  66 HBC  ++ N* TO P + 3 PIS   7/66
M          2850.0    12.0          CITRON    66 CNTR    PI+ P TOTAL       7/66
M         (2883.)   (26.)   (28.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74

               85  N*3/2(2850) WIDTH (MEV) (PROD. EXP.)

W         (150.0)                  BARDADIN  66 HBC  ++                   7/66
W          400.0    40.0           CITRON    66 CNTR                      7/66
W         (380.)   (141.)  (201.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74

               85  N*3/2(2850) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      N*3/2(2850) INTO PI N                            139+ 938
P2      N*3/2(2850) INTO P PI PI PI                      938+ 139+ 139+ 139
P3      N*3/2(2850) INTO N PI PI                         938+ 139+ 139

               85  N*3/2(2850) BRANCHING RATIOS (PROD. EXP.)

R1      N*3/2(2850) INTO (PI N)/TOTAL                    (P1)
R1    ONLY ((J+1/2)*(PI N/TOTAL)) MEASURED FOR THIS STATE
R1  B        (0.224)  (0.016)        BARGER    66 RVUE    TOTAL + CH EXC.  11/67
R1        -  0.261     0.048         CITRON    66 CNTR    TOTAL CROSS.SEC. 11/67
R1  B        (0.40)                  BARGER    67 RVUE    USES KORMANYOS66 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  C        (0.49)                  DIKMEN    67 RVUE    USES KORMANYOS67 11/67
R1  C  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.39)                  DOBROWOLS 67 CNTR    PI+P AT 180 DEG
R1           (0.10)                  KORMANYOS 67 CNTR    PI-P AT 180 DEG. 11/67
R1  D        (0.06) OR LESS  CL=.95  HALDORSE  72 HBC     PP  19  GEV/C    12/72
R1  D   UPPER LIMIT ON ELASTICITY.ALSO FIND J=9/2 OR MORE.
R1           (0.28)   (0.13)   (0.19) REY      74 MPWA ++ PI+ P 180 DEG CS 10/74
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                         REFERENCES FOR N*3/2(2850) (PROD. EXP.)

HOHLER    64 PL  12 149          G HOHLER, J GIESECKE              (KARLSRUHE) I
WAHLIG    64 PRL 13 103          +MANNELLI,SODICKSON,FACKLER,WARD, +    (MIT)
BARDADIN  66 PL  21 357          BARDADIN-OTWINOWSKA,DANYSZ, +        (WARSAW)
BARGER    66 PR  151 1123        V BARGER, M OLSSON                     (WISC)
CITRON    66 PR  144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I

BARGER    67 PR  155 1792        V BARGER, D CLINE                    (WISC) P
DIKMEN    67 PRL 18 798          F N DIKMEN                             (MICH)
DOBROWOL  67 PL  24B 203         DOBROWOLSKI,GUSKOV,LIKHACHEV, +     (DUBNA) P
KORMANYO  67 PR  164 1661        KORMANYOS, KRISCH, OFALLON, +    (MICH,ANL) P
HALDORSE  72 NC  10A 468         HALDORSEN,JACOBSEN                   (OSLO) IJ
REY       74 PRL 32 908          REY,LENNOX,POIRIER,PRETZL       (NDAM+MPIM)IP
     ALSO 74 PRL 33 250          REY,LENNOX,POIRIER,PRETZL       (NDAM+MPIM)IP
     ALSO 75 PRD 11 1777         LENNOX,POIRIER,REY,SANDER+  (NDAM+FNAL+ANL)IP

                         PAPERS NOT REFERRED TO IN DATA CARDS

BAACKE    67 NC  51A 761         J BAACKE, M YVERT          (KARLSRUHE,ORSAY)J-L
DOLEN     68 PR  166 1769        R DOLEN, D HORN, C SCHMID              (CIT)
WAHLIG    68 PR  168 1515        M A WAHLIG, I MANNELLI             (MIT,PISA)
   FINAL VERSION OF DATA USED IN WAHLIG 64.  IN CONJUNCTION WITH
   CITRON 66 TOTAL CROSS SECTIONS, THIS CHARGE EXCHANGE DATA GIVES
   COMPLEX ELASTIC SCATTERING AMPLITUDE AT 0 DEGREES.
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Δ(2950) → K315

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126  N*3/2(2950, JP=15/2+) I=3/2

               126  N*3/2(2950) MASS  (MEV)

M          2850.      100.            HENDRY    78 MPWA    PI N TO PI N     12/79
M          2990.      100.            HOEHLER   79 IPWA    PI N TO PI N     12/79
M          . . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

               126  N*3/2(2950) WIDTH  (MEV)

W           700.      200.            HENDRY    78 MPWA    PI N TO PI N     12/79
W           330.      100.            HOEHLER   79 IPWA    PI N TO PI N     12/79
W          . . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

               126  N*3/2(2950) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      N*3/2(2950) INTO PI N                            139+ 938

               126  N*3/2(2950) BRANCHING RATIOS

R1      N*3/2(2950) INTO (PI N)/TOTAL                    (P1)              12/79
R1             0.03       0.01        HENDRY    78 MPWA    PI N TO PI N    12/79
R1             0.04       0.02        HOEHLER   79 IPWA    PI N TO PI N    12/79
R1          . . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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                         REFERENCES FOR N*3/2(2950)

HENDRY    78 PRL 41 222          ARCHIBALD W. HENDRY                (IND+LBL)IJP
     ALSO 80  TORONTO CONF 113 ARCHIBALD W. HENDRY                     (IND)IJP
HOEHLER   79 HANDBOOK OF PI-N SCATTERING, PHYSIK DATEN VOL.12-1
                                 +KAISER,KOCH,PIETARINEN           /KARLSRUHE IJP
     ALSO 80  TORONTO CONF 3     R.KOCH                            (KARLSRUHE)IJP
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Δ(3230) BUMPS

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86  N*3/2(3230, JP=     ) I=3/2  PRODUCTION EXPERIMENTS

               86  N*3/2(3230) MASS (MEV) (PROD. EXP.)

M         (3230.0)                  CITRON    66 CNTR    PI+ P TOTAL       7/66
M         (3296.)    (79.)   (78.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74

               86  N*3/2(3230) WIDTH (MEV) (PROD. EXP.)

W         (440.0)                   CITRON    66 CNTR                      7/66
W         (687.)   (1043.)  (323.)  REY       74 MPWA ++ PI+ P 180 DEG CS 10/74

               86  N*3/2(3230) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      N*3/2(3230) INTO PI N                            139+ 938
P2      N*3/2(3230) INTO N PI PI                         938+ 139+ 139

               86  N*3/2(3230) BRANCHING RATIOS

R1      N*3/2(3230) INTO (PI N)/TOTAL                    (P1)
R1    ONLY ((J+1/2)*(PI N/TOTAL)) MEASURED FOR THIS STATE
R1  B        (0.03)   (0.01)         BARGER    66 RVUE    TOTAL + CH EXC.  11/67
R1           (0.06)                  CITRON    66 CNTR    TOTAL CROS. SEC. 11/67
R1  B        (0.03)  TO  0.1         BARGER    67 CNTR    USES KORMANYOS66 11/67
R1  B  USES REGGE AMP.+RESON. TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGRE
R1  B  FOR CRITICISM OF THIS METHOD, SEE DOLEN 68.
R1  D        (0.25)                  DIKMEN    67 RVUE    USES KORMANYOS67 11/67
R1  D  USES ONLY RESONANCES TO CALCULATE DIF. CROSS SECTIONS AT 180 DEGREES
R1           (0.45)   (0.09)   (0.13) REY      74 MPWA ++ PI+ P 180 DEG CS 10/74
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                         REFERENCES FOR N*3/2(3230) (PROD. EXP.)

BARGER    66 PR  151 1123        V BARGER, M OLSSON                     (WISC)
CITRON    66 PR  144 1101        +GALBRAITH,KYCIA,LEONTIC,PHILLIPS, +  (BNL) I
BARGER    67 PR  155 1792        V BARGER, D CLINE                    (WISC) P
DIKMEN    67 PRL 18 798          F N DIKMEN                             (MICH)
REY       74 PRL 32 908          REY,LENNOX,POIRIER,PRETZL       (NDAM+MPIM)IP
     ALSO 74 PRL 33 250          REY,LENNOX,POIRIER,PRETZL       (NDAM+MPIM)IP
     ALSO 75 PRD 11 1777         LENNOX,POIRIER,REY,SANDER+  (NDAM+FNAL+ANL)IP

                         PAPERS NOT REFERRED TO IN DATA CARDS

KORMANYO  67 PR  164 1661        KORMANYOS, KRISCH, OFALLON, +    (MICH,ANL) P
DOLEN     68 PR  166 1768        R DOLEN, D HORN, C SCHMID              (CIT)
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EXOTIC NUCLEONS - 1400-1700 MEV REGION

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               EX(1400-1700, JP=     ) I=5/2

               THIS IS NOT A COMPLETE LIST.  WE TABULATE
               ONLY FROM 1970 ON.

               IN A MISSING MASS EXPERIMENT, PI+ P TO PI- X+++,
   BIRULEV 71 FIND NO EVIDENCE FOR EXOTIC (I=5/2) RESONANCES IN THE
   MASS INTERVAL 1.2 TO 2.2 GEV.

               EX(1400-1700) MASS (MEV)

M   A   29 1627.      12.          PRICE     70 DBC  -- K-0 AT 4.91GEV/C  3/71
M   A  FOUR S. D. EFFECT
M   C   25 1400.      12.          ABDIVALI  79 HBC  +++NP TO NP 4PI      2/82*
M   C   CROSS-SECTION IS QUOTED AS 25 MICROBARNS. DECAYS TO DELTA++ PI+

               EX(1400-1700) WIDTH (MEV)

W   B   29    30.   OR LESS  CL=.90  PRICE     70 DBC  -- PI-PI-N BUMP    3/71
W   B  CROSS SECTION 13.0+-3.9 MICROBARNS
W   C   25    43.                    ABDIVALI  79 HBC  +++NP TO NP 4PI    2/82*

               EX(1400-1700) CROSS SECTION LIMITS (MICROBARN)

CS  B        40.    OR LESS          BANNER    70 OSPK +++ PI+P,1.9 GEV/C  7/70
CS  B   I=5/2 LIMIT GIVEN ABOVE IS FOR MASS RANGE 1540-1750 MEV
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                         REFERENCES FOR EX(1400-1700)

BANNER    70 NP  B15 205         +CHEZE,HAMEL,TEIGER,ZACCONE +       (SACLAY)
PRICE     70 PL  33B 533         +BERG,SALANT,WATERS,WEBSTER,WEINBERG (VAND)
ABDIVALI  79 SJNP 29 793         ABDIVALIEV,BESHLIU,GASPARYAN,GRUYA+  (JINR))

                         PAPERS NOT REFERRED TO IN DATA CARDS

AMMANN    71 PL   34B 533        +CARMONY,GARFINKEL,GUTAY,MILLER,YEN  (PURD)
BIRULEV   71 SJNP 12  536        +VOVENKO,GUSKOV,DOBROVOLSKII,++      (JINR)
JOHNSON   71 PL   34B 428        D JOHNSON                             (ANL)
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Note on the S = +1 Baryon System

The evidence for S = +1 baryons was thoroughly reviewed in our 1976 edition,[1] and has been reviewed more recently by Kelly[2] and by Oades.[3]

In the last few years the results of several new experiments have appeared. In particular, the K^+n charge-exchange polarization data of WATTS 80 (for references in this form, see the Listings that follow), the K^+n elastic polarization data of ROBERTSON 80, and the $K_L^0p \to K_S^0p$ data of CAMERON 78, ENGLER 78, and CORDEN 79 provided badly needed new constraints on the I = 0 KN amplitudes.

Three new phase-shift analyses have been reported since our last edition. Energy-independent analyses were made by *Martin and Oades*[4] in the I=0 and I=1 KN channels, and by WATTS 80 in the I=0 and I=1 channels simultaneously. CORDEN 82 made an energy-dependent analysis of the I=0 channel.

All analyses agree there is little real evidence for classical Breit-Wigner Z^* resonances. The Argand diagrams for the P01 and P13 amplitudes exhibit counterclockwise movement, but there are no corresponding speed maxima. However, the parametrizations of MARTIN 75 and ARNDT 78 for the P13 amplitude do have unphysical-sheet poles. The recent low-energy K^+p elastic polarization data of LOVETT 81 can be well described either by the analysis of ARNDT 78 (which used preliminary data of LOVETT 81), or by other analyses not requiring structure in the P13 amplitude.

The multi-quark states predicted by Jaffe[5] in the MIT bag model should be most easily observed in the KN system. Jaffe and Low[6] showed that such multi-quark states need not appear as classical resonances in hadron-hadron scattering. Rather they would manifest themselves as poles in the P-matrix, which connects the discrete quark states inside the bag with the physical scattering states outside. De Swart et al.[7] have predicted the low-lying multi-quark states which might be seen in the KN channel, and Roiesnel[8] (using the partial-wave analysis of MARTIN 75) and CORDEN 82 have found such P-matrix poles. However, the agreement with the predictions of de Swart et al. is not completely compelling.

References

1. Particle Data Group, Rev. Mod. Phys. 48, S188 (1976).
2. R.L. Kelly, in Proceedings of the Meeting on Exotic Resonances (HUPD-7813) (Hiroshima, 1978), ed. I. Endo et al.
3. G.C. Oades, in Low and Intermediate Energy Kaon-Nucleon Physics (1981), ed. E. Ferrari and G. Violini.
4. B.R. Martin and G.C. Oades, in Proceedings of the IVth International Conference on Baryon Resonances (Toronto, 1980), ed. N. Isgur.
5. R.L. Jaffe, Phys. Rev. D15, 267 (1977).
6. R.L. Jaffe and F.E. Low, Phys. Rev. D19, 2105 (1979).
7. J.J. de Swart et al., in Proceedings of the IVth International Conference on Baryon Resonances (Toronto, 1980), ed. N. Isgur.
8. C. Roiesnel, Phys. Rev. D20, 1646 (1979).

S=1 I=0 EXOTIC STATES (Z_0)

Z_0(1780) → **P_{01}**

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55  Z*0(1780, JP=1/2+) I=0

SEE THE MINI-REVIEW PRECEDING THIS LISTING.

WILSON 72 AND GIACOMELLI 74 FIND SOME SOLUTIONS
WITH RESONANT-LIKE BEHAVIOR IN THE P01 PARTIAL WAVE.
THE EFFECT SEEN IN THE I=0 TOTAL CROSS SECTIONS.
IF A RESONANCE, MUST HAVE SPIN=1/2, BECAUSE THE
INELASTIC CROSS SECTION IS VERY SMALL AND THE TOTAL
CROSS SECTION IS ABOUT 4*PI/K**2.

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        55  Z*0(1780) MASS (MEV)

M          1780.0     10.0          COOL      70 CNTR +  K+P, D TOTAL      1/71
M   D      SEEN                     DOWELL    70 CNTR     K+P,D TOTAL      7/70
M   D      SEE ALSO DISCUSSION OF LYNCH 70                                 7/70
M   W     (1830.)                   WILSON    72 PWA     K+N P01 WAVE      3/72
M   W   ESTIMATE OF PARAMETERS FROM BW + QUADRATIC BACKGROUND FIT TO P01.  3/72
M   1     (1750.)                   CARROLL   73 CNTR    KN I=0 TCS,FIT 1  9/73
M   1     (1825.)                   CARROLL   73 CNTR    KN I=0 TCS,FIT 2  9/73
M   1   FIT 1=FIT OF SINGLE L=1 BW+BACKGROUND TO I=0 TCS FROM 0.4-1.1 GEV/C 9/73
M   1   FIT 2=FIT OF L=1 AND L=2 BWS TO SAME DATA,SEE Z0(1865) FOR L=2 PART 9/73
M         (1740.)                   GIACOMEL  74  PWA    .38-1.51 GEV/C   10/74

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        55  Z*0(1780) WIDTH (MEV)

W         (565.0)                   COOL      70 CNTR +  K+P, D TOTAL      1/71
W   W     (300.)                    WILSON    72 PWA     K+N P01 WAVE      3/72
W   1     (600.)                    CARROLL   73 CNTR    KN I=0 TCS,FIT 1  9/73
W   1     (845.)                    CARROLL   73 CNTR    KN I=0 TCS,FIT 2  9/73
W         (330.)                    GIACOMEL  74  PWA    .38-1.51 GEV/C   10/74

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        55  Z*0(1780) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1      Z*0(1780) INTO K N                            493+ 939

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        55  Z*0(1780) BRANCHING RATIOS

R1      Z*0(1780) INTO (K N)/TOTAL                      (P1)
R1         (0.95)                   COOL      70 CNTR +  K+P, D TOTAL      1/71
R1  W      (0.85)                   WILSON    72 PWA     K+N P01 WAVE      3/72
R1  1      (0.75)                   CARROLL   73 CNTR    IF J=1/2,FIT 1    9/73
R1  1      (0.91)                   CARROLL   73 CNTR    IF J=1/2,FIT 2    9/73
R1         (0.65)                   GIACOMEL  74  PWA    .38-1.51 GEV/C   10/74

*************************************************************************

        REFERENCES FOR Z*0(1780)

COOL      70 DUKE CONF 47     R L COOL                              (BNL)
    ALSO  69 PL 30B 564       ABRAMS,COOL,GIACOMELLI,KYCIA,LI +     (BNL)
    ALSO  70 PR D1 1887       COOL,GIACOMELLI,KYCIA,LEONTIC,LI +    (BNL)
DOWELL    70 DUKE 53          J.D. DOWELL                          (BIRM)
WILSON    72 NP B42 445       +GRIFFITHS,MERATA +    (BGNA+GLAS+ROMA+TRST)
CARROLL   73 PL 45B 531       +KYCIA,LI,MICHAEL,MOCKETT,RAHM+       (BNL))
GIACOMEL  74 NP B71 138       GIACOMELLI,+           (BGNA+CLAS+ROMA+TRST)IJP
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                                 PAPERS NOT REFERRED TO IN DATA CARDS

LYNCH     70 DUKE 9                 G LYNCH (REVIEWER OF CR.SEC. DATA)     (LRL)
HIRATA    71 NP B30 157             +GOLDHABER,HALL,SEEGER,THRILLING,WOHL  (LBL)IJP
BOWEN     73 PR D7 22               +JENKINS,KALBACH,PETERSEN +       (ARIZ+MICH)
JOHNSON   74 PL 50B 343             JOHNSON,VLASSOPULOS               (CERN,DURH)
CAMERON   75 PALERMO CONF.          +CAPILUPPI+      (BGNA+EDIN+GLAS+PISA+RHEL)IJP
BIGI      76 NP B110 25             +CAMERON+        (BGNA+EDIN+CLAS+PISA+RHEL)IJP
ROTESNEL  79 PRD 20 1646            C. ROTESNEL                            (METT)
MARTIN    80 TORONTO CONF. 355      B.R.MARTIN,G.C.OADES              (LOUC+AARH)
OADES     81 ROME CONF. 53          LOW + INTERMEDIATE ENERGY KN PHYSICS (AARH)
CORDEN    82 PRD 25 720             +COX,KELSEY,LAWRENCE,WATKINS+     (BIRM+LPNP)

      EXPERIMENTS MAINLY ABOUT ELASTIC CHANNELS --
GOLDHABE  62 PRL 9 135              GOLDHABER,CHINOWSKY,GOLDHABER+    (LRL+UCLA)IJP
RAY       69 PR 183 1183            RAY,BURRIS,FISK,KRAEMER,HILL+       +CARN+BNL
ARMITAGE  72  NAL PAPER 391         +ASTON,DUERDOTH,ELLISON,  +       (MCHS+DARE)
GIACOMEL  72 NP B42 437             GIACOMELLI +               (BGNA+GLAS+ROMA+TRST)
GIACOMEL  73 NP B56 346             GIACOMELLI,+               (BGNA+GLAS+ROMA+TRST)
    ALSO  73 BGNA RPT. AE-73        GIACOMELLI,GRIFITHS,+ (BGNA+GLAS+ROMA+TRST)
LONDON    74 PRD 9 1569             LONDON                                (BNL)IJP
ADAMS     75 NP B87 41              +CARTER,COOK,GLASS,GREEN               (WASH)
ALEXANDE  75 PL 58B 484             ALEXANDER,BAR-NIR,BENARY+         (TELA+HEID)IJP
DAMERELL  75 NP B94 374             +HOTCHKISS,WICKENS,BENTLEY+       (RHEL,BIRM)
CAMERON   78 NP B132 189            +CAPILUPPI+       (BGNA+EDIN+GLAS+PISA+RHEL)
ENGLER    78 PRD 18 3061            +KEYES,KRAEMER,TANAKA,CHO+         (CARN+ANL)
    ALSO  76 PL 60B 293             CHO,DERRICK,MILLER,SMITH,ENGLER+ (ANL+CARN)
CORDEN    79 NP B155 13             +COX,KELSEY,LAWRENCE,WATKINS+     (BIRM+LPNP)

      EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS --
GIACOMEL  72 NP B37 577             GIACOMELLI +               (BGNA+GLAS+ROMA+TRST)
EDELSTEI  76 PRD 14 702             EDELSTEIN,FISK,JOSEPH+         (CARN+IOWA+ANL)
ARMITAGE  77 NP B123 11             +ASTON,DUERDOTH,ELLISON,FITTON+ (MCHS+DARE)
GLASSER   77 PRD 15 1200            +SNOW,TREVVETT,BURNSTEIN,FU,PETRI+(UMD+IIT)
SAKITT    77 PRD 15 1846            +SKELLY,THOMPSON                        (BNL)
ROBERTSO  80 PL 91B 465             ROBERTSON,ASTBURY,GRAYER,SHAW+   (RHEL+LOQM)
WATTS     80 PL 95B 323             +BUGG,CARTER,COUPLAND+            (LOQM+RHEL)
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$Z_0(1865)$ — D_{03}

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96  Z*0(1865, JP=3/2-) I=0

THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K* N
THRESHOLD.  SEE HIRATA 68 AND 70.  WILSON 72 AND
GIACOMELLI2 73 REPORT PARTIAL WAVE ANALYSES.
AARON 73 CLAIMS A RESONANCE IN A MODEL DEPENDENT
PWA.  SEE ALSO Z*0(1780).

                   96  Z*0(1865) MASS (MEV)

M          (1860.0)   (15.0)          CARTER     67 THEO    DISPERSION REL.   8/67
M          (1868.0)   (10.0)          COOL       70 CNTR    K+P, 0 TOTAL      8/67
M          (1830.)                    AARON      73 MPWA    I=0 KN .6-1.6G/C  9/73
M     1    (1840.)                    CARROLL    73 CNTR    KN I=0 TCS,FIT 2  9/73
M     1  FIT2=FIT OF L=1 AND L=2 BWS TO I=0 TCS FROM 0.4-1.1 GEV/C.           9/73
M     1  SEE Z0(1780) FOR FIT 1 AND L=1 PART OF FIT 2.                        9/73

                   96  Z*0(1865) WIDTH (MEV)

W           (200.0)   (50.0)          CARTER     67 THEO                      8/67
W           (160.0)   (30.0)          COOL       70 CNTR                      8/67
W           (100.)                    AARON      73 MPWA    I=0 KN .6-1.6G/C  9/73
W     1      (75.)                    CARROLL    73 CNTR    KN I=0 TCS,FIT 2  9/73

                   96  Z*0(1865) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1       Z*0(1865) INTO K N                              493+ 939
P2       Z*0(1865) INTO N K*(892)                        938+ 891

                   96  Z*0(1865) BRANCHING RATIOS

R1       Z*0(1865) INTO (K N)/TOTAL                      (P1)
R1           (0.155)  (0.025)         CARTER     67 THEO    IF J=3/2          9/73
R1           (0.115)  (0.025)         COOL       70 CNTR    IF J=3/2          9/73
R1    1      (0.085)                  CARROLL    73 CNTR    IF J=3/2,FIT 2    9/73

R2       Z*0(1865) INTO (N K*(892))/TOTAL                (P2)
R2              MAIN INELASTIC DECAY   HIRATA    68 HBC                      11/68
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                             REFERENCES FOR Z*0(1865)

CARTER    67 PRL 19 801             A A CARTER                      (CAVENDISH)
HIRATA    68 PRL 21 1485            HIRATA, WOHL, GOLDHABER, TRILLING     (LRL)
COOL      70 PR D1 1887             COOL,GIACOMELLI,KYCIA,LEONTIC,LI +    (BNL)
    ALSO  66 PRL 17 102             +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    ALSO  69 PL 30B 564             ABRAMS,COOL,GIACOMELLI,KYCIA,LI +     (BNL)
AARON     73 PRD 7 1401             AARON,RICH,HOGAN,SRIVASTAVA     (LASL+NEAS)IJP
CARROLL   73 PL 45B 531             +KYCIA,LI,MICHAEL,MOCKETT,RAHM+       (BNL)I

                             PAPERS NOT REFERRED TO IN DATA CARDS

HIRATA    70 DUKE   479             +GOLDHABER,SEEGER,TRILLING+WOHL        (LRL)
AARON     71 PRL 26 407             +AMADO+SILBAR               (NEAS,PENN,LASL)IJP
HIRATA-1  71 NP B33 445             +GOLDHABER,HALL,SEEGER,TRILLING,WOHL  (LBL)
GIACOMEL  72 NP B37 577             GIACOMELLI +               (BGNA+GLAS+ROMA+TRST)
WILSON    72 NP B42 445             +GRIFFITHS,HIRATA +    (BGNA+GLAS+ROMA+TRST)
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S=1 I=1 EXOTIC STATES (Z_1)

$Z_1(1900)$ — P_{13}

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97  Z*1(1900, JP=3/2+) I=1

THIS EFFECT IS STRONGLY ASSOCIATED WITH THE K-DELTA
THRESHOLD.  SEE THE MINIREVIEW PRECEDING Z*0(1780)

                   97  Z*1(1900) MASS (MEV)

M    1     (1932.0)                   AYED       70 IPWA    P13,SOL.I         6/70
M    1     (1899.0)                   AYED       70 IPWA    P13,SOL.II        6/70
M    1     (2030.0)                   AYED       70 IPWA    S11,SOL.III       6/70
M    1      THREE SOLNS IN ORDER OF DECREASING SIGNIFICANCE. THOUGH AYED 70
M    1      GIVE PARAMETERS,THEY CONCLUDE RESONANT INTERPRETATION DOUBTFUL.
M     2    (1830.)                    BARNETT    70 IPWA    P13,SOLN III      9/73
M    2      RESONANCE SIGNAL BARELY ABOVE BACKGROUND DUE TO THE LARGE ERRORS
M    2      IN THE AMPLITUDES RESULTING FROM THE ANALYSIS
M           1900.0       10.0         COOL       70 CNTR ++ K+P TOTAL         1/71
M          (1880.)                    ALBROW     71 IPWA ++  SOL. GAMMA      10/71
M    K     (1890.)                    KATO       71 IPWA    SOL  I(FIT BW)   10/71
M    K     (2040.)                    KATO       71 IPWA    SOL II(FIT BW)   10/71
M    K   KATO 71 ESTIMATE RESONANCE PARAMETERS -- UPDATED PHASE SHIFTS        3/72
M    K   PUBLISHED IN MILLER 72.                                              3/72

                   97  Z*1(1900) WIDTH (MEV)

W    1      (520.0)                   AYED       70 IPWA    K+P               6/70
W    1      (397.0)                   AYED       70 IPWA    K+P               6/70
W    1      (557.0)                   AYED       70 IPWA    K+P               6/70
W     2     (120.)                    BARNETT    70 IPWA    P13,SOLN III      9/73
W           (240.0)                   COOL       70 CNTR ++ K+- TOTAL         1/71
W           (190.)                    ALBROW     71 IPWA ++ SOL. GAMMA       10/71
W    K      (280.)                    KATO       71 IPWA    SOL  I(FIT BW)   10/71
W    K      (260.)                    KATO       71 IPWA    SOL II(FIT BW)   10/71
       SEE THE NOTES ACCOMPANYING MASSES QUOTED.

                   97  Z*1(1900) REAL PART OF POLE POSITION                   4/75

RE          (1787.)                   ARNDT      74 DPWA    K+ P ELASTIC      4/75
RE   3      (1796.)                   ARNDT      78 DPWA    K+ P              3/79
RE   3   SUPERSEDES ARNDT 74.                                                 3/79

                   97  Z*1(1900) -IMAGINARY PART OF POLE POSITION             4/75

IM          (100.)                    ARNDT      74 DPWA    K+ P ELASTIC      4/75
IM   3      (101.)                    ARNDT      78 DPWA    K+ P              3/79

                   97  Z*1(1900) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1       Z*1(1900) INTO K N                              493+ 939
P2       Z*1(1900) INTO N*3/2(1232) K                   1232+ 493

                   97  Z*1(1900) BRANCHING RATIOS

R1       Z*1(1900) INTO (K N)/TOTAL                      (P1)
R1           (0.10) OR LESS           CARTER     67 THEO    DISPERSION REL.   8/67
R1   1       (0.16)                   AYED       70 IPWA                      6/70
R1   1       (0.20)                   AYED       70 IPWA                      6/70
R1   1       (0.17)                   AYED       70 IPWA                      6/70
R1    2      (0.12)                   BARNETT    70 IPWA    P13,SOLN III      9/73
R1           (0.12) (ASSUMING J=3/2)  COOL       70 CNTR ++ K+P TOTAL         1/71
R1           (0.15)                   ALBROW     71 IPWA ++ SOL. GAMMA       10/71
R1   K       (0.22)                   KATO       71 IPWA    SOL  I(FIT BW)   10/71
R1   K       (0.27)                   KATO       71 IPWA    SOL II(FIT BW)   10/71

       SEE NOTES ACCOMPANYING THE MASSES QUOTED.

R2       Z*1(1900) INTO (K N*3/2(1232))/TOTAL            (P2)
R2              MAIN INELASTIC DECAY    BLAND     67 HBC  ++                   8/67
R2        NO EVIDENCE, SPEED HAS MINIM. GRIFFITHS 72 HBC    K+P .9-1.5 GEV/C  3/72
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                             REFERENCES FOR Z*1(1900)

BLAND     67 PRL 18 1077            +BOWLER,BROWN,G+S GOLDHABER,SEEGER,+  (LRL)
CARTER    67 PRL 18 801             A A CARTER                      (CAVENDISH)

AYED      70 PL 32B 404             +BAREYRE, FELTESSE, VILLET      (SACLAY)IJP
BARNETT   70 U MD.RPT 70-101        BARNETT,GOLDMAN,LAASANEN,STEINBERG   (UMD)IJP
    ALSO  70 DUKE 443               BARNETT,GOLDMAN,LAASANEN,STEINBERG   (UMD)IJP
COOL      70 PR D1 1887             +GIACOMELLI, KYCIA, LEONTIC, LI, +   (BNL) I
    ALSO  66 PRL 17 102             COOL,GIACOMELLI,KYCIA,LEONTIC,LI +   (BNL)

ALBROW    71 NP  B30 273            +ANDERSON,ALMEHED....,UDO,WAGNER    (CERN)IJP
    ALSO  70 DUKE  375              ERNE,SENS,WAGNER                    (CERN)IJP
KATO      71 H.E.PHEN.,MORIOND      +KOEHLER....,YOKOSAWA+BURLESON (ANL,NWES)IJP
    ALSO  70 DUKE 367               A. YOKOSAWA                          (ANL)IJP
    ALSO  70 PRL 24 615             KATO,KOEHLER,NOVEY,YOKOSAWA+   (ANL,NWES)IJP

GRIFFITH  72 NP B38 365             +HIRATA,HUGHES +       (BGNA+GLAS+ROMA+TRST)
MILLER    72 NP B37 401             +NOVEY,YOKOSAWA,CUTKOSKY +  (ANL+CARN+NWES)IJP

ARNDT     74 PRL 33 987             ARNDT,HACKMAN,ROPER,STEINBERG     (VPI,UMD)IJP
ARNDT     78 PRD 18 3278            ARNDT,ROPER,STEINBERG             (VPI,UMD)
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                         PAPERS NOT REFFERED TO IN Z*1 DATA CARDS

     TOTAL-CROSS-SECTION EXPERIMENTS ---
BUGG     68 PR 168 1466         +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
BOWEN    70 PR D2 2599          +CALDWELL, DIKMEN, JENKINS, KALBACH,+(ARIZ) I
BOWEN    73 PR D7 22            +JENKINS,KALBACH,PETERSEN +      (ARIZ+MICH)
CARROLL  73 PL 45B 531          +KYCIA,LI,MICHAEL,MOCKETT,RAHM+        (BNL)

     A K-MATRIX ANALYSIS OF SOME OF THE EARLY K+P DATA ---
HITE     67 THESIS              G E HITE                         (ILLINOIS)

     THEORETICAL AND MODEL DEPENDENT ANALYSES
CARRERAS 70 NP B19 349          B CARRERAS, A DONNACHIE   (DARESBURY, MCHS)
ALCOCK   73 NP B56 3CL          ALCOCK,COTTINGHAM                   (BRIS)IJP
ALCOCK   76 NP B102 173         ALCOCK,COTTINGHAM,DAVIS             (BRIS)IJP
ALCOCK   78 J.PHYS. G 4 323     ALCOCK,COTTINGHAM,DAVIS             (BRIS)IJP
ROIESNEL 79 PRD 20 1646         C. ROIESNEL                            (MIT)

     EXPERIMENTS MAINLY ABOUT INELASTIC CHANNELS ---
BLAND    68 UCRL-18131 THESIS R W BLAND                              (LRL)
BLAND    69 NP B13 595          +BOWLER, BROWN, KADYK, GOLDHABER, +   (LRL)
BLAND    70 NP B18 537          +BOWLER, BROWN, GOLDHABER.            (LRL)
    BLAND 69 AND BLAND 70 REPLACE BLAND 67 AND BLAND 68.
HIRATA-1 71 NP B33 445          +GOLDHABER,HALL,SEEGER,TRILLING,WOHL  (LBL)
BRUNET   72 NP B37 114          BRUNET,NARJOUX,DANYSZ+(CDEF+SACL+LOIC+LOWC)
GRIFFITH 72 NP B38 365          +HIRATA,HUGHES,JACOBS+(BGNA,GLAS,ROMA,TRST)IJP
LOKEN    72 PR D6 2346          +BARISH,GOMEZ,DAVIES,SCHLEIN,+   (CIT,UCLA)
BERTHON  73 NP B63 54           BERTHON,MONTANET,PAUL,SAETRE+   (CERN+SACL)
LEWIS    73 NP B60 283          LEWIS,ALLEN,JACOBS,DANYSZ+ (LOWC+LOIC+CDEF)
LESQUOY  75 NP B99 346          +MULLER,TRIANTIS,BERTHON+       (SACL+CERN)IJP
MUSGRAVE 75 NP B87 365          +PEETERS,SCREINER,WHITMORE,YUTA       (ANL)
GIACOM-2 76 NP B111 365         GIACOMELLI+MANDRIOLI+ (BGNA+GLAS+ROMA+TRST)
ARMITAGE 77 NP B123 11          +ASTON,DUERDOTH,ELLISON,FITTON+ (MCHS+DARE)
GLASSER  77 PRD 15 1200         +SNOW,TREVVETT,BURNSTEIN,FU,PETRI+(UMD+IIT)
SAKITT   77 PRD 15 1846         +SKELLY,THOMPSON                       (BNL)

     THE MAIN ELASTIC SCATTERING AND POLARIZATION EXPERIMENTS --
CARROLL  68 PRL 21 1282         +FISCHER, LUNDBY, PHILLIPS, +    (BNL,ROCH)
ANDERS-1 69 PL 28B 611          ANDERSSON, DAUM, ERNE, LAGNAUX, +    (CERN)
ANDERS-2 69 PL 30B 56           ANDERSSON, DAUM, ERNE, LAGNAUX, +    (CERN)
ASBURY   69 PRL 23 194          +DOWELL, KATO, LUNDQUIST, NOVEY, +(ANL,UMD)
BLAND    69 PL 29B 618          R W BLAND, G GOLDHABER, G H TRILLING  (LRL)
BARBER   70 PL 32B 214          +BROOME, DUFF, HEYMANN, IMRIE,+ (LOUC,RHEL)IJP
GIACOMEL 70 NP B20 301          GIACOMELLI, GRIFFITHS,(BGNA,GLAS,ROMA,TRST)IJP
HALL     70 DUKE    435         +BLAND,GOLDHABER,TRILLING             (LRL)
REBKA    70 PRL 24 160          +ROTHBERG, ETKINS, GLODIS, +        (YALE)IJP
ADAMS    71 PR  D4 2637         +DAVIES,DOWELL,GRAYER,HATTERS+  (BIRM+RHEL)
BARNETT  71 PL 34C 655          +LAASANEN,STEINBERG +  (UMD+ANL+NWES+FNAL)
EHRLICH  71 PRL 26 925          +ETKIN,GLODIS,HUGHES,KONDO,LU,MORI+  (YALE)
WHITMORE 71 PR D3 1092          +ABRAMS,EISENSTEIN,KIM,OHALLORAN,+    (ILL)
ADAMS    72  NAL PAPER 326      +COX,DAVIES,DOWELL,GRAYER +     (BIRM+RHEL)
CHARLES  72 PL 40B 299          +COWAN,EDWARDS,GIBSON,+     (BRIS,RHEL,SHMP)
   ALSO  72  NAL PAPER 287      CHARLES,COWAN,EDWARDS +     (BRIS+RHEL+SHMP)
DANYSZ   72 NP B42 29           +PENNEY,STEWART,THOMPSON,+ (LOIC,CDEF,LOWC)
ADAMS    73 NP B66 36           ADAMS,COX,DAVIES,DOWELL,+       (BIRM+RHEL)IJP
BARBER   73 NP B61 125          BARBER,BROOME,BUSZA,DAVIES,DUFF+(LOUC+RHEL)
BARNETT  73 PRD 8 2751          BARNETT,LAASANEN+       (UMD+ANL+NWES+FNAL)
CHARLES  73 PURDUE CONF. 179    CHARLES,EDWARDS,+     (SHMP+AARH+RHEL+BRIS)
BURNSTEI 74 PRD 10 2767         BURNSTEIN,LEFEBVRE,PETERSEN,RUBIN+(IIT+UMD)
CAMERON  74 NP B78 93           CAMERON,HIRATA,JENNINGS,+  (GLAS,BGNA,TRST)IJP
YUTA     74 NP B81 189          YUTA,BOCK,MUSGRAVE,PEETERS,SCHREINER,+(ANL)I
ABE      75 PRD 11 1719         +BARNETT,GOLDMAN,LAASANEN+         (UMD,ANL)
ADAMS    75 NP B87 41           +CARTER,COOK,GLASS,GREEN              (WASH)
PATTON   75 PRL 34 975          +BARLETTA,EHRLICH,ETKIN+     (YALE,TOKY,BNL)
WATTS    80 PL 95B 373          +BUGG,CARTER,COUPLAND+           (LOQM+RHEL)
LOVETT   81 PRD 23 1924         +HUGHES,MISHINA,ZELLER+    (YALE+BNL+KYOTO)

     PARTIAL-WAVE ANALYSES (SEE ALSO ADAMS 73, CAMERON 74, AND ARNDT 78)
CARRERA1 70 NP B23 525          B CARRERAS, A DONNACHIE             (DARE)IJP
   ALSO  70 DUKE 447            +DONNACHIE,KIRSOPP          (DARE+MCHS+EDIN)
ERNE     70 DUKE 375            +SENS,WAGNER                        (CERN)IJP
LEA      71 NP  B26 413         +MARTIN,THOMPSON               (RHEL,LOUC)IJP
LOVELACE 71 NP  B28 141         +WAGNER                             (CERN)IJP
CUTKOSKY 72  NAL PAPER 210      +HICKS,KELLY,SMTH,JOHNSON    (CARN+ILL+ANL)
EHRLICH  72  NAL PAPER 447      +ETKIN,GLODIS,HUGHES,LU,PATTON +     (YALE)
MARTIN   72  PREPRINT           B.R.MARTIN, C.E.MILLER               (LOUC)
MARTIN   75 NP B94 413          B R MARTIN                           (LOUC)
CUTKOSKY 76 NP B102 139         CUTKOSKY,HICKS,KELLY,+       (CARN+IIT+ANL)IJP
GIACOM-1 76 NP B110 67          GIACOMELLI+MANDRIOLI            (BGNA+GLAS)IJP
MARTIN   80 TORONTO CONF. 355 B.R.MARTIN,G.C.OADES               (LOUC+AARH)

     EARLIER ANALYSES THAT DO NOT INCLUDE RECENT POLARIZATION DATA --
LEA      68 PR 165 1770         LEA, MARTIN, OADES           (RHEL,BNL,CERN)
MARTIN   68 PRL 21 1286         B R MARTIN                             (BNL)
CUTKOSKY 70 PR D1 2547          R E CUTKOSKY, B B DEO    (CARNEGIE-MELLON) I

     LATEST REVIEW TALKS AND PAPERS
LEVISETT 69 LUND CONF 341       R LEVI SETTI  (RAPPORTEUR)         (CHICAGO)
GOLDHABE 70 DUKE   407          G.GOLDHABER (REVIEWER)                 (LRL)
DOWELL   72  NAL REVIEW         REVIEW TALK IN BARYON SESSION         (BIRM)
LOVELACE 72  NAL REVIEW         RAPPORTEUR'S TALK                     (RUTG)
DOWELL   73 PURDUE CONF. 157  DOWELL                                  (BIRM)
CUTKOSKY 74 LONDON CONF II-54 CUTKOSKY                                (CARN)
KELLY    75 ANL-HEP-CP-75-58  REVIEW TALK IN BARYON SESSION            (LBL)
URBAN    75 PL 60B 77           URBAN                                  (LBL)
MARTIN   76 OXFORD CONF. 409  RAPPORTEUR'S TALK                       (LOUC)
KELLY    78 HUPD-7813 44        MTG. ON EXOTIC RESONANCES, HIROSHIMA   (LBL)
OADES    81 ROME CONF. 53       LOW + INTERMEDIATE ENERGY KN PHYSICS (AARH)

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$Z_1(2150)$ BUMPS →

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           53  Z*1(2150, JP=     ) I=1

           A SMALL BUMP IN TOTAL CROSS SECTION AT
           PK=1.8 GEV/C

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                    93  Z*1(2150) MASS (MEV)

M          2150.      20.             ABRAMS    70 CNTR ++ K+P TOTAL      10/71

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                    93  Z*1(2150) WIDTH (MEV)

I         (175.)                      ABRAMS    70 CNTR +  K+P TOTAL      10/71

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                    93  Z*1(2150) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Z*1(2150) INTO K N                               493+ 938

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                    93  Z*1(2150) BRANCHING RATIOS

R1      Z*1(2150) INTO (K N)/TOTAL                      (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1           (0.04)                   ABRAMS    70 CNTR +  K+P TOTAL      10/71

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                           REFERENCES FOR Z*1(2150)

ABRAMS   70 PR  D1 1917         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257           ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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$Z_1(2500)$ BUMPS →

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           94  Z*1(2500, JP=     ) I=1

           A SMALL BUMP IN TOTAL CROSS SECTION AT
           PK=2.7 GEV/C

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                    94  Z*1(2500) MASS (MEV)

M          2500.      20.             ABRAMS    70 CNTR ++ K+P TOTAL      10/71

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                    94  Z*1(2500) WIDTH (MEV)

W         (160.)                      ABRAMS    70 CNTR ++ K+P TOTAL      10/71

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                    94  Z*1(2500) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Z*1(2500) INTO K N                               493+ 938

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                    94  Z*1(2500) BRANCHING RATIOS

R1      Z*1(2500) INTO (K N)/TOTAL                      (P1)
R1        J IS NOT KNOWN, THE FOLLOWING IS (J+1/2)*P1
R1           (0.03)                   ABRAMS    70 CNTR ++ K+P TOTAL      10/71

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                           REFERENCES FOR Z*1(2500)

ABRAMS   70 PR  D1 1917         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI +   (BNL)
   ALSO 67 PRL 19 257           ABRAMS,COOL,GIACOMELLI,KYCIA,LEONTIC+ (BNL)

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Z_1 CROSS SECTION LIMITS

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       SEE MINIREVIEW PRECEDING Z*0

CS  UNITS MICROBARNS
CS         LESS THAN  50.              BASSOMPIE 68 HBC     K+P TO Z** PI+   10/69
CS  A LESS THAN 0.2   +0.3    -0.1   ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  A      ABOVE LIMIT FOR  M=1.2 TO 1.4 GEV -  CL= 95 P.C.
CS  B LESS THAN 1.4   +1.9    -0.5   ANDERSON  69 ASPK +  PI-P TO K-Z*+    10/69
CS  B      ABOVE LIMIT FOR  M=1.5 TO 2.5 GEV

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                        REFERENCES FOR Z*1 CROSS SECTION LIMITS

BASSOMPI 68 PL 27B 468          BASSOMPIERRE, +              (CERN,BRUXELLES)
ANDERSON 69 PL 29B 136          +BLESER, BLIEDEN, COLLINS, + (BNL,CARNEGIE)

                        PAPERS NOT REFERRED TO IN DATA CARDS

TYSON    67 PRL 19 255          +GREENBERG,HUGHES,LU,MINEHART,MORI,  (YALE)
MORI     68 PL 28B 152          +GREENBERG,HUGHES,LU,ROTHBERG, +     (YALE)
MORI     69 PR 185 1687         +GREENBERG, HUGHES, LU, MINEHART, +  (YALE)
    MORI 69 REPLACES TYSON 67 AND MORI 68.

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Note on Λ's and Σ's

The number of established Y^* resonances is still slowly increasing. In 1978 two Λ's and one Σ were promoted to the Baryon Table, in 1980 none were promoted, and in this edition two Λ'S have been promoted. There remain, however, a large number of proposed but unconfirmed resonances in the Data Card Listings. Table I is an attempt to evaluate the status, both overall and channel by channel, of each Y^* in the Listings; the evaluations are of course partly subjective. A blank indicates there is no evidence at all: either the relevant couplings are small or the resonance does not really exist. The Baryon Table includes only the well-established resonances (overall status 3 or 4 stars). Any particular one of the questionable resonances may disappear with the next analysis, but there are probably many new resonances underlying those already established.

None of the Y^*'s proposed in the last few years couple strongly to the main 2-body decay channels $N\bar{K}$, $\Lambda\pi$, and $\Sigma\pi$, and thus they seldom appear in cross sections or invariant mass distributions. Rather, when the reactions $\bar{K}N \to \bar{K}N$, $\bar{K}N \to \Lambda\pi$, and $\bar{K}N \to \Sigma\pi$ are partial-wave analyzed, some of the amplitudes are found to traverse small, more-or-less resonance-like counterclockwise circles. The question in each case is: Is this really a resonance, or is it an idle meander? Is the effect even real, or is it the result of imperfect data and analysis procedures?

TABLE I. STATUS OF Y* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.

PARTICLE	LIJ	OVERALL STATUS	TOTAL* CR. SEC.	KBAR N	LAM PI	SIG PI	OTHER CHANNELS
			STATUS AS SEEN IN --				
LAM(1115)	P01	****					WEAK TO N PI
LAM(1405)	S01	****		****	F	****	
LAM(1520)	D03	****	****	****	O	****	LAM2PI,LAM GAM
LAM(1600)	P01	***		***	R	**	
LAM(1670)	S01	****		****	B	****	LAM ETA
LAM(1690)	D03	****	****	****	I	****	LAM2PI, SIG2PI
LAM(1800)	S01	***		***	D	**	N K*, SIG* PI
LAM(1810)	P01	***		***	D	**	N K*
LAM(1830)	G09	DEAD			E		
LAM(1800)	PE	*			N		LAM PI PI
LAM(1820)	F05	****	****	****	F	****	SIG(1385) PI
LAM(1830)	D05	****		***	O	****	SIG(1385) PI
LAM(1890)	P03	****	**	****	R	**	N K*, SIG* PI
LAM(2000)		*			B	*	LAM OMG, N K*
LAM(2020)	F07	*		*	I	*	
LAM(2100)	G07	****	****	****	D	***	LAM OMG, N K*
LAM(2110)	F05	***		**	D	*	LAM OMG, N K*
LAM(2325)	D03	*		*	E		LAM OMEGA
LAM(2350)		****	****	****	N		
LAM(2585)		***	***	*			
SIG(1193)	P11	****					WEAK TO N PI
SIG(1385)	P13	****			****	****	
SIG(1480)	PE	*		*	*	*	
SIG(1560)	PE	**			**	**	
SIG(1580)	D13	**	**	*	*		
SIG(1620)	S11	**		**	*	*	
SIG(1660)	P11	***		***	*	**	
SIG(1670)	D13	****	**	****	****	****	SEVERAL OTHERS
SIG(1670)	PE	**		**	**	**	SEVERAL OTHERS
SIG(1690)	PE	**	*	*	**	*	LAM 2-PI
SIG(1750)	S11	***		***	**	*	SIG ETA
SIG(1770)	P11	DEAD					
SIG(1775)	D15	****	****	****	****	***	SEVERAL OTHERS
SIG(1840)	P13	*		*	**	*	
SIG(1880)	P11	**		**	**		N K*
SIG(1915)	F15	****	***	***	****	***	SIG(1385) PI
SIG(1940)	D13	***		*	***	**	QUASI-2-BODY
SIG(2000)	S11	*			*		N K*, LAM* PI
SIG(2030)	F17	****	****	****	****	**	SEVERAL OTHERS
SIG(2070)	F15	*		*		*	
SIG(2080)	P13	**			**		
SIG(2100)	G17	*			*	*	
SIG(2250)		****	****	*	*	*	
SIG(2455)		***	***	*			
SIG(2620)		***	***	*			
SIG(3000)		**		*	*		
SIG(3170)	PE	**					MULTI-BODY

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.

* ATTRIBUTED TO THE STATE CLOSEST TO WHERE THE CROSS SECTION PEAKS.

I. Formation Experiments

(by G.P. Gopal, Rutherford and Appleton Laboratories)

Partial-wave analyses have been made mainly for the $N\bar{K}$, $\Lambda\pi$, and $\Sigma\pi$ channels, but there are also a few results for the ΞK, $\Lambda\omega$, and some quasi-2-body channels. The earliest analyses covered, in the main, rather narrow mass ranges, usually the range of a single bubble chamber experiment. Although the amplitudes obtained often did not join smoothly with those from other analyses of the same channel performed in neighboring mass ranges, they gave useful and fairly reliable information about the strongly coupled resonances dominating the middle of the ranges covered. The more recent analyses covering much wider mass ranges have found that using these established dominant states as input provides extremely useful constraints in determining the overall partial-wave amplitudes and thus in getting information about the less strongly coupled resonances. Besides covering wider mass ranges, some of the more ambitious analyses have treated several channels simultaneously so that unitarity constraints are automatically satisfied and only a single mass and width is obtained for each resonance. The early multi-channel analyses[1-3] included the channels $N\bar{K}$, $\Lambda\pi$, and $\Sigma\pi$, and covered the only mass range (1500 to 1900 MeV) with data of relatively good statistical accuracy, nearly all of it from a single bubble chamber experiment.[4]

The amount of bubble chamber data has since been considerably increased below,[5] across,[6] and above[7] the range covered by that experiment, and there are now data with lower statistics up to 2500 MeV.[8] More recently, counter experiments have made major contributions by measuring the $K^-p \to \bar{K}^0n$ total and differential cross sections at low energies,[9] the K^-p polarizations down to 1630 MeV for the first time,[10] the K^-p polarizations over the range 1700 to 1900 MeV with an order of magnitude increase in statistics,[11] the pure I=1 K^-n elastic angular distributions from 1600 to 1800 MeV[12] and from 1900 to 2300 MeV,[13] and the 180° K^-p and 0° $\Sigma^-\pi^+$ differential cross sections from 1550 to 1900 MeV.[14] There are also new data with good statistics on pure I=1 K^0_Lp interactions in the $\Lambda\pi^+$ and, more importantly, the $\Sigma^0\pi^+$ channels.[15-17] Finally, there are new $K^-n \to (\Sigma\pi)^-$ data over the range 1750 to 2200 MeV.[18] All these new data provide sensitive tests of the overall correctness of existing competing partial-wave amplitudes. Some of the new data have yet to be incorporated into new analyses.

In the following, we discuss the more recent partial-wave analyses, comparing them with each other and with the new data.

<u>The $N\bar{K}$ channel</u>: The most recent analysis of this channel is an update[19] of the old Rutherford Lab-Imperial College (RLIC 77) analysis.[20] As was its predecessor, it is a conventional energy-dependent analysis with the added constraint that the masses and widths of the resonances must be consistent with those determined in the inelastic channels analyzed previously -- $\Lambda\pi$, $\Sigma\pi$, $\Lambda(1520)\pi$, $\Sigma(1385)\pi$, and $N\bar{K}^*(892)$. With good angular distributions now available at lower energies,[5] the analysis goes closer to threshold: the range covered is 1470 to 2170 MeV. With the exception of the very high-statistics charge-exchange differential cross-section measurements[9] (which are in serious disagreement with both the earlier and the latest[6] high-statistics bubble chamber measurements) and the backward elastic data,[14] all the new $N\bar{K}$ data mentioned above have been included. As before, angular distributions (a total of 5110 data points) have been fitted directly. The new partial-wave amplitudes are not significantly different from the old RLIC 77 amplitudes for this channel. However, the inclusion of the I=1 K^-n data has removed some of the uncertainties in the I=1 Y^* spectrum.

The LBL-Mt. Holyoke-CERN analysis[21] covers the narrower range of 1500 to 1940 MeV and also includes most of the new data. It is an energy-dependent analysis using a unitary background parametrization in terms of scattering lengths. The cusp effects at the $\Lambda\eta$ and $\Sigma\eta$ thresholds are included by introducing a square-root singularity in the energy variation of the widths of the corresponding resonances. The inclusion of their own high-statistics charge-exchange data[9] -- admittedly not in good agreement with bubble chamber measurements -- all but kills the less well-established resonances.

The University College, London (UCL) K-matrix energy-dependent analysis[22] covers the range 1540 to 2000 MeV. The $N\bar{K}$ amplitudes are consistent with those of the other analyses over the greater part of this range. However, at the low-energy end there are considerable differences, indicating the lack of strong constraints from the dominant D03 $\Lambda(1520)$ state -- just below the range covered. The new K^-n angular distributions and K^-p polarization measurements are not very well described by the amplitudes from this analysis.

These analyses, all below 2200 MeV, are complemented by the College de France-Saclay (CdF-S) energy-dependent analysis[8] covering the range 2070 to 2440 MeV. Besides the conventional polynomial parametrization of the background amplitudes, they also tried a more economical parametrization with constraints imposed from the duality hypothesis (that s-channel backgrounds come exclusively from the t-channel Pomeron exchange amplitude). With 30 fewer free parameters, the results are consistent with the more conventional approach.

<u>The $\Sigma\pi$ channel</u>: There are no new analyses of this channel. There is very little agreement, particularly in the lower partial waves, between the amplitudes of the two multi-channel analyses.[20,22] The low energy $K^0_Lp \to \Sigma^0\pi^+$ data[15,16] are better explained by the RLIC 77 amplitudes than by the UCL amplitudes. At the higher mass end there is good continuity between the RLIC 77 amplitudes and those of the single-channel analysis of the CdF-S collaboration[8] covering the range 2070 to 2440 MeV. The two strongly coupled resonances, D03 $\Lambda(1520)$ and G07 $\Lambda(2110)$, lying below and above the mass range covered by the UCL analysis, clearly provide strong

constraints on the amplitudes.

The Λπ channel: This pure I=1 channel, where simultaneous measurements of the polarization and differential cross section are possible, has been the subject of many wide-range energy-dependent and energy-independent analyses (for example, RLIC 77,[20] UCL,[22] Baillon-Litchfield,[23] de Bellefon-Berthon,[24] and Van Horn[25]). However, even the widespread use of the method of Barrelet zeroes has not helped to resolve the I=1 Y^* spectrum -- probably because most of the I=1 states do not couple strongly to the initial $\overline{N}K$ channel.

Quasi-2-body channels: The RLIC group has made energy-dependent analyses of the Λ(1520)π, Σ(1385)π, and $N\overline{K}^*(892)$ channels over the widest ranges for which data are available. The data are extracted from the appropriate 3-particle final states by making 4-variable fits to an incoherent superposition of quasi-2-body final states and 3-particle Lorentz-invariant phase space. The quality of the fits suggests a maximum model-dependent systematic uncertainty of 10%. The errors quoted on the Y^* couplings do not include this uncertainty. The Λω channel has been analyzed from threshold to 2440 MeV by the CdF-S collaboration.[8]

Figures: Argand plots of fifteen S=-1 partial waves are shown in Fig. 1(a) through (k). The analyses shown were picked for illustrative purposes rather than on the basis of our judgment of their quality. For the $\overline{K}N$ channel, we show the amplitudes from RLIC 77[20] and from LBL-Mt. Holyoke-CERN,[21] and for the Λπ and Σπ channels those from RLIC 77[20] and from UCL.[22]

Errors on masses and widths: Often the errors quoted on resonance parameters from partial-wave analyses are only statistical, and the parameters can change by more than these errors when a different parametrization of the waves is used. Furthermore, the different analyses use more or less the same set of data, so it is not really appropriate to treat the different determinations of the resonance parameters as independent measurements or to average them together. In any case, the spread of the masses, widths, and branching fractions from the different analyses is certainly a better indication of the uncertainties than are the quoted errors. In the Baryon Table, usually a range reflecting the spread of values obtained is given rather than a particular value with error.

For three states, the Λ(1520), the Λ(1820), and the Σ(1775), there is enough information available to make an overall fit of the various branching fractions (see Sec. VII B of the main text). It is then necessary to use the quoted errors, but the errors obtained from the fit are not to be taken seriously.

II. Production Experiments

Partial-wave analyses of course separate partial waves, whereas a peak in a cross section or an invariant mass distribution usually cannot be disentangled from background and analyzed for its quantum numbers; and more than one resonance may be contributing to the peak. Results from partial-wave analyses and from production experiments are generally kept separate in the Listings, and in the Baryon Table results from production experiments are used only for the low mass states. The Σ(1385) and Λ(1405) of course lie below the $\overline{K}N$ threshold and everything about them comes from production experiments; and production and formation experiments agree quite well in the case of Λ(1520) and results have been combined. There is some disagreement between production and formation experiments in the 1600-to-1700 MeV region: see the Σ(1620) and Σ(1670) notes for details.

The most interesting recent result from a production experiment is the observation of a narrow hyperon of mass 3170 MeV decaying to multi-strange final states containing five or six particles (Λ/ΣK$\overline{K}$ + pions, ΞK + pions). The effect is seen in two high-statistics bubble chamber experiments studying K^-p interactions at 6.5 and 8.25 GeV/c.[26] The statistical significance of the peak is about 6.5 standard deviations, and the observed width is consistent with the experimental resolution. The modes with three strange particles possibly suggest an exotic (e.g., $qqqq\overline{q}$) state.

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(see also the Listings)

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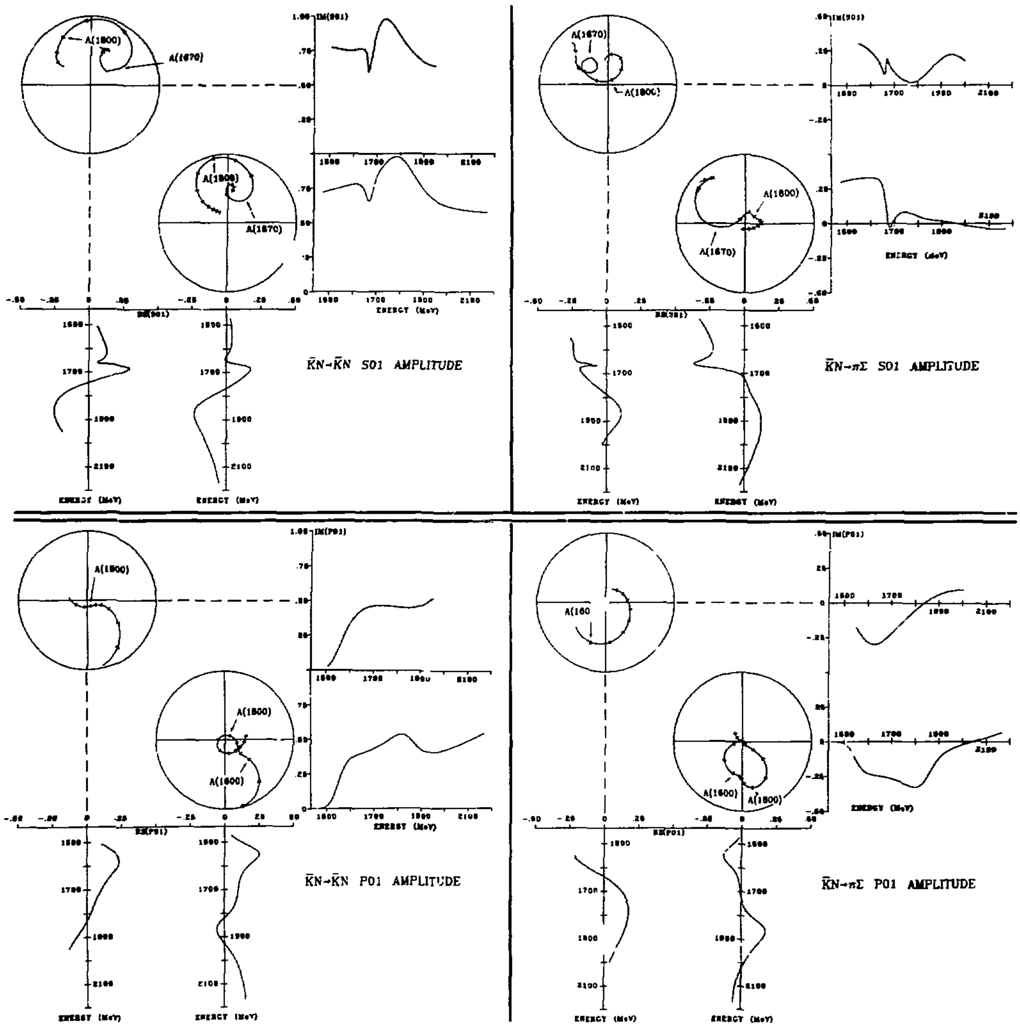


Fig. 1(a). The L·I·2J = S01 and P01 partial-wave amplitudes for $\bar{K}N$ scattering in the elastic and $\Sigma\pi$ channels. The lower plot for each amplitude is from RLIC 77, the upper plots for the elastic amplitudes are from ALSTON 78, and the upper plots for the $\Sigma\pi$ amplitudes are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions [the S01 Λ(1405) is of course below threshold and is not shown]. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.

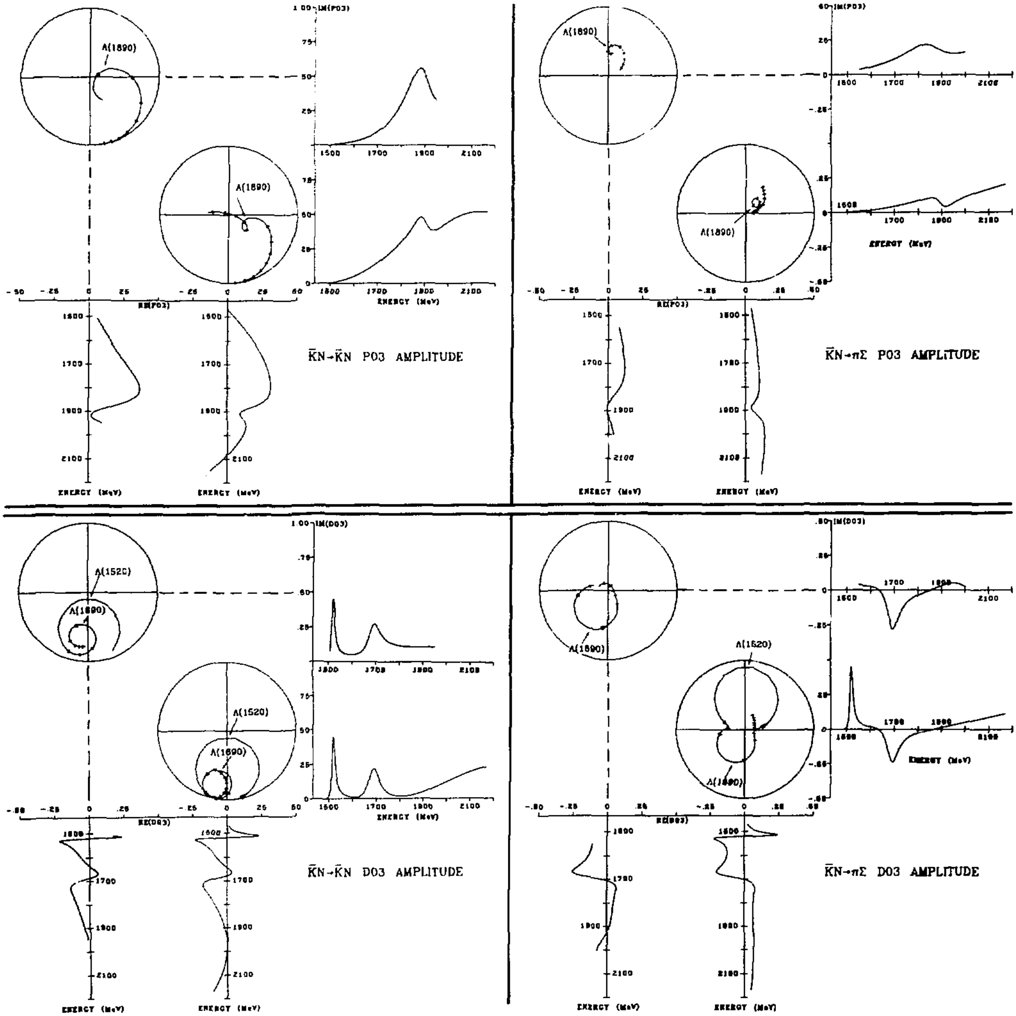


Fig. 1(b). The L·I·2J = P03 and D03 partial-wave amplitudes for K̄N scattering in the elastic and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plots for the elastic amplitudes are from ALSTON 78, and the upper plots for the Σπ amplitudes are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.

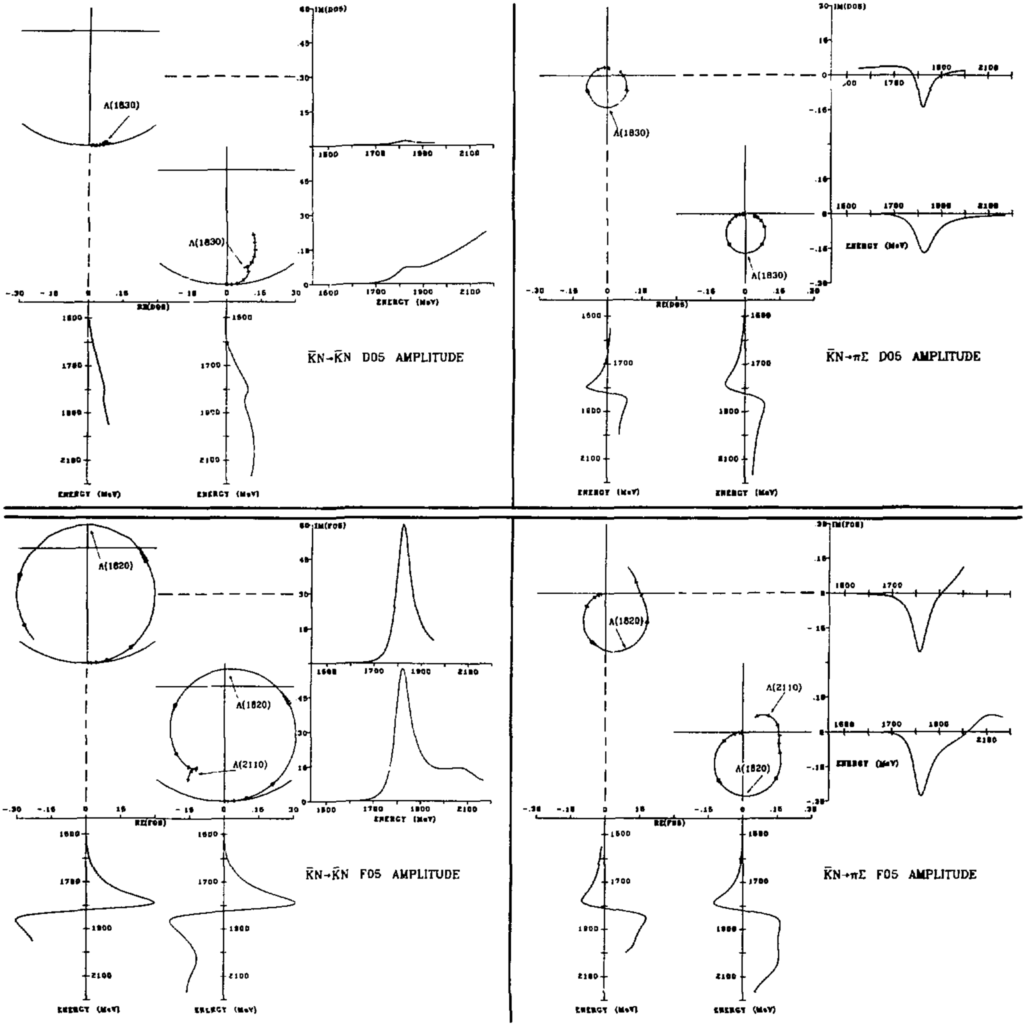


Fig. 1(c). The L·I·2J = D05 and F05 partial-wave amplitudes for K̄N scattering in the elastic and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plots for the elastic amplitudes are from ALSTON 78, and the upper plots for the Σπ amplitudes are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.

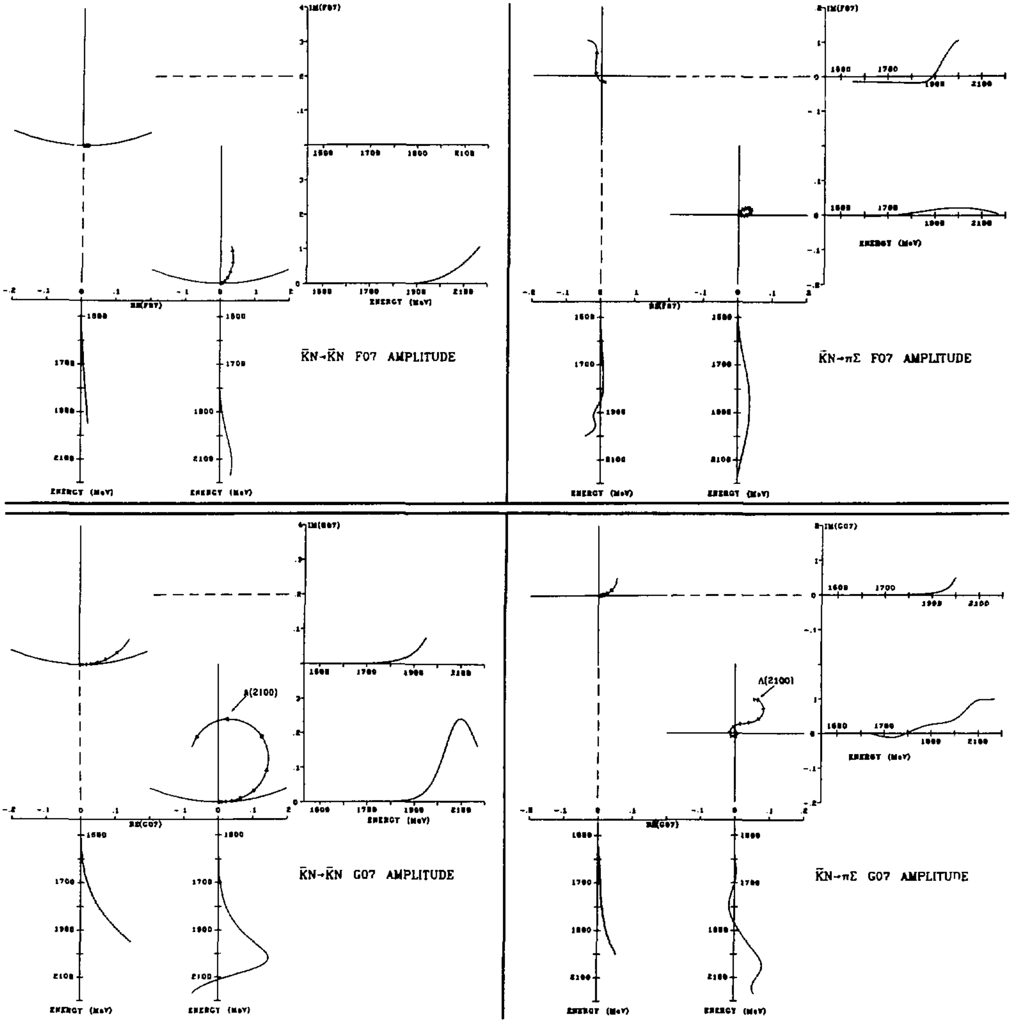
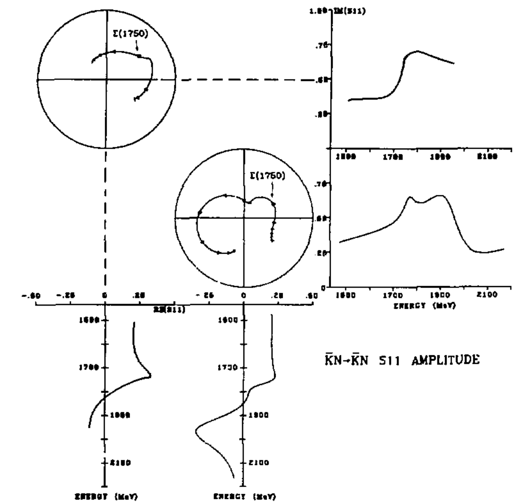
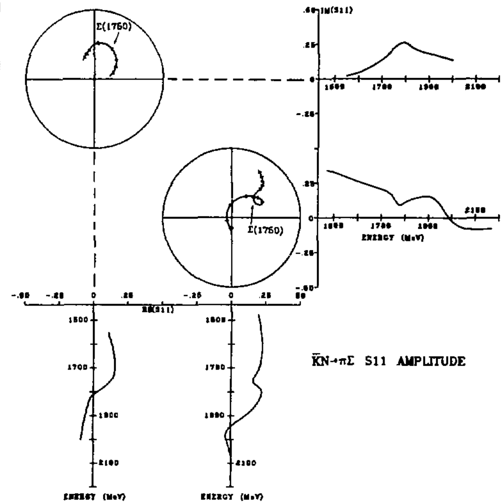


Fig. 1(d). The L·I·2J = F07 and G07 partial-wave amplitudes for $\overline{K}N$ scattering in the elastic and $\Sigma\pi$ channels. The lower plot for each amplitude is from RLIC 77, the upper plots for the elastic amplitudes are from ALSTON 78, and the upper plots for the $\Sigma\pi$ amplitudes are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.





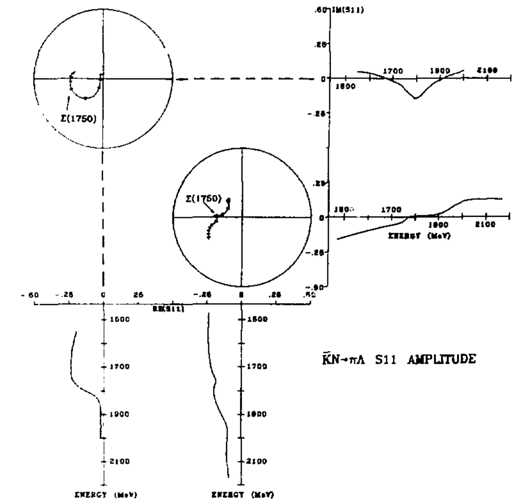
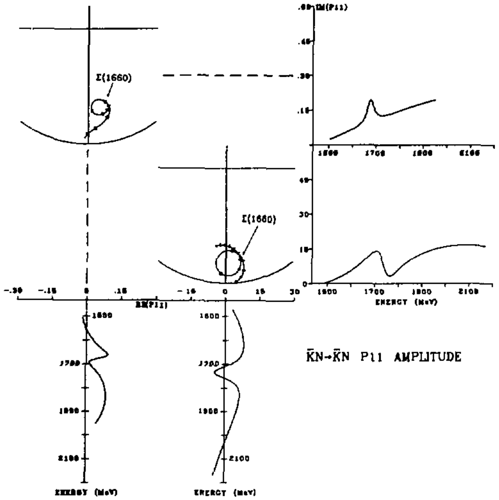
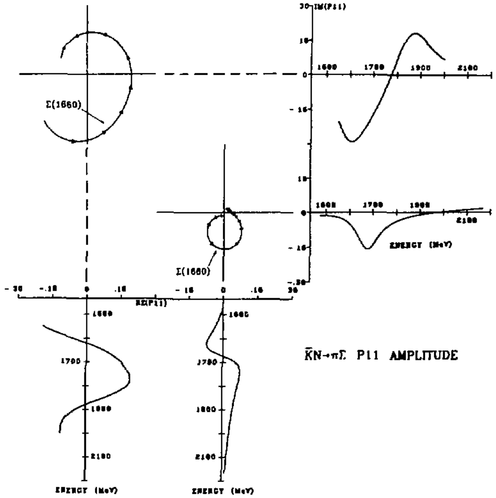


Fig. 1(e). The L·I·2J = S11 partial-wave amplitudes for $\bar{K}N$ scattering in the elastic, $\Lambda\pi$, and $\Sigma\pi$ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the $\Lambda\pi$ and $\Sigma\pi$ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.





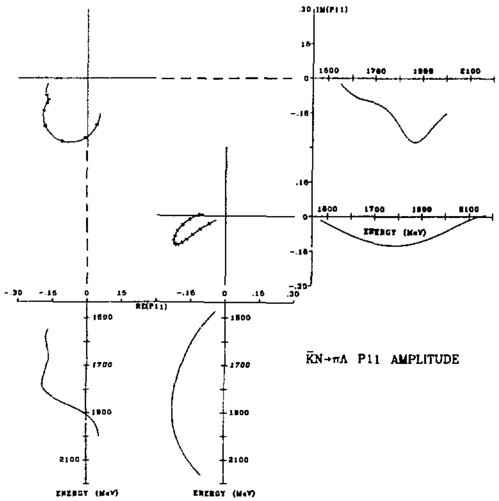
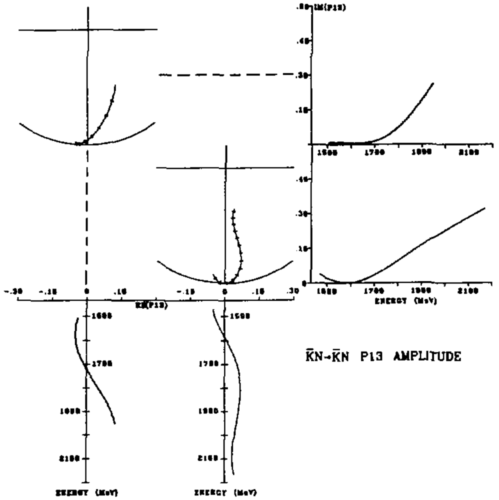
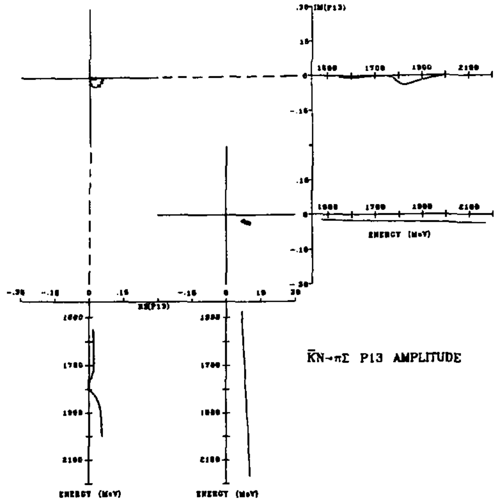


Fig. 1(f). The L·I·2J = P11 partial-wave amplitudes for K̄N scattering in the elastic, Λπ, and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the Λπ and Σπ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.





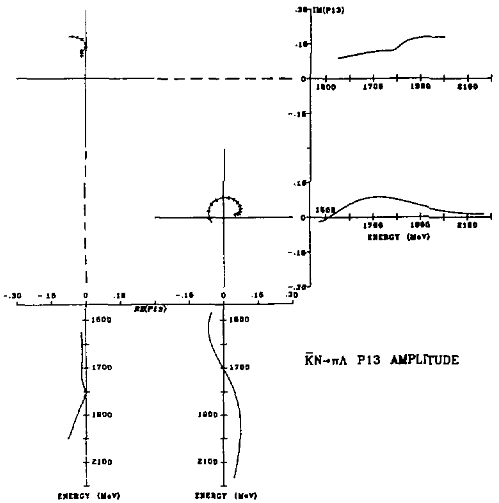
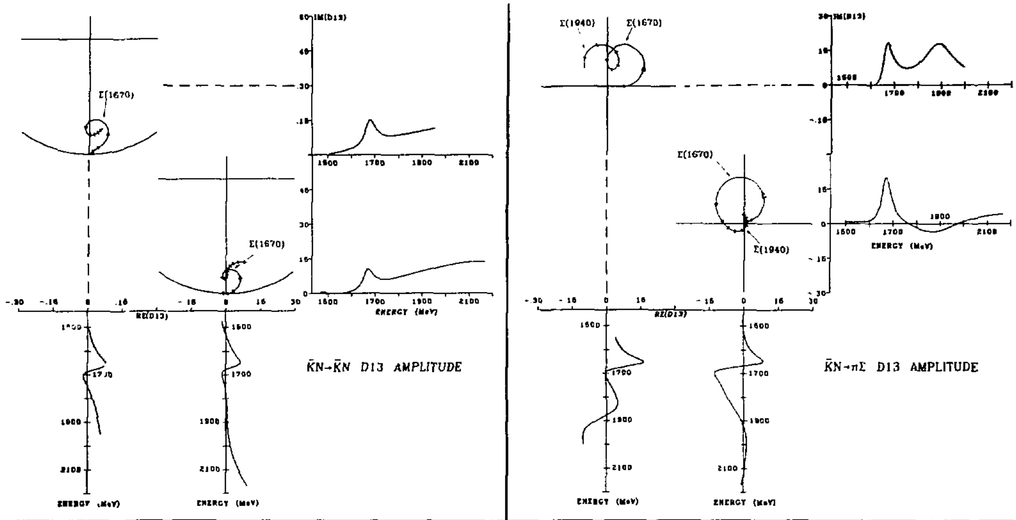


Fig. 1(g). The L·I·2J = P13 partial-wave amplitudes for $\bar{K}N$ scattering in the elastic, $\Lambda\pi$, and $\Sigma\pi$ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the $\Lambda\pi$ and $\Sigma\pi$ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV [the $\Sigma(1385)$ is *of course below threshold*] and is not shown]. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.



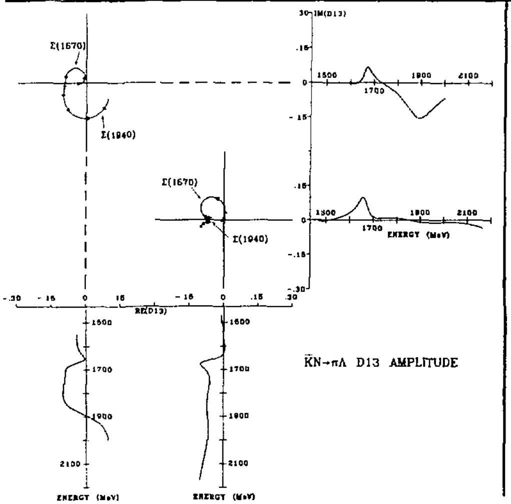
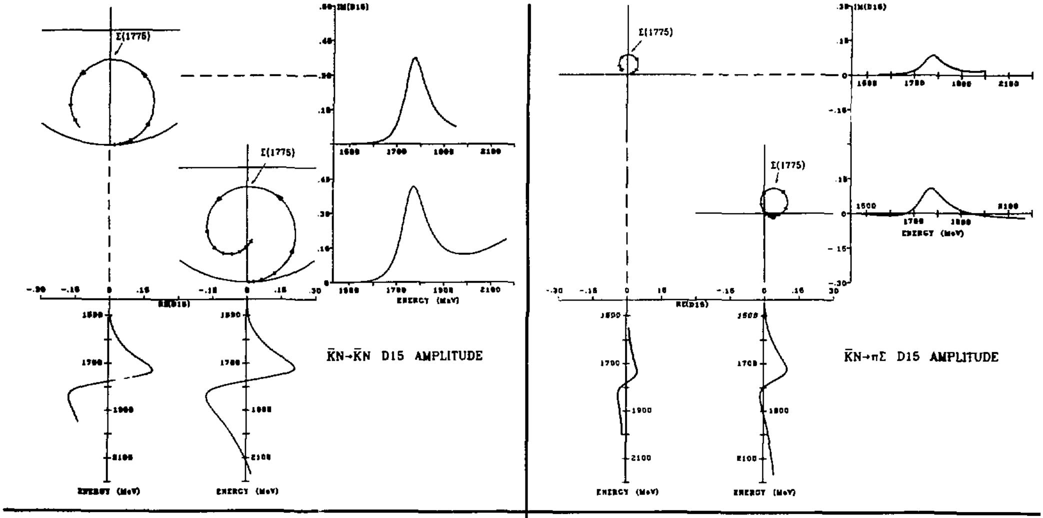


Fig. 1(h). The L·I·2J = D13 partial-wave amplitudes for K̄N scattering in the elastic, Λπ, and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the Λπ and Σπ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.



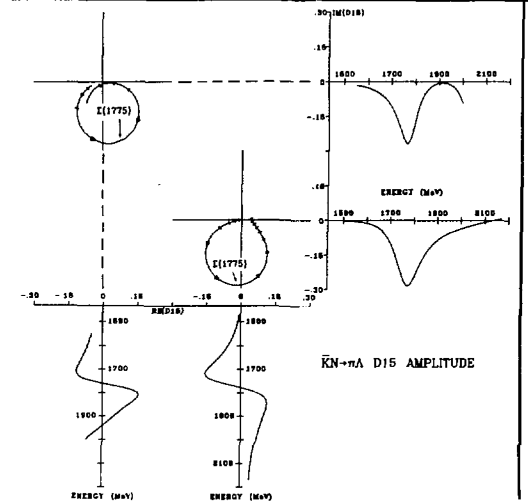
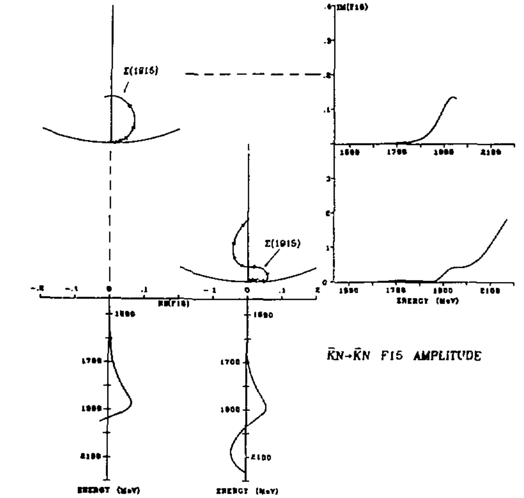
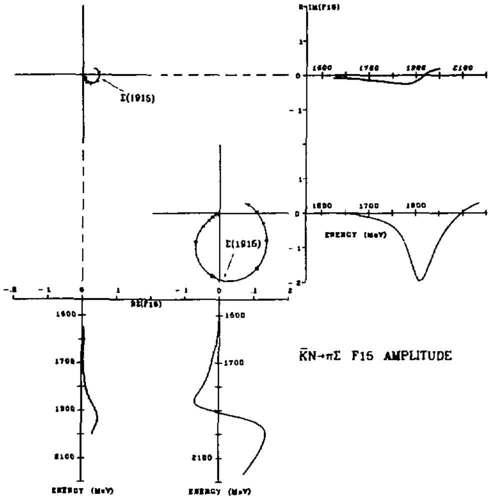


Fig. I(i)._ The L·I·2J = D15 partial-wave amplitudes for $\bar{K}N$ scattering in the elastic, Λπ, and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the Λπ and Σπ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.





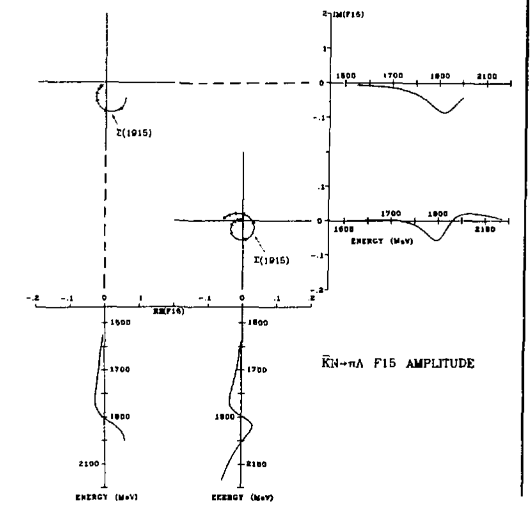
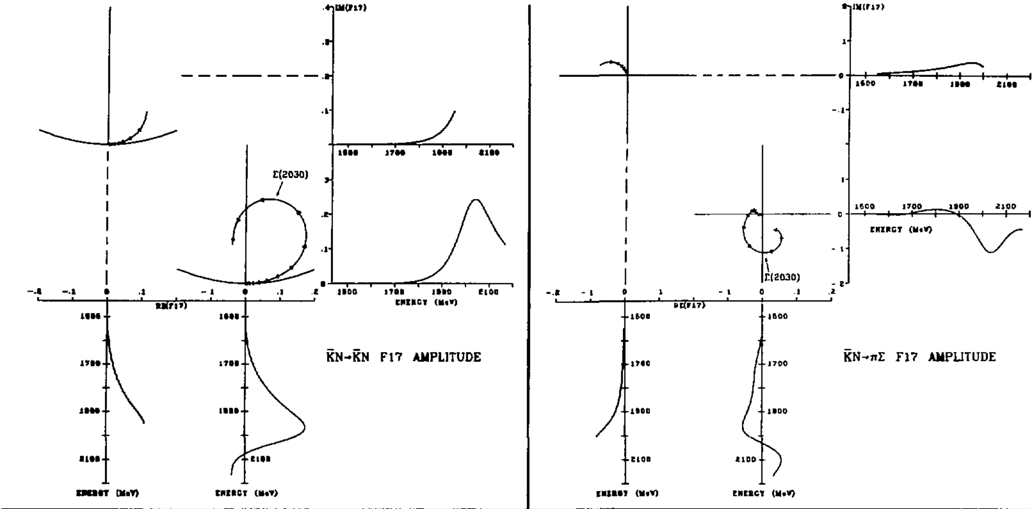


Fig. 1(j). The L·I·2J = F15 partial-wave amplitudes for $\bar{K}N$ scattering in the elastic, Λπ, and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the Λπ and Σπ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.



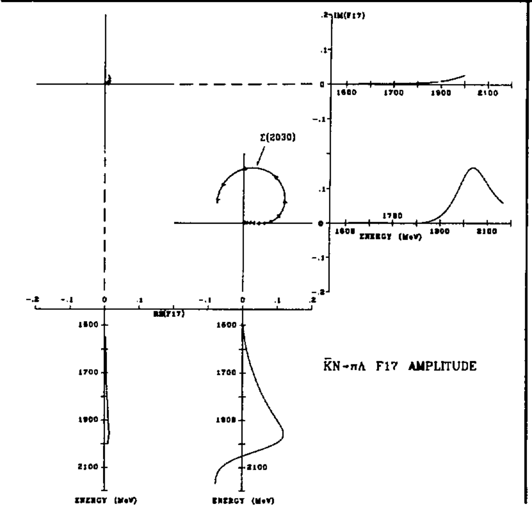


Fig. 1(k). The L·I·2J = F17 partial-wave amplitudes for K̄N scattering in the elastic, Λπ, and Σπ channels. The lower plot for each amplitude is from RLIC 77, the upper plot for the elastic amplitude is from ALSTON 78, and the upper plots for the Λπ and Σπ channels are from MARTIN 77. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonance is shown at its nominal position. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots.

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S=−1 I=0 HYPERON STATES (Λ)

Λ

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18  LAMBDA(1116, JP=1/2+)  I=0

SEE STABLE PARTICLE DATA CARD LISTINGS
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Λ(1405) S_{01}

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37  Y*0(1405, JP=1/2-) I=0
    PRODUCTION EXPERIMENTS

THIS RESONANCE CAN BE IDENTIFIED WITH THE VIRTUAL BOUND
STATE IN THE KBAR-N SYSTEM FOUND IN THE ANALYSIS OF LOW
ENERGY K-P INTERACTION.  WE LIST SUCH EXPERIMENTS SEPA-
RATELY BELOW.  WE USE ONLY PRODUCTION EXPERIMENTS FOR
AVERAGING OF MASSES AND WIDTHS.

37  Y*0(1405) MASS (MEV) (PROD. EXP.)

M       (1405.0)                ALSTON     61 HBC    K-P 1.15 BEV/C
M       (1410.0)                ALEXANDER  62 HBC    PI-P 2.1 BEV/C
M       (1405.0)                ALSTON     62 HBC    K-P 1.2-.5 BEV/C
M       (1382.0)    (8.0)       ENGLER     65 HDBC   PI-P, PI+D 1.68     7/66
M        1400.0     24.0        MUSGRAVE   65 HBC    PBAR P 3-4 BEV/C    7/66
M    67  1400.0      5.0        BIRMINGHA  66 HBC    K-P 3.5             9/67
M   120  1405.0      5.0        GALTIERI   68 DBC    K-D 2.1-2.7BEV/C    6/68
M        . . . . . . . . . .
M  AVG   1402.4      3.5     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

37  Y*0(1405) WIDTH (MEV) (PROD. EXP.)

M        (20.0)                 ALSTON     61 HBC                        7/66
M         35.0       5.0        ALEXANDER  62 HBC
M        (50.0)                 ALSTON     62 HBC
M        (89.0)    (20.0)       ENGLER     65 HDBC                       7/66
M         60.0      20.0        MUSGRAVE   65 HBC                        7/66
M    67   50.0      10.0        BIRMINGHA  66 HBC    K-P 3.5             9/67
M   120   35.0       8.0        GALTIERI   68 DBC    K-D 2.1-2.7BEV/C    6/68
M        . . . . . . . . . .
M  AVG    38.1       3.9     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

37  Y*0(1405) PARTIAL DECAY MODES (PROD. EXP.)
                                                     DECAY MASSES
P1      Y*0(1405) INTO SIGMA PI                      1189+ 139

REFERENCES FOR Y*0(1405) (PROD. EXP.)

ALSTON   61 PRL 6 698         +ALVAREZ,EBERHARD,GOOD,GRAZIANO +    (LRL) I
ALEXANDE 62 PRL 8 447         ALEXANDER,KALBFLEISCH,MILLER,SMITH   (LRL) I
ALSTON   62 CERN CONF 311     +ALVAREZ,FERRO-LUZZI,ROSENFELD +     (LRL) I
ENGLER   65 PRL 15 224        +FISK,KRAEMER,MELTZER,WESTGARD,+ (CARN,BNL) IJ
MUSGRAVE 65 NC 35 735         +PETMEZAS,+     (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH 66 PR  152  1148     BIRMINGHAM,GLASGOW,LOIC, OXFORD,RUTHERFORD
GALTIERI 68 PRL 21 573        BARBARO-GALTIERI,CHADWICK +          (LRL,SLAC)
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1405 MEV REGION: EXTRAPOLATIONS BELOW THRESHOLD

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24  Y*0(1405, JP=1/2-) I=0        S*01
    EXTRAPOLATION BELOW THRESHOLD

SEE NOTE IN Y*0(1405) PRODUCTION EXPERIMENTS.  THE DIF-
FICULTIES IN EXTRAPOLATING FROM THE PHYSICAL REGION TO
THE RESONANCE LOCATION ARE DISCUSSED BY DALITZ 67.

     THE QUESTION ON WHETHER Y*(1405) IS A KBAR-N BOUND
STATE OR A CDD POLE (DALITZ 70, RAJASEKARAN 72 HAS BEEN INVESTIGATED
BY CLINE 71, MARTIN 71, GALTIERI 72, AND DOBSON 72.  THE LAST TWO
PAPERS CONCLUDE THAT THE DATA CANNOT TELL THE DIFFERENCE.

 THE (N KBAR)/(PI SIGMA) COUPLING RATIO IS DISCUSSED BY OADES 77.

24  Y*0(1405) MASS (MEV)

M        1410.7     (1.0)        KIM        65 HBC    0-EFF-RANGE FIT     7/66
M        1409.6     (1.7)        SAKITT     65 HBC    0-EFF-RANGE FIT     7/66
M                          DATA OF SAKITT ARE USED IN FIT BY KITTEL.
M        1407.5     (1.2)        KITTEL     66 HBC    0-EFF-RANGE FIT     7/66
M        1403.0     (3.0)        KIM        67 HBC    K MATRIX FIT(KP)    8/67
M        1416.0     (4.0)        MARTIN     69 HBC    CONST. K MATRIX    10/69
M       (1421.0)                 MARTIN     70 RVUE   CONST. K MATRIX     6/70
M    1  (1406.)                  CHAO       73 DPWA   0-RNG. FIT.SOL B    9/73
M    1  SEE ALSO THE ACCOMPANYING PAPER OF THOMAS73.                      9/73

24  Y*0(1405) WIDTH (MEV)

M         37.0      (3.2)        KIM        65 HBC                        7/66
M         28.2      (4.1)        SAKITT     65 HBC                        7/66
M         34.1      (4.1)        KITTEL     66 HBC                        7/66
M         50.0      (5.0)        KIM        67 HBC    K MATRIX FIT(KP)    8/67
M         29.0      (6.0)        MARTIN     69 HBC    CONST. K MATRIX    10/69
M        (20.0)                  MARTIN     70 RVUE   CONST. K MATRIX     6/70
M    1   (55.)                   CHAO       73 DPWA   0-RNG. FIT.SOL B    9/73
M    1  ASYMMETRIC RESONANCE SHAPE,W/2=41 MEV BELOW RESONANCE,14 MEV ABOVE. 9/73
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                              REFERENCES FOR Y*0(1405) (FROM EXTRAPOLATIONS)

KIM       65 PRL 14 29          J K KIM                              (COLUMBIA)IJP
SAKITT    65 PR 139 B719        +DAY,GLASSER,SEEMAN,FRIEDMAN, +      (UMD,LRL)IJP
KITTEL    66 PL 21 349          W KITTEL, G OTTER, I WACEK           (VIENNA)IJP
KIM       67 PRL 19 1074        J KIM                                  (YALE)JP
MARTIN    69 PR 183 1352        B R MARTIN, M SAKITT                 (LOUC+BNL)
MARTIN    70 NP B16 479         A D MARTIN, G G ROSS                 (DURHAM)IJP
CHAO      73 NP B56 46          CHAO,KRAEMER,THOMAS,MARTIN (RHEL+CARN+LOUC)IJP
    ALSO  73 NP B56 15          THOMAS,ENGLER,FISK,KRAEMER             (CARN)IJ

                              PAPERS NOT REFERRED TO IN DATA CARDS

ABRAMS    65 PR 139 B454        G S ABRAMS, B SECHI-ZORN               (UMD)IJP
DONALD    66 PL 22 711          + EDWARDS, LYS, NISAR, MOORE     (LIVERPOOL)
KADYK     66 PRL 17 599         +OREN, G+S GOLDHABER, TRILLING         (LRL)IJP
    FIT SOLUTIONS GIVING AN I=0 S1                           (2 RESONANCE.)
    ABRAMS 65, KADYK 66, AND DONALD 66 SUPPORT THOSE EFFECTIVE-RANGE-
DALITZ    67 PR 153 1617        DALITZ, WONG, RAJASEKARAN   (OXFORD,BOMBAY)
DALITZ    70 DUKE-HR 70 03      R D DALITZ                            (OXF)
CLINE     71 PRL 26 1194        D CLINE,R LAUMANN,J MAPP              (WISC)
MARTIN    71 PL 35B 62          A D MARTIN,B R MARTIN,ROSS (DURH+LOUC+RHEL)
DOBSON    72 PR D6 3256         P N DOBSON,R MCELHANEY                (HAWA)
GALTIERI  72 LBL 555            A.BARBARO-GALTIERI                     (LBL)
RAJASEKA  72 PR D5 610          RAJASEKARAN                           (TIFR)
    ALSO EARLIER PAPERS CITED IN RAJASEKARAN72
SHAW      73 PURDUE CONF. 417   SHAW                                  (UCI)IJP
DADES     77 NC 42A 462         G.C.OADES,G.RASCHE               (AARH+ZURI)IJP
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Λ(1520) 38 Y*0(1520, JP=3/2-) I=0 **D_{03}'**

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PRODUCTION AND FORMATION EXPERIMENTS AGREE QUITE WELL
WITH EACH OTHER, SO THE RESULTS OF THE TWO KINDS OF
EXPERIMENTS ARE LISTED TOGETHER HERE.

THE DECAY MODE LAMBDA PI PI IS LARGELY DUE TO
Y*1(1385) PI.  ONLY THE VALUES OF (Y*1(1385) PI)/(LAMBDA PI PI) GIVEN
BY MAST 72 AND CORDEN 75 ARE BASED ON REAL 3-BODY PARTIAL WAVE ANALYSES
(THE OLDER RESULTS BEING OBTAINED USING CRUDER METHODS).  THE
DISCREPANCY BETWEEN THE 2 RESULTS IS ESSENTIALLY DUE TO THE DIFFERENT
HYPOTHESIS MADE CONCERNING THE SHAPE OF THE EPSILON MESON.
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                    38  Y*0(1520) MASS (MEV)

M        145 1517.2       3.0          GALTIERI  63 DBC     K-D 1.51 BEV/C
M            1519.4       2.0          WATSON    63 HBC     K-P ALL CHANNELS
M         29 1520.0       4.0          ALMEIDA   64 HBC     K-P 1.45 BEV/C
M           (1511.0)     (15.0)        MUSGRAVE  65 HBC     PBAR P 3-4 BEV/C   7/66
M        30 (1510.0)     (2.0)         BIRMINGHA 66 HBC     K-P 3.5            9/67
M    B       1517.2       1.2          BURKHARDT 69 HBC     K-P .8-1.2 GEV/C  10/69
M    B         QUOTED ERROR INCREASED TO ACCOUNT FOR DISAGREEMENT BETWEEN
M    B         TWO MEASUREMENTS DONE BY SAME AUTHORS (K-P AND SIGMA PI)
M           (1519.)                    KIM       71 DPWA    K-MATRIX ANAL.     3/71
M      1669 1517.+/-1. TO 1521.+/-1.   BERTHON   74 HBC   0 QUASI 2 BODY CS   10/74
M      2000 1519.4       0.3           CORDEN    75 DBC     K- D 1.4-1.8GV/C   4/75
M        4K 1519.7       0.3           CAMERON   77 HBC     K-P 0.96-1.36GEV   1/78
M            1519.       1.            RLIC      77 DPWA    KBAR N MULTICHNL   1/76
M            1520.       0.5           ALSTON    78 DPWA    KBAR N ELASTIC     1/78
M        5K  1517.8      1.2           BARLAG    79 HBC     K-P AT 4.2 GEV/C  12/79
M       300  1517.3      1.5           BARBER    80 SPEC    GAM P TO K+ Y*     2/82*
M            1519.0      1.0           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
M            . . . . . . . . . . .
M    AVG     1519.44     0.21    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.2)
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                    38  Y*0(1520) WIDTH (MEV)

W            16.4        2.0           WATSON    63 HBC
W           (19.0)      (19.0)         MUSGRAVE  65 HBC                        7/66
W        30 (59.0)      (10.0)         BIRMINGHA 66 HBC     K-P 3.5            9/67
W           (16.0)  OR LESS            DAHL      67 HBC                        9/66
W            14.7        1.8           BURKHARDT 69 HBC     K-P .8-1.2 GEV/C  10/69
W           (16.)                      KIM       71 DPWA    K-MATRIX ANAL.     3/71
W      2000  15.5        1.6           CORDEN    75 DBC     K- D 1.4-1.8GV/C   4/75
W        4K  16.3        0.5           CAMERON   77 HBC     K-P 0.96-1.36GEV   1/78
W            15.         0.5           RLIC      77 DPWA    KBAR N MULTICHNL   1/76
W            15.4        0.5           ALSTON    78 DPWA    KBAR N ELASTIC     1/78
W    R  677  14.         3.            BARLAG    79 HBC     K-P AT 4.2 GEV/C  12/79
W    R     FROM BEST-RESOLUTION SAMPLE OF LAMBDA PI PI EVENTS ONLY.           12/79
W       300  16.3        3.3           BARBER    80 SPEC    GAM P TO K+ Y*     2/82*
W            16.0        1.0           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
W            . . . . . . . . . . .
W    AVG     15.58       0.27    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
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                    38  Y*0(1520) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1     Y*0(1520) INTO N KBAR                              938+ 493
P2     Y*0(1520) INTO SIGMA PI                            1190+ 139
P3     Y*0(1520) INTO LAMBDA PI PI                        1115+ 139+ 139
P4     Y*0(1520) INTO LAMBDA GAMMA                        1115+   0
P5     Y*0(1520) INTO SIGMA0 GAMMA                        1192+   0
P6     Y*0(1520) INTO SIGMA PI PI                         1192+ 139+ 139
P7     Y*0(1520) INTO (Y*1(1385)+PI)                      1385+ 139
P8     Y*0(1520) INTO Y*1(1385) PI INTO LAMBDA PI PI      1115+ 139+ 139
         NOTE THAT P8/P7 IS THE BRANCHING FRACTION FOR Y*1(1385) INTO LM PI   9/73
P9     Y*0(1520) INTO LAMBDA EPSILON                      1520+1300
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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle\delta P_i \delta P_i\rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle\delta P_i \delta P_j\rangle/(\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.4465+-.0060					
P 2	-.6290	.4219+-.0063				
P 3	-.2605	-.3603	.0954+-.0043			
P 4	-.0834	-.1020	-.0415	.0079+-.0014		
P 5	-.2134	-.2607	-.1061	-.0216	.0196+-.0034	
P 6	-.0319	-.0389	-.0158	-.0032	-.0083	.0086+-.0006

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                    38  Y*0(1520) BRANCHING RATIOS

R1      Y*0(1520) INTO (SIGMA PI)/(KBAR N)                    (P2)/(P1)
R1           1.72       0.78         MUSGRAVE  65 HBC                          8/67
R1           0.96       0.20         DAHL      67 HBC       PI-P 1.6-4 GEV/C   9/66
R1           0.73       0.11         DAUBER    67 HBC       K-P AT 2.GEV/C     8/67
R1           1.06       0.14         SCHEUER   68 DBC     0 K-N 3 GEV/C       10/69
R1           0.82       0.09         BURKHARDT 69 HBC       K-P .8-1.2 GEV/C  10/69
R1          (1.06)     (0.12)        BERTHON   74 HBC     0 QUASI 2 BODY CS   10/74
R1   4       0.98       0.03         RLIC      77 DPWA      KBAR N MULTICHNL   1/76
R1   4  KBAR N TO SIGMA PI AMPLITUDE AT RESONANCE IS +0.46 +/- 0.01           1/76
R1           . . . . . . . . . . .
R1  AVG      0.951      0.044    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R1  FIT      0.945      0.024   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R2      Y*0(1520) INTO (LAMBDA PI PI)/(KBAR N)                (P3)/(P1)
R2           0.17       0.05         DAHL      67 HBC       PI-P 1.6-4 GEV/C   9/66
R2           0.21       0.18         DAUBER    67 HBC       K-P AT 2.GEV/C     8/67
R2           0.19       0.04         SCHEUER   68 DBC     0 K-N 3 GEV/C       10/69
R2           0.22       0.03         BURKHARDT 69 HBC       K-P .8-1.2 GEV/C  10/69
R2          (0.2)                    KIM       71 DPWA      K-MATRIX ANAL.     3/71
R2          (0.27)     (0.13)        BERTHON   74 HBC     0 QUASI 2 BODY CS   10/74
R2           . . . . . . . . . . .
R2  AVG      0.202      0.021    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2  FIT      0.214      0.011   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R3      Y*0(1520) INTO (SIGMA PI)/(LAMBDA PI PI)              (P2)/(P3)
R3           4.5        1.0          ARMENTERO 65 HBC                          7/66
R3           3.3        1.1          BIRMINGHA 66 HBC       K-P 3.5            9/67
R3           3.9        1.0          UHLIG     67 HBC       K-P .9-1.0 BEV/C   9/66
R3           . . . . . . . . . . .
R3  AVG      3.94       0.59     AVERAGE (ERROR INCLUDES SCALE FACTOR OF [illegible])
R3  FIT      4.42       0.23    FROM FIT (ERROR INCLUDES SCALE FACTOR OF [illegible])

R4      Y*0(1520) INTO (LAMBDA GAMMA)/TOTAL (PERCENT)         (P4)
R4     238   0.80       0.14         MAST      68 HBC     0 USING ELAST=.45    1/68
R4           . . . . . . . . . . .
R4  FIT      0.79       0.14    FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.[illegible])

R5      Y*0(1520) INTO (SIGMA0 GAMMA)/TOTAL (PERCENT)         (P5)
R5   S       2.0        0.35         MAST      68 HBC       SEE NOTE S        10/69
R5   S     RATIOS CALCULATED FROM R4,ASSUMING SU(3). NEEDED TO CONSTRAIN
R5   S     ALL THE Y*0(1520) BRANCHING RATIOS TO BE UNITY.
R5           . . . . . . . . . . .
R5  FIT      1.96       0.34    FROM FIT (ERROR INCLUDES SCALE FACTOR OF [illegible])

R6      Y*0(1520) INTO (KBAR N)/TOTAL                          (P1)
R6           0.29       0.05         WATSON    63 HBC       K-P ALL CHANNELS  10/71
R6           0.447      0.018        GALTIERI  69 HBC       K- P .28-.[illegible] G/C 10/69
R6           0.47       0.03         COLLEY    71 DBC       K-N 1.5 [illegible] PROD 10/71
R6          (0.45)                   KIM       71 DPWA      K-MATRIX [illegible]AL. 3/71
R6           0.448      0.014        CORDEN    75 DBC       K- D 1.[illegible].8GV/C 4/75
R6          (0.42)                   MAST      76 HBC     0 K- P CE[illegible]    1/76
R6   D      (0.47)     (0.01)        RLIC      77 DPWA      KBAR N [illegible]TICHNL 1/76
R6   D  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R6           0.45       0.03         ALSTON    78 DPWA      KBAR N [illegible]LASTIC 1/78
R6           0.47       0.02         GOPAL     80 DPWA      KBAR N [illegible]LASTIC 12/81*
R6           . . . . . . . . . . .
R6  AVG      0.449      0.013    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
R6  FIT      0.4465     0.0060  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R7      Y*0(1520) INTO (SIGMA PI)/TOTAL                        (P2)
R7           0.55       0.09         WATSON    63 HBC       [illegible]LL CHANNELS 10/71
R7           0.418      0.017        GALTIERI  69 HBC     0 [illegible] .28-.45GEV/C 6/69
R7           0.43      (0.03)        COLLEY    71 DBC       [illegible] 1.5 GEV PROD 10/71
R7          (0.46)                   KIM       71 DPWA      [illegible]TRIX ANAL. 3/71
R7   3       0.426      0.014        CORDEN    75 DBC       [illegible] 1.4-1.8GV/C 4/75
R7   3  SUPERSEDES COLLEY 71                                                   1/76
R7           . . . . . . . . . . .
R7  AVG      0.425      0.011    AVERAGE (ERROR INCLUDES S[illegible] FACTOR OF 1.0)
R7  FIT      0.4219     0.0063  FROM FIT (ERROR INCLUDES SC[illegible] FACTOR OF 1.2)

R8      Y*0(1520) INTO (SIGMA PI PI)/TOTAL                     (P6)
R8           0.010      0.0015       GALTIERI  69 HBC     0 K-P .28-.45GEV/C  10/69
R8   2       0.0085     0.0006       MAST2     73 MPWA      K-P TO 2PI SIG     9/73
R8   2  BASED ON ASSUMED ELASTICITY OF 0.46                                    9/73
R8 A         0.007      0.002        CORDEN    75 DBC       K- D 1.4-1.8GV/C   4/75
R8 A    CONSIDERABLE FRACTION OF THE SIGMA PI PI DECAY PROCEEDS VIA THE        4/75
R8 A    Y*1(1385) PI INTERMEDIATE STATE.                                       4/75
R8           . . . . . . . . . . .
R8  AVG      0.00858    0.00054  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R8  FIT      0.00858    0.00054 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R9      Y*0(1520) TO Y*1(1385) PI TO LM PI PI/LM PI [illegible]  (P8)/(P3)     9/73
R9        MORE THAN     0.10         CLINE     [illegible] HBC  K-D TO 2PI LAM N  9/69
R9   B       0.35       0.10         BURKHARDT [illegible] HBC  LAM. 3PI PROD.     3/71
R9   C      (1.0)                    CHAN      [illegible] DPWA K-P TO LAM 2PI     2/73
R9   M       0.82       0.10         MAST      [illegible] DPWA K-P TO 2PI LAM    12/72
R9           0.58       0.22         CORDEN    75 DBC       K- D 1.4-1.8GV/C   4/75
R9   B  CENTRAL BIN(1514-1524) GIVES .74+-.10    OTHER BINS LOWER BY 2-5SIG
R9   C  ONLY THE Y*(1385)D503 SEEMS TO CONTRI[illegible]
R9   M  BOTH Y*(1385)D503 AND SIGMA (PI PI)DP[illegible] CONTRIBUTE
R9           . . . . . . . . . . .
R9  AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)

R10     Y*0(1520) INTO (Y*1(1385) PI)/TOTAL                    (P7)
R10          0.041      0.005        CHAN      72 HBC       K-P TO LAM 2PI     3/71

R11     Y*0(1520) INTO (LAMBDA PI PI)/TOTA[illegible]          (P3)
R11          0.10      (0.02)        CO[illegible]Y  71 DBC     K-N 1.5 GEV PROD  10/71
R11  1       0.11       0.01         M[illegible]    73 DPWA    K-P TO 2PI LAM     9/73
R11  1  BASED ON ASSUMED ELASTICITY OF [illegible]46+/-0.02                    9/73
R11  3       0.091      0.006        [illegible]RDEN 75 DBC     K- D 1.4-1.8GV/C   4/75
R11  3  SUPERSEDES COLLEY 71                                                   1/76
R11          . . . . . . . . . . .
R11 AVG      0.0960     0.0084   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.6)
R11 FIT      0.0954     0.0043  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R12     Y*0(1520) INTO (LAMBDA EPSIL[illegible]N)/TOTAL       (P9)              4/75
R12          0.20       0.08         CORDEN    75 DBC       K- D 1.4-1.8GV/C   4/75
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                              RE[illegible]RENCES FOR Y*0(1520)

GALTIERI  63 PL 6 296           [illegible]BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)
WATSON    63 PR 131 2248        [illegible] WATSON, M FERRO-LUZZI, R D TRIPP (LRL)IJP
ALMEIDA   64 PL 9 204           [illegible] ALMEIDA, G R LYNCH                (CERN)
ARMENTER  65 PL 19 338          [illegible]ARMENTEROS,F-LUZZI, +   (CERN,HEID,SACLAY)
MUSGRAVE  65 NC 35 735          [illegible]TMEZAS,+         (BIRM,CERN,EPOL,LOIC,SACLAY)

BIRMINGH  66 PR 152 1148        BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
DAHL      67 PR 163 1377        DAHL,HARDY,HESS,KIRZ,MILLER                  (LRL)
DAUBER    67 PL 24B 525         +MALAMUD,SCHLEIN,SLATER,STORK                (UCLA)
UHLIG     67 PR 155 1448        +CHARLTON,CONDON,GLASSER,YODH,+         (UMD,NRL)
MAST      68 PRL 21 1715        MAST,ALSTON,BANGERTER,GALTIERI+              (LRL)
SCHEUER   68 NP B8 503          SABRE COLLAB.        (SACL+AMST+BGNA+REHO+EPOL)
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BURKHARDT 69  NP B14 106          +FILTHUTH+KLUGE+..    (HEID+EF)+CERN+SACLAY)
CLINE     69  LNC 2 407           +LAUMANN+MAPP                          (WISC)
GALTIERI  69  LUND 352            BARBARO-GALTIERI,BANGERTER,MAST,TRIPP (LRL)
     ALSO 70  DUKE 95             R D TRIPP                              (LRL)

BURKHARDT71   NP  B27 64          +FILTHUTH,KLUGE,OBERLACK++  (HEID+CERN+SACL)
COLLEY    71  NP  B31 61          +COX,EASTWOOD,FRY+..  (BIRM+EDIN+GLAS+LOIC)
KIM       71  PRL 27 356          J K KIM                             (HARV)IJP
     ALSO 70  DUKE 161            J. K. KIM                           (HARV)IJP

CHAN      72  PRL 28 256          +BUT.-SHAFER,HERTZBACH,KOFLER++ (MASA,YALE)
MAST      73  PR D7 5             +ALSTON-GARNJOST,BANGERTER,+...       (LBL)IJP
MAS 2     73  PRD 7 3212          +BANGERTER,ALSTON-GARNJOST,+          (LBL)IJP
BERTHON   74  NC 21A 146          BERTHON,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)
CORDEN    75  NP B84 306          CORDEN,COX,DARTNELL,KENYON,ONEALE,+  (BIRM)

MAST      76  PRD 14 13           MAST,ALSTON-GARNJOST,BANGERTER+       (LBL)
CAMERON   77  NP B131 399         +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
RLIC      77  NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON    78  PR D18 182          +KENNEY,POLLARD,ROSS+         (LBL+MTHO+CERN)IJP
     ALSO 77  PRL 38 1007         ALSTON-GARNJOST,KENNEY        (LBL+MTHO+CERN)IJP
BARLAG    79  NP B149 220         +BLOKZIJL,JONGEJANS+     (AMST+CERN+NIJM+OXF)
BARBER    80  ZPHY C7 17          +DAINTON,LEE,MARSHALL+      (DARE+LANC+SHEF)
GOPAL     80  TORONTO CONF 159 G.P.GOPAL                              (RHEL)IJP

                                  PAPERS NOT REFERRED TO IN DATA CARDS

BERLEY    70  PR D1 1996          +YAMIN,KOFLER,MANN,MEISNER+ (BNL,MASA,YALE)IJP
GOLOWICH  74  PRD 10 3861         EUGEN GOLOWICH                         (SLAC)
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Λ(1600) P_{01}'

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IC1  Y*0(1600, JP=1/2+) I=0                                              1/76

SEE THE NOTE FOR THE Y*0(1800, JP=1/2+) P''01.
SOMEWHERE IN THIS REGION THERE IS PROBABLY ONE,
AND PERHAPS TWO, P01 STATES.

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                IC1  Y*0(1600) MASS (MEV)                                1/76

M    1       (1573.)                    KIM       71 DPWA    K-MATRIX ANA     1/76
M    1  POSSIBLE EFFECT IN SIGMA PI AND KBAR N CHANNELS.
M            1620.0      10.0           LANGBEIN  72 IPWA    MULTICHANNEL     1/76
M            1596.0      (6.0)          KANE      74 DPWA    K-P TO PI SIG   12/81*
M    2       1646.       7.             CARROLL   76 DPWA    I=0 TOTAL CS     2/77
M    3       1572. OR 1617.             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    3  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    3  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M            1573.       75.            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M            1703.       100.           ALSTON    78 DPWA    KBAR N ELASTIC    1/78
M            1569.0      (20.0)         GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
M                . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                IC1  Y*0(1600) WIDTH (MEV)                               1/76

W    1       (50.)                      KIM       71 DPWA    K-MATRIX ANAL.    1/76
W            60.0        10.0           LANGBEIN  72 IPWA    MULTICHANNEL      1/76
W            175.0       (20.0)         KANE      74 DPWA    K-P TO PI SIG    12/81*
W    2       (20.)                      CARROLL   76 DPWA    I=0 TOTAL CS      2/77
W    3       247. OR 271.               MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W            147.        50.            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W            593.        200.           ALSTON    78 DPWA    KBAR N ELASTIC    1/78
W            116.0       (20.0)         GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
W        SEE THE NOTES ACCOMPANYING MASSES QUOTED
W                . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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                IC1  Y*0(1600) PARTIAL DECAY MODES                       1/76

                                                          DECAY MASSES
P1      Y*0(1600) INTO N KBAR                             938+ 493
P2      Y*0(1600) INTO SIGMA PI                           1189+ 139

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                IC1  Y*0(1600) BRANCHING RATIOS                          1/76

R1      Y*0(1600) INTO (KBAR N)/TOTAL                   (P1)             1/76
R1           0.25        0.15           LANGBEIN  72 IPWA    MULTICHANNEL      1/76
R1   2  TOTAL CROSS SECTION BUMP WITH (J+1/2)X=.04   SEEN BY CARROLL 76    2/77
R1   3       (0.30)OR    0.29           MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C       (0.24)      (0.04)         RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.14        0.05           ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R1           0.23        (0.04)         GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
R1               . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      Y*0(1600) FROM KBAR N INTO SIGMA PI                SQRT(P1*P2)      1/76
R2           0.28        0.09           LANGBEIN  72 IPWA    MULTICHANNEL      1/76
R2           -0.33       (0.11)         KANE      74 DPWA    K-P TO PI SIG    12/81*
R2         NOT SEEN                     HEPP2     76 DPWA -0 K- NUC TO SIG PI  2/77
R2   3       (-0.39)OR -0.39            MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2           -0.16       0.04           RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R2               . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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REFERENCES FOR Y*0(1600)


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KIM       71  PRL 27 356          J K KIM                             (HARV)IJP
     ALSO 70  DUKE 161            J. K. KIM                           (HARV)IJP

LANGBEIN  72  NP B47 477          +WAGNER                             (MPIM)IJP
KANE      74  LBL-7452            D.F.KANE                             (LBL)IJP

CARROLL   76  PRL 37 806          +CHIANG,KYCIA,LI,MAZUR,MICHAEL+      (BNL)I
HEPP2     76  PL 65B 487          +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP
MARTIN    77  NP B127 349         MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
     ALSO 77  NP B126 266         MARTIN,PIDCOCK                        (LOUC)
     ALSO 77  NP B126 285         MARTIN,PIDCOCK                        (LOUC)IJP
RLIC      77  NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON    78  PR D18 182          +KENNEY,POLLARD,ROSS+         (LBL+MTHO+CERN)IJP
     ALSO 77  PRL 38 1007         ALSTON-GARNJOST,KENNEY        (LBL+MTHO+CERN)IJP
GOPAL     80  TORONTO CONF 159 G.P.GOPAL                              (RHEL)IJP
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Λ(1670) S_{01}''

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40  Y*0(1670, JP=1/2-) I=0

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

THIS RESONANCE IS WELL ESTABLISHED.

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                40  Y*0(1670) MASS (MEV)

M    M       (1666.0)OR(1675.0)         BERLEY    65 HBC   0 K-P TO LAM ETA    7/66
M    M  THE FIRST VALUE ASSUMES THE BRANCHING RATIO INTO LAMBDA ETA IS
M       SMALL, THE SECOND THAT IT IS LARGE.  BECAUSE THE RESONANCE IS NEAR
M       THE LAMBDA ETA THRESHOLD, THE BRANCHING RATIO AFFECTS THE MOMENTUM
M       DEPENDENCE OF THE TOTAL WIDTH, AND THUS ALSO THE RESONANCE PARA-
M       METERS OBTAINED BY FITTING TO THE DATA.
M    N       (1663.0)    (3.0)          ARMENT-1  68 HBC   0 ETA [illegible]      11/68
M    N       (1679.0)    (2.0)          ARMENT-2  68 HBC   0 K-P TO SIGMA PI   11/68
M    N  THE APPARENT DISCREPANCY BETWEEN THESE RESULTS IS PROBABLY NOT
M       SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE SYSTEMATIC
M       ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION FORCED ON
M       THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.
M    A       1674.0      (5.0)          ARMENT-3  69 HBC   0 MULTICHANNEL       9/69
M    A              THE MULTICHANNEL ANALYSIS INCLUDES ELASTIC AND SIGMA PI .  10/69
M    N       1662.0      (3.0)          ARMENT-4  69 HBC   0 ELAST,CH.EXC.ED    9/69
M    N       1673.0      (1.0)          ARMENT-4  69 HBC   0 K-P TO SIG PI.ED   9/69
M            1674.0                     BERLEY    69 HBC   0 K-P TO SIGMA PI    6/70
M            1683.0      (5.0)          GALTIERI  70 HBC   0 SIG PI,EDPWA       7/70
M            1670.                      KIM       71 DPWA    K-MATRIX ANAL.     3/71
M            1640.0      (40.0)         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M            1700.       (10.)          BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74
M            1672.       (1.)           HART      73 DPWA    EL+CX..7-.8GEV/C   2/74
M            1679.0      (1.0)          KANE      74 DPWA    K-P TO PI SIG     12/81*
M            1665.       (5.)           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
M            1675.       (2.)           HEPP2     76 DPWA -0 K- NUC TO SIG PI   2/77
M    2       (1664.)                    MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    2  MARTIN 77 OBTAINS IDENTICAL RESONANCE PARAMETERS FROM THE
M    2  T-MATRIX POLE AND FROM A B-W FIT.
M            1670.       (5.)           RLIC      77 DPWA    KBAR N MULTICHNL   1/76
M            1671.       (3.)           ALSTON    78 DPWA    KBAR N ELASTIC     1/76
M            1667.0      (5.0)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

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                40  Y*0(1670) WIDTH (MEV)

W    M       (22.0)OR(15.0)             BERLEY    65 HBC   0 SEE NOTE M ABOVE   7/66
W    N       (26.0)      (8.0)          ARMENT-1  68 HBC   0 SEE NOTE N ABOVE  11/68
W    N       (26.0)      (5.0)          ARMENT-2  68 HBC   0                   11/68
W    A       23.0        (3.0)          ARMENT-3  69 HBC   0                    9/69
W    N       38.0        (15.0)         ARMENT-4  69 HBC   0 ELAST,CH EXC.ED    9/69
W    N       33.0        (5.0)          ARMENT-4  69 HBC   0 K-P TO SIG PI.ED   9/69
W            31.0                       BERLEY    69 HBC   0 K-P TO SIGMA PI    6/70
W            25.0        (5.0)          GALTIERI  70 HBC   0 SIG PI,EDPWA       7/70
W            35.                        KIM       71 DPWA    K-MATRIX ANAL.     3/71
W            45.0        (20.0)         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
W            65.         (20.)          BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74
W            19.         (2.)           HART      73 DPWA    EL+CX..7-.8GEV/C   2/74
W            40.0        (3.0)          KANE      74 DPWA    K-P TO PI SIG     12/81*
W            19.         (5.)           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
W            45.         (5.)           HEPP2     76 DPWA -0 K- NUC TO SIG PI   2/77
W    2       (12.)                      MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W            45.         (10.)          RLIC      77 DPWA    KBAR N MULTICHNL   1/76
W            29.         (5.)           ALSTON    78 DPWA    KBAR N ELASTIC     1/78
W            29.0        (5.0)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
           SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                40  Y*0(1670) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*0(1670) INTO N KBAR                             938+ 493
P2      Y*0(1670) INTO LAMBDA ETA                         1115+ 549
P3      Y*0(1670) INTO SIGMA PI                           1189+ 139
P4      Y*0(1670) INTO SIGMA(1385) PI                      139+1385

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                40  Y*0(1670) BRANCHING RATIOS

R1      Y*0(1670) INTO (KBAR N)/TOTAL                   (P1)
R1   P       (0.14)      (0.04)         ARMENT-1  68 HBC   0 OLD DATA          11/68
R1           0.17                       ARMENT-3  69 HBC   0                    9/69
R1   P       0.14        (0.04)         ARMENT-4  69 HBC   0 NEW DATA           9/69
R1   A       (0.39)      (0.05)         CONFORTO  71 HBC   0 K-P,ELAST,CEX      6/70
R1           0.28                       KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1           0.35        (0.06)         LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R1           0.36        (0.03)         HART      73 DPWA    EL+CX..7-.8GEV/C   2/74
R1   2       (0.15)                     MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C       (0.20)      (0.03)         RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.17        (0.03)         ALSTON    78 DPWA    KBAR N ELASTIC     1/78
R1           0.18        (0.03)         GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
R1   A    EFFECT BELOW REGION ANALYZED. VALUE OF 0.18 DOES NOT
R1   A  AFFECT FIT OR VALUES OF OTHER PARAMETERS.
R1   F   THIS IS THE DIAMETER OF THE CIRCLE IN THE ARGAND PLOT.  IT IS
R1      SUPERIMPOSED ON A LARGE BACKGROUND.

R2      Y*0(1670) FROM KBAR N TO LAMBDA ETA                SQRT(P1*P2)
R2   M       (0.20) OR 0.23             BERLEY    65 HBC   0 SEE NOTE M ABOVE   7/66
R2           (0.26)                     ARMENT-3  69 HBC   0                    9/69
R2           (0.24)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2           +0.20       (0.05)         BAXTER    73 DPWA  0 K- P TO NEUTRALS 10/74
        SEE THE NOTES ACCOMPANYING MASSES QUOTED
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R3      Y*0(1670) FROM KBAR N TO SIGMA PI                      SQRT(P1*P3)
R3  1       (-0.25)   (0.06)          ARMENT-2  68 HBC    0 OLD DATA
R3  1       (-0.27)                   ARMENT-3  69 HBC    0                   9/69
R3  1       (-0.30)   (0.03)          ARMENT-4  69 HBC    0 NEW DATA          9/69
R3  1   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R3           -0.27                    BERLEY    69 HBC    0 K-P TO SIGMA PI   6/70
R3           -0.29    (0.03)          GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
R3           -0.38                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
R3           -0.28    (0.05)          BAXTER    73 DPWA   0 K- P TO NEUTRALS 10/74
R3           -0.27    (0.02)          KANE      74 DPWA     K-P TO PI SIG    12/81*
R3           -0.23    (0.03)          LONDON    75 HLBC   0 K- P TO SIGO PIO  4/75
R3           -0.29    (0.03)          HEPP2     76 DPWA  -0 K- NUC TO SIG PI  2/77
R3  2       (-0.13)                   MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
R3           -0.31    (0.03)          RLIC      77 DPWA     KBAR N MULTICHNL  1/76

R4      Y*0(1670) FROM KBAR N TO SIGMA(1385) PI                SQRT(P1*P4)
R4           -0.18     0.05           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
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REFERENCES FOR Y*0(1670)


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BERLEY    65 PRL 15 641          +CONNOLLY, HART, RAUM, STONEHILL, +     (BNL)IJP
ARMENT-1  68 NP B8 195           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2  68 NP B8 223           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP

ARMENT-3  69 LUND PAPER 229      ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
    VALUES ARE QUOTED IN LEVI SETTI 69.
ARMENT-4  69 NP B14 91           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430          + HART, RAHM, WILLIS, YAMAMOTO           (BNL)IJP
GALTIERI  70 DUKE 173            A. BARBARO GALTIERI                      (LRL)IJP

CONFORTO  71 NP B34 41           +LEVI SETTI,LASINSKI,.OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356          J K KIM                                 (HARV)IJP
    ALSO  70 DUKE 161            J. K. KIM                               (HARV)IJP
LANGBEIN  72 NP B47 477          +WAGNER                                 (MPIM)IJP
BAXTER    73 NP B67 125          BAXTER,BUCKINGHAM,CORBETT,DUNN,+     (OXFORD)IJP
HART      73 PURDUE CONF. 311    +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
KANE      74 LBL-2452            D.F.KANE                                 (LBL)IJP
PREVOST   74 NP B69 246          PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)
LONDON    75 NP B85 289          LONDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)

HEPP2     76 PL 65B 467          +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP
MARTIN    77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE           (LOUC+GLAS)IJP
    ALSO  77 NP B126 266         MARTIN,PIDCOCK                           (LOUC)
    ALSO  77 NP B126 285         MARTIN,PIDCOCK                          (LOUC)IJP
RLIC      77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON    78 PR D18 182          +KENNEY,POLLARD,ROSS+          (LBL+MTHO+CERN)IJP
    ALSO  77 PRL 38 1007         ALSTON-GARNJOST,KENNEY         (LBL+MTHO+CERN)IJP
GOPAL     80 TORONTO CONF 159    G.P.GOPAL                               (RHEL)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS

BIRMINGH  66 PR 152 1148          (BIRMINGHAM,GLASGOW,LOIC,OXFORD,RUTHERFD)
LEVISETT  69 LUND 339            R LEVI SETTI  (RAPPORTEUR)          (CHICAGO)
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Λ(1690)

55 Y*0(1690, JP=3/2-) I=0 D_{03}

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

THIS RESONANCE IS WELL ESTABLISHED.

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55 Y*0(1690) MASS (MEV)

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M          (1696.0)   (3.0)           ARMENT-1  68 HBC    0 ELASTIC, CH EXCH 11/68
M          (1681.0)   (2.0)           ARMENT-3  68 HBC    0 K P TO SIGMA PI  11/68
M           1681.     (8.)            BARTLEY   68 OBC    0 K-P AND K-D DATA 11/68
M           1695.0    (4.0)           BUGG      68 CNTR   0 K-P, D TOTAL      7/68
M   M      (1697.0)   (2.0)           CONFORTO  68 HBC    0 ELASTIC, CH EXCH 11/68
M   M    THE Y*0(1690) IS AT THE EDGE OF THE ENERGY REGION ANALYZED BY
M   M  CONFORTO. THE SAME DATA AS WELL AS OTHERS EXTENDING TO LOWER
M   M  ENERGIES ARE INCLUDED IN ARMENTEROS 1.
M   A       1691.0    (2.0)           ARMENT-4  69 HBC    0 ELAS,CH EXC,ED    9/69
M   A    ANALYSIS INCLUDES OLD AND NEW DATA OF CHS COLLAB. 0.43-.8 GEV/C
M   A    THE APPARENT DISCREPANCY BETWEEN THE SIGMA PI AND OTHER RESULTS IS
M   A  PROBABLY NOT SERIOUS.  THE ERRORS GIVEN ARE JUST STATISTICAL.  THE
M   A  SYSTEMATIC ERRORS THAT RESULT FROM THE RESTRICTIVE PARAMETRIZATION
M   A  OF THE PARTIAL-WAVE AMPLITUDES ARE NOT INCLUDED, AND CAN BE LARGE.
M   A       1698.0    (2.0)           ARMENT-4  69 HBC    0 K-P TO SIG PI,ED  9/69
M           1689.0                    BERLEY    69 HBC    0 K-P TO SIGMA PI   6/70
M           1701.0    (4.0)           BERTANZA  69 HBC    0 ELASTIC, CH EXCH  9/69
M           1680.0    (5.0)           GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
M           1688.0    (3.0)           CONFORTO  71 HBC    0 K-P,ELAST,CEX     6/70
M           1690.                     KIM       71 DPWA     K-MATRIX ANAL.    3/71
M           1680.0   (20.0)           LANGBEIN  72 IPWA     MULTICHANNEL     12/72
M           1670.    (10.)            BAXTER    73 DPWA   0 K- P TO NEUTRALS 10/74
M           1684.     (3.)            HART      73 DPWA     EL+CX,.7-.8GEV/C  2/74
M           1689.0    (1.0)           KANE      74 DPWA     K-P TO PI SIG    12/81*
M   2       1692.     (4.)            CARROLL   76 DPWA     I=0 TOTAL CS      2/77
M           1690.     (3.)            HEPP2     76 DPWA  -0 K- NUC TO SIG PI  2/77
M   3       1687. OR 1689.            MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
M   3    THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M   3    PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M   3    ANOTHER 3/2- LAMBDA AT 1966 MEV IS ALSO SUGGESTED BY MARTIN77,
M   3    BUT IS VERY UNCERTAIN.
M           1690.     (5.)            RLIC      77 DPWA     KBAR N MULTICHNL  1/76
M           1692.     (5.)            ALSTON    78 DPWA     KBAR N ELASTIC    1/78
M           1690.0    (5.0)           GOPAL     80 DPWA     KBAR N ELASTIC   12/81*
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55 Y*0(1690) WIDTH (MEV)

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W           (35.0)    (7.0)           ARMENT-1  68 HBC    0 OLD DATA         11/68
W           (85.0)    (7.0)           ARMENT-3  68 HBC    0 OLD DATA         11/68
W            48.     (15.)            BARTLEY   68 OBC    0 K-P AND K-D DATA 11/68
W            40.0     (7.0)           BUGG      68 CNTR   0                   7/68
W   M       (27.0)    (5.0)           CONFORTO  68 HBC    0 SEE NOTE M ABOVE 11/68
W   A        31.0     (7.0)           ARMENT-4  69 HBC    0 ELAS,CH EXC,ED    9/69
W   A        72.0     (6.0)           ARMENT-4  69 HBC    0 K-P TO SIG PI ED  9/69
W            57.0                     BERLEY    69 HBC    0 K-P TO SIGMA PI   6/70
W            28.0     (8.0)           BERTANZA  69 HBC    0                   9/69
W            85.0    (10.0)           GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
W            64.0     (5.0)           CONFORTO  71 HBC    0 K-P,ELAST,CEX     6/70
W            55.                      KIM       71 DPWA     K-MATRIX ANAL.    3/71
W            40.0    (10.0)           LANGBEIN  72 IPWA     MULTICHANNEL     12/72
W            30.     (10.)            BAXTER    73 DPWA   0 K- P TO NEUTRALS 10/74
W            86.      (9.)            HART      73 DPWA     EL+CX,.7-.8GEV/C  2/74
W            60.0     (4.0)           KANE      74 DPWA     K-P TO PI SIG    12/81*
W   2       (38.)                     CARROLL   76 DPWA     I=0 TOTAL CS      2/77
W            82.      (8.)            HEPP2     76 DPWA  -0 K- NUC TO SIG PI  2/77
W   3        62. OR 67.               MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
W            60.      (5.)            RLIC      77 DPWA     KBAR N MULTICHNL  1/76
W            64.     (10.)            ALSTON    78 DPWA     KBAR N ELASTIC    1/78
W            61.0     (5.0)           GOPAL     80 DPWA     KBAR N ELASTIC   12/81*
             SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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55 Y*0(1690) PARTIAL DECAY MODES

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                                                          DECAY MASSES
P1      Y*0(1690)  INTO N KBAR                            938+ 494
P2      Y*0(1690)  INTO SIGMA PI                          1189+ 139
P3      Y*0(1690)  INTO LAMBDA PI PI                      1115+ 139+ 139
P4      Y*0(1690)  INTO SIGMA PI PI                       1192+ 139+ 139
P5      Y*0(1690)  INTO Y*1(1385) PI S-WAVE                139+1385
P6      Y*0(1690)  INTO LAMBDA ETA                        1115+ 548
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55 Y*0(1690) BRANCHING RATIOS

THE SUM OF ALL THE QUOTED BRANCHING RATIOS IS MORE THAN 1.0. THE TWO-BODY RATIOS ARE FROM PARTIAL WAVE ANALYSES, AND THUS PROBABLY ARE MORE RELIABLE THAN THE THREE-BODY RATIOS, WHICH ARE DETERMINED FROM BUMPS IN CROSS SECTIONS. OF THE LATTER, THE SIGMA PI PI BUMP LOOKS MORE SIGNIFICANT (THE ERROR GIVEN FOR THE LAMBDA PI PI RATIO LOOKS UNREASONABLY SMALL). HARDLY ANY OF THE SIGMA PI PI DECAY CAN BE VIA Y*1(1385), FOR THEN NINE TIMES AS MUCH LAMBDA PI PI DECAY WOULD BE REQUIRED.

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R1      Y*0(1690) INTO (KBAR N)/TOTAL                          (P1)
R1          (0.18)    (0.03)          ARMENT-1  68 HBC    0                  11/68
R1          (0.23)                    BUGG      68 CNTR   0 ASSUMING J=3/2    7/68
R1  M       (0.22)    (0.03)          CONFORTO  68 HBC    0 SEE NOTE M ABOVE 11/
R1           0.18     (0.02)          ARMENT-4  69 HBC    0 NEW DATA          /69
R1           0.28     (0.04)          BERTANZA  69 HBC    0                   9/69
R1  N       (0.34)    (0.02)          CONFORTO  71 HBC    0 K-P,ELAST,CEX     6/70
R1  N   EFFECT IS AT END OF REGION ANALYZED. THIS COULD AFFECT VALUE OF X1.
R1           0.22                     KIM       71 DPWA     K-MATRIX ANAL.    3/71
R1           0.15     (0.05)          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R1           0.24     (0.01)          HART      73 DPWA     EL+CX,.7-.8GEV/C  2/74
R1  3       (0.28)OR  0.26            MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
R1  C       (0.24)    (0.03)          RLIC      77 DPWA     KBAR N MULTICHNL  1/76
R1  C   (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.22     (0.03)          ALSTON    78 DPWA     KBAR N ELASTIC    1/78
R1           0.23     (0.03)          GOPAL     80 DPWA     KBAR N ELASTIC   12/81*

R2      Y*0(1690) FROM KBAR N TO SIGMA PI                      SQRT(P1*P2)
R2  1       (-0.33)   (0.02)          ARMENT-3  68 HBC    0 OLD DATA         11/68
R2  1       (-0.36)   (0.02)          ARMENT-4  69 HBC    0 NEW DATA          9/69
R2  1   PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R2           -0.27                    BERLEY    69 HBC    0 K-P TO SIGMA PI   6/70
R2           -0.31    (0.03)          GALTIERI  70 HBC    0 SIG PI,EDPWA      7/70
R2           -0.40                    KIM       71 DPWA     K-MATRIX ANAL.    3/71
R2            0.26    (0.01)          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
R2           -0.20    (0.03)          BAXTER    73 DPWA   0 K- P TO NEUTRALS 10/74
R2           -0.28    (0.02)          KANE      74 DPWA     K-P TO PI SIG    12/81*
R2           -0.28    (0.03)          LONDON    75 HLBC   0 K- P TO SIGO PIO  4/75
R2           -0.29    (0.03)          HEPP2     76 DPWA  -0 K- NUC TO SIG PI  2/77
R2  3       (-0.30)OR -0.26           MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
R2           -0.25    (0.03)          RLIC      77 DPWA     KBAR N MULTICHNL  1/76

R3      Y*0(1690) FROM KBAR N TO LAMBDA PI PI                  SQRT(P1*P3)
R3  B       (0.25)    (0.02)          BARTLEY   68 HDBC   0 LAM 2PI CROS SEC 11/68
R3  B   ONLY CROSS-SECTION DATA USED. ENHANCEMENT NOT SEEN BY PREVOST 71.      3/72

R4      Y*0(1690) FROM KBAR N TO SIGMA PI PI                   SQRT(P1*P4)
R4          (0.21)                    ARMENT-2  68 HDBC   0 K-N TO SIG PI PI 11/68

R5      Y*0(1690) FROM KBAR N INTO LAMBDA ETA                  SQRT(P1*P6)
R5           0.00     (0.03)          BAXTER    73 DPWA   0 K- P TO NEUTRALS 10/74

R6      Y*0(1690) FROM KBAR N TO Y*1(1385) PI S-WAVE           SQRT(P1*P5)
R6           +0.27     0.04           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
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REFERENCES FOR Y*0(1690)


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ARMENT-1  68 NP B8 195           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2  68 NP B8 216           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
ARMENT-3  68 NP B8 223           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BARTLEY   68 PRL 21 1111         +CHU,DOWD,GREENE,+       (TUFTS,FSU,BRANDEIS) I
BUGG      68 PR 168 1466         +GILMORE, KNIGHT, +         (BIRM,CAVE,RHEL) I
    ALSO  67 PRL 18 62           DAVIES,DOWELL,+              (BIRM,CAVE,RHEL) I
CONFORTO  68 NP B8 265           +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP

ARMENT-4  69 NP B14 91           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY    69 PL 30B 430          + HART, RAHM, WILLIS, YAMAMOTO           (BNL)IJP
BERTANZA  69 PR 177 2036         +BIGI,CAPRARA,CASALI, +     (PISA,BNL,YALE)IJP

GALTIERI  70 DUKE 173            A. BARBARO GALTIERI                      (LRL)IJP
CONFORTO  71 NP B34 41           +LEVI SETTI,LASINSKI,.OBERLACK++ (EFI+HEID)IJP
KIM       71 PRL 27 356          J K KIM                                 (HARV)IJP
    ALSO  70 DUKE 161            J. K. KIM                               (HARV)IJP
LANGBEIN  72 NP B47 477          +WAGNER                                 (MPIM)IJP
BAXTER    73 NP B67 125          BAXTER,BUCKINGHAM,CORBETT,DUNN,+     (OXFORD)IJP
HART      73 PURDUE CONF. 311    +RICE,BACASTOW,FUNG,+  (TENN+UCR+MASA+BUFF)IJP
KANE      74 LBL-2452            D.F.KANE                                 (LBL)IJP
PREVOST   74 NP B69 246          PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)

LONDON    75 NP B85 289          LONDON,YU,BOYD,+  (BNL,CERN,EPOL,ORSA,TORI)
CARROLL   76 PRL 37 806          +CHIANG,KYCIA,LI,MAZUR,MICHAEL+           (BNL)I
HEPP2     76 PL 65B 467          +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP

MARTIN    77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE           (LOUC+GLAS)IJP
    ALSO  77 NP B126 266         MARTIN,PIDCOCK                           (LOUC)
    ALSO  77 NP B126 285         MARTIN,PIDCOCK                          (LOUC)IJP
RLIC      77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON    78 PR D18 182          +KENNEY,POLLARD,ROSS+          (LBL+MTHO+CERN)IJP
    ALSO  77 PRL 38 1007         ALSTON-GARNJOST,KENNEY         (LBL+MTHO+CERN)IJP
GOPAL     80 TORONTO CONF 159    G.P.GOPAL                               (RHEL)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS

PREVOST   71 AMSTERDAM CONF      + CHS COLLABORATION             (CERN+HEID+SACL)
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Λ(1800) S''_{01}

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76   Y*0(1800, JP=1/2-) I=0

THE S01 AMPLITUDE SHOWS A RATHER CLEAR SECOND RESONANCE
BEHAVIOR IN THE 1700-1900 MEV REGION.  THERE ARE WIDE
DISAGREEMENTS AMONG THE MASS, WIDTH, AND COUPLING
DETERMINATIONS.

                 76   Y*0(1800) MASS (MEV)

M          (1872.0)    (10.0)          BRICMAN    70 DPWA   TOT, ELAS, CHEX    1/71
M          (1780.)                     KIM        71 DPWA   K-MATRIX ANAL.     3/71
M           1830.0     (20.0)          LANGBEIN   72 DPWA   MULTICHANNEL      12/72
M    1      1767. OR 1842.             MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
M    1  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    1  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1825.      (20.)           PLIC       77 DPWA   KBAR N MULTICHNL   1/76
M           1725.      (20.)           ALSTON     78 DPWA   KBAR N ELASTIC     1/76
M           1841.0     (10.0)          GOPAL      80 DPWA   KBAR N ELASTIC    12/81*

                 76   Y*0(1800) WIDTH (MEV)

W          (100.0)     (20.0)          BRICMAN    70 DPWA   TOT, ELAS, CHEX    1/71
W          (40.)                       KIM        71 DPWA   K MATRIX ANAL.     3/71
W           70.0       (15.0)          LANGBEIN   72 DPWA   MULTICHANNEL      12/72
W    1      435. OR 473.               MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
W           230.       (20.)           PLIC       77 DPWA   KBAR N MULTICHNL   1/76
W           145.       (20.)           ALSTON     78 DPWA   KBAR N ELASTIC     1/76
W           228.0      (20.0)          GOPAL      80 DPWA   KBAR N ELASTIC    12/81*

                 76   Y*0(1800) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*0(1800) INTO N KBAR                                939+ 493
P2      Y*0(1800) INTO SIGMA PI                             1189+ 139
P3      Y*0(1800) INTO Y*1(1385) PI                         1385+ 139
P4      Y*0(1800) INTO N K*(890), S1 WAVE                    939+ 891
P5      Y*0(1800) INTO N K*(890), D3 WAVE                    939+ 891

                 76   Y*0(1800) BRANCHING RATIOS

R1      Y*0(1800) INTO (KBAR N)/TOTAL                     (P1)
R1          (0.18)     (0.02)          BRICMAN    70 DPWA   TOT, ELAS, CHEX    1/71
R1          (0.80)                     KIM        71 DPWA   K-MATRIX ANAL.     3/71
R1           0.35      (0.15)          LANGBEIN   72 DPWA   MULTICHANNEL      12/72
R1   1      (1.21)OR   0.70            MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
R1   C      (0.37)     (0.05)          PLIC       77 DPWA   KBAR N MULTICHNL   1/76
R1   C  (KBAR N)/TOTAL FROM PLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.28      (0.05)          ALSTON     78 DPWA   KBAR N ELASTIC     1/76
R1           0.37      (0.04)          GOPAL      80 DPWA   KBAR N ELASTIC    12/81*

R2      Y*0(1800) FROM KBAR N TO SIGMA PI                 SQRT(P1*P2)
R2          (0.24)                     KIM        71 DPWA   K-MATRIX ANAL.     3/71
R2   1      (-0.74)OR -0.43            MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
R2          -0.09      (0.05)          PLIC       77 DPWA   KBAR N MULTICHNL   1/76

R3      Y*0(1800) FROM KBAR N INTO Y*1(1385) PI           SQRT(P1*P3)
R3   2       +0.056     0.028          CAMERON    78 DPWA   0 K-P TO SIG1385PI 1/78
R3   2  SIGN CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.        12/79

R4      Y*0(1800) FROM KBAR N INTO N K*(890), S1 WAVE     SQRT(P1*P4)
R4   3      -0.17       0.03           CAMERON2   78 DPWA   K-P TO K*N        12/79
R4   3  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST        12/79
R4   3  CONVENTION.                                                           12/79

R5      Y*0(1800) FROM KBAR N INTO N K*(890), D3 WAVE     SQRT(P1*P5)
R5          -0.13       0.06           CAMERON2   78 DPWA   K-P TO K*N        12/79
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                 REFERENCES FOR Y*0(1800)

BRICMAN  70 PL 33B 511          C BRICMAN, M FERRO-LUZZI, J P LAGNAUX (CERN) IJP
KIM      71 PRL 27 356          J K KIM                                  (HARV) IJP
   ALSO  70 DUKE 161            J. K. KIM                                (HARV) IJP
LANGBEIN 72 NP B47 477          +WAGNER                                  (MPIM) IJP

MARTIN   77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE            (LOUC+GLAS) IJP
   ALSO  77 NP B126 266         MARTIN,PIDCOCK                            (LOUC)
   ALSO  77 NP B126 285         MARTIN,PIDCOCK                            (LOUC) IJP
PLIC     77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+      (LOIC+RHEL) IJP
ALSTON   78 PR D18 182          +KENNEY,POLLARD,ROSS+          (LBL+MTHO+CERN) IJP
   ALSO  77 PRL 38 1007         ALSTON-GARNJOST,KENNEY         (LBL+MTHO+CERN) IJP
CAMERON  78 NP B143 189         +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC) IJP
CAMERON2 78 NP B146 327         +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC) IJP
GOPAL    80 TORONTO CONF 159 G.P.GOPAL                                  (RHEL) IJP
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Λ(1800) P''_{01}

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77   Y*0(1800, JP=1/2+) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE EVIDENCE FOR THIS STATE IS SOMEWHAT CONFUSED.  IT
WAS FIRST SUGGESTED IN A PARTIAL WAVE ANALYSIS OF
KBAR N DATA BY THE BEHAVIOUR OF THE P01 AMPLITUDE
WHEN IT WAS PARAMETRIZED AS A TWO-STRAIGHT-LINE
BACKGROUND (ARMENTEROS 68).

  ALMOST ALL THE RECENT ANALYSES CONTAIN A P01 STATE, AND SOMETIMES
TWO, BUT THE MASSES, WIDTHS, AND BRANCHING RATIOS OBTAINED IN THE
DIFFERENT ANALYSES VARY GREATLY.  SEE ALSO THE Y*0(1600)P01 LISTING.

                 77   Y*0(1800) MASS (MEV)

M          (1745.0)                    ARMENTERO  69 HBC    0 ELASTIC, CH EXCH 11/68
M          (1740.0)                    BAILEY     69 DPWA   0 ELASTIC, CH EXCH 10/70
M          (1800.0)                    ARMENTERO  70 HBC    0 ELASTIC, CH EX    6/70
M          (1750.0)                    ARMENTERO  70 HBC    0 SIGMA PI          6/70
M    N     (1693.0)    (10.0)          GALTIERI   70 HBC    0 SIG PI,EDPWA      7/70
M    N  ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED     1/71
M          (1755.)                     KIM        71 DPWA   K-MATRIX ANAL.     3/71
M           1740.0     20.0            LANGBEIN   72 DPWA   MULTICHANNEL      12/72
M           1746.      10.             PREVOST    74 DPWA   K-N TO SIG1385PI  10/74
M    1      1735.      5.              CARROLL    76 DPWA   ISO TOTAL CS        2/77
M    2      1861. OR 1553.             MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
M    3  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    3  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1853.      20.             PLIC       77 DPWA   KBAR N MULTICHNL   1/76
M           1841.0     (20.0)          GOPAL      80 DPWA   KBAR N ELASTIC    12/81*
M
M       AVERAGE MEANINGLESS (SCALE FACTOR = ...)

                 77   Y*0(1800) WIDTH (MEV)

W          (147.0)                     ARMENTERO  68 HBC    0
W          (300.0)                     BAILEY     69 DPWA   0 ELASTIC, CH EXCH 10/70
W          (30.0)                      ARMENTERO  70 HBC    0 ELASTIC, CH EX    6/70
W          (70.0)                      ARMENTERO  70 HBC    0 SIGMA PI          6/70
W    N     (22.0)                      GALTIERI   70 HBC    0 SIG PI, EDPWA     7/70
W          (55.)                       KIM        71 DPWA   K-MATRIX ANAL.     3/71
W           120.0      15.             LANGBEIN   72 DPWA   MULTICHANNEL      12/72
W           66.        23.             PREVOST    74 DPWA   K-N TO SIG1385PI  10/74
W    1      (28.)                      CARROLL    76 DPWA   ISO TOTAL CS        2/77
W    2      535. OR 585.               MARTIN     77 DPWA   KBAR N MULTICHNL  11/77
W           166.       20.             PLIC       77 DPWA   KBAR N MULTICHNL   1/76
W           93.0       25.0            CAMERON2   78 DPWA   K-P TO K*(890)N   12/79
W           178.0      (20.0)          GOPAL      80 DPWA   KBAR N ELASTIC    12/81*
W
W       AVERAGE MEANINGLESS (SCALE FACTOR = ...)
            SEE THE NOTES ACCOMPANYING MASSES ABOVE.

                 77   Y*0(1800) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*0(1800) INTO N KBAR                                939+ 493
P2      Y*0(1800) INTO SIGMA PI                             1189+ 139
P3      Y*0(1800) INTO SIGMA(1385) PI                       1385+ 139
P4      Y*0(1800) INTO N K*(890), P1 WAVE                    939+ 891
P5      Y*0(1800) INTO N K*(890), P3 WAVE                    939+ 891

                 77   Y*0(1800) BRANCHING RATIOS

R1      Y*0(1800) INTO (KBAR N)/TOTAL                     (P1)
R1          (0.4)                      ARMENTERO  68 DPWA     ELASTIC, CH EXCH 11/68
R1          (0.51)                     BAILEY     69 DPWA   0 ELASTIC, CH EXCH 10/70
R1          (0.18)                     ARMENTERO  70 DPWA   0 ELASTIC, CH EXCH 10/70
R1          (0.30)                     KIM        71 DPWA     K-MATRIX ANAL.    3/71
R1           0.16       0.05           LANGBEIN   72 DPWA     MULTICHANNEL     12/72
R1   3      (0.52)OR   0.45            MARTIN     77 DPWA     KBAR N MULTICHNL 11/77
R1   C      (0.21)     (0.04)          PLIC       77 DPWA     KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM PLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.24      (0.04)          GOPAL      80 DPWA     KBAR N ELASTIC   12/81*

R2      Y*0(1800) FROM KBAR N INTO SIGMA PI               SQRT(P1*P2)
R2   2      (+0.20)                    ARMENTERO  70 DPWA   0 K-P TO SIGMA PI   6/70
R2   2  PUBLISHED SIGN CHANGED TO AGREE WITH LOVELACE CONVENTION (SEE ...)     1/74
R2   N      (-0.13)    (0.04)          GALTIERI   70 DPWA   0 K-P TO SIGMA PI   7/70
R2          (0.17)                     KIM        71 DPWA     K-MATRIX ANAL.    3/71
R2          (0.01) OR LESS             LANGBEIN   72 DPWA     MULTICHANNEL     12/72
R2   3      (+0.25)OR +0.25            MARTIN     77 DPWA     KBAR N MULTICHNL 11/77
R2          -0.24       0.04           PLIC       77 DPWA     KBAR N MULTICHNL  1/76

R3      Y*0(1800) FROM KBAR N INTO SIGMA(1385) PI         SQRT(P1*P3)
R3           +0.18      0.10           PREVOST    74 DPWA   0 K-N TO SIG1385PI 10/74

R4      Y*0(1800) FROM KBAR N INTO N K*(890), P1 WAVE     SQRT(P1*P4)
R4   4        0.14      0.04           CAMERON2   78 DPWA     K-P TO K*N       12/79
R4   4  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST         12/79
R4   4  CONVENTION.                                                            12/79

R5      Y*0(1800) FROM KBAR N INTO N K*(890), P3 WAVE     SQRT(P1*P5)
R5           +0.25      0.06           CAMERON2   78 DPWA     K-P TO K*N       12/79

        SEE THE NOTES ACCOMPANYING MASSES ABOVE.
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                 REFERENCES FOR Y*0(1800)

ARMENTER 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN+HEID+SACL) IJP
BAILEY   69 THESIS UCRL-50617  JAMES SAAL BAILEY                 (LRL LIVERMORE) IJP
ARMENTER 70 DUKE CONF 123      ARMENTEROS, BAILLON, +           (CERN+HEID) IJP
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                      (LRL) IJP
KIM      71 PRL 27 356         J K KIM                                (HARV) IJP
   ALSO  70 DUKE 161           J. K. KIM                              (HARV) IJP
LANGBEIN 72 NP B47 477         +WAGNER                                (MPIM) IJP

PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+           (SACL+CERN+HEID)
CARROLL  76 PRL 37 806         +CHIANG,KYCIA,LI,MAZUR,MICHAEL+            (BNL) I
MARTIN   77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE           (LOUC+GLAS) IJP
   ALSO  77 NP B126 266        MARTIN,PIDCOCK                           (LOUC)
   ALSO  77 NP B126 285        MARTIN,PIDCOCK                           (LOUC) IJP
PLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+     (LOIC+RHEL) IJP
CAMERON2 78 NP B146 327        +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC) IJP
GOPAL    80 TORONTO CONF 159 G.P.GOPAL                                (RHEL) IJP
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Λ(1800) → G_{09}

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102   Y*0(1800, JP=9/2-) I=0                                                1/76

THIS NARROW STATE WAS REQUIRED TO FIT A PEAK IN THE A7
COEFFICIENT OF THE K-P ANGULAR DISTRIBUTION IN PLIC 77.
IT WAS NOT REQUIRED IN PI SIGMA.  NEW KBAR N ANALYSIS
(GOPAL 80) FINDS THE STATE INCONSISTENT WITH THE NEW
HIGH STATISTICS K-P POLARIZATION MEASUREMENTS (BRYANT
80).

                 102   Y*0(1800) MASS (MEV)                                 1/76

M           1808.      5.              PLIC       77 DPWA   KBAR N MULTICHNL   1/76
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                    102  Y*0(1800) WIDTH (MEV)                                  1/76

W            27.        5.          RLIC      77 DPWA    KBAR N MULTICHNL   1/76

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                    102  Y*0(1800) PARTIAL DECAY MODES                          1/76

                                                                 DECAY MASSES
P1      Y*0(1800) INTO N KBAR                                    938+ 493
P2      Y*0(1800) INTO SIGMA PI                                  1197+ 139

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                    102  Y*0(1800) BRANCHING RATIOS                             1/76

R1      Y*0(1800) INTO (KBAR N)/TOTAL                     (P1)                  1/76
R1   C        (0.04)    (0.01)       RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1            0.03      (0.03)       GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

R2      Y*0(1800) FROM KBAR N INTO SIGMA PI               SQRT(P1*P2)           1/76
R2           LESS THAN 0.04          RLIC      77 DPWA    KBAR N MULTICHNL   1/76

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                          REFERENCES FOR Y*0(1800)

RLIC      77 NP B119 362       GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)
GOPAL     80 TORONTO CONF 159 G.P.GOPAL                                (RHEL)  IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

BRYANT    80 NP B165 207       +CARTER,COUPLAND,EISENHANDLER,+ (LOQM+RHEL)

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Λ(1800) BUMPS

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        119  Y*0(1800, JP=      ) I=?       PRODUCTION EXPERIMENTS

        LOCKMAN 78 OBSERVE A 5 STD. DEV. ENHANCEMENT IN THE
        LAMBDA PI+ PI- MASS SPECTRUM FROM THE REACTION
        PP --> LAMBDA PI+ PI- + ANYTHING IN A CERN ISR
        EXPERIMENT AT C.M. ENERGIES OF 43 AND 62 GEV.
        THE MAIN DECAY MODES APPEAR TO BE Y*1(1385) PI AND
        Y*1(1560) PI (SEE THE ENTRY FOR Y*1(1560)).
  THE I-SPIN IS NOT ESTABLISHED, BUT SINCE THE LARE A PI DECAY IS NOT
  OBSERVED, I=0 IS MARGINALLY PREFERRED.

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                    119  Y*0(1800) MASS (MEV) (PROD. EXP.)

M        60 1802.        3.          LOCKMAN   78 SPEC  0 PP TO L PI PI X  12/79

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                    119  Y*0(1800) WIDTH (MEV) (PROD. EXP.)

W  C     60   24.        8.          LOCKMAN   78 SPEC  0 PP TO L PI PI X  12/79
W  C     OBSERVED WIDTH CONSISTENT WITH EXPERIMENTAL RESOLUTION.

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                    119  Y*0(1800) PARTIAL DECAY MODES (PROD. EXP.)

                                                                 DECAY MASSES
P1      Y*0(1800) INTO LAMBDA PI PI                              1115+ 139+ 139
P2      Y*0(1800) INTO Y*1(1385) PI                              1385+ 139
P3      Y*0(1800) INTO Y*1(1560) PI                              1560+ 139

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                    119  Y*0(1800) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(1800) INTO (LAMBDA PI PI)/TOTAL                (P1)
R1          SEEN                     LOCKMAN   78 SPEC  0 PP TO L PI PI X  12/79

R2      Y*0(1800) INTO (Y*1(1385) PI)/TOTAL                (P2)
R2          SEEN                     LOCKMAN   78 SPEC  0 PP TO L PI PI X  12/79

R3      Y*0(1800) INTO (Y*1(1560) PI)/TOTAL                (P3)
R3          SEEN                     LOCKMAN   78 SPEC  0 PP TO L PI PI X  12/79

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                    REFERENCES FOR Y*0(1800) (PROD. EXP.)

LOCKMAN   78  CERN DPHPE 78-01  +MEYER,RANDER,POSTER,SCHLEIN+   (UCLA+SACL)

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Λ(1820) **F'_{05}**

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        39  Y*0(1820, JP=5/2+) I=0

        SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

        THIS STATE IS WELL ESTABLISHED. MOST OF THE QUOTED ER-
        RORS ARE STATISTICAL ONLY. THE SYSTEMATIC ERRORS DUE TO
        THE PARTICULAR PARAMETRIZATION USED IN THE P.W.A. ARE
  NOT INCLUDED. FOR THIS REASON WE DO NOT CALCULATE WEIGHTED AVERAGES FOR
  MASS AND WIDTH.

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                    39  Y*0(1820) MASS (MEV)

M   N     1813.0     (2.0)       ARMENT-1  67 HBC   0 K-P TO SIGMA PI    8/67
M   N     1816.0     (4.0)       BELL      67 HDBC  0 K-N TO SIGMA PI   11/67
M   N     1817.0     (2.0)       ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
M   N     1819.0     (4.0)       BUGG      68 CNTR  0 K-P, D TOTAL      6/68
M   N     1825.0     (1.0)       BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M   N     1819.0     (1.0)       BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
M         1830.0    (10.0)       COOL      70 CNTR    K-P, D TOTAL     10/70
M         1820.0    (10.0)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M   N     1818.0     (2.0)       CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M         1819.                  KIM       71 DPWA    K-MATRIX ANAL.    3/71
M   4    (1813.0)    (3.0)       KANE      72 DPWA  0 K-P TO PI SIG    10/71
M   4  KANE 72 IS SUPERSEDED BY KANE 74.
M   N     1819.0     (3.0)       LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M         1821.0     (2.0)       KANE      74 DPWA    K-P TO PI SIG    12/81*
M        (1830.)                 DECLA..   77 DPWA    KBAR N TO KBAR N  1/78
M   2     1817. OR 1819.         MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M   2  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M   2  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M   N     1822.      (2.)        RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M         1819.      (2.)        ALSTON    78 DPWA    KBAR N ELASTIC    1/78
M         1823.0     (3.0)       GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
M   N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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                    39  Y*0(1820) WIDTH (MEV)

W          87.0     (15.0)       ARMENT-1  67 HBC   0                   8/67
W          64.0     (12.0)       BELL      67 HDBC  0                  11/67
W   N      71.0      (4.0)       ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
W   N      75.0      (7.0)       BUGG      68 CNTR  0 K-P, D TOTAL      6/68
W   N      80.0      (6.0)       BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W   N      79.0      (3.0)       BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
W         100.0                  COOL      70 CNTR    K-P, D TOTAL     10/70
W         100.0     (20.0)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W   N      90.0      (4.0)       CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W          70.                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
W   4     (104.0)   (16.0)       KANE      72 DPWA  0 K-P TO PI SIG    10/71
W   N      70.0      (5.0)       LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W          87.0      (3.0)       KANE      74 DPWA    K-P TO PI SIG    12/81*
W         (82.)                  DECLAIS   77 DPWA    KBAR N TO KBAR N  1/78
W   2      76. OR 76.            MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W   N      81.       (5.)        RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W          72.       (5.)        ALSTON    78 DPWA    KBAR N ELASTIC    1/78
W          77.0      (5.0)       GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
        SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                    39  Y*0(1820) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1      Y*0(1820) INTO N KBAR                                    938+ 493
P2      Y*0(1820) INTO SIGMA PI                                  1189+ 139
P3      Y*0(1820) INTO SIGMA PI PI                               1192+ 139+ 139
P4      Y*0(1820) INTO ETA LAMBDA                                548+1115
P5      Y*0(1820) INTO Y*1(1385) PI P-WAVE                       139+1385
P6      Y*0(1820) INTO Y*1(1385) PI F-WAVE                       139+1385

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows. The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

	P 1	P 2	P 3	P 4	P 5	P 6
P 1	.6044+-.0216					
P 2	-.4984	.1145+-.0082				
P 3	-.1146	.0571	.1028+-.0287			
P 4	-.3954	.0151	-.7879	.1560+-.0340		
P 5	-.0643	.0320	.0074	-.2237	.0152+-.0085	
P 6	-.0401	.0200	.0046	-.1678	.0026	.0070+-.0062

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                    39  Y*0(1820) BRANCHING RATIOS

        ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
        TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*0(1820) INTO (KBAR N)/TOTAL                     (P1)
R1            0.67      0.02       ARMENT-3  68 HBC   0 ELASTIC, CH EXCH 11/68
R1           (0.72)                BUGG      66 CNTR  0 K-P, D TOTAL      6/68
R1            0.65      0.02       BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1            0.58      0.07       BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1           (0.8)                 COOL      70 CNTR    K-P, D TOTAL     10/70
R1            0.63      0.01       CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.52)                KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.47      0.02       LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1           (0.51)                DECLAIS   77 DPWA    KBAR N TO KBAR N  1/78
R1   2       (0.55)OR   0.58       MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C       (0.57)    (0.02)      RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1            0.60      0.03       ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R1            0.58     (0.02)      GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
R1          . . . . . . . . . .
R1   AVG      0.605     0.024   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 3.4)
R1   FIT      0.604     0.022   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 3.1)

R2      Y*0(1820) FROM KBAR N INTO SIGMA PI                 SQRT(P1*P2)
R2   1       -0.27      0.01       ARMENT-1  67 DPWA  0 K-P TO SIGMA PI  10/74
R2   1 PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R2            0.23      0.025      BELL      67 DPWA  0 K-P TO SIGMA PI  11/67
R2           -0.26      0.03       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2           (0.26)                KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2   4      (-0.268)   (0.027)     KANE      72 DPWA  0 K P TO PI SIG    10/71
R2            0.25      0.03       LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2           -0.28     (0.01)      KANE      74 DPWA    K-P TO PI SIG    12/81*
R2   2      (-0.25)OR  -0.25       MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2           -0.28      0.03       RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R2          . . . . . . . . . .
R2   AVG MOD  0.2642    0.0082  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R2   FIT      0.2631    0.0082 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      Y*0(1820) FROM KBAR N TO ETA LAMBDA                 SQRT(P1*P4)       9/73
R3           -0.096     0.040    0.020 RADER     73 MPWA                      9/73
R3          . . . . . . . . . .
R3   FIT      0.096     0.027   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      Y*0(1820) INTO (Y*1(1385) PI)/TOTAL                 (P5)
R4            0.20      0.05       BIRGE     65 HBC   0 K-P TO LAM PI PI  7/66
R4          . . . . . . . . . .
R4   FIT      0.103     0.029   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R5      Y*0(1820) INTO (SIGMA PI PI)/TOTAL                  (P3)
R5   P        NO CLEAR SIGNAL              ARMENT-4  68 HDBC  0 K-N TO SIG PI PI 11/68
R5   P    THERE IS A SUGGESTION OF A BUMP, ENOUGH TO BE CONSISTENT WITH
R5      WHAT IS EXPECTED FROM SIGMA PI DECAY OF THE Y*1(1385) -- ABOUT 0.02.
R5
R5          . . . . . . . . . .
R5   FIT      0.156     0.034   FROM FIT
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R6       Y*0(1820) FROM KBAR N TO Y*1(1385) PI P-WAVE       SQRT(P1*P5)
R6   A         (0.3)      (0.05)             ARMENT-2  67 HBC    0 K-P TO LAM P+ P+
R6             +0.27       0.03              PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
R6    3        -0.167      0.054             CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R6             . . . . . . . . . .
R6   AVG MOD    0.246      0.044   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R6   FIT        0.249      0.035  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R7       Y*0(1820) FROM KBAR N TO Y*1(1385) PI F-WAVE       SQRT(P1*P6)
R7    3        +0.065      0.029             CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R7    3  THE SIGN HERE AND IN R6 IS CHANGED TO BE IN ACCORD WITH THE              12/79
R7    3  BARYON-FIRST CONVENTION.                                                 12/79
R7             . . . . . . . . . .
R7   FIT        0.065      0.029  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

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REFERENCES FOR Y*0(1820)


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BIRGE    65 ATHENS CONF   296  +ELY,KALMUS,KERNAN,LOUIE,SAHOURIA, +  (LRL)IJP
ARMENT-1 67 PL 24B 198         ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-2 67 ZEIT PHYS 202 486  ARMENTEROS, F LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL     67 PRL 19 936         R B BELL                                (LRL)IJP
ARMENT-3 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENT-4 68 NP B8 216          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY) I
BUGG     68 PR 168 1466        +GILMORE, KNIGHT,    +      (RHEL+BIRM+CAVE) I

BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
BRICMAN1 70 PL 33B 511         +FERRO-LUZZI,LAGNAUX                   (CERN)
COOL     70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                     (LRL)IJP

CONFORTO 71 NP B34 41          +LEVI SETTI,LASINSKI,.OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356         J K KIM                                (HARV)IJP
    ALSO 70 DUKE 161           J. K. KIM                              (HARV)IJP

KANE     72 PR D5 1583         D F KANE                               (LBL)IJP
LANGBEIN 72 NP B47 477         +WAGNER                                (MPIM)IJP
RADER    73 NC 16A 178         +BARLOUTAUD,+     (SACL+HEID+CERN+RHEL+CDEF)
KANE     74  LBL-2452          D.F.KANE                               (LBL)IJP
PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)

DECLAIS  77  CERN 77-16        +DUCHON,LOUVEL,PATRY,SEGUINOT+  (CAEN+CERN)IJP
MARTIN   77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266        MARTIN,PIDCOCK                        (LOUC)
    ALSO 77 NP B126 285        MARTIN,PIDCOCK                        (LOUC)IJP
RLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON   78 PR D18 182         +KENNEY,POLLARD,ROSS+       (LBL+MTHO+CERN)IJP
    ALSO 77 PRL 38 1007        ALSTON-GARNJOST,KENNEY      (LBL+MTHO+CERN)IJP
CAMERON  78 NP B143 189        +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159  G.P.GOPAL                             (RHEL)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS

THE FOLLOWING PAPERS ARE NOW OF ONLY HISTORICAL INTEREST --


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CHAMBERL 62 PR 125 1696        CHAMBERLAIN,CROWE,KEEFE,KERTH, +      (LRL) I
GALTIERI 63 PL 6 296           A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
SODICKSO 64 PR 133 B757        SODICKSON,MANNELLI,FRISCH,WAHLIG (MIT)(BNL)I J
HOLLEY   65 UCRL-16274 THESIS  W P HOLLEY                            (LRL) J
BIRMINGH 66 PR 152 1148        BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
COOL     66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LUNDBY +     (BNL)I
GELFAND  66 PRL 17 1224        +HARMSEN,LEVI-SETTI,PREDAZZI+        (EFI,ANL)I
ARMENTER 67 NP B3 592          ARMENTEROS,FERRO-LUZZI+ (CERN,HEID,SACLAY)IJP
CONFORTO 68 NP B8 265          +HARMSEN, LASINSKI, +      (CHICAGO,HEIDEL)IJP
LASINSKI 68 PR 163 1792        LASINSKI, LEVI SETTI, PREDAZZI   (CHICAGO) JP
PREVOST  71  AMSTERDAM CONF    + CHS COLLABORATION          (CERN+HEID+SACL)
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Λ(1830)

56 Y*0(1830, JP=5/2-) I=0 — D_{05}

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SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THE BEST EVIDENCE FOR THIS RESONANCE COMES FROM THE
SIGMA PI CHANNEL.  IT IS WELL ESTABLISHED.

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                    56  Y*0(1830) MASS (MEV)

M    N        1827.0     (3.0)          ARMENTERO 67 HBC   0 K-P TO SIGMA PI   8/67
M    N        1837.0    (11.0)          BELL      67 HBC   0 K-P TO SIGMA PI  11/67
M    N        1907.0    (10.0)          ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
M             1840.0    (15.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
M    N        1831.0     (5.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M             1830.                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
M    K       (1720.)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
M    3       (1832.0)    (5.0)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
M    3  KANE 72 IS SUPERCEDED BY KANE 74.
M             1810.0    (10.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M             1825.0     (1.0)          KANE      74 DPWA    K-P TO PI SIG    12/81*
M    1        1817. OR 1818.            MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    1  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    1  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M             1825.     (10.)           RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M             1831.0    (10.0)          GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
M    K  POSSIBLE EFFECT MAINLY IN SIGMA PI.  NOT CLEAR IF UNCORRELATED
M    K  WITH THE 1830 EFFECT
M    N  ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED  1/71

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                    56  Y*0(1830) WIDTH (MEV)

W             75.0       (9.0)          ARMENTERO 67 HBC   0 K-P TO SIGMA PI   8/67
W             74.0      (18.0)          BELL      67 HBC   0 K-P TO SIGMA PI   8/67
W            123.0      (32.0)          ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
W            159.0      (30.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
W            104.0      (35.0)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W             80.                       KIM       71 DPWA    K-MATRIX ANAL.    3/71
W    K       (20.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
W    3       (88.0)     (10.0)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
W             60.0      (20.0)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W            119.0       (3.0)          KANE      74 DPWA    K-P TO PI SIG    12/81*
W    1        56. OR 56.                MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W             94.       (10.)           RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W            100.0      (10.0)          GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
     SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                 56  Y*0(1830) PARTIAL DECAY MODES

                                                                 DECAY MASSES
P1       Y*0(1830) INTO N KBAR                                    938+ 493
P2       Y*0(1830) INTO SIGMA PI                                 1189+ 139
P3       Y*0(1830) INTO Y*1(1385) PI D-WAVE                       139+1385
P4       Y*0(1830) INTO ETA LAMBDA                                548+1115

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                 56  Y*0(1830) BRANCHING RATIOS

R1       Y*0(1830) INTO (KBAR N)/TOTAL                      (P1)
R1            0.09     (0.01)          ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
R1            0.03     (0.02)          BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1            0.05     (0.02)          CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           (0.24)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1            0.10     (0.03)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1    I      (0.04)OR   0.04           MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1    C      (0.04)    (0.03)          RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1    C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1            0.02     (0.02)          ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R1            0.08     (0.03)          GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

R2       Y*0(1830) FROM KBAR N INTO SIGMA PI                SQRT(P1*P2)
R2    A     (-0.15)    (0.02)          ARMENTERO 67 DPWA  0 K-P TO SIGMA PI  10/74
R2    A  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R2            0.19     (0.01)          BELL      67 DPWA  0 K-P TO SIGMA PI  11/67
R2           -0.16     (0.03)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R2            0.15                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2    3     (-0.138)   (0.018)         KANE      72 DPWA  0 K-P TO PI SIG    10/71
R2            0.27     (0.07)          LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2           -0.15     (0.01)          KANE      74 DPWA    K-P TO PI SIG    12/81*
R2    1     (-0.17)OR  -0.17           MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2           -0.17     (0.03)          RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R3       Y*0(1830) FROM KBAR N TO ETA LAMBDA                SQRT(P1*P4)       9/73
R3           -0.044     0.020          RADER     73 MPWA                      9/73

R4       Y*0(1830) FROM KBAR N TO Y*1(1385) PI D-WAVE       SQRT(P1*P3)
R4           +0.13      0.03           PREVOST   74 DPWA 0- K-N TO S(1385)PI 10/74
R4    2      +0.141     0.014          CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R4    2  CAMERON  78 UPPER LIMIT ON G-WAVE DECAY IS 0.03.  THE SIGN HERE IS   12/79
R4    2  CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.            12/79
R4            . . . . . . . . . .
R4   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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REFERENCES FOR Y*0(1830)


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ARMENTER 67 PL 24B 198         ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
BELL     67 PRL 19 936         R B BELL                                (LRL)IJP
ARMENTER 68 NP B8 195          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
CONFORTO 68 NP B8 265          +HARMSEN, LASINSKI, +       (CHICAGO,HEIDEL)IJP
    IS SUPERSEDED BY CONFORTO 71.
BRICMAN1 70 PL 33B 511         +FERRO-LUZZI,LAGNAUX                   (CERN)
GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                     (LRL)IJP

CONFORTO 71 NP B34 41          +LEVI SETTI,LASINSKI,.OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356         J K KIM                                (HARV)IJP
    ALSO 70 DUKE 161           J. K. KIM                              (HARV)IJP
KANE     72 PR D5 1583         D F KANE                               (LBL)IJP
LANGBEIN 72 NP B47 477         +WAGNER                                (MPIM)IJP
RADER    73 NC 16A 178         +BARLOUTAUD,+     (SACL+HEID+CERN+RHEL+CDEF)

KANE     74  LBL-2452          D.F.KANE                               (LBL)IJP
PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)

MARTIN   77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266        MARTIN,PIDCOCK                        (LOUC)
    ALSO 77 NP B126 285        MARTIN,PIDCOCK                        (LOUC)IJP
RLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON   78 PR D18 182         +KENNEY,POLLARD,ROSS+       (LBL+MTHO+CERN)IJP
    ALSO 77 PRL 38 1007        ALSTON-GARNJOST,KENNEY      (LBL+MTHO+CERN)IJP
CAMERON  78 NP B143 189        +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159  G.P.GOPAL                             (RHEL)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS


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PREVOST  71  AMSTERDAM CONF    + CHS COLLABORATION          (CERN+HEID+SACL)
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Λ(1890)

60 Y*0(1890, JP=3/2+) I=0 — P_{03}

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THE JP=3/2+ ASSIGNMENT IS CONSISTENT WITH ALL
AVAILABLE DATA (INCLUDING POLARIZATION) AND RECENT
PARTIAL WAVE ANALYSES. THE DOMINANT INELASTIC
MODES REMAIN UNKNOWN.  SEE ALSO Y*0(2000) MINI-REVIEW.

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                    60  Y*0(1890) MASS (MEV)

M    A  F07 1864.0      2.0            ARMENTERO 68 DPWA  0 ELASTIC, CH EXCH 11/68
M     N     1870.0      5.0            BUGG      68 CNTR  0 K-P TOTAL         7/68
M    A  F07 1877.0      6.0            BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
M           1870.0      6.0            BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71
M     N     1883.0     10.0            CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
M    I     (1710.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
M           1850.0     20.0            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M     2    (1868.)                     LEA       73 CPWA    MULTICHNL K-MTRX  9/73
M           1894.      10.             HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75
M     3    (1900.)                     NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.  1/76
M           SEEN                       BACCARI   77 IPWA  0 K-P TO LAM. OMG.  1/78
M     4     1856. OR 1868.             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M     4  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M     4  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1900.       5.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M           1908.      10.             ALSTON    78 DPWA    KBAR N ELASTIC    1/78
M           1897.0     (5.0)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
M    A     THESE TWO ANALYSES GAVE THE F07 ASSIGNMENT. THEY HAVE TO BE        1/71
M    A     DISCARDED IN VIEW OF CONFORTO 70 AND BRICMAN1 70
M     N    DUE TO PARTICULAR PARAMETERIZATION USED.ERROR CAN BE LARGE         1/71
M    1  POSSIBLE EFFECT MAINLY IN SIGMA PI. WE TENTATIVELY LIST IT HERE.
M     2  ONLY UNCONSTRAINED STATES FROM TABLE I OF LEA73 ARE IN LISTINGS.     9/73
M     3  FOUND IN ONE OF TWO BEST SOLUTIONS.                                  1/76
M           . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

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                60  Y*0(1890) WIDTH (MEV)

W   A  F07   39.0      7.0            ARMENTERO 68 DPWA  0 ELASTIC, CH EXCH 11/68
W    N       40.0     10.0            BUGG      68 CNTR  0 K-P TOTAL         7/68
W   A  F07   24.0     15.0            BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W            37.0     10.0            BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71
W    N       80.0     20.0            CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
W   1       (20.)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
W           125.0     20.0            LANGBEIN  72 IPWA    MULTICHANNEL     12/72
W   2      (323.8)                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W           107.      10.             HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75
W   3      (130.)                     NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.  1/76
W   4       191. OR 193.              MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W            72.      10.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W           119.      20.             ALSTON    78 DPWA    KBAR N ELASTIC    1/78
W            74.0     (10.0)          GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
W        SEE THE NOTES ACCOMPANYING MASSES QUOTED
W            . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                60  Y*0(1890) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*0(1890) INTO N KBAR                                 938+ 493
P2      Y*0(1890) INTO SIGMA PI                              1189+ 139
P3      Y*0(1890) INTO LAMBDA OMEGA                          1115+ 782
P4      Y*0(1890) INTO Y*1(1385) PI P-WAVE                    139+1385
P5      Y*0(1890) INTO Y*1(1385) PI F-WAVE                    139+1385
P6      Y*0(1890) INTO N K*(890), P1 WAVE                     939+ 891

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                60  Y*0(1890) BRANCHING RATIOS

R1      Y*0(1890) INTO (KBAR N)/TOTAL                         (P1)
R1  A  F07   0.12      0.02           ARMENTERO 68 HBC   0 ELASTIC, CH EXCH 11/68
R1          (J+1/2)P1= 0.40           BUGG      68 CNTR  0                   7/68
R1  A  F07   0.07      0.02           BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1           0.14      0.02           BRICMAN1  70 DPWA  0 SIGTOT,ELAS,CHEX  1/71
R1   N       0.25      0.03           CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1           0.37      0.05           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1  2       (0.32)                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R1           0.24      0.04           HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75
R1  4      (0.36)OR    0.34           MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1  C      (0.18)     (0.02)          RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1  C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.34      0.05           ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R1           0.20     (0.02)          GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
R1       SEE THE NOTES ACCOMPANYING MASSES QUOTED
R1           . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

R2      Y*0(1890) INTO (SIGMA PI)/TOTAL                       (P2)
R2   P       PROBABLY SEEN            GALTIERI  68 DBC    0 K-N TO SIG PI PI 11/68
R2          (0.03) OR LESS            LANGBEIN  72 IPWA     MULTICHANNEL    12/72
R2   P   POSSIBLY THIS BUMP SEEN AT 1840+-10 MEV WITH A WIDTH OF 35+-10 MEV
R2     IS THE Y*0(1830), WHICH DECAYS STRONGLY TO SIGMA PI.  HOWEVER THE
R2     NARROW WIDTH HERE ARGUES FOR ITS BEING THE Y*0(1890).

R3      Y*0(1890) FROM KBAR N TO SIGMA PI                     SQRT(P1*P2)        9/73
R3  2      (+0.15)                    LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R3  4      (+0.15)OR +0.14            MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R3          -0.09      0.03           RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R4      Y*0(1890) FROM KBAR N INTO LAMBDA OMEGA               SQRT(P1*P3)        1/76
R4  3       (0.032)                   NAKKASYA  75 DPWA  0 K-P  0 LAM. OMG.  1/76

R5      Y*0(1890) FROM KBAR N INTO Y*1(1385) PI P-WAVE    SQRT(P1*P4)
R5       LESS THAN 0.03               CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78

R6      Y*0(1890) FROM KBAR N INTO Y*1(1385) PI F-WAVE    SQRT(P1*P5)
R6  5      -0.126      0.055          CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R6  5  SIGN CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.      12/79

R7      Y*0(1890) FROM KBAR N INTO N K*(890), P1 WAVE     SQRT(P1*P6)
R7  6      -0.07       0.03           CAMERON2  78 DPWA    K-P TO K*N      12/79
R7  6  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST      12/79
R7  6  CONVENTION.  UPPER LIMITS ON THE P3 AND F3 WAVES ARE EACH 0.03.     12/79

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REFERENCES FOR Y*0(1890)


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ARMENTERO68 NP B8 195           ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BUGG      68 PR 168 1466        +GILMORE, KNIGHT, +         (RHEL,BIRM,CAVE) I
GALTIERI  68 PRL 21 573         BARBARO-GALTIERI, MATISON, +      (LRL,SLAC)

BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+    (CERN,CAEN,SACLAY)
BRICMAN1  70 PL 33B 511         +FERRO-LUZZI,LAGNAUX                   (CERN)
CONFORTO  71 NP B34  41         +LEVI SETTI,LASINSKI..OBERLACK+ (EFI+HEID)IJP
KIM       71 PRL 27 356         J K KIM                             (HARV)IJP
   ALSO   70 DUKE 161           J. K. KIM                           (HARV)IJP
LANGBEIN  72 NP B47 477         +WAGNER                             (MPIM)IJP

LEA       73 NP B56 77          +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARH)SIJP
HEMINGWA  75 NP B91 12          HEMINGWAY,EADES,HARMSEN+     (CERN,HEID,MPIM)IJP
NAKKASYA  75 NP B93 85          A. NAKKASYAN                        (CERN)IJP

MARTIN    77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE        (LOUC+GLAS)IJP
   ALSO   77 NP B126 266        MARTIN,PIDCOCK                         (LOUC)
   ALSO   77 NP B126 285        MARTIN,PIDCOCK                      (LOUC)IJP
RLIC      77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+   (LOIC+RHEL)IJP
ALSTON    78 PR D18 182         +KENNEY,POLLARD,ROSS+    (LBL+MTHO+CERN)IJP
   ALSO   77 PRL 38 1007        ALSTON-GARNJOST,KENNEY   (LBL+MTHO+CERN)IJP
CAMERON   78 NP B143 189        +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
CAMERON2  78 NP B146 327        +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL     80   TORONTO CONF 159 G.P.GOPAL                           (RHEL)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS

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ARMENTER 67 NP B3 592          ARMENTEROS, F-LUZZI, + (CERN,HEIDEL,SACLAY)IJP
   REPLACED BY ARMENTEROS 68 AND CONFORTO 68.
CONFORTO 68 NP B8 265          +HARMSEN, LASINSKI, +       (CHICAGO,HEIDEL)IJP
   SUPERSEDED BY CONFORTO 71.
LEVISETT 69 LUND 339           R.LEVI SETTI  (RAPPORTEUR)               (EFI)
ALBROW   71 NP B29 413         +ANDERSON,BOSNJAKOVIC,DAUM,ERNZ,+       (CERN)
BACCARI  77 NC 41A 96          +POULARD,REVEL,TALLINI+           (SACL+CDEF)IJP
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Λ(2000)

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89  Y*0(2000,         ) I=0

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

WE LIST HERE ALL THE AMBIGUOUS RESONANCE POSSIBILITIES
WITH A MASS AROUND 2 GEV.  THE PROPOSED QUANTUM NUMBERS
ARE D3 (GALTIERI 70 IN SIGMA PI), D3+F5, P3+D5, OR
P1+D3 (BRANDSTETTER 72 IN LAMBDA OMEGA), AND S1
(CAMERON2 78 IN NK*).  THE FIRST TWO OF THE ABOVE ANALYSES SHOULD NOW
BE CONSIDERED OBSOLETE.

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                89  Y*0(2000) MASS (MEV)

M          (2010.0)   (30.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M    1      1935. TO 1971.            BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74
M    1      1951. TO 2034.            BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74
M    1  PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS. THE LOWER         11/75
M    1  (HIGHER) MASS STATE PROBABLY HAS J.LE.3/2(5/2).                      11/75
M           2030.0     30.0           CAMERON2  78 DPWA    K-P TO K*(890) N 12/79

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                89  Y*0(2000) WIDTH (MEV)

W          (130.0)    (50.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
W    1      180. TO  240. (LWR. MASS) BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74
W    1       73. TO  154. (HGR. MASS) BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74
W           125.0      25.0           CAMERON2  78 DPWA    K-P TO K*(890) N 12/79
         SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                89  Y*0(2000) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*0(2000) INTO N KBAR                                938+ 493
P2      Y*0(2000) INTO SIGMA PI                             1189+ 139
P3      Y*0(2000) INTO LAMBDA OMEGA                         1115+ 782
P4      Y*0(2000) INTO N K*(890), S1 WAVE                    939+ 891
P5      Y*0(2000) INTO N K*(890), D3 WAVE                    939+ 891

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                89  Y*0(2000) BRANCHING RATIOS

R1      Y*0(2000) FROM KBAR N TO SIGMA PI                   SQRT(P1*P2)
R1          (-0.20)   (0.04)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70

R2      Y*0(2000) FROM KBAR N INTO LAMBDA OMEGA             SQRT(P1*P3)
R2   1      (0.17) TO 0.25 (LWR.)     BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74
R2   1      (0.04) TO 0.15 (HGR.)     BRANDSTE  72 DPWA  0 K-P TO LAM. OMG.   1/74

R3      Y*0(2000) FROM KBAR N INTO N K*(890), S1 WAVE       SQRT(P1*P4)
R3   2     -0.12       0.03           CAMERON2  78 DPWA    K-P TO K*N        12/79
R3   2  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST       12/79
R3   2  CONVENTION.                                                          12/79

R4      Y*0(2000) FROM KBAR N INTO N K*(890), D3 WAVE       SQRT(P1*P5)
R4         +0.09       0.03           CAMERON2  78 DPWA    K-P TO K*N        12/79

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REFERENCES FOR Y*0(2000)


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GALTIERI 70 DUKE CONF 173      A BARBARO-GALTIERI                     (LRL)IJP
BRANDSTE 72 NP B39 13          BRANDSTETTER,BUTTERWORTH,+ (RHEL+LOIC+SACL)
CAMERON2 78 NP B146 327        +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
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PAPERS NOT REFERRED TO IN DATA CARDS

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NAKKASYA 75 NP B93 85          A. NAKKASYAN                          (CERN)IJP
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Λ(2020)   **F_{07}**

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27  Y*0(2020, JP=7/2+) I=0

EFFECTS IN THIS PARTIAL WAVE HAVE BEEN OBSERVED AT
DIFFERENT ENERGIES IN TWO CHANNELS.  IN LITCHFIELD 71,
NEED FOR THE STATE RESTS SOLELY ON POSSIBLY
INCONSISTENT POLARIZATION MEASUREMENT AT 1.784 GEV/C.
HEMINGWAY 75 ANALYSIS OF KBAR N DOES NOT REQUIRE THIS
STATE.  RLIC 77 DO NOT NEED IT IN EITHER KBAR N OR PI SIGMA.  WITH NEW
K- NEUTRON ANGULAR DISTRIBUTIONS INCLUDED  DECLAIS 77 SEE THIS STATE.
HOWEVER, THIS AND OTHER NEW DATA ARE INCLUDED IN GOPAL 80 AND THIS
STATE IS NOT REQUIRED.  BACCARI 77 WEAKLY SUPPORTS THIS STATE.

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                27  Y*0(2020) MASS (MEV)

M          (2020.0)   (20.0)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
M          (2100.)    (30.)           LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
M          (2140.)                    BACCARI   77 DPWA  C K-P TO LAM. OMG.   1/76
M          (2117.)                    DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78

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                27  Y*0(2020) WIDTH (MEV)

W          (160.0)    (30.0)          GALTIERI  70 DPWA  C K-P TO SIGMA PI    7/70
W          (120.)     (30.)           LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
W          (128.)                     BACCARI   77 DPWA  C K-P TO LAM. OMG.   1/78
W          (167.)                     DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78

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                27  Y*0(2020) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      Y*0(2020) INTO N KBAR                                938+ 493
P2      Y*0(2020) INTO SIGMA PI                             1189+ 139
P3      Y*0(2020) INTO LAMBDA OMEGA                         1115+ 782

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                27  Y*0(2020) BRANCHING RATIOS

R1      Y*0(2020) INTC (KBAR N)/TOTAL                          (P1)
R1            (0.05)    (0.02)          LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
R1            (0.05)                    DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78

R2      Y*0(2020) FROM KBAR N TO SIGMA PI                      SQRT(P1*P2)
R2          (-0.15)     (0.02)          GALTIERI  70 DPWA  O K-P TO SIGMA PI    7/70

R3      Y*0(2020) FROM KBAR N TO LAMBDA OMEGA                  SQRT(P1*P3)      1/78
R3            LESS THAN 0.05            BACCARI   77 DPWA  O K-P TO LAM. OMG.   1/78

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                        REFERENCES FOR Y*0(2020)

GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                      (LRL)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

BACCARI  77 NC 41A 96           +POULARD,REVEL,TALLINI+            (SACL+CDEF)IJP
DECLAIS  77  CERN 77-16         +DUCHON,LOUVEL,PATRY,SEGUINOT+   (CAEN+CERN)IJP

                        PAPERS NOT REFERRED TO IN DATA CARDS

HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+    (CERN,HEID,MPIM)IJP

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Λ(2100)

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            41  Y*0(2100, JP=7/2-) I=0                 G07

            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

            THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE
            ANALYSES.  PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS
            AND INVARIANT-MASS DISTRIBUTIONS AROUND 2100 MEV ARE
            GIVEN IN A SEPARATE ENTRY BELOW.

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                41  Y*0(2100) MASS (MEV)

M           (2120.0)                    WOHL      66 HBC     K-P CH EX          7/66
M    A      (2080.0)    (10.0)          BURGUN    68 DPWA  O K-P TO XI K       10/69
M    L      (2130.0)    (20.0)          BERTHONI  70 DPWA  O K-P TO SIGMA PI   10/70
M             2110.0    (20.0)          GALTIERI  70 DPWA  O K-P TO SIGMA PI    7/70
M             2100.     (15.)           LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
M     L       2110.0    (30.0)          LITCHFIE  71 DPWA    K-P TO SIG PI     10/71
M     1       2113. TO 2154.            BRANDSTE  72 DPWA  O K-P TO LAM. OMG.   1/74
M    5      (2092.0)    (12.0)          KANE      72 DPWA  O K-P TO PI SIG     10/71
M    5   KANE 72 IS SUPERSEDED BY KANE 74.
M             2115.0    (10.0)          KANE      74 DPWA    K-P TO PI SIG     12/81*
M             2105.     (10.)           HEMINGWA  75 DPWA  O K- P TO KBAR N    11/75
M     2       2110. OR 2089.            NAKKASYA  75 DPWA  O K-P TO LAM. OMG.  11/75
M    3      (2094.)                     BACCARI   77 DPWA  O K-P TO LAM. OMG.   1/78
M           (2094.)                     DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78
M             2110.     (10.)           RLIC      77 DPWA    KBAR N MULTICHNL   1/76
M             2106.     (30.)           BELLEFON  78 DPWA  O KBAR N TO KBAR N   1/78
M             2104.0    (10.0)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
M     2  QUOTED PARAMETERS CORRESPOND TO THE TWO BEST SOLUTIONS FOUND.         11/75
M     2  EACH HAS THE Y*0(2100) AND ONE ADDITIONAL RESONANCE (P3 OR F5).       11/75
M    A     BURGUN 68 SEE A RESONANCE-LIKE EFFECT IN THIS REGION IN THE
M        REACTION K-P TO XI K.  HOWEVER, AS THEY POINT OUT, IT IS NOT CLEAR
M        WHETHER IT IS MAINLY THE G07 Y*0(2100) OR INSTEAD A SO FAR OTHERWISE
M        UNOBSERVED RESONANCE WITH A SPIN LESS THAN 7/2.
M    L   LITCHFIELD 71 IS AN UPDATE OF BERTHONI 70                              3/72
M     1  PARAMETERS QUOTED ARE RANGES FROM THREE BEST FITS.                     1/74

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                41  Y*0(2100) WIDTH (MEV)

W           (145.0)                     WOHL      66 HBC                        7/66
W    A       (80.0)     (10.0)          BURGUN    68 DPWA  O K-P TO XI K       10/69
W             140.0     (15.0)          BERTHONI  70 DPWA  O K-P TO SIGMA PI   10/70
W              60.0     (25.0)          GALTIERI  70 DPWA  O K-P TO SIGMA PI    7/70
W    B      (170.) TO(300.)             LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
W    B  LARGER VALUE CORRESPONDS TO PURE B.W. LOWER VALUE, TO B.W. + BCKGRD
W     L       140.0     (50.0)   (30.0) LITCHFIE  71 DPWA    K-P TO SIG PI     10/71
W     1       208. TO  229.             BRANDSTE  72 DPWA  O K-P TO LAM. OMG.   1/74
W    5      (144.0)     (26.0)          KANE      72 DPWA  O K-P TO PI SIG     10/71
W             152.0     (15.0)          KANE      74 DPWA    K-P TO PI SIG     12/81*
W             241.      (30.)           HEMINGWA  75 DPWA  O K- P TO KBAR N    11/75
W     2       244. OR  302.             NAKKASYA  75 DPWA  O K-P TO LAM. OMG.  11/75
W    3        (98.)                     BACCARI   77 DPWA  O K-P TO LAM. OMG.   1/78
W            (250.)                     DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78
W             250.      (30.)           RLIC      77 DPWA    KBAR N MULTICHNL   1/76
W             157.      (40.)           BELLEFON  78 DPWA  O KBAR N TO KBAR N   1/78
W    4       (250.0)                    GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
W    4   WIDTH NOT WELL CONSTRAINED BY THE DATA.  HENCE FIXED TO THE RLIC 77   12/81*
W    4   VALUE.                                                                12/81*
          SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                41  Y*0(2100) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*0(2100) INTO N KBAR                             938+ 493
P2      Y*0(2100) INTO SIGMA PI                          1189+ 139
P3      Y*0(2100) INTO XI K                              1321+ 497
P4      Y*0(2100) INTO LAMBDA OMEGA                      1115+ 782
P5      Y*0(2100) INTO ETA LAMBDA                         548+1115
P6      Y*0(2100) INTC N K*(890), D3 WAVE                 939+ 891
P7      Y*0(2100) INTC N K*(890), G1 WAVE                 939+ 891

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                41  Y*0(2100) BRANCHING RATIOS

P1      Y*0(2100) INTC (KBAR N)/TOTAL                          (P1)
R1            (0.25)                    WOHL      66 HBC                        7/66
R1   D        (0.33)                    DAUM      68 CNTR    K-P ELA,POL,SIGT   7/70
R1             0.30     (0.03)          LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
R1             0.31     (0.03)          HEMINGWA  75 DPWA  O K- P TO KBAR N    11/75
R1            (0.29)                    DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78
R1   C        (0.30)    (0.03)          RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1             0.24     (0.06)          BELLEFON  78 DPWA  O KBAR N TO KBAR N   1/78
R1             0.34     (0.03)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
R1   D   DAUM 68 ASSUMES (J+1/2)*X VALUE SEEN IN TOTAL CROSS SECTION.

R2      Y*0(2100) FROM KBAR N INTO SIGMA PI                    SQRT(P1*P2)
R2   L      (+0.16)     (0.02)          BERTHONI  70 DPWA  O K-P TO SIGMA PI   10/70
R2            +0.06     (0.03)          GALTIERI  70 DPWA  O K-P TO SIGMA PI    7/70
R2    L        0.16     (0.05)          LITCHFIE  71 DPWA    K-P TO SIG PI     10/71
R2   5     (+0.096)     (0.037)         KANE      72 DPWA  O K-P TO PI SIG     10/71
R2            +0.11     (0.01)          KANE      74 DPWA    K-P TO PI SIG     12/81*
R2            +0.12     (0.04)          RLIC      77 DPWA    KBAR N MULTICHNL   1/76

R3      Y*0(2100) FROM KBAR N TO XI K                          SQRT(P1*P3)
R3            (0.05)                    TRIPP     67 RVUE  O K-P TO XI K        6/67
R3   B        (0.05)    (0.01)          BURGUN    68 DPWA  O K-P TO XI K       10/69
R3            (0.003)                   MULLER    69 DPWA  O                    7/70
R3             0.035     0.018          LITCHFIE  71 DPWA    K-P TO XI K        3/72
R3   B   BURGUN 68 UPDATED BY LITCHFIELD 71, WHO TAKES SOLUTION C OF BURGUN     3/72

R4      Y*0(2100) FROM KBAR N INTO LAMBDA OMEGA                SQRT(P1*P4)
R4    1       (0.05) TO 0.11            BRANDSTE  72 DPWA  O K-P TO LAM. OMG.   1/74
R4    2       (0.122)OR 0.154           NAKKASYA  75 DPWA  O K-P TO LAM. OMG.  11/75
R4   3      (-0.070)                    BACCARI   77 DPWA  O GD37-WAVE          1/78
R4   3      (+0.011)                    BACCARI   77 DPWA  O GG17-WAVE          1/78
R4   3      (+0.008)                    BACCARI   77 DPWA  O GG37-WAVE          1/78
R4   3   NOTE THAT THE 3 ENTRIES FOR BACCARI77 ARE FOR 3 DIFFERENT WAVES.       1/78

R5      Y*0(2100) FROM KBAR N TO ETA LAMBDA                    SQRT(P1*P5)      9/73
R5            -0.050     0.020          RADER     73 MPWA                       9/73

R6      Y*0(2100) FROM KBAR N INTO N K*(890), D3 WAVE    SQRT(P1*P6)
R6            +0.21      0.04           CAMERON2  78 DPWA    K-P TO K*N        12/79

R7      Y*0(2100) FROM KBAR N INTO N K*(890), G1 WAVE    SQRT(P1*P7)
R7   4        -0.04      0.03           CAMERON2  78 DPWA    K-P TO K*N        12/79
R7   4   THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST        12/79
R7   4   CONVENTION.  THE UPPER LIMIT ON THE G3 WAVE IS 0.03.                   12/79

          SEE THE NOTES ACCOMPANYING MASSES QUOTED

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                        REFERENCES FOR Y*0(2100)

WOHL     66 PRL 17 107          C G WOHL, F T SOLMITZ, M L STEVENSON   (LRL)IJP
TRIPP    67 NP B3 10            + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN   68 NP B8 447           +MEYER,PAULI, +       (SACLAY,COLFRANCE,RHEL)
DAUM     68 NP B7 19            +ERNE, LAGNAUX, SENS, STEUER, UDO      (CERN)JP
    CONFIRMS THE SPIN-PARITY ASSIGNMENT.
MULLER   69 THESIS,UCRL 19372 R A MULLER                                (LRL)

BERTHONI 70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                      (LRL)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP

BRANDSTE 72 NP B39 13           BRANDSTETTER+,...+TALLINI    (RHEL,CDEF,SACL) IJP
KANE     72 PR D5 1583          D F KANE                                (LBL)IJP
RADER    73 NC 16A 178          +BARLOUTAUD,+      (SACL+HEID+CERN+RHEL+CDEF)
KANE     74  LBL-2452           D.F.KANE                                (LBL)IJP

HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+     (CERN,HEID,MPIM)IJP
NAKKASYA 75 NP B93 85           A. NAKKASYAN                           (CERN)IJP

BACCARI  77 NC 41A 96           +POULARD,REVEL,TALLINI+            (SACL+CDEF)IJP
DECLAIS  77  CERN 77-16         +DUCHON,LOUVEL,PATRY,SEGUINOT+   (CAEN+CERN)IJP
RLIC     77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+   (LOIC+RHEL)IJP
BELLEFON 78 NC 42A 403          +BERTHON,BILLOIR,BRUNET+            (CDEF+SACL)IJP
CAMERON2 78 NP B146 327         +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159 G.P.GOPAL                                (RHEL)IJP

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2100 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                25  Y*0(2100, JP=    ) I=0        PRODUCTION EXPERIMENTS

                SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                SEE THE NOTE TO THE G07 Y*0(2100), WHICH PRECEDES THIS
                ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
  SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*0(2100),
  BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTAB-
  LISHED OTHER RESONANCES IN THIS REGION.

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                25  Y*0(2100) MASS (MEV) (PROD. EXP.)

M          (2097.0)     (6.0)           BOCK      65 HBC     PBAR P 5.7 GEV/C   7/66
M            2100.0     (7.0)           BUGG      68 CNTR    K-P, D TOTAL       6/68
M            2121.0     (5.0)           BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
M            2107.0    (10.0)           COOL      70 CNTR    K-P, D TOTAL      10/70
M          (2135.0)    (20.0)           LU        70 CNTR  O GAMMA P TO K+ Y*   1/71

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                25  Y*0(2100) WIDTH (MEV) (PROD. EXP.)

W            (24.0)    (14.0)   (24.0)  BOCK      65 HBC     INTO KBAR N (P1)   7/66
W             140 0    (15.0)           BUGG      68 CNTR                       6/68
W             147.0    (15.0)           BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
W             185.0                     COOL      70 CNTR    K-P, D TOTAL      10/70
W            (40.0)                     LU        70 CNTR  O GAMMA P TO K+ Y*   1/71

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                25  Y*0(2100) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*0(2100) INTC N KBAR                             938+ 493
P2      Y*0(2100) INTC N KBAR PI                          938+ 497+ 139
P3      Y*0(2100) INTO LAMBDA ETA                        1115+ 548
P4      Y*0(2100) INTO LAMBDA OMEGA                      1115+ 782

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                25  Y*0(2100) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(2100) INTC (KBAR N)/TOTAL                          (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1            0.305                     BUGG      68 CNTR                       6/68
R1            0.24      (0.02)          BRICMAN   70 CNTR  O TOTAL AND CH EX    6/70
R1            0.4                       COOL      70 CNTR    K-P, D TOTAL      10/70

R2      Y*0(2100) INTO (KBAR N PI)/TOTAL                       (P2)
R2                SEEN                  BOCK      65 HBC
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R3     Y*0(2100) FROM KBAR N INTO LAMBDA ETA                SQRT(P1*P3)
R3           (0.09) OR LESS            FLATTE 2  67 HBC    0 K-P TO LAM ETA     6/68

R4     Y*0(2100) INTO (LAMBDA OMEGA)/TOTAL                  (P4)
R4           (0.1)  OR LESS            FLATTE 1  67 HBC    0 K-P TO LAM OMEGA   8/67

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REFERENCES FOR Y*0(2100) (PROD. EXP.)


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BOCK       65 PL 17 166         +COOPER,FRENCH,KINSON, +        (CERN,SACLAY)
FLATTE 1 67 PR 155 1517         S M FLATTE                               (LRL)
FLATTE 2 67 PR 163 1441         S M FLATTE, C G WOHL                     (LRL)
BUGG       68 PR 168 1466       +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN    70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL       70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +     (BNL) I
LU         70 PR D2 1846        +GREENBERG, HUGHES, MINEHART, MORI,+  (YALE)
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PAPERS NOT REFERRED TO IN DATA CARDS

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COOL       66 PRL 16 1228       +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
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Λ(2110) 35 Y*0(2110, JP=5/2+) I=0 **F''_{05}**

BERTHONI 70 FIND EITHER F05 OR D05 POSSIBLE IN THE SIG PI CHANNEL, WITH F05 SLIGHTLY PREFERRED. IN THE KBAR N CHANNEL, LITCHFIELD 71 (SAME GROUP) FIND ONLY D05. AS USUAL, THE STATISTICS ARE MUCH BETTER IN THE ELASTIC CHANNEL.

ALTHOUGH KANE 72 FINDS AN F05 EFFECT, THE UNUSUALLY BROAD WIDTH MAY INVALIDATE A RESONANT INTERPRETATION. HOWEVER RLIC 77, BELLEFON 77, AND BELLEFON 78 ALSO FIND AN F05. THE EVIDENCE FOR F05 FROM THE LAMBDA OMEGA ANALYSES, NAKKASYAN 75 AND BACCARI 77, IS QUITE WEAK, BUT THEY GIVE NO EVIDENCE IN FAVOR OF D05. THE WEIGHT OF THE EVIDENCE IS THUS IN FAVOR OF F05. SEE ALSO THE Y*0(2000) MINI-REVIEW.

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                    35  Y*0(2110) MASS (MEV)

M          (2110.)      (10.)            BERTHONI  70 DPWA -  K- P TO SIG PI     1/71
M      D05 2140.         40.             LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
M   A      (2141.0)     (6.0)            KANE      72 DPWA  0 K-P TO PI SIG     10/71
M   A   RESONANCE OUTSIDE RANGE OF DATA.  SUPERSEDED BY KANE 74.
M           2112.0       7.0             KANE      74 DPWA    K-P TO PI SIG     12/81*
M    1     (2103.)                       NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.   1/76
M    1  FOUND IN ONE OF TWO BEST SOLUTIONS.                                      1/76
M          (2137.)                       BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78
M           2140.       (20.)            BELLEFON  77 DPWA  0 K- P TO SIG PI    11/77
M           2130.       (50.)            RLIC      77 DPWA    KBAR N MULTICHNL   1/76
M           2106.       (50.)            BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/78
M           2125.0      (25.0)           CAMERON2  78 DPWA    K-P TO K*(890) N  12/79
M           2092.0      (25.0)           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

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                    35  Y*0(2110) WIDTH (MEV)

W           185.         30.             BERTHONI  70 DPWA -  K- P TO SIG PI     1/71
W      D05  123.         40.             LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
W   A      (504.0)      (10.0)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
W           190.0       (30.0)           KANE      74 DPWA    K-P TO PI SIG     12/81*
W    1     (391.)                        NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.   1/76
W          (132.)                        BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78
W           140.        (20.)            BELLEFON  77 DPWA  0 K- P TO SIG PI    11/77
W           203.        (50.)            RLIC      77 DPWA    KBAR N MULTICHNL   1/76
W           251.        (50.)            BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/78
W           160.0       (30.0)           CAMERON2  78 DPWA    K-P TO K*(890) N  12/79
W           245.0       (25.0)           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

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                    35  Y*0(2110) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*0(2110) INTO N KBAR                                   938+ 493
P2      Y*0(2110) INTO SIGMA PI                                1189+ 139
P3      Y*0(2110) INTO LAMBDA OMEGA                            1115+ 782
P4      Y*0(2110) INTO Y*1(1385) PI P-WAVE                      139+1385
P5      Y*0(2110) INTO N K*(890), F1 WAVE                       939+ 891

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                    35  Y*0(2110) BRANCHING RATIOS

R1      Y*0(2110) FROM KBAR N TO SIGMA PI                 SQRT(P1*P2)
R1           +0.17       0.03           BERTHONI  70 DPWA -  K- P TO SIG PI     1/71
R1   A      (+0.156)    (0.013)         KANE      72 DPWA  0 K-P TO PI SIG     10/71
R1           +0.70      (0.03)          KANE      74 DPWA    K-P TO PI SIG     12/81*
R1           +0.14      (0.01)          BELLEFON  77 DPWA  0 K- P TO SIG PI     1/76
R1          (+0.10)     (0.03)          RLIC      77 DPWA    KBAR N MULTICHNL   1/76

R2      Y*0(2110) INTO (KBAR N)/TOTAL                     (P1)
R2      D05  0.14        0.04           LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
R2   C      (0.07)      (0.03)          RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R2   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R2   2       0.27       (0.06)          BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/78
R2   2  THE PUBLISHED ERROR OF 0.6 WAS A MISPRINT.                             12/79
R2           0.07       (0.03)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

R3      Y*0(2110) FROM KBAR N INTO LAMBDA OMEGA           SQRT(P1*P3)           1/76
R3   1      (0.112)                     NAKKASYA  75 DPWA  0 K-P TO LAM. OMG.   1/76
R3          LESS THAN 0.05              BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78

R4      Y*0(2110) FROM KBAR N TO Y*1(1385) PI P-WAVE      SQRT(P1*P4)
R4   2       +0.071      0.025          CAMERON   78 DPWA  0 K-P TO S(1385)PI   1/78
R4   2  CAMERON  78 UPPER LIMIT ON F-WAVE DECAY IS 0.03.  THE SIGN HERE IS     12/79
R4   2  CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.              12/79

R5      Y*0(2110) FROM KBAR N INTO N K*(890), F1 WAVE     SQRT(P1*P5)
R5   3       -0.17       0.04           CAMERON2  78 DPWA    K-P TO K*N        12/79
R5   3  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST         12/79
R5   3  CONVENTION.  UPPER LIMITS ON THE P3 AND F3 WAVES ARE EACH 0.03.        12/79

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REFERENCES FOR Y*0(2110)


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BERTHONI 70 NP B24 417          +VRANA,BUTTERWORTH,+       (CDEF,RHEL,SACLAY)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUIN,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583          D F KANE                                  (LBL)IJP
KANE     74  LBL-2452           D.F.KANE                                  (LBL)IJP

NAKKASYA 75 NP B93 85           A. NAKKASYAN                             (CERN)IJP
BACCARI  77 NC 41A 96           +POULARD,REVEL,TALLINI+             (SACL+CDEF)IJP
BELLEFON 77 NC 37A 175          DE BELLEFON,BERTHON,BILLOIR+        (CDEF+SACL)IJP
RLIC     77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+      (LOIC+RHEL)IJP

BELLEFON 78 NC 42A 403          +BERTHON,BILLOIR,BRUNET+            (CDEF+SACL)IJP
CAMERON  78 NP B143 189         +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
CAMERON2 78 NP B146 327         +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159 G.P.GOPAL                                  (RHEL)IJP
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Λ(2325) 112 Y*0(2325, JP=3/2-) I=0 **D''_{03}**

BACCARI 77 FIND THIS STATE WITH JP EITHER 3/2- OR 3/2+ IN A DPWA OF K- P TO LAMBDA OMEGA FROM 2070 TO 2436 MEV. A SUBSEQUENT SEMI-ENERGY-INDEPENDENT PWA FROM THRESHOLD TO 2436 MEV SELECTS 3/2-. BELLEFON 78 (SAME GROUP) ALSO SEE THIS STATE IN A DPWA OF K- P ELASTIC AND CHARGE-EXCHANGE DATA IN THE SAME ENERGY RANGE, AND FIND JP=3/2- OR 3/2+. THEY AGAIN PREFER JP=3/2-, BUT ONLY ON THE BASIS OF MODEL DEPENDENT CONSIDERATIONS.

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                    112  Y*0(2325) MASS (MEV)

M    3      2327.        20.            BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78
M           234          30.            BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/78
M           . .          . . . .
M    AVERAGE MEA[illegible]S (SCALE FACTOR = 1.0)

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                    112  Y*0(2325) WIDTH (MEV)

W    3      160.         40.            BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78
W           177.         40.            BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/78
W           . . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    112  Y*0(2325) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*0(2325) INTO N KBAR                                   938+ 493
P2      Y*0(2325) INTO LAMBDA OMEGA                            1115+ 782

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                    112  Y*0(2325) BRANCHING RATIOS

R1      Y*0(2325) FROM KBAR N TO LAMBDA OMEGA             SQRT(P1*P2)
R1   3        0.06       0.02           BACCARI   77 IPWA  0 D533-WAVE          1/78
R1   3        0.05       0.02           BACCARI   77 DPWA  0 D013 WAVE          1/78
R1   3        0.08       0.03           BACCARI   77 DPWA  0 D033-WAVE          1/78
R1   3  NOTE THAT THE 3 ENTRIES FOR BACCARI77 ARE FOR 3 DIFFERENT WAVES.        1/78
R1            . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      Y*0(2325) INTO (KBAR N)/TOTAL                     (P1)
R2            0.19       0.06           BELLEFON  78 DPWA  0 KBAR N TO KBAR N   1/76

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REFERENCES FOR Y*0(2325)


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BACCARI  77 NC 41A 96           +POULARD,REVEL,TALLINI+             (SACL+CDEF)IJP
BELLEFON 78 NC 42A 403          +BERTHON,BILLOIR,BRUNET+            (CDEF+SACL)IJP
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Λ(2350) BUMPS 42 Y*0(2350, JP=) I=0   PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

DAUM 68 FAVORS JP=7/2- OR 9/2+. BRICMAN 70 FAVORS 9/2+. LASINSKI 71 SUGGESTS THREE STATES IN THIS REGION USING A POMERON + RESONANCES MODEL. THERE ARE NOW ALSO THREE FORMATION EXPERIMENTS FROM THE COLLEGE DE FRANCE-SACLAY GROUP WHICH WE INCLUDE HERE, BELEFON 77, BACCARI 77, AND BELLEFON 78, WHICH FIND 9/2+ IN DPWAS OF KBAR N TO SIGMA PI, LAMBDA OMEGA, AND KBAR N.

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                    42  Y*0(2350) MASS (MEV) (PROD. EXP.)

M          2340.0       (7.0)           BUGG      68 CNTR    K-P, D TOTAL        6/68
M          2358.0       (6.0)           BRICMAN   70 CNTR  0 TOTAL AND CH EX     6/70
M          2344.0      (15.0)           COOL      70 CNTR    K-P, D TOTAL       10/70
M         (2360.0)     (20.0)           LU        70 CNTR  0 GAMMA P TO K+ Y*    1/71
M         (2372.)                       BACCARI   77 DPWA  0 K-P TO LAM. OMG.    1/78
M          2365.        20.             BELLEFON  77 DPWA  0 K- P TO SIG PI     11/77
M          2370.        50.             BELLEFON  78 DPWA  0 KBAR N TO KBAR N    1/78
M          . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    42  Y*0(2350) WIDTH (MEV) (PROD. EXP.)

W           140.0      (20.0)           BUGG      68 CNTR    K-P, D TOTAL        6/68
W           324.0      (30.0)           BRICMAN   70 CNTR  0 TOTAL AND CH EX     6/70
W          (190.0)                      COOL      70 CNTR    K-P, D TOTAL       10/70
W           (55.0)                      LU        70 CNTR  0 GAMMA P TO K+ Y*    1/71
W          (257.)                       BACCARI   77 DPWA  0 K-P TO LAM. OMG.    1/78
W           110.        20.             BELLEFON  77 DPWA  0 K- P TO SIG PI     11/77
W           204.        50.             BELLEFON  78 DPWA  0 KBAR N TO KBAR N    1/78
W          . . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.7)

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          42  Y*0(2350) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      Y*0(2350) INTO N KBAR                            938+ 493
P2      Y*0(2350) INTO SIGMA PI                          1189+ 139
P3      Y*0(2350) INTO LAMBDA OMEGA                      1115+ 782

          42  Y*0(2350) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(2350) INTO (KBAR N)/TOTAL                    (P1)
R1          0.12      0.06         BELLIFON  78 DPWA  0 KBAR N TO KBAR N   1/78

R2      Y*0(2350) FROM KBAR N INTO SIGMA PI              SQRT(P1*P2)        1/76
R2          -0.11     0.02         BELLEFON  77 DPWA  0 K- P TO SIG PI    11/77

R3      Y*0(2350) FROM KBAR N TO LAMBDA OMEGA            SQRT(P1*P3)        1/78
R3          LESS THAN 0.05         BACCARI   77 DPWA  0 K-P TO LAM. OMG.   1/78

R4      Y*0(2350) INTO (KBAR N)/TOTAL                    (J+1/2)*(P1)
R4        J IS NOT DETERMINED IN THESE EXPTS.  THE FOLLOWING IS (J+1/2)*P1
R4          (0.?7)                 BIGG      68 CNTR     K-P, 0 TOTAL      3/78
R4          1.1       0.25         BRICMAN   70 CNTR  0 TOTAL AND CH EX    3/78
R4          (1.0)                  COOL      70 CNTR     K-P, 0 TOTAL      3/78

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                    REFERENCES FOR Y*0(2350) (PROD. EXP.)

BIGG      68 PR 168 1466        +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I
A(?)      68 NP B7 15           +ERNE, LAGNAUX, SENS, UDO, ?  (CERN,JP
BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL      70 PR 1D 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
?         70 PR D2 1446         +GUTENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BACCARI   77 NC 41A 96          +POULARD,RIVET,TALLINI+       (MADR+DE+IJP
BELLEFON  77 NC 37A 175         DE BELLEFON,BERTHON,BILLOIR+  (COLL+SACL+IJP
BELLEFON  78 NC 42A 403         +BERTHON,BILLOIR,BRUNET+      (COLL+SACL+IJP

                    PAPERS NOT REFERRED TO IN DATA CARDS
COOL      66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
LASINSKI  71 NP B29 1?5         T A LASINSKI                  (EFI) IJP
BELLEFON  75 NC 28A 289         DE BELLEFON,BERTHON,BILLOIR+  (CDEF+SACL)
    PRESENTLY LISTED UNDER Y*1(2250), BUT ISOSPIN UNDETERMINED.

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Λ(2585) BUMPS

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   ?  Y*0(2585, JP=    ) I=0         PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

   ?  Y*0(2585) MASS (MEV) (PROD. EXP.)

M         [illegible]    [illegible]       ABRAMS    70 CNTR     K-P, 0 TOTAL      10/7?
M         (2??5.0)       (25.0)            LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71

   ?  Y*0(2585) WIDTH (MEV) (PROD. EXP.)

W         [illegible]                      ABRAMS    70 CNTR     K-P, 0 TOTAL      10/70
W         (1??.0)                          LU        70 CNTR  0 GAMMA P TO K+ Y*   1/71

   ?  Y*0(2585) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      Y*0(2585) INTO N KBAR                            938+ 493

   ?  Y*0(2585) BRANCHING RATIOS (PROD. EXP.)

R1      Y*0(2585) INTO (KBAR N)/TOTAL                    (P1)
R1         J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1          (?.?)                  ABRAMS    70 CNTR     K-P, 0 TOTAL      10/70
R1  C       (0.12)    (0.12)       BRICMAN   70 CNTR     TOTAL AND CH EX   10/70
R1  C     ??? MASS ? AT END OF REGION ANALYZED -- NO CLEAR SIGNAL.

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                    REFERENCES FOR Y*0(2585) (PROD. EXP.)

ABRAMS    70 PR D1 1917         +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN   70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
LU        70 PR    1446         +GUTENBERG, HUGHES, MINEHART, MORI,+ (YALE)

                    PAPERS NOT REFERRED TO IN DATA CARDS
?         66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LUNDBY +    (BNL) I

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S=−1 I=1 HYPERON STATES (Σ)

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Σ^+

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   35  SIGMA+(1189, JP=1/2+) I=1

   SEE STABLE PARTICLE DATA CARD LISTINGS

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Σ^-

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   2?  SIGMA-(1197, JP=1/2+) I=1

   SEE STABLE PARTICLE DATA CARD LISTINGS

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Σ^0

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   21  SIGMA0(1193, JP=1/2+) I=1

   SEE STABLE PARTICLE DATA CARD LISTINGS

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Σ(1385) **P_{13}**

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   43  Y*1(1385, JP=3/2+) I=1

            SERIOUS INCOMPATIBILITIES EXIST BETWEEN DIFFERENT
            MEASUREMENTS OF THE Y*1(1385) MASS AND WIDTH. THESE
            INCOMPATIBILITIES ARE AT LEAST PARTIALLY ACCOUNTED FOR
            BY SOME EXPERIMENTS QUOTING UNREALISTICALLY SMALL
ERRORS. WE CONSISTENTLY INCREASE UNREALISTIC ERRORS BEFORE AVERAGING
(SEE THE TYPED NOTE ON K*(892)).
IN THE LISTINGS BELOW WE ATTEMPT TO OBTAIN THE BEST VALUES FOR THE
SEPARATE CHARGE STATE MASSES AND WIDTHS. THUS WE DO NOT USE RESULTS
QUOTED FOR MIXED CHARGES.
WE NO LONGER USE EVERY PUBLISHED VALUE, BUT AVERAGE ONLY THE MOST
SIGNIFICANT DETERMINATIONS. NEITHER DO WE AVERAGE RESULTS FROM
INCLUSIVE EXPERIMENTS WITH LARGE BACKGROUNDS OR RESULTS WHICH ARE NOT
ACCOMPANIED BY AT LEAST A DISCUSSION ON EXPERIMENTAL RESOLUTION.
NEVERTHELESS SYSTEMATIC DIFFERENCES BETWEEN EXPERIMENTS REMAIN (SEE
THE IDEOGRAMS INSERTED IN THE DATA CARD LISTINGS BELOW). THESE
DIFFERENCES COULD ARISE FROM INTERFERENCE EFFECTS THAT CHANGE WITH
PRODUCTION MECHANISM AND/OR BEAM MOMENTUM. THEY CAN ALSO BE ACCOUNTED
FOR IN PART BY DIFFERENCES IN THE PARAMETRIZATIONS EMPLOYED (SEE
BORENSTEIN 74 FOR A DISCUSSION ON THIS POINT). THUS BORENSTEIN 74 USE A
BREIT-WIGNER WITH ENERGY INDEPENDENT WIDTH, SINCE A P-WAVE WAS FOUND
TO GIVE UNSATISFACTORY FITS. CAMERON 78 USE THE SAME FORM.
ON THE OTHER HAND HOLMGREN 77 OBTAIN A GOOD FIT TO THEIR LAMBDA PI MASS
SPECTRUM WITH A P-WAVE BREIT-WIGNER, BUT INCLUDE THE PARTIAL WIDTH FOR
THE SIGMA PI DECAY MODE IN THE PARAMETRIZATION.

   43  Y*1(1385) MASS (MEV)

M        14(1384.0)                    ALSTON    60 HBC   +  K-P 1.15 BEV/C
M          (1385.0)                    BERGE     61 HBC   +- K-P 1.? BEV/
M        38(1384.0)                    MARTIN    61 HBC   +0 K?? P .?? BEV/C
M          (1392.0)    (7.0)           COLLEY    62 HLBC  -0 PI- P?P 2. BEV/C
M          (1389.0)    (3.0)           BALTAY    65 HBC   +- PBAR P 3.7 BEV/C  7/66
M          (1392.0)    (10.0)          MUSGRAVE  65 HBC   +-PBAR P 3-4 BEV/C  7/66
M       200(1384.?)    (2.0)           ATHERTON  71 HBC   +  LAM PI+ + ?.?.  11/77
M       190(1380.?)    (5.?)           AMMANN    73 DBC   +- K-N 4.5GEV/C    11/77
M       200(1386.?)                    ATHERTON  75 HBC   +-PBAR P 5.7 ?.?/   1/76
M       242(1394.?)    (5.?)           DIONISI   78 HBC   +- K-P TO Y* K KBAR  ?/??
M    I   1K(1383.?)    (1.?)           BANERJEE  79 HBC   +- LAM PI+ + ?.?.   1/??
M    I  500(1398.?)    (2.?)           BANERJEE  79 HBC   +- LAM PI- + ?.?.   1/80
M    I   FROM FIT TO INCLUSIVE LAMBDA PI + C.C. SPECTRA

M0      106(1381.0)    (4.0)           CURTIS    63 OSPK   0 PI-P 1.5 BEV/C
M0 F    240 1385.?      2.?            THOMAS    73 HBC    0 PI-P TO PI0K0LM  11/77
M0 F     ERROR ENLARGED BY US TO GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
M0 2   3100 1383.       2.             BORENSTE  74 HBC    0 K-P TO(1385)+PIS 11/77
M0 2     FROM FIT TO LAM PI0 MASS SPECTRUM (IN LAM PI+ PI- PI0 EVENTS) WITH
M0 2     W0 FIXED AT 36 MEV.
M0 F    500(1389.?)    (3.?)           BAUBILLIE 79 HBC    0 K-P AT 8.25 GEV   1/80
M0 F     FROM FIT TO INCLUSIVE LAMBDA PI0 SPECTRUM WITH WIDTH FIXED AT
M0 F     4? MEV.
M0
M0  AVG     1382.?       ?.?      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.?)

M+ F    154(1376.0)    (3.9)           ELY       61 HLBC  +  K-P 1.11 BEV/C  11/77
M+      170(1375.0)    (3.9)           COOPER    64 HBC   +  K-P 1.45 BEV/C  11/77
M+      859 1381.0      1.6            HUME      64 HBC   +  K-P 1.22 BEV/C
M+      750 1382.0      1.0            ARMENTERO 65 HBC   +  K-P .9-1.2 BEV/C
M+ F     50(1384.3)    (1.9)           SMITH     65 HBC   +  K-P 1.8 BEV/C   11/77
M+ F    250(1382.6)    (2.1)           SMITH     65 HBC   +  K-P 1.95 BEV/C  11/77
M+ F    ?2(1383.0)     (8.0)           BIRMINGHA 66 HBC   +  K-P 3.5 GEV/C   11/77
M+      135(1378.0)    (5.0)           LONDON    66 HBC   +  K-P 2.24 BEV/   11/77
M+     1260 1384.4      1.0            SIEGEL    67 HBC   +  K-P AT 2.1 GEV/C 10/69
M+       46(1390.0)    (6.0)           AGUILAR   70 HBC   +  K-P 4 GEV/SIG.PI 11/77
M+      400 1382.0      2.0            AGUILAR   72 HBC   +  K-P TO LAM+PIS   10/74
M+     2300 1383.5      0.85           HABIBI    73 HBC   +  K-P TO 2PI LAM    9/73
M+  R  3740(1382.?)    (1.?)           BERTHON   74 HBC   +  K-P 1263-1843MEV 10/74
M+  R    ERRORS STATISTICAL ONLY. RESOLUTION NOT UNFOLDED.
M+     6846 1381.       1.             BORENSTE  74 HBC   +  K-P TO(1385)+PIS 10/74
M+  I      (1383.?)    (2.?)           BARDADIN  75 HBC   +  K- P 14.3 GEV/C  11/77
M+ HI   22K(1385.?)    (3.?)           BARREIRO  77 HBC   +  K-P AT 4.2 GEV   11/77
M+ H     INCLUDES DATA OF HOLMGREN 77
M+     2594 1385.       1.             HOLMGREN  77 HBC   +  K-P AT 4.2 GEV   11/77
M+     6900 1381.9      0.3            CAMERON   78 HBC   +  K-P 0.96-1.36GEV 11/77
M+  I    7K(1381.1)    (2.?)           BAUBILLIE 79 HBC   +  K-P AT 8.25 GEV   1/80
M+       2K(1391.1)    (2.?)           CAUTIS    79 HYBR  +  PI+P ? 11.? GEV   1/80
M+  I  1300(1393.1)    (2.?)           SUGAHARA  79 HBC   +  PI-P AT ? GEV/C   1/80
M+      600(1385.1)    (1.2)           BAKER     80 HYBR  +  PI+P 7 GEV/C      2/82*
M+      750(1383.2)    (1.0)           BAKER     80 HYBR  +  K-P 7 GEV/C       2/82*
M+
M+  I    FROM FIT TO INCLUSIVE LAMBDA PI SPECTRUM
M+ F     ERROR ENLARGED BY US TO GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
M+
M+  AVG     1382.29      0.39     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.?)
                                  (SEE IDEOGRAM BELOW )

M-       93(1382.0)    (3.0)           DAHL      61 DBC   -  K-D 0.45 BEV/C   11/77
M- F    224(1376.0)    (4.4)           ELY       61 HLBC  -  K-P 1.11 BEV/C   11/77
M-      200(1392.0)    (6.2)           COOPER    64 HBC   -  K-P 1.45 BEV/C   11/77
M- I   1086 1385.3      1.9            HUME      64 HBC   -  K-P 1.15-1.30GEV 11/77
M-     1380 1384.0      1.0            ARMENTERO 65 HBC   -  K-P .9-1.2 BEV/C
M- F    120(1391.5)    (2.6)           SMITH     65 HBC   -  K-P 1.8 BEV/C    11/77
M- F     59(1399.8)    (2.2)           SMITH     65 HBC   -  K-P 1.95 BEV/C   11/77
M-       15(1389.0)    (9.0)           LONDON    66 HBC   -  K-P AT 2.24 GEV  11/77
M-      370 1390.7      2.0            SIEGEL    67 HBC   -  K-P AT 2.1 GEV/C 10/69
M-     1900 1390.7      1.2            HABIBI    73 HBC   -  K-P TO 2PI LAM    9/73
M- F    630 1387.1      1.9            THOMAS    73 HBC      PI-P TO PI-K+LM  11/77
M-  R  3060(1389.?)    (1.?)           BERTHON   74 HBC   -  K-P 1263-1843MEV 10/74
M-  R    ERRORS STATISTICAL ONLY. RESOLUTION NOT UNFOLDED.
M-     2303 1383.       2.             BORENSTE  74 HBC   -  K-P TO(1385)+PIS 10/74
M-  I      (1383.?)    (2.?)           BARDADIN  75 HBC   -  K- P 14.3 GEV/C  11/77
M- H    12K(1387.?)    (3.?)           BARREIRO  77 HBC   -  K-P AT 4.2 GEV   11/77
M- H     INCLUDES DATA OF HOLMGREN 77
M-      193 1391.       3.             HOLMGREN  77 HBC   -  K-P AT 4.2 GEV   11/77
M-     9720 1387.6      0.3            CAMERON   78 HBC   -  K-P 0.96-1.36GEV 11/77
M-  I 4.5K(1383.?)     (1.?)           BAUBILLIE 79 HBC   -  K-P AT 8.25 GEV   1/80
M-  I   150(1380.?)    (6.?)           SUGAHARA  79 HBC   -  PI-P AT 6 GEV/C   1/80
M-
M-  I    FROM FIT TO INCLUSIVE LAMBDA PI SPECTRUM
M- F     ERROR ENLARGED BY US TO GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
M-
M-  AVG     1387.44      0.58     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)
                                  (SEE IDEOGRAM BELOW )
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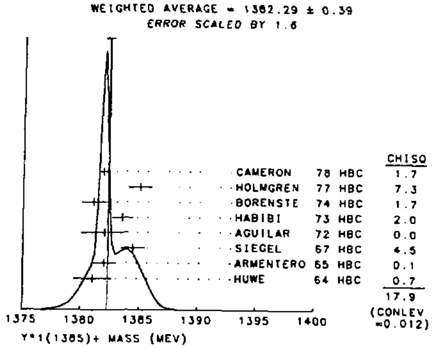

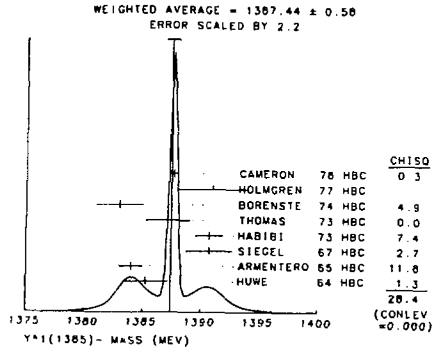


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43  (Y*-) - (Y*+) MASS DIFFERENCE (MEV)

D-+ R       (0.0)     (4.2)           ELY        61 HLBC +- K-P 1.11 BEV/C     8/66
D-+ R      (17.)      (7.)            COOPER     64 HBC  +- K-P 1.45 BEV/C    10/69
D-+ R       (4.3)     (2.2)           HUWE       64 HBC  +- K-P 1.22 BEV/C     8/66
D-+ R       (2.0)     (1.5)           ARMENTERO  65 HBC  +- K-P .9-1.2 BEV/C   8/66
D-+ R       (7.2)     (2.1)           SMITH      65 HBC  +- K-P 1.8 uEV/C      9/66
D-+ R      (17.2)     (2.0)           SMITH      65 HBC  +- K-P 1.95 BEV/C     9/66
D-+ R      (11.0)     (9.0)           LONDON     66 HBC  +- K-P 2.24 BEV/C     8/66
D-+          9.0       6.0            LONDON     66 HBC  +- LAMBDA 3 PI EVTS   7/66
D-+ R       (6.3)     (2.0)           SIEGEL     67 HBC  +- K-P AT 2.1 GEV/C  10/69
D-+ R       (7.2)     (1.4)           HABIBI     73 HBC  +- K-P TO 2PI LAM     9/73
D-+ R    BETWEEN -2 AND +6 CL=.95     BORENSTE   74 HBC  +- K-P TO(1385)+PIS  11/77
D-+
D-+ R  REDUNDANT WITH DATA IN MASS LISTINGS
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43  (Y*0) - (Y*+) MASS DIFFERENCE (MEV)

D0+ R    BETWEEN -4 AND +4 CL=.95     BORENSTE   74 HBC  +0 K-P TO(1385)+PIS  11/77
D0+ R  REDUNDANT WITH DATA IN MASS LISTINGS
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43  (Y*-) - (Y*0) MASS DIFFERENCE (MEV)

D-0 R       (2.0)     (2.4)           THOMAS     73 HBC  -0 PI-P TO PI-K+LN   11/77
D-0 R  REDUNDANT WITH DATA IN MASS LISTINGS
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43  Y*1(1385) WIDTH (MEV)

W        141  (64.0)                  ALSTON     60 HBC  +- K-P 1.15 BEV/C
W             (40.0)                  BERGE      62 HBC  +- K-P .4-.85 BEV/C
W         38  (20.0)  OR LESS         MARTIN     61 HBC  +0 K20 P .98 BEV/C
W             (80.0)    (10.0)        COLLEY     62 HLBC -0 PI- PRP 2. BEV/C
W             (26.0)    (5.0)         BALTAY     65 HBC  +- PBAR P 3.7 BEV/C   7/66
W             (38.0)    (9.0)         MUSGRAVE   65 HBC  +-OPBAR P 3-4 BEV/C   7/66
W     T 200   (20.)     (4.)          ATHERTON   71 HBC  +- LAM PI+ + C.C.    11/77
W     T  FIT B.W. + PHASE SPACE BCKGRD
W     R 200   (35.)     (5.)          ATHERTON   71 HBC  +- LAM PI+ + C.C.    11/77
W     R  FIT B.W. AND NO BCKGRD
W        190  (61.)     (10.)         AMMANN     73 DBC  +- K-N 4.5GEV/C      11/77
W        200  (89.)     (23.)         ATHERTON1  75 HBC  +-OPBAR P 5.7 GEV/C  11/77
W    D        (20.)     (10.)         ALSTON     78 DPWA -0 KBAR N ONLY        1/78
W    D   WITH MASS FIXED AT 1385 MEV.  FROM RESULTS OF PARTIAL WAVE ANALYSIS   1/78
W    D   OF KBAR N SYSTEM EXTRAPOLATED BELOW THRESHOLD.                        1/78
W        242  (53.)     (14.)         DIONISI    78 HBC  +- K-P TO Y* K KBAR   3/79
W    I    1K  (35.)     (2.)          BANERJEE   79 HBC  +- LAM PI+ + C.C.     1/80
W    I   500  (36.)     (4.)          BANERJEE   79 HBC  +- LAM PI- + C.C.     1/80
W    I   FROM FIT TO INCLUSIVE LAMBDA PI + C.C. SPECTRA
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W0        106  (30.0)    (9.0)        CURTIS     63 OSPK  0 PI-P 1.5 BEV/C
W0 E      240   39.3     10.2         THOMAS     73 HBC   0 PI-P TO PI0K0LM  11/77
W0 E    ERROR ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
W0   C 3100  (53.)      (8.)         BORENSTE   74 HBC   0 K-P TO(1385)+PIS 11/77
W0   C 3100 CONSISTENT WITH W0=W+=W-  BORENSTE   74 HBC   0 K-P TO(1385)+PIS 11/77

W+ E      154  (48.0)   (16.0)        ELY        61 HLBC +  K-P 1.11 BEV/C     11/77
W+ E      170  (51.0)   (16.0)        COOPER     64 HBC  +  K-P 1.45 BEV/C     11/77
W+ E      859   46.5      6.4         HUWE       64 HBC  +  K-P 1.15-1.30GEV   11/77
W+ E      750   32.0      4.7         ARMENTERO  65 HBC  +  K-P .95-1.20 GEV   11/77
W+ E      250  (30.3)    (7.5)        SMITH      65 HBC  +  K-P 1.8 BEV/C      11/77
W+ E      250  (33.1)    (8.3)        SMITH      65 HBC  +  K-P 1.95 BEV/C     11/77
W+ E       62  (25.0)   (32.0)        BIRMINGHA  66 HBC  +  K-P 3.5 GEV/C      11/77
W+ E     1260   36.0      4.0         SIEGEL     67 HBC  +  K-P AT 2.1 GEV/C   11/77
W+ E       46  (33.)    (20.0)        AGUILAR    70 HBC  +  K-P 4 GEV/SIG.PI   11/77
W+        400   32.5      6.0         AGUILAR    72 HBC  +  K-P TO LAM+PIS     10/74
W+ E     2300   38.3      3.2         HABIBI     73 HBC  +  K-P TO 2PI LAM     11/77
W+  R    3740  (48.)     (3.)         BERTHON    74 HBC  +  K-P 1263-1843MEV   10/74
W+  R   ERRORS STATISTICAL ONLY. RESOLUTION NOT UNFOLDED.
W+ I     6846   34.       1.6         BORENSTE   74 HBC  +  K-P TO(1385)+PIS   11/77
W+ I   RESULTS FROM LAM PI+ PI- AND LAM PI+ PI- PI0 COMBINED BY US.
W+  I          (40.)     (3.2)        BARDADIN   75 HBC  +  K- P 14.3 GEV/C    11/77
W+ HI     22K  (43.)     (5.)         BARREIRO   77 HBC  +  K-P AT 4.2 GEV     11/77
W+ H    INCLUDES DATA OF HOLMGREN 77
W+       2594   34.       2.          HOLMGREN   77 HBC  +  K-P AT 4.2 GEV     11/77
W+       6900   35.5      1.9         CAMERON    78 HBC  +  K-P 0.96-1.36GEV   11/77
W+  I      7K  (37.)     (2.)         BAUBILLIE  79 HBC  +  K-P AT 8.25 GEV     1/80
W+         2K  (30.)     (4.)         CAUTIS     79 HYBR +  PI+/K-P 11.5 GEV    1/80
W+  I     100  (30.)     (6.)         SUGAHARA   79 HBC  +  PI-P AT 6 GEV/C     1/80
W+        600  (40.)     (3.)         BAKER      80 HYBR +  PI+P 7 GEV/C        2/82*
W+        750  (37.)     (2.)         BAKER      80 HYBR +  K-P 7 GEV/C         2/82*
W+
W+  I   FROM FIT TO INCLUSIVE LAMBDA PI SPECTRUM
W+ E    ERROR ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
W+             . . . . . . . . . .
W+  AVG        34.96      0.92     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W-             (40.0)                 DAHL       61 DBC  -  K-D 0.45 BEV/C
W- E      224  (66.0)   (18.0)        ELY        61 HLBC -  K-P 1.11 BEV/C     11/77
W- E      200  (88.0)   (24.0)        COOPER     64 HBC  -  K-P 1.45 BEV/C     11/77
W-       1086   62.0      7.0         HUWE       64 HBC  -  K-P I.I5-I.30GEV
W- E     1382   38.0      4.1         ARMENTERO  65 HBC  -  K-P .95-1.20 GEV   11/77
W- E      120  (29.2)   (10.6)        SMITH      65 HBC  -  K-P 1.80 BEV/C     11/77
W- E       58  (17.1)    (6.9)        SMITH      65 HBC  -  K-P 1.95 BEV/C     11/77
W- E      370   31.0      6.5         SIEGEL     67 HBC  -  K-P AT 2.1 GEV/C   11/77
W- E     1900   51.9      4.8         HABIBI     73 HBC  -  K-P TO 2PI LAM     11/77
W- E      630   48.2      7.7         THOMAS     73 HBC  -  PI-P TO PI-K0LM    11/77
W-  R    3060  (40.)     (3.)         BERTHON    74 HBC  -  K-P 1263-1843ME.   10/74
W-  R   ERRORS STATISTICAL ONLY. RESOLUTION NOT UNFOLDED.
W- I     2303   35.       3.          BORENSTE   74 HBC  -  K-P TO(1385)+PIS   11/77
W- I   RESULTS FROM LAM PI+ PI- AND LAM PI+ PI- PI0 COMBINED BY US.
W-  I          (47.)     (6.)         BARDADIN   75 HBC  -  K- P 14.3 GEV/C    11/77
W- HI     12K  (45.)     (5.)         BARREIRO   77 HBC  -  K-P AT 4.2 GEV     11/77
W- H    INCLUDES DATA OF HOLMGREN 77
W-        193  (35.)    (10.)         HOLMGREN   77 HBC  -  K-P AT 4.2 GEV     11/77
W-       9720   39.2      1.7         CAMERON    78 HBC  -  K-P 0.96-1.36GEV   11/77
W-  I    4.5K  (44.)     (4.)         BAUBILLIE  79 HBC  -  K-P AT 8.25 GEV     1/80
W-  I     150  (58.)     (4.)         SUGAHARA   79 HBC  -  PI-P AT 6 GEV/C     1/80
W-
W-  I   FROM FIT TO INCLUSIVE LAMBDA PI SPECTRUM
W- E    ERROR ENLARGED BY US TO 4*GAMMA/SQRT(N). SEE TYPED NOTE ON K* MASS.
W-             . . . . . . . . . .
W-  AVG        39.9       2.4      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.9)
                                   (SEE IDEOGRAM BELOW)
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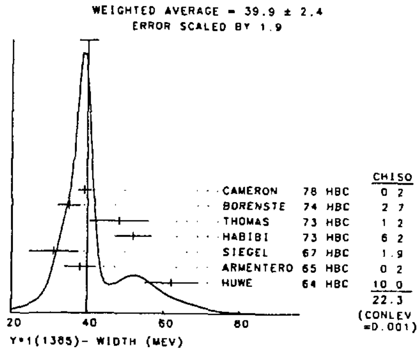


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43  Y*1(1385) REAL PART OF POLE POSITION                               4/75

RE+       1379.0     1.0              LICHTENB  74      +  EXTRAP HABIBI73   4/75
RE-       1383.0     1.0              LICHTENB  74      -  EXTRAP HABIBI73   4/75
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43  Y*1(1385) IMAGINARY PART OF POLE POSITION                          4/75

IM+         17.5     1.5              LICHTENB  74      +  EXTRAP HABIBI73   4/75
IM-         22.5     1.5              LICHTENB  74      -  EXTRAP HABIBI73   4/75
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43  Y*1(1385) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1     Y*1(1385) INTO LAMBDA PI                            1115+ 139
P2     Y*1(1385) INTO SIGMA PI                             1189+ 139
P3     Y*1(1385) INTO LAMBDA GAMMA                         1115+   0
P4     Y*1(1385) INTO N KBAR                                493+ 938
P5     Y*1(1385) INTO SIGMA GAMMA                          1197+   0
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                  43  Y*1(1385) BRANCHING RATIOS

R1      Y*1(1385) INTC (SIGMA PI)/(LAMBDA PI)                   (P2)/(P1)
R1            (0.04)    (0.04)          BASTIEN    61 HBC  +-
R1            (0.04) OR LESS            ALSTON     62 HBC  +-OK-P 1.15 BEV/C
R1             0.09       0.04          HUME       64 HBC  +-  K-P 1.2-1.7 GEV
R1             0.163      0.041         ARMENTERO  65 HBC  +-  K-P .95-1.20 GEV   7/66
R1             0.08       0.06          LONDON     66 HBC  +   K-P 2.24 BEV/C     7/66
R1             0.13       0.04          PAN        69 HBC  +   PI+ P - K Y PI    12/72
R1             0.13       0.04          COLLEY     71 DBC  -0  K-N 1.5 GEV PROD  10/71
R1             0.16       0.07          AGUILAR    72 HBC  +   K-P 3.9,4.6 GEV   10/74
R1             0.18       0.04          MAST2      73 MPWA +-  K-P - 2PI SIG/LM   9/73
R1             0.10       0.05          THOMAS     73 HBC  -   PI-P TO PI K Y     9/73
R1             0.16       0.03          BERTHON    74 HBC  +   K-P 1263-1843MEV  11/77
R1             0.11       0.02          BERTHON    74 HBC  -   K-P 1263-1843MEV  11/77
R1             0.21       0.05          BORENSTE   74 HBC  +   K-P TO(1385)+PIS  10/74
R1             0.20       0.06          DIONISI    78 HBC  +-  K-P TO Y* K KBAR   3/79
R1                 . . . . . . . . . .
R1  AVG        0.135      0.011    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R2      Y*1(1385) INTC (LAMBDA GAMMA)/TOTAL                     (P3)
R2        1   (0.17)    (0.17)          MEISNER    72 HBC  0   1 EVENT ONLY       1/73

R3      Y*1(1385) FRCM KBAR N TO LAMBDA PI                      SQRT(P1*P4)        4/75
R3 C         +0.586     0.319           DEVENISH   74          0 FIXED T DISP REL 4/75
R3 C    EXTRAPOLATION OF PARAMETRIZED AMPLITUDE BELOW THRESHOLD                   4/75

R4      Y*1(1385) INTO (LAMBDA GAMMA)/(LAMBDA PI)               (P3)/(P1)          1/76
R4            (0.06) OR LESS  CL=.90    COLAS      75 HLBC  0 K-P 575-970 MEV     1/76

R5      Y*1(1385) INTO (SIGMA GAMMA)/(LAMBDA PI)                (P5)/(P1)          1/76
R5            (0.05) OR LESS  CL=.90    COLAS      75 HLBC  0 K-P 575-970 MEV     1/76

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                         REFERENCES FOR Y*1(1385)

ALSTON     60 PRL 5 520              +ALVAREZ,EBERHARD,GOOD,GRAZIANO, +     (LRL) I
BASTIEN    61 PRL 6 702              P BASTIEN,M FERRO-LUZZI,A H ROSENFELD (LRL)
BERGE      61 PRL 6 557              +BASTIEN,DAHL,FERRO-LUZZI,KIRZ, +      (LRL)
DAHL       61 PRL 6 142              +HORWITZ,MILLER,MURRAY,WHITE           (LRL)
ELY        61 PRL 7 461              +FUNG,GIDAL,PAN,POWELL,WHITE           (LRL) J
MARTIN     61 PRL 6 283              +LEIPUNER,CHINOWSKY,SHIVELY, +    (BNL,YALE)

ALSTON     62 CERN CONF 311          +ALVAREZ,FERRO-LUZZI,ROSENFELD, +      (LRL)
COLLEY     62 PR 128 1930            +GELFAND,NAUENBERG, +    (COLUMBIA,RUTGERS) JP
CURTIS     63 PR 132 1771            +COFFIN,MEYER,TERWILLIGER             (MICH) J
COOPER     64 PL 8 365               +FILTHUTH,FRIDMAN,MALAMUD, +     (CERN,AMST)
HUME       64 UCRL-11291 THESIS      D O HUME                              (LRL) JP
   ALSO    69 PR 180 1824            D O HUME                              (LRL)

ARMENTER   65 PL 19 75               ARMENTEROS, +           (CERN,HEIDEL,SACLAY)
BALTAY     65 PR 140 B1027           +SANDWEISS,TAFT,CULWICK,KOPP, +   (YALE,BNL)
MUSGRAVE   65 NC 35 735              +PETMEZAS,+    (BIRM,CERN,EPOL,LOIC,SACLAY)
SMITH      65 THESIS (UCLA)          L T SMITH                             (UCLA)

BIRMINGH   66 PR  152  1148          BIRMINGHAM,GLASGOW,I.C., OXFORD,RUTHERFORD
LONDON     66 PR 143 1034            +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+ (BNL,SYRA) J
SIEGEL     67 UCRL 18041 THESIS      D M SIEGEL                            (LRL)
PAN        69 PRL 23 808             +FORMAN                              (PENN) I
AGUILAR    70 PRL 25 58              +BARNES, BASSANO, CHUNG, EISNER,+(BNL,SYRA)
ATHERTON   71 NP B29 477             +CELNIKIER,CLAYTON,FRENCH,FRISK,+    (CERN)
COLLEY     71 NP B31 61              +COX,EASTWOOD,FRY+..   (BIRM+EDIN+GLAS+LOIC)

AGUILAR    72 PR D6 29               AGUILAR-BENITEZ,CHUNG,EISNER,SAMIOS   (BNL)
MEISNER    72 NC 12A 62              G MEISNER                  (U NC GREENSBORO+LBL)
AMMANN     73 PRD 7 1345             +CARMONY,GARFINKEL,GUTAY,+         (PURD+IUPU)
MAST2      73 PRD 7 3212             +BANGERTER,ALSTON-GARNJOST,+         (LBL) IJP
   ALSO    73 PRD 7 5                MAST,BANGERTER,ALSTON-GARNJOST,+     (LBL) IJP
HABIBI     73 NEVIS 199(THESIS)      M,HABIBI                         (COLUMBIA)
   ALSO    73 PURO73, PG. 387        BALTAY,BRIDGEWATER,COOPER,+  (COLUMBIA+BING)
THOMAS     73 NP B56 15              THOMAS,ENGLER,FISK,KRAEMER           (CARN) JP

BERTHON    74 NC 21A 146             BERTHON,TRISTRAM,+      (CDEF+RHEL+SACL+STRB)
BORENSTE   74 PR D9 3006             BORENSTEIN,KALBFLEISCH,STRAND,+  (BNL+MICH)
DEVENISH   74 NP B81 330             DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
LICHTENB   74 PRD 10 3865            D B LICHTENBERG          (INDIANA UNIVERSITY)
   AL      74 PRIV. COMM.            D B LICHTENBERG          (INDIANA UNIVERSITY)

ATHERTO1   75 NC 25A 1               ATHERTON,BAR-NIR,FRENCH               (CERN)
BARDADIN   75 NP B9E 418             BARDADIN-OTWINOWSKA+        (SACL+LPOL+RHEL)
COLAS      75 NP B91 253             COLAS,FARWELL,FERRER,SIX              (ORSA)

BARREIRO   77 NP B126 319            +BERGE,GANGULI,BLOKZIJL+    (CERN+AMST+NIJM)
HOLMGREN   77 NP B119 261            +AGUILAR-BENITEZ,KLUYVER+   (CERN+AMST+NIJM)
ALSTON     78 PR D18 182             ALSTON-GARNJOST,KENNEY+     (LBL+MHCO+CERN)
CAMERON    78 NP B143 189            +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)
DIONISI    78 PL 78B 154             +ARMENTEROS,DIAZ            (CERN+AMST+NIJM+OXF)

BANERJEE   79 ZPHY C3 1              +GANGULI,MALHOTRA,RAGHAVAN,SUDHAKAR   (TIFR)
BAUBILLI   79 NP B148 18             BAUBILLIER+          (BIRM+CERN+GLAS+MSU+LPNP)
CAUTIS     79 NP B156 507            +BALLAM,BOUCHEZ,CARROLL,CHADWICK+     (SLAC)
SUGAHARA   79 NP B156 237            +OCHIAI,FUKUI,COOPER+             (KEK+OSKC+KINK)
BAKER      80 NP B166 207            +CHIMA,DORNAN,GIBBS,HALL,MILLER+      (LOIC)

                         PAPERS NOT REFERRED TO IN DATA CARDS

MALAMUD    64 PL 10 145              E MALAMUD, P E SCHLEIN          (CERN,UCLA) JP
SHAFER     64 PR 134 B1372           J B SHAFER, D O HUME                  (LRL) JP
HUNGERBU   74 PRD 10 2051            HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)
WALTER     79 ZPHY C3 69             +BECKER+        (BERL+AACH+CERN+SERP+SACL+VIEN)
AGUILAR    80 ZPHY C6 109            AGUILAR-BENITEZ+          (MADR+STOH+CERN+CDEF)
BALAND     80 ZPHY C3 187            +POIRET+(MONS+SEPP+SACL+ALMA-ATA+MOSU+BELG)
BIAGI      81 ZPHY C9 305            +        (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RHEL)

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Σ(1480) BUMPS

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23  Y*1(1480, JP=   ) I=1          PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

PEAKS ARE SEEN IN LAMBDA PI AND SIGMA PI SPECTRA IN
THE REACTION PI+P TO K+ PI Y AT 1.7 GEV/C.  ALSO THE
Y POLARIZATION OSCILLATES IN THE SAME REGION.

    SEE MILLER 70 FOR A DISCUSSION OF THIS STATE.  HE SUGGESTS A POS-
SIBLE ALTERNATE EXPLANATION IN TERMS OF A REFLECTION OF N*1/2(1675)
DECAY TO LAMBDA K. HOWEVER, SUCH AN EXPLANATION FOR THE K+ SIGMA+ PIO
CHANNEL SEEMS UNLIKELY (SEE PAN 70) IN TERMS OF KNOWN N*3/2(1650)
DECAY INTO SIGMA K. IN ADDITION SUCH REFLECTIONS WOULD ALSO HAVE
TO ACCOUNT FOR THE OSCILLATION OF THE Y POLARIZATION IN THE 1480
MASS REGION.
     HANSON 71, WITH FEWER DATA THAN PAN 70, CAN NEITHER CONFIRM NOR
     DENY THE EXISTENCE OF THIS STATE.  MAST 75 SEES NO STRUCTURE IN THIS
     MASS REGION IN K- P TO LAMBDA PIO.
     ENGELEN 81 PERFORM A MULTI-CHANNEL ANALYSIS OF K-P --> KO PI- P AT
     4.2 GEV/C.  THEY OBSERVE A 3.5 STD. DEV. SIGNAL AT 1480 MEV IN P KOBAR
     WHICH CANNOT BE EXPLAINED AS A REFLECTION OF ANY COMPETING CHANNEL.

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                   23  Y*1(1480) MASS (MEV) (PROD. EXP.)

M          1479.      10.               PAN        70 HBC  +  PI+P TO K PI LAM  3/71
M          1465.      15.               PAN        70 HBC  +  PI+P TO K PI SIG  3/71
M          1485       10.               CLINE      73 MPWA    K- D TO LM PI- P  9/73
M     120(1480.)                        ENGELEN    80 HBC  +  K-P TO KO PI- P   2/82*
M               . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                   23  Y*1(1480) WIDTH (MEV) (PROD. EXP.)

M            31.      15.               PAN        70 HBC  +  PI+P TO K PI LAM  3/71
M            30.      20.               PAN        70 HBC  +  PI+P TO K PI SIG  3/71
M            40.      20.               CLINE      73 MPWA    K- D TO LM PI- P  9/73
M      120   80.      20.               ENGELEN    80 HBC  +  K-P TO KO PI- P   2/82*
M               . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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                   23  Y*1(1480) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(1480) INTC N KBAR                                 938+ 493
P2      Y*1(1480) INTC LAMBDA PI                              1115+ 139
P3      Y*1(1480) INTC SIGMA PI                               1189+ 139

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                   23  Y*1(1480) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1480) INTO (SIGMA PI)/(LAMBDA PI)                 (P3)/(P2)
R1            0.82       0.51           PAN        70 HBC  +                    3/71

R2      Y*1(1480) INTO (PROTON KOBAR)/(LAMBDA PI)             (P1)/(P2)
R2            0.36       0.25           PAN        70 HBC  +                    3/71

R3      Y*1(1480) INTO (KBAR N)/TOTAL                         (P1)                9/73
R3           SMALL                      CLINE      73 MPWA    K- D TO LM PI- P  9/73

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                    REFERENCES FOR Y*1(1480) (PROD. EXP.)

PAN        70 PR D2, 49              +FORMAN,KO,HAGOPIAN,SELOVE           (PENN)
CLINE      73 LNC 6 205              CLINE,LAUMANN,MAPP             (WISCONSIN)IJP
ENGELEN    80 NP B167 61             +HEINEN,KITTEL,METZGER+(NIJM+AMST+CERN+OXF)

                    PAPERS NOT REFERRED TO IN DATA CARDS

YU-LI PA   69 PRL 23 806             YU-LI PAN, F L FORMAN               (PENN) I
YU-LI PA   69 PRL 23 808             YU-LI PAN, F L FORMAN               (PENN) I
MILLER     70 DUKE 229               D H MILLER      (REVIEW TALK)     (PURDUE)
HANSON     71 PR D4 1296             +KALMUS,LOUTE                        (LBL) I
MAST       75 PRD 11 3078            +ALSTON-GARNJOST,BANGERTER+          (LBL)

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Σ(1560) BUMPS

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80  Y*1(1560, JP=   ) I=1          PRODUCTION EXPERIMENTS

THIS ENTRY LISTS PEAKS REPORTED IN MASS SPECTRA AROUND
1560 MEV WITHOUT IMPLYING THAT THEY ARE NECESSARILY
RELATED.
DIONISI 78 OBSERVE A 6 STD. DEV. ENHANCEMENT AT 1553
MEV IN THE CHARGED (LAMBDA/SIGMA PI ) MASS SPECTRA
FROM K-P --> LAMBDA/SIGMA PI K KBAR AT 4.2 GEV/C.
IN A CERN ISR EXPERIMENT, LOCKMAN 78 REPORT A NARROW
6 STD. DEV. ENHANCEMENT AT 1572 MEV IN THE LAMBDA PI+/PI- SYSTEMS
FROM THE REACTION PP --> LAMBDA PI+ PI- + ANYTHING AT C.M. ENERGIES
OF 53 AND 62 GEV.
THESE ENHANCEMENTS ARE UNLIKELY TO BE ASSOCIATED WITH THE Y*1(1580)
(WHICH HAS NOT BEEN CONFIRMED BY SEVERAL RECENT EXPERIMENTS - SEE
THE DATA CARD LISTINGS BELOW).
CARROLL 76 OBSERVE A BUMP AT 1550 MEV (AS WELL AS AT 1580 MEV) IN THE
K-N I=1 TOTAL CROSS SECTION, BUT UNCERTAINTIES IN CROSS SECTION
MEASUREMENTS OUTSIDE THE MASS RANGE OF THE EXPERIMENT PRECLUDE
ESTIMATING ITS SIGNIFICANCE.
SEE ALSO MEADOWS 80 FOR A REVUE OF THIS STATE.
IN NEED OF CONFIRMATION.  OMITTED FROM TABLES.

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                   80  Y*1(1560) MASS (MEV) (PROD. EXP.)

M       121 1553.        7.             DIONISI    78 HBC  +- K-P TO Y* K KBAR  3/79
M        40 1572.        4.             LOCKMAN    78 SPEC +- PP TO L PI PI X  12/79
M               . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.4)

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                   80  Y*1(1560) WIDTH (MEV) (PROD. EXP.)

M       121   79.       30.             DIONISI    78 HBC  +- K-P TO Y* K KBAR  3/79
M  C     40   15.        6.             LOCKMAN    78 SPEC +- PP TO L PI PI X  12/79
M  C     OBSERVED WIDTH CONSISTENT WITH EXPERIMENTAL RESOLUTION.
M               . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                   80  Y*1(1560) PARTIAL DECAY MODES (PROD. EXP.)

                                                              DECAY MASSES
P1      Y*1(1560) INTC LAMBDA PI                              1115+ 139
P2      Y*1(1560) INTC SIGMA PI                               1189+ 139

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                  80  Y*1(1560) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(1560) INTO SIGMA PI/(SIGMA PI + LAMBDA PI)   (P2)/(P1+P2)
R1           0.35      0.12            DIONISI   78 HBC  +- K-P TO Y* K KBAR  3/79

R2     Y*1(1560) INTO (LAMBDA PI)/TOTAL                 (P1)
R2         SEEN                        LOCKMAN   78 SPEC +- PP TO L PI PI X  12/79

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                           REFERENCES FOR Y*1(1560) (PROD. EXP.)

DIONISI  78 PL 78B 154       +ARMENTEROS,DIAZ+        (CERN+AMST+NIJM+OXF)I
LOCKMAN  78  CEN DPHPE 78-01  +MEYER,RANDER,POSTER,SCHLEIN+   (UCLA+SA.L)

                           PAPERS NOT REFERRED TO IN DATA CARDS

CARROLL  76 PRL 37 806       +CHIANG,KYCIA,LI,MAZUR,MICHAEL+        (BNL)I
MEADOWS  80 TORONTO CONF. 283 B.T.MEADOWS                           (CINC)

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Σ(1580) → **D'_{13}**

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           CO  Y*1(1580, JP=3/2-) I=1                                 4/75

           OBSERVED IN K- N I=1 TOTAL CS WITHOUT JP ASSIGNMENT AT
           ENL(LI 73, CARROLL 73, CARROLL 76) AND IN PWA OF K- P
           --> LAMBDA PI FOR CM ENERGIES=1560-1600 MEV BY
           LITCHFIELD 74. LITCHFIELD 74 FINDS JP=3/2-.  NOT SEEN B
           ENGLER 78 OR BY CAMERON 78 (WITH LARGER STATISTICS).
           IN KLONG P TO PI+ LAMBDA AND PI+ SIGMA0.

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           DO  Y*1(1580) MASS (MEV)                                   4/75

M  L       1582.       4.         LITCHFIEL 74 DPWA  0 K- P TO LAM PI   4/75
M    C     1583.       4.         CARROLL   76 DPWA    I=1 TOTAL CS     2/77

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           CO  Y*1(1580) WIDTH (MEV)                                  4/75

M  L        11.        4.         LITCHFIEL 74 DPWA  0 K- P TO LAM PI   4/75
M    C     (15.)                  CARROLL   76 DPWA    I=1 TOTAL CS     2/77

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           DO  Y*1(1580) PARTIAL DECAY MODES                          4/75

                                                         DECAY MASSES
P1     Y*1(1580) INTO N KBAR                           938+ 493
P2     Y*1(1580) INTO LAMBDA PI                       1115+ 139
P3     Y*1(1580) INTO SIGMA PI                        1189+ 139

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           CO  Y*1(1580) BRANCHING RATIOS                             4/75

R1     Y*1(1580) INTO (KBAR N)/TOTAL                    (P1)          4/75
R1 L        +0.03     0.01         LITCHFIEL 74 DPWA    KBAR N MULTICHNL  4/75
R1 L    MAIN EFFECT OBSERVED BY LITCHFIELD 74 IS IN PI LAMBDA FINAL STATE.  4/75
R1 L    KBAR N AND SIGMA PI COUPLINGS ALSO ESTIMATED FROM MULTICHANNEL FIT  4/75
R1 L    INCLUDING TOTAL CROSS SECTION DATA (LI 73).                    4/75
R1   C  TOTAL CROSS SECTION BUMP WITH (J+1/2)X=.06   SEEN BY CARROLL 76  2/77

R2     Y*1(1580) FROM KBAR N TO LAMBDA PI                SQRT(P1*P2)   4/75
R2 L        +0.10     0.02         LITCHFIEL 74 DPWA  D K- P TO LAM PI   4/75
R2        NOT SEEN                 CAMERON   78 HBC  +  KL P TO PI+ LAM  1/78
R2        NOT SEEN                 ENGLER    78  HBC +  KL P TO PI+ LAM  2/77

R3     Y*1(1580) FROM KBAR N TO SIGMA PI                 SQRT(P1*P3)   4/75
R3 L        +0.03     0.04         LITCHFIEL 74 DPWA    KBAR N MULTICHNL  4/75
R3        NOT SEEN                 CAMERON   78 HBC  +  KL P TO PI+ SIGD  1/78
R3        NOT SEEN                 ENGLER    78  HBC +  KL P TO PI+ SIGD  2/77

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                           REFERENCES FOR Y*1(1580)

LITCHFIE 74 PL 51B 509       LITCHFIELD                          (CERN)IJP
CARROLL  76 PRL 37 806       +CHIANG,KYCIA,LI,MAZUR,MICHAEL+        (BNL)I
ENGLER   76 PL 63B 231       +KEYES,KRAEMER,SCHLERETH,TANAKA+ (CARN,ANL)I
CAMERON  78 NP B132 189      +CAPILUPPI+       (BGNA+EDIN+CLAS+PISA+RHEL)I
ENGLER   78 PR D18 3061      +KEYES,KRAEMER,TANAKA,CHO,+        (CARN,ANL)

                           PAPERS NOT REFERRED TO IN DATA CARDS

CARROLL  73 APS BRKLY MTG 208 CARROLL,CHIANG,KYCIA,LI,MAZUR,MICHAEL+(BNL)I
LI       73 PURDUE CONF. 283  LI                                    (BNL)I

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<u>Note on the Σ(1620)</u>

This state was first suggested by CRENNELL 68 from evidence in the reaction $K^-n \to \Sigma(1620)^{\pm}\pi^{\mp}\pi^-$ at 3.9 GeV/c, with the $\Sigma(1620)^{\pm}$ decaying into $\Lambda\pi^{\pm}$. The situation is still far from clear.

MILLER 70 is a good review of the production experiments; there has been no new evidence from them since 1970. The evidence is only in the $\Lambda\pi$ channel. CRENNELL 69 claimed the effect in this channel with no evidence seen in $\overline{K}N$ or $\overline{K}N\pi$. SABRE 70 studied the same reaction at 3.0 GeV/c with comparable statistics and saw no evidence in the $\Lambda\pi$ channel; on the contrary, they believe the effect to be a spurious peak resulting from misidentified Σ^0 from the production of $\Sigma(1670)$ decaying into $\Sigma^0\pi^+$. AMMANN 70 studied the same reaction at 4.5 GeV/c and reported a state at 1640 MeV, again decaying only into $\Lambda\pi$ (no evidence seen in the $\Sigma\pi$ or $\overline{K}N$ channels). HUNGERBUHLER 74 reported upper limits on production cross sections for a 25 GeV/c Σ^- beam.

CARROLL 76 measured the K^-p and K^-d total cross sections from 0.4 to 1.1 GeV/c and found three narrow (10–15 MeV wide) bumps in the I = 1 $\overline{K}N$ cross section at 1583, 1608, and 1633 MeV.

Several partial-wave analyses have found evidence for one or two fairly narrow states within about 50 MeV of the effect seen in production: see the entries for the D13 Σ(1580), the S11 Σ(1620), and the P11 Σ(1660). However, the various analyses do not agree on widths or branching ratios.

In conclusion, clarification of the Σ(1620) question probably must await more data and a more complete understanding of the entire region from 1600 to 1700 MeV. The closeness of the Σ(1620) and Σ(1670) masses suggests that the complications of the two regions may be related (see the "Note on the Σ(1670)" below).

Σ(1620) → **S'_{11}**

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         32  Y*1(1620, JP=1/2-) I=1

         THE S11 STATE AT 1697 MEV REPORTED BY VANHORN 75 IS
         INTERMEDIATE IN MASS BETWEEN THE SIGMA(1620) AND
         SIGMA(1750).  WE TENTATIVELY LIST IT UNDER SIGMA(1750).
         CARROLL 76 SEES TWO BUMPS IN THE I=1 TOTAL CROSS
         SECTIONS NEAR THIS MASS.

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         32  Y*1(1620) MASS (MEV)

M         (1620.)                   KIM       71 DPWA    K-MATRIX ANAL.    3/71
M          1630.0    (10.0)         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M    L     1608.       5.           CARROLL   76 DPWA    I=1 TOTAL CS      2/77
M     H    1633.      10.           CARROLL   76 DPWA    I=1 TOTAL CS      2/77
M   1     (1600.0)   (6.0)          MORRIS    78 DPWA -  K- N TO LAM PI-   3/79
M   1  AN EQUALLY GOOD FIT IS OBTAINED WITHOUT INCLUDING THIS RESONANCE.   3/79
M              . . . . . . . . . . .
M   AVG    1613.0     10.0     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)

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         32  Y*1(1620) WIDTH (MEV)

M          (40.)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
M           65.0     (20.0)         LANGBEIN  72 IPWA    MULTICHANNEL     12/72
M    L     (15.)                    CARROLL   76 DPWA    I=1 TOTAL CS      2/77
M     H    (10.)                    CARROLL   76 DPWA    I=1 TOTAL CS      2/77
M   1      (87.0)    (19.0)         MORRIS    78 DPWA -  K- N TO LAM PI-   3/79

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         32  Y*1(1620) PARTIAL DECAY MODES

                                                       DECAY MASSES
P1     Y*1(1620) INTO N KBAR                         938+ 493
P2     Y*1(1620) INTO SIGMA PI                      1189+ 139
P3     Y*1(1620) INTO LAMBDA PI                     1115+ 134

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                32  Y*1(1620) BRANCHING RATIOS

R1      Y*1(1620) INTO (KBAR N)/TOTAL                              (P1)
R1            (0.05)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1 A           0.05  OR LESS            WONG      71 DPWA    K-+P--LAM+PI     10/71
R1             0.22    (0.02)           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R1   L  TOTAL CROSS SECTION BUMP WITH (J+1/2)X=.06   SEEN BY CARROLL 76        2/77
R1   H  TOTAL CROSS SECTION BUMP WITH (J+1/2)X=.04   SEEN BY CARROLL 76        2/77
R1 A    K-MATRIX FIT(NEGLECTS 3-BODY CHANNELS) REQUIRES NO RESONANCE          10/71

R2      Y*1(1620) FROM KBAR N TO SIGMA PI                     SQRT(P1*P2)
R2            (0.08)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2             0.40    (0.06)           LANGBEIN  72 IPWA    MULTICHANNEL     12/72
R2          NOT SEEN                    HEPP2     76 DPWA -0 K- NUC TO SIG PI  2/77

R3      Y*1(1620) FROM KBAR N TO LAMBDA PI                    SQRT(P1*P3)
R3            (0.15)                    KIM       71 DPWA    K-MATRIX ANAL.    3/71
R3          NOT SEEN                    BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R3  1         (0.12)   (0.02)           MORRIS    78 DPWA -  K- N TO LAM PI-   3/79

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                         REFERENCES FOR Y*1(1620)

KIM       71 PRL 27 356        J K KIM                                (HARV)IJP
   ALSO   70 DUKE 161          J. K. KIM                              (HARV)IJP
WONG      71 NC 2A 353         N S WONG                               (YALE)IJP
LANGBEIN  72 NP B47 477        +WAGNER                                (MPIM)IJP

BAILLON   75 NP B94 39         P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
CARROLL   76 PRL 37 806        +CHIANG,KYCIA,LI,MAZUR,MICHAEL+        (BNL)I
HEPP2     76 PL 65B 487        +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP
MORRIS    78 PR D17 55         +ALBRIGHT,COLLERAINE,KIMEL,LANNUTTI     (FSU)IJP

                         PAPERS NOT REFERRED TO IN DATA CARDS

VANHORN   75 NP B87 145        A. J. VAN HORN                          (LBL)IJP
   ALSO   75 NP B87 157        A. J. VAN HORN                          (LBL)IJP
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1620 MEV REGION - PRODUCTION EXPERIMENTS

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                   78  Y*1(1620, JP=    ) I=1         PRODUCTION EXPERIMENTS

                   SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

                   THIS RESONANCE NEEDS CONFIRMATION. THE RESULTS OF
                   CRENNELL 69 AT 3.9 GEV/C ARE NOT CONFIRMED BY THE SABRE
   COLLABORATION AT 3.0 GEV/C (SABRE 70).  HOWEVER IN AN EXPERIMENT AT
   4.5 GEV/C, AMMANN 70 SEE A PEAK AT 1642 MEV WHICH ON THE BASIS OF
   BRANCHING RATIOS THEY DO NOT ASSOCIATE WITH THE Y*1(1670). SEE MILLER
   70 FOR A REVIEW OF THESE CONFLICTS.

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                   76  Y*1(1620) MASS (MEV) (PROD. EXP.)

M   N      (1614.0)     (8.0)          CRENNELL  68 DBC  +- K-D 3.9 BEV/C    11/68
M   N    EVENTS OF CRENNELL 68 ARE IN THE LARGER SAMPLE OF CRENNELL 69.
M       20 1618.0       3.0            BLUMENFEL 69 HBC  +  KO LONG + PELTON  9/69
M          1619.0       8.0            CRENNELL  69 DBC  +- K-N TO LAM 3 PI   9/69
M          1642.0      12.0            AMMANN    70 DBC     K-N 4.5 GEV/C     9/73
M          . . . . . . . . . . .
M   AVG    1619.4       3.8     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)

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                   78  Y*1(1620) WIDTH (MEV) (PROD. EXP.)

W   N        (56.0)    (16.0)          CRENNELL  68 DBC  +- SEE NOTE N ABOVE 11/68
W       20    30.0      10.0           BLUMENFEL 69 HBC  +                    9/69
W             72.0      22.0    15.0   CRENNELL  69 DBC  +-                   9/69
W             55.0      24.0           AMMANN    70 DBC     K-N 4.5 GEV/C     9/73
W          . . . . . . . . . . .
W   AVG       41.3      12.2    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.5)
                   SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                   78  Y*1(1620) PARTIAL DECAY MODES (PROD. EXP.)

                                                         DECAY MASSES
P1      Y*1(1620) INTO N KBAR                            938+ 493
P2      Y*1(1620) INTO LAMBDA PI                         1115+ 139
P3      Y*1(1620) INTO Y*1(1385) PI                      1385+ 139
P4      Y*1(1620) INTO LAMBDA PI PI                      1115+ 139+ 139
P5      Y*1(1620) INTO SIGMA PI                          1189+ 139
P6      Y*1(1620) INTO Y*0(1405) PI                      1405+ 139

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                   78  Y*1(1620) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1620) INTO (LAMBDA PI PI)/(LAMBDA PI)          (P4)/(P3)
R1       14   (2.5)  APPROX          BLUMENFEL 69 HBC  +

R2      Y*1(1620) INTO (KBAR N)/(LAMBDA PI)                (P1)/(P2)
R2           (0.0)    (0.1)          CRENNELL  68 DBC  +
R2            0.4      0.4           AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

R3      Y*1(1620) INTO (LAMBDA PI)/TOTAL                   (P2)
R3            LARGE                  CRENNELL  68 DBC  +-                  11/68

R4      Y*1(1620) INTO (Y*1(1385) PI)/(LAMBDA PI)          (P3)/(P2)
R4           (0.2)    (0.1)          CRENNELL  68 DBC  +-                  11/68
R4           (0.3) OR LESS  CL=.95   AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

R5      Y*1(1620) INTO (SIGMA PI)/(LAMBDA PI)              (P5)/(P2)
R5           (1.1)(55 PC UPPER LIMIT) AMMANN   70 DBC     K-N 4.5 GEV/C     9/73

R6      Y*1(1620) INTO (Y*0(1405) PI)/(LAMBDA PI)          (P6)/(P2)
R6            0.7      0.4           AMMANN    70 DBC     K-P 4.5 GEV/C     6/70

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                   REFERENCES FOR Y*1(1620) (PROD. EXP.)

CRENNELL 68 PRL 21 648         +DELANEY, FLAMINIO, KARSHON. +   (BNL,CUNY) I
BLUMENFE 69 PL 29B 58          BLUMENFELD, KALBFLEISCH                 (BNL) I
CRENNELL 69 LUND PAPER 183     +KARSHON, LAI, ONEIL, SCARR, +   (BNL,CUNY) I
    RESULTS ARE QUOTED IN LEVI SETTI 69.

AMMANN    70 PRL 24 327        + GARFINKEL, CARMONY, GUTAY,+   (PURDUE,IND)
    ALSO  73 PR D7 1345        AMMANN,CARMONY,GARFINKEL,         (PURD+IUPU)

                      PAPERS NOT REFERRED TO IN DATA CARDS

ARMENTER 68 NP B8 183        ARMENTEROS,BAILLON +           (CERN+HEID+SACL)
LEVISETT 69 LUND CONF        R LEVI SETTI     (RAPPORTEUR)             EFINS
TRIPP    69 UCRL 19361       R D TRIPP                                  (LRL)
ARMENTER 70 DUKE 123         ARMENTEROS,BAILLON +           (CERN+HEID+SACL)
MILLER   70 DUKE 229         D H MILLER    (REVIEW TALK)             (PURDUE)
SABRE    70 NP B16 201       SABRE COLLAB.    (SACL,ANST,BGNA,REHO,EPOL)
HUNGERBU 74 PR D10 2051      HUNGERBUHLER,MAJKA,+     (YALE,FNAL,BNL,PITT)
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Σ(1660) **P_{11}**

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                 79  Y*1(1660, JP=1/2+) I=1

                 SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

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                 75  Y*1(1660) MASS (MEV)

M          1500. -- 1600.              ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
M         (1670.)                      KIM       71 DPWA    K-MATRIX ANAL.    3/71
M          1658.       (4.)            HART      73 DPWA    EL+CX..7-.8GEV/C  2/74
M    2    (1621.)                      LEA       73 DPWA    MULTICHNL K-MTRX  9/73
M    2  ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.      9/73
M          1670.0     (20.0)           KANE      74 DPWA    K-P TO PI SIG    12/81*
M    1    (1660.)     (30.)            BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
M    1  FROM SOLUTION 1 OF BAILLON 75. NOT PRESENT IN SOLUTION 2             11/75
M    3    (1671.)     (2.)             PONTE     75 DPWA  0 K- P TO LAM PI    1/76
M    3  FROM SOLUTION 2 OF PONTE 75, NOT PRESENT IN SOLUTION 1.               1/76
M          1669.      (25.)            VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75
M    4     1565. OR 1597.              MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    4  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    4  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M          1676.      (15.)            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M          1679.      (10.)            ALSTON    78 DPWA    KBAR N ELASTIC    1/78
M          1670.0     (10.0)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                 79  Y*1(1660) WIDTH (MEV)

W          (50.0)                      ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
W          (50.)                       KIM       71 DPWA    K-MATRIX ANAL.    3/71
W           40.       (10.)            HART      73 DPWA    EL+CX..7-.8GEV/C  2/74
W    2     (51.8)                      LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W          250.0      (110.0)          KANE      74 DPWA    K-P TO PI SIG    12/81*
W    1     (80.)      (40.)            BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
W    3     (91.)      (10.)            PONTE     75 DPWA  0 K- P TO LAM PI    1/76
W          230.       (165.)    (60.)  VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75
W    4     202. OR 217.                MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W          120.       (20.)            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W           38.       (10.)            ALSTON    78 DPWA    KBAR N ELASTIC    1/78
W          152.0      (20.0)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                 75  Y*1(1660) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*1(1660) INTO N KBAR                               938+ 493
P2      Y*1(1660) INTO SIGMA PI                             1189+ 139
P3      Y*1(1660) INTO LAMBDA PI                            1115+ 139

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                 75  Y*1(1660) BRANCHING RATIOS

R1      Y*1(1660) FROM KBAR N TO SIGMA PI                     SQRT(P1*P2)
R1         (+0.2)                      ARMENTERO 70 HDBC -0 K-N TO SIGMA PI   6/70
R1          (0.24)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R1   2     (-0.21)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R1          -0.11     (0.01)           KANE      74 DPWA    K-P TO PI SIG    12/81*
R1        NOT SEEN                     HEPP2     76 DPWA -0 K- NUC TO SIG PI  2/77
R1   4     (-0.34)OR -0.37             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1          -0.16     (0.03)           RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R2      Y*1(1660) INTO (KBAR N)/TOTAL                         (P1)
R2          (0.14)                     KIM       71 DPWA    K-MATRIX ANAL.    3/71
R2   2      (0.10)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R2           0.11     (0.02)           HART      73 DPWA    EL+CX..7-.9GEV/C  2/74
R2   4      (0.27)OR  0.29             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2   C      LESS THAN 0.04             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R2   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R2           0.10     (0.05)           ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R2           0.12     (0.03)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

R3      Y*1(1660) FROM KBAR N TO LAMBDA PI                    SQRT(P1*P3)
R3          (0.0)                      KIM       71 DPWA    K-MATRIX ANAL.    2/73
R3   2     (+0.07)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R3   1     (-0.04)    (0.02)           BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R3   3     (+0.16)    (0.01)           PONTE     75 DPWA  0 K- P TO LAM PI    1/76
R3           0.12     (0.12)    (0.04) VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75
R3   4     (-0.10)OR -0.11             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R3          LESS THAN 0.04             RLIC      77 DPWA    KBAR N MULTICHNL  1/76

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                      REFERENCES FOR Y*1(1660)

ARMENTER 70 DUKE 123           ARMENTEROS, BAILLON, +         (CERN,HEIDEL)IJP
KIM      71 PRL 27 356         J K KIM                                (HARV)IJP
   ALSO  70 DUKE 161           J. K. KIM                              (HARV)IJP
HART     73 PURDUE CONF. 311   +RICE,BACASTOW,FUNG,+   (TENN+UCR+MASA+BUFF)IJP
LEA      73 NP B56 77          +MARTIN,MOORHOUSE+ (RHEL+LOUC+GLAS+AARHUS)IJP
KANE     74 LBL-2452           D.F.KANE                                (LBL)IJP

BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
PONTE    75 PRD 12 2597        +HERTZBACH,BUTTON-SHAFER+    (MASA+TENN+UCR)IJP
VANHORN  75 NP B87 145         A. J. VAN HORN                          (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HORN                          (LBL)IJP

HEPP2    76 PL 65B 487         +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP
MARTIN   77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE          (LOUC+GLAS)IJP
   ALSO  77 NP B126 266        MARTIN,PIDCOCK                        (LOUC)
   ALSO  77 NP B126 285        MARTIN,PIDCOCK                         (LOUC)IJP
RLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+ (LOIC+RHEL)IJP
ALSTON   78 PR D18 182         +KENNEY,POLLARD,ROSS+         (LBL+MTHO+CERN)IJP
   ALSO  77 PRL 38 1007        ALSTON-GARNJOST,KENNEY        (LBL+MTHO+CERN)IJP
GOPAL    80 TORONTO CONF 159   G.P.GOPAL                              (RHEL)IJP
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Note on the Σ(1670)

Production experiments: The measured $\Sigma\pi/\Sigma\pi\pi$ branching ratio for produced Σ(1670)'s is strongly dependent on momentum transfer. This was first discovered by EBERHARD 69, who suggested the existence of two Y_1^*'s with the same mass and quantum numbers: one with a large $\Sigma\pi\pi$ [mainly $\Lambda(1405)\pi$] decay mode produced peripherally, and the other with a large $\Sigma\pi$ decay mode produced at larger angles. These results were confirmed by AGUILAR-BENITEZ 70, ASPELL 74, ESTES 74, and TIMMERMANS 76. When determined, the most likely quantum numbers for both the $\Sigma\pi$ and the $\Lambda(1405)\pi$ objects are D13. There is also possibly a third Y_1^*, the Σ(1690) in the Listings, with a large $\Lambda\pi/\Sigma\pi$ branching ratio and somewhat larger mass; the large branching ratio is the main evidence for its existence, which needs confirmation. These topics have been reviewed by EBERHARD 73 and by MILLER 70.

Formation experiments: Two states are also observed near this mass in formation experiments. One of these, the D13 Σ(1670), has the same quantum numbers as those observed in production and has a large $\Sigma\pi/\Sigma\pi\pi$ branching ratio. It may well be the Σ(1670) produced at larger angles (see TIMMERMANS 76). The other state, the P11 Σ(1660), has different quantum numbers from those seen in production, and its $\Sigma\pi/\Sigma\pi\pi$ branching ratio is unknown. Thus its relation to the produced Σ(1670)'s remains obscure. (See also the "Note on the Σ(1620)" above.)

Σ(1670)

D_{13}''

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44   Y*1(1670, JP=3/2-) I=1

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

WELL ESTABLISHED RESONANCE.  IT HAS BEEN SEEN IN BOTH
FORMATION AND PRODUCTION EXPERIMENTS.

SEE LISTING OF PRODUCTION EXPERIMENTS BELOW

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                     44   Y*1(1670) MASS (MEV)

M        1660.0                    BERLEY     64 HBC   0 K-P TO LAM PI0     7/66
M        1668.      (5.)           ARMENTER   68 HBC   0 K-P ELAS.+CH.EX   11/68
M       (1661.0)    (7.0)          ARMENTE2   68 HBC   0 K-P TO SIGMA PI   11/68
M        1680.                     ARMENTE4   69 DBC     K-N TO SIG- PI0   12/68
M        1663.0     (7.0)          ARMENT-5   69 HBC   0 K-P TO SIGMPI ED   9/69
M        1672.0                    BERLEY     69 HBC     K-P TO SIG PI      5/70
M        1669.                     ARMENTER   70 HBC   0 K-P TO LAM.PI EL   5/70
M        1681.0     (3.0)          BRUCKER    70 DBC   - K-N TO SIG 2PI    10/71
M        1662.0     (5.0)          GALTIERI   70 HBC   0 SIG PI.EDPWA       7/70
M        1665.     (10.)           GALTIERI   70 HBC   0 LAM. PI. EDPWA     7/70
M        1676.      (2.)           BUDGEN     71 DPWA    LAM PI0.CHS DATA  10/71
M        1670.                     KIM        71 DPWA    K-MATRIX ANAL.     3/71
M        1675.0    (15.0)          LANGBEIN   72 IPWA    MULTICHANNEL      12/72
M        1670.0     (2.0)          KANE       74 DPWA    K-P TO PI SIG     12/81*
M        1685.     (20.)           BAILLON    75 IPWA    KBAR N TO LAM PI  11/75
M    C  (1671.)     (3.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76
M    C  FROM SOLUTION 1 OF PONTE 75.                                        1/76
M    D  (1655.)     (2.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76
M    D  FROM SOLUTION 2 OF PONTE 75.                                        1/76
M        1659.     (12.)    (5.)   VANHORN    75 DPWA  0 K- P TO LAM PI0   11/75
M       (1650.)                    BELLEFON   76 IPWA  0 K- P TO LAM PI     2/77
M        1670.      (6.)           HEPP2      76 DPWA -0 K- NUC TO SIG PI   2/77
M    1   1667. OR 1668.            MARTIN     77 DPWA    KBAR N MULTICHNL  11/77
M    1  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    1  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
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M        1673.      (5.)           RLIC       77 DPWA    KBAR N MULTICHNL   1/76
M        1679.     (10.)           ALSTON     78 DPWA    KBAR N ELASTIC     1/78
M        1682.0     (5.0)          GOPAL      80 DPWA    KBAR N ELASTIC    12/81*

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                     44   Y*1(1670) WIDTH (MEV)

W          60.0                    BERLEY     64 HBC   0                    7/66
W          56.     (18.)           ARMENTER   68 HBC   0 K-P ELAS.+CH.EX   11/68
W         (44.0)    (4.0)          ARMENTE2   68 HBC   0 K-P TO SIGMA PI   11/68
W          47.0                    ARMENTE4   69 DBC     K-N TO SIG- PI0   12/68
W          49.0     (4.0)          ARMENT-5   69 HBC   0 K-P TO SIGMPI ED   9/69
W          34.0                    BERLEY     69 HBC                        5/70
W          50.                     ARMENTER   70 HBC   0 K-P TO LAMB.PI     5/70
W          30.0    (10.0)          BRUCKER    70 DBC   - K-N TO SIG 2PI    10/71
W          48.0     (5.0)          GALTIERI   70 HBC   0 SIG PI.EDPWA       7/70
W          50.     (10.)           GALTIERI   70 HBC   0 LAM. PI. EDPWA     7/70
W          59.      (4.5)          BUDGEN     71 DPWA    LAM PI0           10/71
W          45.                     KIM        71 DPWA    K-MATRIX ANAL.     3/71
W          65.0    (20.0)          LANGBEIN   72 IPWA    MULTICHANNEL      12/72
W          70.     (20.)           BAXTER     73 DPWA  0 K- P TO NEUTRALS  10/74
W          79.0     (6.0)          KANE       74 DPWA    K-P TO PI SIG     12/81*
W          85.     (25.)           BAILLON    75 IPWA    KBAR N TO LAM PI  11/75
W    C    (44.)    (11.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76
W    D    (76.)     (5.)           PONTE      75 DPWA  0 K- P TO LAM PI     1/76
W          32.     (11.)           VANHORN    75 DPWA  0 K- P TO LAM PI0   11/75
W         (80.)                    BELLEFON   76 IPWA  0 K- P TO LAM PI     2/77
W          56.      (3.)           HEPP2      76 DPWA -0 K- NUC TO SIG PI   2/77
W    1     46. OR 46.              MARTIN     77 DPWA    KBAR N MULTICHNL  11/77
W          50.      (5.)           RLIC       77 DPWA    KBAR N MULTICHNL   1/76
W          56.     (20.)           ALSTON     78 DPWA    KBAR N ELASTIC     1/78
W          79.0    (10.0)          GOPAL      80 DPWA    KBAR N ELASTIC    12/81*

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                     44   Y*1(1670) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*1(1670) INTO N KBAR                             939+ 493
P2      Y*1(1670) INTO LAMBDA PI                          1115+ 139
P3      Y*1(1670) INTO SIGMA PI                           1192+ 139
P4      Y*1(1670) INTO LAMBDA PI PI                       1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                        1192+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI S-WAVE                139+1385
P7      Y*1(1670) INTO Y*0(1405) PI                       1405+ 139
P8      Y*1(1670) INTO LAMBDA(1520) PI                    139+1520

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                     44   Y*1(1670) BRANCHING RATIOS

R1      Y*1(1670) INTO (KBAR N)/TOTAL                        (P1)
R1           (0.09)     (0.02)     ARMENTER   68 HBC                        9/69
R1            0.08      (0.02)     ARMENT-5   69 HBC   0 ELAS. +CH.EX. ED   9/69
R1            0.07                 KIM        71 DPWA    K MATRIX ANAL.     3/71
R1            0.10      (0.03)     LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R1            NOT SEEN             HART       73 DPWA    EL+CX..7-.8GEV/C   2/74
R1   1       (0.07)OR  0.07        MARTIN     77 DPWA    KBAR N MULTICHNL  11/77
R1   C       (0.08)     (0.03)     RLIC       77 DPWA    KBAR N MULTICHNL   1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1            0.11      (0.03)     ALSTON     78 DPWA    KBAR N ELASTIC     1/78
R1            0.10      (0.03)     GOPAL      80 DPWA    KBAR N ELASTIC    12/81*

R2      Y*1(1670) INTO (LAMBDA PI PI)/TOTAL                  (P4)
R2           (0.11) OR LESS        ARMENTE3   68 HBC     K-P (P1=.79)       9/69

R3      Y*1(1670) INTO (SIGMA PI PI)/TOTAL                   (P5)
R3   A       (0.14) OR LESS        ARMENTE3   68 HBC     K-P AND D-P1=.09  11/68
R3   A  RATIO ONLY FOR (SIG2PI) SYSTEM IN I=1, WHICH CANNOT BE Y*1(1385)   11/68

R4      Y*1(1670) INTO (Y*0(1405) PI)/TOTAL                  (P7)
R4           (0.06) OR LESS        ARMENTE3   68 HBC     K-P AND D-P1=.79  11/66

R5      Y*1(1670) FROM KBAR N TO LAMBDA PI                SQRT(P1*P2)
R5   2       (+0.1)                ARMENTER   70HBC      K-P TO LAMB PI     5/70
R5   2  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R5           +0.07      (0.07)     GALTIERI   70 HBC   0 LAM. PI. EDPWA     7/70
R5            0.165     (0.01)     BUDGEN     71 DPWA    LAM PI0           10/71
R5            0.08                 KIM        71 DPWA    K-MATRIX ANAL.     3/71
R5            0.11      (0.03)     LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R5           +0.10      (0.02)     BAXTER     73 DPWA  0 K- P TO NEUTRALS  10/74
R5           +0.018      0.060     DEVENISH   74       0 FIXED T DISP REL   4/75
R5           +0.06      (0.02)     BAILLON    75 IPWA    KBAR N TO LAM PI  11/75
R5   C       (0.08)     (0.01)     PONTE      75 DPWA  0 K- P TO LAM PI     1/76
R5   D       (0.17)     (0.01)     PONTE      75 DPWA  0 K- P TO LAM PI     1/76
R5           +0.09      (0.02)     VANHORN    75 DPWA  0 K- P TO LAM PI0   11/75
R5          (+0.05)                BELLEFON   76 IPWA  0 K- P TO LAM PI     2/77
R5   1      (+0.08)OR +0.08        MARTIN     77 DPWA    KBAR N MULTICHNL  11/77
R5           +0.10      (0.02)     RLIC       77 DPWA    KBAR N MULTICHNL   1/76
R5   F        0.17      (0.03)     MORRIS     78 DPWA -  K- N TO LAM PI-    3/79
R5   F        0.13      (0.02)     MORRIS     78 DPWA -  K- N TO LAM PI-    3/79
R5   F  RESULTS ARE WITH AND WITHOUT AN S11 SIG(1620) IN THE FIT.

R6      Y*1(1670) FROM KBAR N TO SIGMA PI                 SQRT(P1*P3)
R6          (+0.21)     (0.01)     ARMENTE2   68 HBC   0 OLD DATA          11/66
R6           +0.15                 ARMENTE4   69 DBC                        9/69
R6           +0.23      (0.01)     ARMENT-5   69 HBC   0 NEW DATA           9/69
R6           +0.18                 BERLEY     69 HBC                        5/70
R6           +0.18      (0.06)     GALTIERI   70 HBC   0 SIG PI.EDPWA       7/70
R6            0.15                 KIM        71 DPWA    K-MATRIX ANAL.     3/71
R6            0.23      (0.05)     LANGBEIN   72 IPWA    MULTICHANNEL      12/72
R6           +0.21      (0.03)     KANE       74 DPWA    K-P TO PI SIG     12/81*
R6           +0.20      (0.01)     HEPP2      76 DPWA -0 K- NUC TO SIG PI   2/77
R6   1      (+0.18)OR +0.17        MARTIN     77 DPWA    KBAR N MULTICHNL  11/77
R6           +0.21      (0.02)     RLIC       77 DPWA    KBAR N MULTICHNL   1/76

R7      Y*1(1670) FROM KBAR N TO Y*1(1385) PI S-WAVE      SQRT(P1*P6)
R7   S       (0.17)     (0.02)     SIMS       68 DBC   -  LAM 2PI CROS.SEC 10/71
R7   S  SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY  3/72
R7           +0.11       0.03      PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74

R8      Y*1(1670) INTO (Y*0(1405)PI)*(KBAR N)/TOTAL**2     (P7*P1)
R8           (0.03) OR LESS        BERLEY     69 HBC   0 K-P .6-.82 BEV/C   5/70
R8   B        0.007     (0.002)    BRUCKER    70 DBC   -  K-N TO SIG 2PI   10/71
R8   B  ASSUMING Y*0(1405) PI CROSS SECTION BUMP DUE SOLEY TO 3/2- RESON.  10/71

R9      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)       (P7)/(P6)
R9            0.23      (0.08)     BRUCKER    70 DBC   -  K-N TO SIG 2PI   10/71

R10     Y*1(1670) FROM KBAR N TO LAMBDA(1520) PI          SQRT(P1*P8)
R10  3        0.081      0.016     CAMERON    77 DPWA  D P-WAVE DECAY       1/78
R10  3  CAMERON77 UPPER LIMIT ON F-WAVE DECAY IS 0.03                       1/76
R10  3  ASSUMES LAMBDA(1520) ELASTICITY=.46.                                1/78

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Data Card Listings

For notation, see key at front of Listings.


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                              REFERENCES FOR Y*1(1670)

BERLEY    64 DUBNA CONF I 565   +CONNOLLY,HART,RAHM,STONEHILL, +       (BNL)IJP

ARMENTER 68 NP B8 195         ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE1 68 NP B8 183         ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE2 68 NP B8 223         ARMENTEROS+BAILLON +      (CERN+HEID+SACLAY)IJP
ARMENTE3 68 PL 28B 521        ARMENTEROS,BAILLON +      (CERN+HEID+SACLAY)I
SIMS     68 PRL 21 1413       SIMS,ALBRIGHT,BARTLEY,MEER+ (FSU,TUFT BRAN)

ARMENTE4 69 NP B1? 459        ARMENTEROS,BAILLON,MINTEN +   (CERN+SACLAY) J
ARMENT-5 69 NP B14 91         ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
BERLEY   69 PL 30B 430        BERLEY,HART,RAHM,WILLIS,YAMAMOTO        (BNL)

ARMENTER 70 DUKE 123          ARMENTEROS, BAILLON, +            (CERN,HEID)
BRUCKER  70 DUKE 155          +HARRISON,SIMS,ALBRIGHT,CHANDLER++      (FSU)I
GALTIERI 70 DUKE 173          A. BARBARO GALTIERI                     (LRL)IJP
BUDGEN   71 LNC 2 85          D BUDGEN                               (DURH)IJP
KIM      71 PRL 27 356        J K KIM                                (HARV)IJP
    ALSO 70 DUKE 161          J. K. KIM                              (HARV IJP

LANGBEIN 72 NP B47 477        +WAGNER                                (MPIM)IJP
BAXTER   73 NP B67 125        BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
HART     73 PURDUE CONF. 311  +RICE,BACASTOW,FUNG,+   (TENN+UCR+MASA+BUFF)IJP
DEVENISH 74 NP B81 330        DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
KANE     74 LBL-2452          D.F.KANE                                (LBL)IJP
PREVOST  74 NP B69 246        PREVOST,BARLOUTAUD,+          (SACL+CERN+HEID)

BAILLON  75 NP B94 39         P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
PONTE    75 PRD 12 2597       +HERTZBACH,BUTTON-SHAFER+    (MASA+TENN+UCR)IJP
VANHORN  75 NP B87 145        A. J. VAN HORN                          (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HORN                          (LBL)IJP

BELLEFON 76 NP B109 129       DE BELLEFON,BERTHON                    (CDEF)IJP
HEPP2    76 PL 65B 487        +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)IJP
CAMERON  77 NP B131 399       +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
MARTIN   77 NP B127 ?49       MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266       MARTIN,PIDCOCK                         (LOUC)
    ALSO 77 NP B126 285       MARTIN,PIDCOCK                         (LOUC)IJP
RLIC     77 NP B119 362       GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP

ALSTON   78 PR D18 182        +KENNEY,POLLARD,ROSS+         (LBL+MTHO+CERN)IJP
    ALSO 77 PRL 38 1007       ALSTON-GARNJOST,KENNEY        (LBL+MTHO+CERN)IJP
MORRIS   78 PR D17 55         +ALBRIGHT,COLLERAINE,KIMEL,LANNUTTI   (FSU)IJP
GOPAL    80 TORONTO CONF 159 G.P.GOPAL                              (RHEL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

BASTIEN1 63 PRL 10 188        P L BASTIEN, J P BERGE                  (LRL) IJ
   REPLACED BY BASTIEN 2, BUT SIMILAR AND MORE READILY AVAILABLE.
BASTIEN2 63 UCRL-10779 THESIS P L BASTIEN                             (LRL) IJ
T-ZADEH  63 PRL 11 470        TAHER-ZADEH,PROWSE,SCHLEIN,SLATER,+  (UCLA) JP
   SEE NOTE FOLLOWING SCHLEIN 66.
SCHLEIN 66  UCLA-1016         P.E. SCHLEIN, T.G. TRIPPE              (UCLA) JP
   REANALYSES DATA OF TAHER-ZADEH 63,    BASTIEN 63 AND ALL PUBLISHED
   LAMBDA PI CROSS SECTION DATA IN THE LIGHT OF THE NOW KNOWN
   Y*1(1775) .   REVERSES THE MODEL-DEPENDENT CONCLUSION OF TAHER-
   ZADEH ON THE PREFERRED JP ASSIGNMENT (FROM 3 2+ TO 3          (2-).)
SMART    66 PRL 17 556        H M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
ARMENTER 67 NP B3 592         ARMENTEROS,FERRO-LUZZI+   (CERN,HEID,SACLAY)
PREVOST  71 AMSTERDAM CONF    + CHS COLLABORATION         (CERN+HEID+SACL)

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Σ(1670) BUMPS

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51  Y*1(1670, JP=    ) I=1 PROD. AND CROSS SECT. EXPS.

SEE NOTE PRECEDING Y*1(1670)
PROBABLY THERE ARE TWO STATES AT SAME MASS WITH SAME
QUANTUM NUMBERS, ONE DECAYING INTO SIGMA PI AND LAMBDA
PI, THE OTHER INTO Y*0(1405) PI.

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                 51  Y*1(1670) MASS (MEV) (PROD. EXP.)

M          (1685.0.                         ALEXANDER 62 HBC  -0 PI-P 2-2.2 BEV/C
M           1660.0     10.0                 ALVAREZ   63 HBC  +  K-P 1.51 BEV/C
M          (1665.0)    (5.0)                BUGG      68 CNTR    K-P, 0 TOTAL C.S
M   P   70(1661.)      (9.)                 PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
M   P       SEE BARNES 69 FOR NEW ANALYSIS OF DATA (3 TIMES MORE DATA)            10/69
M           1670.0      6.0                 AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
M           1669.0     10.0                 AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
M           1665.       1.0                 APSELL    74 HBC     K- P 2.87 GEV/C   4/75
M     1200 1686+/-2. OR 1683+/-5.           BERTHON   74 HBC   0 QUASI 2 BODY CS   4/75
M    5      1670.       4.                  CARROLL   76 DPWA    I=1 TOTAL CS      2/77
M    5  TOTAL CROSS SECT ON BUMP WITH (J+1/2)X=.23                                 2/77
M    2      1675.      10.                  HEPP1     76 DBC  -  K-N 1.6-1.75 GEV  2/77
M    2  ENHANCEMENTS IN SIG PI AND SIG PI PI CHANNEL CROSS SECTIONS.               2/77
M           1655. TO 1677.                  TIMMERMA  76 HBC  +  K- P 4.2 GEV/C    2/77
M   B  150(1668.)     (10.)                 FERRER    81 OMEG -  PI-P 9.12 GEV/C   2/82*
M   B   BACKWARD PRODUCTION IN LAMBDA PI- K+ FINAL STATE.
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 51  Y*1(1670) WIDTH (MEV) (PROD. EXP.)

W           (45.0)                          ALEXANDER 62 HBC  -0
W            60.0     10.0                  ALVAREZ   63 HBC  +
W           (33.0)    (15.0)                BUGG      68 CNTR                     11/66
W   P   70  (60.)     (20.)                 PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
W           110.0     12.0                  AGUILAR   70 HBC     SIG.PI K-P 4 GEV  5/70
W           135.0     40.0     30.0         AGUILAR   70 HBC     SIG.2PI K-P 4GEV  5/70
W            67.       2.4                  APSELL    74 HBC     K- P 2.87 GEV/C   4/75
W    5      152.)                           CARROLL   76 DPWA    I=1 TOTAL CS      2/77
W            44. TO 67.                     TIMMERMA  76 HBC  +  K- P 4.2 GEV/C    2/77
W   B  150  (95.)     (20.)                 FERRER    81 OMEG -  PI-P 9.12 GEV/C   2/82*
W                 SEE THE NOTES ACCOMPANYING THE MASSES QUOTED.
W            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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            51  Y*1(1670) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*1(1670) INTO N KBAR                             938+ 493
P2      Y*1(1670) INTO LAMBDA PI                          1115+ 139
P3      Y*1(1670) INTO SIGMA PI                           1189+ 139
P4      Y*1(1670) INTO LAMBDA PI PI                       1115+ 139+ 139
P5      Y*1(1670) INTO SIGMA PI PI                        1192+ 139+ 139
P6      Y*1(1670) INTO Y*1(1385) PI                       1385+ 139
P7      Y*1(1670) INTO Y*0(1405) PI                       1405+ 139

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            51  Y*1(1670) BRANCHING RATIOS (PROD  EXP.)

R1      Y*1(1670) INTO (KBAR N)/(SIGMA PI)               (P1)/(P3)
R1       0    (0.19) OR LESS            ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R1            (0.5)+- 0.25 OR MORE      SMITH     63 HBC  -0
R1            (0.6)  OR LESS            LONDON    66 HBC  +  K-P 2.25 BEV/C   7/66
R1            (0.025)                   BUGG      68 CNTR  0 ASSUMING J=3/2  11/66
R1       0    (0.24) OR LESS            PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
R1            (0.26) OR LESS            BARNES    69 HBC  +  K-P 3.9-5 GEV/C  1? 69
R1            (0.2)  OR LESS            AGUILAR   70 HBC                      5/70
R1            (0.10) OR LESS            BERTHON   74 HBC   0 QUASI 2 BODY CS  4/75
R1            (0.03) OR LESS            TIMMERMA  76 HBC  +  K- P 4.2 GEV/C   2/77

R2      Y*1(1670) INTO (LAMBDA PI)/(SIGMA PI)            (P2)/(P3)
R2      130   (1.20)                    ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R2            (1.2)                     SMITH     63 HBC  -0
R2             0.15     0.07            HUME      64 HBC  +
R2             0.6    OR LESS           LONDON    66 HBC  +  K-P 2.25 BEV/C   7/66
R2       33    0.11     0.06            BUTTON-S  68 HBC  +  K-P AT 1.7 GEV/C 10/69
R2  P    0    (0.1)                     PRIMER    68 HBC  +  K-P 3.9-5 GEV/C  10/69
R2  P   PRIMER 68 ASSUMED THIS DECAY TO BE ALL Y*1(1660)- SEE BARNES 69 FOR
R2  P   NEW INTERPRATATION OF DATA.(3 TIMES MORE DATA) -
R2             0.45     0.15            BARNES    69 HBC  +  K-P 3.9-5 GEV/L  10/69
R2            (0.55)   (0.11)           BERTHON   74 HBC   0 QUASI 2 BODY CS  4/75
R2             0.76     0.09            ESTES     74 HBC   0 K-P,2.1+2.6GEV/C 11/75
R2            (0.45)+/- 0.07 OR LESS    TIMMERMA  76 HBC  +  K- P 4.2 GEV/L   2/77
R2             . . . . . . . . . .
R2  AVERAGE MEANINGLESS (SCALE FACTOR = 3.7)

R3      Y*1(1670) INTO (LAMBDA PI PI)/(SIGMA PI)         (P4)/(P3)
R3       90   (0.56)                    ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R3            (0.17)                    SMITH     63 HBC  -0
R3            (0.6)  OR LESS            LONDON    66 HBC  +  K-P AT 2.25 BEV/C 7/66

R4      Y*1(1670) INTO (SIGMA PI PI)/(SIGMA PI)          (P5)/(P3)
R4      180   (0.56)                    ALVAREZ   63 HBC  +  K-P 1.15 BEV/C
R4  B       LARGEST AT SMALL ANGLES     ESTES     74 HBC   0 K-P,2.1+2.6GEV/C 11/75
R4    2      (0.21)OR LESS              HEPP1     76 DBC  -  K-N 1.6-1.75 GEV  2/77

R5      Y*1(1670) INTO (Y*0(1405) PI)/(SIGMA PI)         (P7)/(P3)
R5       50    3.        1.6            LONDON    66 HBC  +  K-P 2.25 BEV/C   7/66
R5  P    17   (0.58)    (0.20)          PRIMER    68 HBC  +  K-P 4.6-5. GEV/C  7/68
R5  B       LARGEST AT SMALL ANGLES     ESTES     74 HBC  +- K-P 2.1+2.6GEV/C 11/75
R5  BD      1.8+/-0.3 TO 0.02+/-0.07    TIMMERMA  76 HBC  +  K P 4.2 GEV/C    11/77
R5  D   DEPENDING ON PRODUCTION ANGLE

R6      Y*1(1670) INTO (SIGMA PI)/(SIGMA PI PI)          (P3)/(P5)
R6             0.4    OR LESS           BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67
R6             0.30     0.15            LONDON    66 HBC  +  K-P 2.25 GEV/C   7/66
R6  C       BETWEEN 2.5 AND 0.24        EBERHARD  69 HBC     K-P AT 2.6 GEV/C 9/69
R6  D   DEPENDING ON THE PRODUCTION ANGLE
R6  B       VARIES WITH PROD. ANGLE     APSELL    74 HBC  +  K-P 2.87 GEV/C   4/75
R6            (1.39)   (0.16)           BERTHON   74 HBC   0 QUASI 2 BODY CS  4/75
R6  B   APSELL 74, ESTES 74 AND TIMMERMANS 76 FIND STRONG BRANCHING RATIO
R6  B   DEPENDENCE ON PRODUCTION ANGLE, AS IN EARLIER PROD. EXPERIMENTS.

R7      Y*1(1670) INTO (Y*0(1405) PI)/(SIGMA PI PI)      (P7)/(P5)
R7             0.90     0.10     0.15   EBERHARD  65 HBC  +  K-P 2.45 BEV/C   7/66
R7             1.00     0.02            APSELL    74 HBC     K- P 2.87 GEV/C  4/7?
R7             0.97     0.08            TIMMERMA  76 HBC     K- P 4.2 GEV/C   ?/?
R7             . . . . . . . . . .
R7  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R8      Y*1(1670) INTO (Y*0(1405) PI)/(Y*1(1385) PI)     (P7)/(P6)
R8            (0.8)  OR LESS            EBERHARD  65 HBC  +  K-P 2.45 BEV/C   7/66

R9      Y*1(1670) INTO (LAMBDA PI PI)/(SIGMA PI PI)      (P4)/(P5)
R9             0.35     0.2             BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67

R10     Y*1(1670) INTO (LAMBDA PI)/(SIGMA PI PI)         (P2)/(P5)
R10           (0.2)  OR LESS            BIRMINGHA 66 HBC  +  K-P AT 3.5 GEV/C 11/67

R11     Y*1(1670) INTO (LAMBDA PI)/(LAMBDA PI + SIG PI)  (P2)/(P2+P3)
R11           (0.6)  OR LESS            AGUILAR   70 HBC                      5/70

R12     Y*1(1670) INTO (Y*1(1385) PI)/(SIGMA PI)         (P6)/(P3)            1/76
R12           (0.21)+/- 0.05 OR LESS    TIMMERMA  76 HBC     K- P 4.2 GEV/C   2/77

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            51  Y*1(1670) QUANTUM NUMBER DETERMINATION (PROD. EXP.)

Q1                JP=3/2+               LEVEQUE   65 HBC     INTO Y*1(405)+PI 11/68
Q3                JP=3/2-               EBERHARD  67 HBC  +  INTO Y*(1405) PI 11/68
Q4      400       JP=3/2-               BUTTON-SH 68 HBC  +- INTO SIGZERO+PI  11/66

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                              REFERENCES FOR Y*1(1670) (PROD. EXP.)

ALEXANDL 62 CERN CONF 320       ALEXANDER,JACOBS,KALBFLEISCH,MILLER,+ (LRL) I
ALVAREZ  63 PRL 10 184          +ALSTON,FERRO-LUZZI,HUME, +            (LRL) I
SMITH    63 ATHENS CONF 67      G A SMITH                              (LRL)
HUME     64 PR 180 1824(1969)   D O HUME                               (LRL)
EBERHARD 65 PRL 14 466          +SHIVELY,ROSS,SIEGAL,FICENEC, +   (LRL,ILL) I

BIRMINGH 66 PR  152  1148       BIRMINGHAM,GLASGOW,I.C.,OXFORD,RUTHERFORD
LONDON   66 PR 143 1034         +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL,SYRA) IJ
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+      (BIRM,CAV,RHEL)I
BUTTON-S 68 PRL 21 1123         J BUTTON SHAFER                  (MASA+LRL) JP
PRIMER   68 PRL 2? 610          +GOLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)

BARNES   69 BNL 13823           +CHUNG,EISNER,FLAMINIO+             (BNL,SYRA)
EBERHARD 69 PRL 22 200          +FRIEDMAN,PRIPSTEIN,ROSS               (LRL)
AGUILAR  70 PRL 25 56           +BARNES, BASSANO, CHUNG, EISNER,+(BNL,SYRA)

APSELL   74 PRD 10 1419         APSELL,FORD,GOUREVITCH+(BRAN,MD,SYRA,TUFTS)
BERTHON  74 NC 21A 146          BERTHON,TRISTRAM,+     (CDEF+RHEL+SACL+STRB)
ESTES    74 LBL-3827 (THESIS) R. D. ESTES                              (LRL)
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CARROLL  76 PRL 37 806          +CHIANG,KYCIA,LI,MAZUR,MICHAEL+          (BNL)I
HEPPI    76 NP B115 82          +BRAUN,GRIMM,STROBELE,THOL+(CERN,HEID,MPIM)I
TIMMERMA 76 NP B112 77          TIMMERMANS,ENGELEN+      (NIJM+CERN+AMST+OXF) JP
FERRER   81 NP B178 373         +TRETLLE+RIVET,VOLTE+ (CERN+COEF+EPOL+LALO)

                                PAPERS NOT REFERRED TO IN DATA CARDS

LEVEQUE  65 PL 18 69            +         (SACLAY,EPOL,GLASGOW,LOIC,OXF,RHEL) JP
LEE      66 PRL 17 45           Y Y LEE, D D REEDER, R W HARTUNG       (WISC) JP
EBERHARD 67 PR 163 1446         +PRIPSTEIN,SHIVELY,KRUSE,SWANSON  (LRL,ILL)JP
MILLER   70 DUKE 229            D H MILLER    (REVIEW TALK)           (PURDUE)
EBERHARD 73 PURDUE CONF. 247    EBERHARD                                (LBL)JP
HUNGERBU 74 PRD 10 2051         HUNGERBUHLER,MAJKA,+     (YALE,FNAL,BNL,PITT)
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Σ(1690) BUMPS

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58  Y*1(1690, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE THE MINI-REVUE AT THE START OF THE Y* LISTINGS.

SEE NOTE PRECEDING Y*1(1670) LISTINGS. SEEN IN PRO.
EXPERIMENTS ONLY. MAIN DECAY MODE IS LAMBDA PI.
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                 58  Y*1(1690) MASS (MEV) (PROD. EXP.)

M       30(1715.0)   (12.0)          COLLEY    67 HBC  +  K-P 6 GEV/C       8/67
M   P   60(1694.0)   (24.0)          PRIMER    68 HBC  +  K-P 4.6-5 GEV/C   7/68
M   P    SEE Y*1(1670) LISTING-AGUILAR 70 WITH THREE TIMES THE DATA OF
M   P    PRIMER 68  SHOW THAT THEY HAVE NO EVIDENCE FOR Y*1(1690)
M    N    (1700.0)   (6.0)           SIMS      68 HBC  -  K-N TO LAM PI PI 11/68
M    N   THIS ANALYSIS, WHICH IS DIFFICULT AND REQUIRES SEVERAL ASSUMPTIONS
M    N   AND SHOWS NO UNAMBIGUOUS Y*1(1690) SIGNAL, SUGGESTS JP=5/2+.
M    N   SUCH A Y* WOULD LEAD ALL PREVIOUSLY KNOWN Y* TRAJECTORIES.
M       15(1698.0)   (20.0)          ADERHOLZ  69 HBC  +  PI+P 8 GEV/C     12/79
M       46(1682.0)    (2.0)          BLUMENFEL 69 HBC  +  K0 LONG + PROTON  9/69
M         (1700.0)   (20.0)          MOTT      69 HBC  +  K-P 5.5 GEV/C     9/69
M   F   70(1698.0)   (20.0)          GODDARD   79 HBC  +  PI+P 10.3 GEV/C  12/79
M   S   40(1707.0)   (20.0)          GODDARD   79 HBC  +  PI+P 10.3 GEV/C  12/79
M   F    FROM (LAMBDA PI+) K+ FINAL STATE. J>1/2 NOT REQUIRED BY DATA.
M   S    FROM (LAMBDA PI+) (K PI)+ FINAL STATE. J>1/2 INDICATED, BUT LARGE
M   S    BACKGROUND PRECLUDES DEFINITE CONCLUSION.
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                 58  Y*1(1690) WIDTH (MEV) (PROD. EXP.)

W       30 (100.0)   (35.0)          COLLEY    67 HBC  +                    8/67
W   P   60 (105.0)   (35.0)          PRIMER    68 HBC  +                    7/68
W    N     (62.0)    (14.0)          SIMS      68 HBC  -  SEE NOTE N ABOVE 11/68
W       15 (142.0)   (40.0)          ADERHOLZ  69 HBC  +  PI+P 8 GEV/C     12/79
W       46  (25.0)   (10.0)          BLUMENFEL 69 HBC  +                    9/69
W          (130.0)   (25.0)          MOTT      69 HBC  +                    9/69
W   F   70 (240.0)   (60.0)          GODDARD   79 HBC  +  PI+P 10.3 GEV/C  12/79
W   S   40 (130.0)  (100.0)   (60.0) GODDARD   79 HBC  +  PI+P 10.3 GEV/C  12/79
                  SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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                 58  Y*1(1690) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1      Y*1(1690) INTO N KBAR                              938+ 493
P2      Y*1(1690) INTO LAMBDA PI                           1115+ 139
P3      Y*1(1690) INTO SIGMA PI                            1189+ 139
P4      Y*1(1690) INTO Y*1(1385) PI                        1385+ 139
P5      Y*1(1690) INTO LAMBDA PI PI (INCLUDING P4)         1115+ 139+ 139
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                 58  Y*1(1690) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1690) INTO (KBAR N)/(LAMBDA PI)               (P1)/(P2)
R1      18    0.4       0.25         COLLEY    67 HBC  +  6/30 EVENTS       8/67
R1         (0.2) OR LESS             MOTT      69 HBC  +                    9/69
R1         SMALL                     GODDARD   79 HBC  +  PI+P 10.2 GEV/C  12/79

R2      Y*1(1690) INTO (SIGMA PI)/(LAMBDA PI)             (P3)/(P2)
R2         0.3        0.3            COLLEY    67 HBC  +  4/30 EVENTS       6/67
R2         (0.4) OR LESS  CL=.90     MOTT      69 HBC  +                    9/69
R2         SMALL                     GODDARD   79 HBC  +  PI+P 10.2 GEV/C  12/79

R3      Y*1(1690) INTO (Y*1(1385) PI)/(LAMBDA PI)         (P4)/(P2)
R3         (0.5) OR LESS             MOTT      69 HBC  +                    9/69

R4      Y*1(1690) INTO (LAMBDA PI PI)/(LAMBDA PI)         (P5)/(P2)
R4         0.5        0.25           COLLEY    67 HBC  +  15/30 EVENTS      6/67
R4         2.0        0.6            BLUMENFEL 69 HBC  +  31/15 EVENTS      9/69
R4         . . . . . . . . . .
R4  AVG    0.72       0.53     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)

R5      Y*1(1690) INTO (Y*1(1385) PI)/(  A PI PI)         (P4)/(P5)
R5         SMALL                       EY      67 HBC  +                    8/67
R5         LARGE                               68 HBC  -  K-N TO L2PI      11/68
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                         REFERENCES FOR Y*1(1690) (PROD. EXP.)

COLLEY   67 PL 24B 489                 (BIRM,GLAS,LOIC,MUNICH,OXFORD,RHEL) I
DERRICK  67 PRL 18 266          +FIELDS, LOKEN, AMMAR,  (ARGONNE,NORTHWEST) I
    REPLACED BY MOTT 69.
PRIMER   68 PRL 20 610          +GOLDBERG, JAEGER, BARNES, + (SYRACUSE,BNL) I
SIMS     68 PRL 21 1413         +ALBRIGHT, +              (FSU,TUFTS,BRANDEIS) I

ADERHOLZ 69 NP B11 259          +BARTSCH,SCHULTE+(AACH+BERL+CERN+CRAC+WARS)I
BLUMENFE 69 PL 29B 58           B J BLUMENFELD, G R KALBFLEISCH        (BNL) I
MOTT     69 PR 177 1966         +AMMAR, DAVIS, KROPAC, +(NORTHWEST,ARGONNE) I

GODDARD  79 PR D19 1350         +KEY,LUSTE,PRENTICE,YOON,GORDON+ (TNTO+BNL)I,J

                                PAPERS NOT REFERRED TO IN DATA CARDS

AGUILAR  70 PRL 25 58           AGUILAR-BENITEZ,BARNES,BASSANO+  (BNL+SYRA)
COOPER   70 NP B23 605          +MANNER,MUSGRAVE,POLLARD,YOVVODIC     (ANL)I
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Σ(1750) S_{11}

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57  Y*1(1750, JP=1/2-) I=1

THERE IS EVIDENCE FOR THIS STATE IN MANY PARTIAL-
WAVE ANALYSES, BUT WITH RATHER WIDE VARIATIONS IN
THE MASS, WIDTH AND COUPLINGS.  THE LATEST ANALYSES
INDICATED SIGNIFICANT COUPLINGS TO KBAR N AND LAMBDA PI, AS WELL AS
SIGMA ETA WHOSE THRESHOLD IS NEARBY AT 1746 MEV (JONES 74).
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                 57  Y*1(1750) MASS (MEV)

M           NEAR SIGMA ETA THRESHOLD   CLINE      67 DBC  -  K-N TO SIGMA ETA  9/66
M           ABOUT 1750.0               MEYER      67 RVUE                      9/69
M           ABOUT 1730.0               ARMENTERO  70 HDBC -0 K-N TO LAMBDA PI  6/70
M           (1757.0)    (10.0)         CONFORTO   71 DPWA  0 ELASTIC, CH EXCH  6/70
M           (1790.)                    KIM        71 DPWA    K-MATRIX ANAL.    3/71
M           (1790.0)    (15.0)         LANGBEIN   72 IPWA    MULTICHANNEL     12/72
M           (1716.)     (10.)          BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74
M           (1785.)     (12.)          CHU        74 DBC   - FIT SIG- ETA CS  10/74
M    1      (1760.)      (5.)          JONES      74 HBC   0 FIT SIG0 ETA CS   1/74
M           (1739.)     (10.)          PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74
M    1  S-WAVE BW FIT TO THRSHLD C.S., NO BKGND. ERRORS STATISTICAL ONLY       1/74
M   A       (1780.)     (30.)          BAILLON    75 IPWA    KBAR N TO LAM PI 11/75
M   A   FROM SOLUTION 1 OF BAILLON 75.                                         11/75
M   B       (1700.)     (30.)          BAILLON    75 IPWA    KBAR N TO LAM PI  1/76
M   B   FROM SOLUTION 2 OF BAILLON 75.                                          1/76
M           (1697.)     (20.)   (10.)  VANHORN    75 DPWA  0 K- P TO LAM PI0  11/75
M           (1730.)                    BELLEFON   76 IPWA  0 K- P TO LAM PI    2/77
M    3      1715.       10.            CARROLL    76 DPWA    I=1 TOTAL CS      2/77
M    4      1800. OR 1813.             MARTIN     77 DPWA    KBAR N MULTICHNL 11/77
M    4  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    4  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1770.       15.            RLIC       77 DPWA    KBAR N MULTICHNL  1/76
M           1770.       10.            ALSTON     78 DPWA    KBAR N ELASTIC    1/78
M           1756.0      (10.0)         GOPAL      80 DPWA    KBAR N ELASTIC   12/81*
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.0)
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                 57  Y*1(1750) WIDTH (MEV)

W           ABOUT 50.0                 MEYER      67 RVUE                      9/69
W           ABOUT 60.0                 ARMENTERO  70 HDBC -0 K-N TO LAMBDA PI  6/70
W           (55.0)      (10.0)         CONFORTO   71 DPWA  0 ELASTIC, CH EXCH  6/70
W           (50.)                      KIM        71 DPWA    K-MATRIX ANAL.    3/71
W           (100.0)     (20.0)         LANGBEIN   72 IPWA    MULTICHANNEL     12/72
W           (60.)       (20.)          BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74
W           (89.)       (33.)          CHU        74 DBC   - FIT SIG- ETA CS  10/74
W    1      (92.)        (7.)          JONES      74 HBC   0 FIT SIG+ETA CS    1/74
W           (108.)      (20.)          PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74
W   A       (140.)      (30.)          BAILLON    75 IPWA    KBAR N TO LAM PI 11/75
W   B       (160.)      (50.)          BAILLON    75 IPWA    KBAR N TO LAM PI  1/76
W           (56.)       (14.)   (12.)  VANHORN    75 DPWA  0 K- P TO LAM PI0  11/75
W           (110.)                     BELLEFON   76 IPWA  0 K- P TO LAM PI    2/77
W    3      (110.)                     CARROLL    76 DPWA    I=1 TOTAL CS      2/77
W    4      117. OR 119.               MARTIN     77 DPWA    KBAR N MULTICHNL 11/77
W           50.         10.            RLIC       77 DPWA    KBAR N MULTICHNL  1/76
W           161.        20.            ALSTON     78 DPWA    KBAR N ELASTIC    1/78
W           64.0        (10.0)         GOPAL      80 DPWA    KBAR N ELASTIC   12/81*
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 4.5)
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                 57  Y*1(1750) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*1(1750) INTO N KBAR                              93 + 493
P2      Y*1(1750) INTO SIGMA ETA                           1192+ 548
P3      Y*1(1750) INTO LAMBDA PI                           1115+ 134
P4      Y*1(1750) INTO SIGMA PI                            1189+ 139
P5      Y*1(1750) INTO SIGMA(1385) PI                      139+1385
P6      Y*1(1750) INTO LAMBDA(1520) PI                     139+1520
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                 57  Y*1(1750) BRANCHING RATIOS

R1      Y*1(1750) INTO (KBAR N)/TOTAL                       (P1)
R1          (0.12)      (0.05)         CONFORTO   71 DPWA  0 ELASTIC, CH EXCH  6/70
R1          (0.8)                      KIM        71 DPWA    K-MATRIX ANAL.    3/71
R1          (0.45)      (0.05)         LANGBEIN   72 IPWA    MULTICHANNEL     12/72
R1   3  TOTAL CROSS SECTION BUMP WITH (J+1/2)X=.30    SEEN BY CARROLL 76       2/77
R1   4      (0.06)OR  0.05             MARTIN     77 DPWA    KBAR N MULTICHNL 11/77
R1   C      (0.15)      (0.03)         RLIC       77 DPWA    KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1          0.33        0.05           ALSTON     78 DPWA    KBAR N ELASTIC    1/78
R1          0.14        (0.03)         GOPAL      80 DPWA    KBAR N ELASTIC   12/81*

R2      Y*1(1750) FROM KBAR N INTO SIGMA ETA              SQRT(P1*P2)
R2          SEEN                       CLINE      69 DBC   -  THRESHOLD BUMP   9/69
R2   1      (0.23)      (0.01)         JONES      74 HBC   0 FIT SIG+ETA CS    1/74

R3      Y*1(1750) FROM KBAR N INTO LAMBDA PI              SQRT(P1*P3)
R3   2      (-0.25)                    ARMENTERO  70 IPWA -0 K-N TO LAMBDA PI  6/70
R3   2  PUBLISHED SIGN CHANGED TO AGREE WITH LUND 1969 CONVENTION (SEE TEXT) 10/74
R3          (0.09)                     KIM        71 DPWA    K-MATRIX ANAL.    3/71
R3          (0.30)      (0.05)         LANGBEIN   72 IPWA    MULTICHANNEL     12/72
R3          (-0.20)     (0.05)         BAXTER     73 DPWA  0 K- P TO NEUTRALS 10/74
R3          (-0.120)    (0.077)        DEVENISH   74         0 FIXED T DISP REL 4/75
R3   A      (-0.12)     (0.02)         BAILLON    75 IPWA    KBAR N TO LAM PI 11/75
R3   B      (-0.13)     (0.03)         BAILLON    75 IPWA    KBAR N TO LAM PI  1/76
R3          (-0.13)     (0.04)         VANHORN    75 DPWA  0 K- P TO LAM PI0  11/75
R3          (-0.12)                    BELLEFON   76 IPWA  0 K- P TO LAM PI    2/77
R3   4      (-0.10)OR -0.09            MARTIN     77 DPWA    KBAR N MULTICHNL 11/77
R3          (0.04)      (0.03)         RLIC       77 DPWA    KBAR N MULTICHNL  1/76

R4      Y*1(1750) FROM KBAR N TO SIGMA PI                 SQRT(P1*P4)
R4          (0.16)                     KIM        71 DPWA    K-MATRIX ANAL.    3/71
R4          (0.13)      (0.02)         LANGBEIN   72 IPWA    MULTICHANNEL     12/72
R4   4      (+0.06)OR +0.06            MARTIN     77 DPWA    KBAR N MULTICHNL 11/77
R4          -0.09       0.05           RLIC       77 DPWA    KBAR N MULTICHNL  1/76

R5      Y*1(1750) FROM KBAR N TO SIGMA(1385) PI           SQRT(P1*P4)
R5          +0.18       0.15           PREVOST    74 DPWA 0- K-N TO S(1385)PI 10/74

R6      Y*1(1750) FROM KBAR N TO LAMBDA(1520) PI          SQRT(P1*P6)
R6   5      0.032       0.021          CAMERON    77 DPWA  D P-WAVE DECAY      1/78
R6   5  ASSUMES LAMBDA(1520) ELASTICITY=.46                                    1/78
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                              REFERENCES FOR Y*1(1750)

CLINE    67 PL 25B 41          CLINE, OLSSON                    (WISCONSIN)IJP
MEYER    67 HEIDELBERG C 117   J MEYER  (RAPPORTEUR)                (SACLAY)IJP
ARMENTER 70 DUKE 123           ARMENTEROS, BAILLON, +       (CERN,HEIDEL)IJP
CONFORTO 71 NP  B34  41        +LEVI SETTI,LASINSKI,.OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356         J K KIM                              (HARV)IJP
   ALSO  70 DUKE 161           J. K. KIM                            (HARV)IJP
LANGBEIN 72 NP B47 477         +WAGNER                              (MPIM)IJP

BAXTER   73 NP B67 125         BAXTER,BUCKINGHAM,CORBETT,DUNN,+    (OXFORD)IJP
CHU      74 NC 20A 35          CHU,BARTLEY,+ (SUNY PLATTSBURGH+TUFTS+BRAN)IJP
JONES    74 NP B73 141         JONES                         (U. CHICAGO)IJP
DEVENISH 74 NP B81 330         DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
PREVOST  74 NP B69 246         PREVOST,BARLOUTAUD,+        (SACL+CERN+HEID)

BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145         A. J. VAN HORN                        (LBL)IJP
   ALSO  75 NP B87 157         A. J. VAN HORN                        (LBL)IJP

BELLEFON 76 NP B109 129        DE BELLEFON,BERTHON                  (CDEF)IJP
CARROLL  76 PRL 37 806         +CHIANG,KYCIA,LI,MAZUR,MICHAEL+       (BNL)I

CAMERON  77 NP B131 399        +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
MARTIN   77 NP B127 349        MARTIN,PIDCOCK,MOORHOUSE        (LOUC+GLAS)IJP
   ALSO  77 NP B126 266        MARTIN,PIDCOCK                        (LOUC)
   ALSO  77 NP B126 285        MARTIN,PIDCOCK                        (LOUC)IJP
RLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP

ALSTON   78 PR D18 182         +KENNEY,POLLARD,ROSS+       (LBL+MTHO+CERN)IJP
   ALSO  77 PRL 38 1007        ALSTON-GARNJOST,KENNEY      (LBL+MTHO+CERN)IJP
GOPAL    80  TORONTO CONF 159  G.P.GOPAL                            (RHEL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

FERRO-LU 66 BERKELEY CONF 183  M FERRO LUZZI  (RAPPORTEUR)          (CERN)
ARMENTER 68 NP B8 183          ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
ARMENTER 69 LUND CONF PAPER    ARMENTEROS, BAILLON, + (CERN,HEIDEL,SACLAY)IJP
HARRISON 70 FSU-HEP 70 3 1     W.C. HARRISON (THESIS)                (FSU)

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Σ(1770) — P_{11}

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100  Y*1(1770, JP=1/2+) I=1
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→ EVIDENCE FOR THIS STATE NOW RESTS SOLELY ON SOLUTION 1 OF BAILLON 75 - BUT THE LAMBDA PI PARTIAL WAVE AMPLITUDES OF THIS SOLUTION ARE IN DISAGREEMENT WITH AMPLITUDES FROM MOST OTHER LAMBDA PI ANALYSES.

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                    100  Y*1(1770) MASS  (MEV)

M   3    (1772.0)                  KANE      72 DPWA   K-P TO SIGMA PI  11/77
M   3  STATE IS NOT REQUIRED IN KANE 74 WHICH SUPERSEDES KANE 72.       12/81*
M    1    1770.     20.            BAILLON   75 IPWA   KBAR N TO PI LAM 11/75
M    1  FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2.        1/76
M   2    (1738.)    (10.)          RLIC      77 DPWA   KBAR N MULTICHNL  1/76
M   2  STATE REQUIRED TO FIT I=1 TOTAL X-SECTION OF CARROLL 76 IN KBAR N   12/81*
M   2  CHANNEL. NEW K-P POLARIZATION AND K- NEUTRON DIFFERENTIAL X-SECTION 12/81*
M   2  DATA ARE MORE CONSISTENT WITH Y*1(1660) P'11 IN GOPAL 80 ANALYSIS.  12/81*

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                    100  Y*1(1770) WIDTH (MEV)

W   3     (80.)                    KANE      72 DPWA   K-P TO SIGMA PI  11/77
W    1     80.      30.            BAILLON   75 IPWA   KBAR N TO PI LAM 11/75
W   2     (72.)    (10.)           RLIC      77 DPWA   KBAR N MULTICHNL  1/76

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                    100  Y*1(1770) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1770) INTO N KBAR                            938+ 493
P2      Y*1(1770) INTO LAMBDA PI                        1115+ 139
P3      Y*1(1770) INTO SIGMA PI                         1189+ 139

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                    100  Y*1(1770) BRANCHING RATIOS

R1      Y*1(1770) INTO (KBAR N)/TOTAL                    (P1)               1/76
R1  2        (0.14)   (0.04)       RLIC      77 DPWA   KBAR N MULTICHNL  1/76

R2      Y*1(1770) FROM KBAR N INTO LAMBDA PI             SQRT(P1*P2)
R2   1       -0.08      0.02       BAILLON   75 IPWA   KBAR N TO PI LAM 11/75
R2           LESS THAN 0.04        RLIC      77 DPWA   KBAR N MULTICHNL  1/76

R3      Y*1(1770) FROM KBAR N INTO SIGMA PI              SQRT(P1*P3)        1/76
R3  3        (-0.108)              KANE      72 DPWA   K-P TO SIGMA PI  11/77
R3           LESS THAN 0.04        RLIC      77 DPWA   KBAR N MULTICHNL  1/76

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                              REFERENCES FOR Y*1(1770)

KANE     72 PR D5 1583         D F KANE                              (LBL)
BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
RLIC     77 NP B119 362        GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

KANE     74 LBL-2452           D.F.KANE                              (LBL)IJP
CARROLL  76 PRL 37 806         +CHIANG,KYCIA,LI,MAZUR,MICHAEL,+      (BNL)I

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Σ(1775) — D_{15}

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45  Y*1(1775, JP=5/2-) I=1
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SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                    45  Y*1(1775) MASS (MEV)

M          1765.0     10.0          GALTIERI  63 DBC    0 K-P 1.51 BEV/C
M          1755.0     10.0          ARMENTER  65 HBC    0 K-P TO Y*1520 PI   7/66
M          1760.0     10.0          BELL 1    66 DBC    - K-N TO Y*1520 PI   7/66
M    N     1768.0      2.0          ARMENT-1  68 DPWA   0 ELASTIC, CH EXCH 11/68
M    N     1768.0      4.0          BUGG      68 CNTR     K-P, 0 TOTAL     11/66
M          1775.0      7.0          SMART     68 RVUE  -0 K-N TO LAMBDA PI   7/68
M          1770.0     10.0          COOL      70 CNTR     K-P, 0 TOTAL     10/70
M          1765.0     10.0          GALTIERI  70 DPWA   0 K-P TO LAMBDA PI   7/70
M    N     1770.0      3.0          CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
M         (1765.)                   KIM       71 DPWA     K-MATRIX ANAL.     3/71
M          1758.7      3.9          BARLETTA  72 DPWA   0 KPPI 0.8-1.2GEV  12/72
M   3     (1765.0)    (9.0)         KANE      72 DPWA   0 K-P TO PI SIG    10/71
M   3   KANE 72 IS SUPERSEDED BY KANE 74.
M    N     1770.0      5.0          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
M          1772.0     (6.0)         KANE      74 DPWA     K-P TO PI SIG    12/81*
M          1775.      10.           BAILLON   75 IPWA     KBAR N TO LAM PI 11/75
M          1774.      10.           VANHORN   75 DPWA   0 K- P TO LAM PI0  11/75
M         (1765.)                   BELLEFON  76 IPWA   0 K- P TO LAM PI    2/77
M    1     1772. OR 1777.           MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
M    1  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    1  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M          1774.       5.           RLIC      77 DPWA     KBAR N MULTICHNL  1/76
M          1777.       5.           ALSTON    78 DPWA     KBAR N ELASTIC    1/78
M          1778.0     (5.0)         GOPAL     80 DPWA     KBAR N ELASTIC   12/81*
M    N   ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED 1/71
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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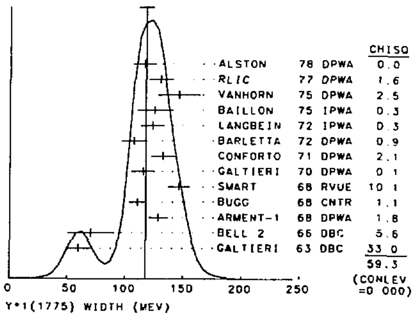
                    45  Y*1(1775) WIDTH (MEV)

W            60.0     10.0          GALTIERI  63 DBC    0
W            73.0     20.0          BELL 2    66 DBC    -                   7/66
W           128.0      8.0          ARMENT-1  68 DPWA   0 ELASTIC, CH EXCH 11/68
W           113.0      7.0          BUGG      68 CNTR     K-P,0 TOTAL       7/68
W           146.0      9.0          SMART     68 RVUE  -0                   7/68
W          (100.0)                  COOL      70 CNTR     K-P, 0 TOTAL     10/70
W           115.0     10.0          GALTIERI  70 DPWA   0 K-P TO LAMBDA PI  7/70
W           132.0     10.0          CONFORTO  71 DPWA   0 ELASTIC, CH EXCH  6/70
W          (100.)                   KIM       71 DPWA     K-MATRIX ANAL.    3/71
W           107.2     10.9          BARLETTA  72 DPWA   0 LAM(1520)PI CH.  12/72
W   3      (120.0)   (38.0)         KANE      72 DPWA   0 K-P TO PI SIG    10/71
W           123.0     10.0          LANGBEIN  72 IPWA     MULTICHANNEL     12/72
W           154.0    (10.0)         KANE      74 DPWA     K-P TO PI SI.    12/81*
W           125.      15.           BAILLON   75 IPWA     KBAR N TO LAM PI 11/75
W           146.      18.           VANHORN   75 DPWA   0 K- P TO LAM PI0  11/75
W          (120.)                   BELLEFON  76 IPWA   0 K- P TO LAM PI    2/77
W    1      102. OR 103.            MARTIN    77 DPWA     KBAR N MULTICHNL 11/77
W           130.      10.           RLIC      77 DPWA     KBAR N MULTICHNL  1/76
W           116.      10.           ALSTON    78 DPWA     KBAR N ELASTIC    1/78
W           137.0    (10.0)         GOPAL     80 DPWA     KBAR N ELASTIC   12/81*
W            . . . . . . . . . .
W   AVG     117.4      6.2     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)
                               (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 117.4 ± 6.2
ERROR SCALED BY 2.2

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                    45  Y*1(1775) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1775) INTO N KBAR                            938+ 493
P2      Y*1(1775) INTO LAMBDA PI                        1115+ 139
P3      Y*1(1775) INTO Y*0(1520) PI                     1520+ 139
P4      Y*1(1775) INTO Y*1(1385) PI D-WAVE               1385+ 139
P5      Y*1(1775) INTO SIGMA PI                         1189+ 139
P6      Y*1(1775) INTO SIGMA ETA                        1192+ 548
P7      Y*1(1775) INTO SIGMA PI PI                      1192+ 139+ 139

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FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2          P 3          P 4          P 5          P 6
P 1 .4134+-.0150
P 2   -.0585   .1399+-.0130
P 3   -.3812      -.0122   .1929+-.0333
P 4   -.3190       .0187      .1214  .0859+-.0090
P 5   -.0879       .0051      .0334      .0280  .0153+-.0064
P 6    .0555      -.3436     -.8284     -.2512     -.1878  .1526+-.0347
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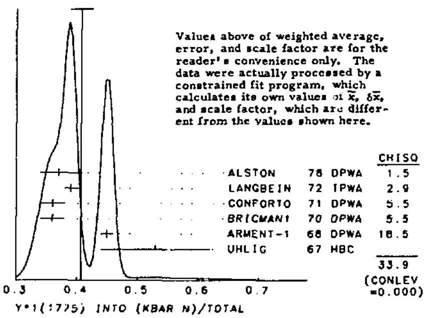
45  Y*1(1775) BRANCHING RATIOS

ERRORS QUOTED BY EXPERIMENTERS DO NOT INCLUDE UNCERTAINTY DUE
TO PARAMETRIZATION USED IN THE P.W.A.  THEY SHOULD BE INCREASED.

R1      Y*1(1775) INTC (KBAR N)/TOTAL                      (P1)
R1          (0.6)                  GALTIERI  63 HBC   0 K-P RVUE
R1           0.53      0.09        UHLIG     67 HBC   0                        9/66
R1           0.45      0.01        ARMENT-1  68 DPWA  0 ELASTIC, CH EXCH 11/68
R1          (0.37)                 BUGG      68 CNTR                          11/66
R1           0.36      0.02        BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
R1          (0.4)                  COOL      70 CNTR    K-P, D TOTAL      10/70
R1           0.36      0.02        CONFORTO  71 DPWA  D ELASTIC, CH EXCH   6/70
R1          (0.42)                 KIM       71 DPWA    K-MATRIX ANAL.     3/71
R1           0.39      0.01        LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R1   1      (0.37)OR   0.36        MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C      (0.41)    (0.03)       RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.37      0.03        ALSTON    78 DPWA    KBAR N ELASTIC     1/78
R1           0.40     (0.02)       GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
R1           . . . . . . . . . .
R1  AVG      0.407     0.018   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.9)
R1  FIT      0.413     0.015  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.6)
                               (SEE IDEOGRAM BELOW )
```

WEIGHTED AVERAGE = 0.407 ± 0.018
ERROR SCALED BY 2 9

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R2      Y*1(1775) FROM KBAR N INTO LAMBDA PI              SQRT(P1*P2)
R2           -0.266    0.017            SMART     68 DPWA -0 K-N TO LAMBDA PI   7/68
R2           -0.22     0.03             GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
R2           (0.30)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R2            0.15     0.04             LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R2           -0.259    0.048            DEVENISH  74       0 FIXED T DISP REL   4/75
R2           -0.25     0.02             BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
R2           -0.28     0.04      0.05   VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
R2          (-0.30)                     BELLEFON  76 IPWA  D K- P TO LAM PI     2/77
R2   1      (-0.29)OR -0.28             MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
R2           -0.28     0.03             RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R2           . . . . . . . . . .
R2  AVG 400   0.251    0.013   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)
R2  FIT       0.241    0.012  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R3      Y*1(1775) FROM KBAR N INTO Y*0(1520) PI           SQRT(P1*P3)
R3            0.27     0.03             ARMENTERO 65 HBC   0 K-P TO Y*1520 PI   9/66
R3            0.31     0.02             BARLETTA  72 DPWA  0 K-P TO Y*1520 PI  12/72
R3   2       -0.305    0.010            CAMERON   77 DPWA  0 K-P TO L(1520)PI   1/78
R3   2  LISTED RATE COMBINES P- AND F-WAVE DECAYS AND ASSUMES LAMBDA(1520)      1/78
R3   2  ELASTICITY=.46. THE CAMERON 77 RESULTS FOR THE SEPARATE P- AND          1/78
R3   2  F-WAVE DECAYS ARE -0.303+/-.010 AND -0.037+/-.014, RESPECTIVELY.       12/79
R3   2  THE SIGNS ARE CHANGED HERE TO BE IN ACCORD WITH THE BARYON-FIRST       12/79
R3   2  CONVENTION.                                                            12/79
R3           . . . . . . . . . .
R3  AVG MOD   0.3031   0.0086  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R3  FIT       0.282    0.023  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 2.9)

R4      Y*1(1775) FROM KBAR N TO Y*1(1385) PI D-WAVE      SQRT(P1*P4)
R4  A        (0.24)   (0.03)            ARMENT-2  67 HBC   0 K-P TO LAM PI PI   8/67
R4  S        (0.32)   (0.06)            SIMS      68 DBC   -  K-N TO LAM PI PI 11/68
R4  S   SIMS 68 USES ONLY CROSS-SECT. DATA. RESULT USED AS UPPER LIMIT ONLY     3/72
R4           +0.20     0.02             PREVOST   74 DPWA 0- K-N TO S(1385)PI  10/74
R4   2       -0.184    0.011            CAMERON   78 DPWA  0 K-P TO S(1385)PI   1/78
R4   2  CAMERON  78 UPPER LIMIT ON G-WAVE DECAY IS 0.03                         1/78
R4           . . . . . . . . . .
R4  AVG MOD   0.1877   0.0096  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
R4  FIT       0.1884   0.0094 FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R5      Y*1(1775) FROM KBAR N INTO SIGMA PI               SQRT(P1*P5)
R5           +0.07     0.02             ARMENTERO 67 DPWA  0 K-P TO SIGMA PI   10/74
R5           +0.06     0.03             GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70
R5           (0.09)                     KIM       71 DPWA    K-MATRIX ANAL.     3/71
R5   3      (+0.074)  (0.017)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
R5            0.09  OR LESS             LANGBEIN  72 IPWA    MULTICHANNEL      12/72
R5            0.09    (0.01)            KANE      74 DPWA    K-P TO PI SIG     12/81*
R5   1      (+0.08)OR +0.08             MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
R5           +0.13     0.02             RLIC      77 DPWA    KBAR N MULTICHNL   1/76
R5           . . . . . . . . . .
R5  AVG       0.093    0.022   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.7)
R5  FIT       0.080    0.017  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R6      Y*1(1775) INTO (LAMBDA PI)/(KBAR N)               (P2)/(P1)
R6            0.33     0.05             UHLIG     67 HBC   0 K-P,.9 GEV/C        9/66
R6           . . . . . . . . . .
R6  FIT       0.339    0.034  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3)

R7      Y*1(1775) INTO (Y*0(1520)PI)/(KBAR N)             (P3)/(P1)
R7            0.28     0.05             UHLIG     67 HBC   0 K-P,.9 GEV/C        9/66
R7           . . . . . . . . . .
R7  FIT       0.467    0.088  FROM FIT (ERROR    LUDES SCALE FACTOR OF 3.3)

R8      Y*1(1775) INTO (Y*1(1385)PI)/(KBAR N)             (P4)/(P1)
R8            0.25     0.09             UHLIG      HBC   0 K-P,.9 GEV/C        9/66
R8           . . . . . . . . . .
R8  FIT       0.208    0.025  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R9      Y*1(1775) INTO (SIGMA PI PI)/TOTAL                (P7)
R9   P       (0.12)                     ARMENT-2  6   DBC -0 K-N TO SIG PI PI 11/68
R9   P   FOR ABOUT 3/4 OF THIS  THE SIGMA PI SYSTE  HAS I=0 AND IS ALMOST
R9   P ENTIRELY Y*0(1520).  FOR THE OTHER 1/4, THE  IGMA PI HAS I=1.  THIS
R9   P IS ABOUT WHAT IS EXPECTED FROM THE KNOWN RATE  Y*1(1775) TO Y*1(1385)
R9   P PI, AS SEEN IN LAMBDA PI PI.

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*REFERENCES FOR Y*1(1775)*


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GALTIERI 63 PL 6 296            A BARBARO-GALTIERI,A HUSSAIN,RD TRIPP (LRL)IJ
ARMENTER 65 PL 19 338           ARMENTEROS, +         (CERN,HEIDELBERG,SACLAY)IJP
BELL 1   66 PRL 16 203          R B BELL, R W BIRGE, Y-L   N, R T PU    (LRL)IJP
BELL 2   66 UCRL-16536 THESIS   R B BELL                                (LRL)IJP
ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (  PN,HEID,SACLAY)IJP
ARMENT-2 67 ZEIT.PHYS.202 486   ARMENTEROS,FERRO-LUZZI+  (  PN,HEID,SACLAY)
UHLIG    67 PR 155 1448         +CHARLTON,CONDON,GLASSER,Y   +    (UMD,NRL)

ARMENT-1 68 NP B8 195           ARMENTEROS, BAILLON, + (CER  HEIDEL,SACLAY)IJP
ARMENT-2 68 NP B8 216           ARMENTEROS, BAILLON, + (CE   HEIDEL,SACLAY) I
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+        M,CAVE,RHEL)I
SIMS     68 PRL 21 1413         SIMS,ALBRIGHT,BARTLEY,MEER+    SU,TUFT,BRAN)
SMART    68 PR 169 1330         W M SMART                               (LRL)IJP

BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                    (CERN)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +      (BNL) I
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                      (LRL)IJP

CONFORTO 71 NP  B34  41         +LEVI SETTI,LASINSKI,,OBERLACK++ (EFI+HEID)IJP
KIM      71 PRL 27 356          J K KIM                                (HARV)IJP
    ALSO 70 DUKE 161            J. K. KIM                              (HARV)IJP

BARLETTA 72 NP B40 45           W.A. BARLETTA                           (EFI) IJP
KANE     72 PR D5 1583          D F KANE                                (LBL)IJP
LANGBEIN 72 NP B47 477          +WAGNER                                (MPIM)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
KANE     74  LBL-2452           D.F.KANE                                (LBL)IJP
PREVOST  74 NP B69 246          PREVOST,BARLOUTAUD,+         (SACL+CERN+HEID)

BAILLON  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
VANHORN  75 NP B87 145          A. J. VAN HORN                          (LBL)IJP
    ALSO 75 NP B87 157          A. J. VAN HORN                          (LBL)IJP

BELLEFON 76 NP B109 129         DE BELLEFON,BERTHON                    (CDEF)IJP
CAMERON  77 NP B131 399         +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
MARTIN   77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266         MARTIN,PIDCOCK                         (LOUC)
    ALSO 77 NP B126 285         MARTIN,PIDCOCK                         (LOUC)IJP
RLIC     77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP

ALSTON   78 PR D18 182          +KENNEY,POLLARD,ROSS+       (LBL+MTHO+CERN)IJP
    ALSO 77 PRL 38 1007         ALSTON-GARNJOST,KENNEY      (LBL+MTHO+CERN)IJP
CAMERON  78 NP B143 189         +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159   G.P.GOPAL                              (RHEL)IJP

                                PAPERS NOT REFERRED TO IN DATA CARDS

FENSTER  66 PRL 17 841          +GELFAND,HARMSEN,L-SETTI,+ (CHIC,ANL,CERN)IJP
     -- FENSTER 66 IS SUPERSEDED BY BARLETTA 72
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +       (CHICAGO,HEIDEL)IJP
    SUPERSEDED BY CONFORTO 71.
HARRISON 70 FSU-HEP 70 3 1      W.C. HARRISON (THESIS)                  (FSU)
PREVOST  71  AMSTERDAM CONF     + CHS COLLABORATION          (CERN+HEID+SACL)
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Σ(1840) →

P''_{13}

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01  Y*1(1840, JP=3/2+) I=1

SEE THE MINI-REVIEWS PRECEDING THE Y*0'S.

FOR THE TIME BEING, WE LIST ALL RESONANCE CLAIMS IN THE
P13 WAVE IN THE 1700-1900 MEV MASS REGION TOGETHER UNDER THIS HEADING.

01  Y*1(1840) MASS (MEV)

M          1840.0    (10.0)             LANGBEIN  72 IPWA    MULTICHANNEL      12/72
M   1     (1720.)    (30.)              BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
M   1   FROM SOLUTION 1 OF BAILLON 75, NOT PRESENT IN SOLUTION 2.               1/76
M          1925.     (200.)             VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
M   2      1798. OR 1802.               MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
M   2   THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M   2   PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
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                 01  Y*1(1840) WIDTH (MEV)

W           120.0    (10.0)            LANGBEIN  72 IPWA     MULTICHANNEL       12/72
W   1      (120.)    (30.)             BAILLON   75 IPWA     KBAR N TO LAM PI  11/75
W           65.      (50.)     (20.)   VANHORN   75 DPWA   0 K- P TO LAM PI0   11/75
W     2     93. OR 53.                 MARTIN    77 DPWA     KBAR N MULTICHNL  11/77
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                 C1  Y*1(1840) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*1(1840) INTO N KBAR                               938+ 493
P2      Y*1(1840) INTO SIGMA PI                            1189+ 139
P3      Y*1(1840) INTO LAMBDA PI                           1115+ 134
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                 C1  Y*1(1840) BRANCHING RATIOS

R1      Y*1(1840) INTO (KBAR N)/TOTAL                      (P1)
R1            0.37     (0.13)          LANGBEIN  72 IPWA     MULTICHANNEL       12/72
R1    2      (0.0)OR(0.0)              MARTIN    77 DPWA     KBAR N MULTICHNL  11/77

R2      Y*1(1840) FROM KBAR N INTO SIGMA PI                SQRT(P1*P2)
R2            0.15     (0.04)          LANGBEIN  72 IPWA     MULTICHANNEL       12/72
R2    2     (-0.04)OR -0.04            MARTIN    77 DPWA     KBAR N MULTICHNL  11/77

R3      Y*1(1840) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P3)
R3            0.20     (0.04)          LANGBEIN  72 IPWA     MULTICHANNEL       12/72
R3           +0.122     0.078          DEVENISH  74        0 FIXED T DISP REL   4/75
R3  1       (+0.11)    (0.02)          BAILLON   75 IPWA     KBAR N TO LAM PI  11/75
R3           +0.06     (0.04)          VANHORN   75 DPWA   0 K- P TO LAM PI0   11/75
R3    2     (+0.03)OR +0.03            MARTIN    77 DPWA     KBAR N MULTICHNL  11/77
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                      REFERENCES FOR Y*1(1840)

LANGBEIN 72 NP B47 477          +WAGNER                           (MPIM)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLON  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD    (CERN,RHEL)IJP
VANHORN  75 NP B87 145          A. J. VAN HORN                        (LBL)IJP
    ALSO 75 NP B87 157          A. J. VAN HORN                        (LBL)IJP

MARTIN   77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266         MARTIN,PIDCOCK                           (LOUC)
    ALSO 77 NP B126 285         MARTIN,PIDCOCK                        (LOUC)IJP
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Σ(1880) P_{11}

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67  Y*1(1880, JP=1/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

A RESONANCE IS SUGGESTED BY SEVERAL PARTIAL-WAVE
ANALYSES ACROSS THIS REGION, BUT WITH WIDE VARIATIONS
IN THE MASS AND OTHER PARAMETERS.  WE LIST HERE
ALL CLAIMS WHICH LIE WELL ABOVE THE Y*1(1770).
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                 67  Y*1(1880) MASS (MEV)

M           1882.0     40.0            SMART     68 DPWA -0 K- N TO LAM PI      7/68
M          (1850.0)                    BAILEY    69 DPWA  0 ELASTIC, CH EXCH  10/70
M           ABOUT 1850.0               ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH   6/70
M           1950.0     50.0            GALTIERI  70 DPWA -0 K- N TO LAM PI     7/70
M           1920.0     30.0            LITCHFIEL 70 DPWA -0 K- N TO LAM PI     6/70
M     2    (1898.)                     LEA       73 DPWA    MULTICHNL K-MTRX   9/73
M     2  ONLY UNCONSTRAINED STATES FROM TABLE I OF LEA73 ARE IN LISTINGS.      9/73
M   1      (1960.)    (30.)            BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
M   1    FROM SOLUTION 1 OF BAILLON 75. NOT PRESENT IN SOLUTION 2.             1/76
M           1985.      50.             VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
M     3     1847. OR 1863.             MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
M     3  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M     3  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1870.0     10.0            CAMERON2  78 DPWA    K-P TO K*(890) N  12/79
M           1826.0    (20.0)           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
M             . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)
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                 67  Y*1(1880) WIDTH (MEV)

W            222.0    150.0            SMART     68 DPWA -0 K- N TO LAM PI      7/68
W           (200.0)                    BAILEY    69 DPWA  0 ELASTIC, CH EXCH  10/70
W           ABOUT 30.0                 ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH   6/70
W            200.0     50.0            GALTIERI  70 DPWA -0 K- N TO LAM PI     7/70
W            170.0     40.0            LITCHFIEL 70 DPWA -0 K- N TO LAM PI     6/70
W     2     (222.2)                    LEA       73 DPWA    MULTICHNL K-MTRX   9/73
W   1       (260.)    (40.)            BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
W            220.     140.             VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
W     3      216. OR 220.              MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
W             83.0     10.0            CAMERON2  78 DPWA    K-P TO K*(890) N  12/79
W             86.0    (15.0)           GOPAL     80 DPWA    KBAR N ELASTIC    12/81*
W             . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)
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                 67  Y*1(1880) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      Y*1(1880) INTO N KBAR                               938+ 493
P2      Y*1(1880) INTO LAMBDA PI                           1115+ 134
P3      Y*1(1880) INTO SIGMA PI                            1197+ 139
P4      Y*1(1880) INTO N K*(890), P1 WAVE                   939+ 891
P5      Y*1(1880) INTO N K*(890), P3 WAVE                   939+ 891
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                 67  Y*1(1880) BRANCHING RATIOS

R1      Y*1(1880) INTO (KBAR N)/TOTAL                      (P1)
R1           (0.22)                    BAILEY    69 DPWA  0 ELASTIC, CH EXCH  10/70
R1           (0.20)                    ARMENTERO 70 IPWA -0 ELASTIC, CH EXCH   6/70
R1    2      (0.31)                    LEA       73 DPWA    MULTICHNL K-MTRX   9/73
R1    3      (0.27)OR  0.27            MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
R1            0.06     (0.02)          GOPAL     80 DPWA    KBAR N ELASTIC    12/81*

R2      Y*1(1880) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P2)
R2           -0.11      0.03           SMART     68 DPWA -0 K- N TO LAM PI      7/68
R2           -0.05      0.04           GALTIERI  70 DPWA -0 K- N TO LAM PI      7/70
R2           -0.14      0.03           LITCHFIEL 70 DPWA -0 K- N TO LAM PI      6/70
R2    2     (-0.30)                    LEA       73 DPWA    MULTICHNL K-MTRX    9/73
R2           -0.169     0.119          DEVENISH  74       0 FIXED T DISP REL    4/75
R2  1       (-0.12)    (0.02)          BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
R2           +0.05      0.07     0.02  VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
R2    3     (-0.24)OR -0.24            MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
R2            . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R3      Y*1(1880) FROM KBAR N TO SIGMA PI                  SQRT(P1*P3)          9/73
R3    2       NOT SEEN                 LEA       73 DPWA    MULTICHNL K-MTRX    9/73
R3    3     (+0.30)OR +0.29            MARTIN    77 DPWA    KBAR N MULTICHNL  11/77

R4      Y*1(1880) FROM KBAR N INTO N K*(890), P1 WAVE      SQRT(P1*P4)
R4    4      -0.05      0.03           CAMERON2  78 DPWA    K-P TO K*N         12/79
R4    4  THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST         12/79
R4    4  CONVENTION.                                                            12/79

R5      Y*1(1880) FROM KBAR N INTO N K*(890), P3 WAVE      SQRT(P1*P5)
R5           +0.11      0.03           CAMERON2  78 DPWA    K-P TO K*N         12/79
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                      REFERENCES FOR Y*1(1880)

SMART    68 PR 169 1330          W M SMART                             (LRL)IJP
BAILEY   69 THESIS UCRL-50617 DAVID SAAL BAILEY              (LRL LIVERMORE)IJP
ARMENTER 70 DUKE CONF 123        ARMENTEROS, BAILLON, +       (CERN, HEIDEL)IJP
GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                    (LRL)IJP
LITCHFIE 70 NP B22 269           P J LITCHFIELD                 (RUTHERFORD)IJP

LEA      73 NP B56 77            +MARTIN,MOORHOUSE+  (PHEL+LOUC+GLAS+AARHUS)IJP
DEVENISH 74 NP B81 330           DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
BAILLON  75 NP B94 39            P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145           A. J. VAN HORN                        (LBL)IJP
    ALSO 75 NP B87 157           A. J. VAN HORN                        (LBL)IJP

MARTIN   77 NP B127 349          MARTIN,PIDCOCK,MOORHOUSE         (LOUC+GLAS)IJP
    ALSO 77 NP B126 266          MARTIN,PIDCOCK                           (LOUC)
    ALSO 77 NP B126 285          MARTIN,PIDCOCK                        (LOUC)IJP
CAMERON2 78 NP B146 327          +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL    80 TORONTO CONF 159 G.P.GOPAL                                (RHEL)IJP
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Σ(1915) F_{15}

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46  Y*1(1915, JP=5/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS RESONANCE WA  FIRST SEEN IN THE TOTAL-CROSS-SEC-
TION MEASUREMENTS OF COOL 66.  IN THIS ENTRY, HOWEVER,
WE LIST ONLY THE RESULTS FROM PARTIAL-WAVE ANALYSES.
SEE THE NEXT ENTRY FOR THE PARAMETERS OF PEAKS SEEN AROUND 1900-1950
MEV IN CROSS SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  WE MAKE THIS
SEPARATION BECAUSE ONLY THE PARTIAL-WAVE ANALYSES ISOLATE THE F15 WAVE.
SEE ALSO THE NOTE TO THE NEXT ENTRY.
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                 46  Y*1(1915) MASS (MEV)

M           1902.0     11.0            SMART     68 DPWA -0 K-N TO LAMBDA PI   7/68
M           1910.0     20.0            BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
M           1900.0     15.0            BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
M   N       1936.0    (13.0)           BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
M           1903.0     10.0            COX       70 DPWA -  K-N TO LAMBDA PI   6/70
M           1905.0     30.0            GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
M           1895.0     10.0            LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
M           1910.      15.             LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
M     6    (1925.0)    (8.0)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
M     6  KANE 72 IS SUPERSEDED BY KANE 74.
M           1920.0     (5.0)           KANE      74 DPWA    K-P TO PI SIG     12/81*
M           1920.      30.             BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
M           1914.      10.             HEMINGWA  75 DPWA  0 K- P TO KBAR N    11/75
M           1920.      15.       20.   VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
M          (1915.)                     BELLEFON  76 IPWA  0 K- P TO LAM PI     2/77
M     3     1900.       4.             CORDEN    76 DPWA  - K- N TO PI- LAM    2/77
M     3  PREFERRED SOLUTION 3. SEE CORDEN 76 FOR OTHER POSSIBILITIES.          2/77
M     3  CORDEN 76 INCLUDES THE DATA OF COX 70 AS A SUBSAMPLE
M   1       1894.       5.             CORDEN1   77       - K- N TO PI SIG    11/77
M   2       1909.       5.             CORDEN1   77       - K- N TO PI SIG    11/77
M   1    THE 2 ENTRIES FOR CORDEN177 ARE FROM 2 DIFFERENT ACCEPTABLE SLTNS.   11/77
M        NOT SEEN                      DECLAIS   77 DPWA    KBAR N TO KBAR N   1/78
M     4     1925. OR 1933.             MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
M     4  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M     4  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1920.      10.             RLIC      77 DPWA    KBAR N MULTICHNL   1/76
M           1937.      20.             ALSTON    78 DPWA    KBAR N ELASTIC     1/78
M   N    ERROR STATIST. ONLY- NO ERROR DUE TO PARTICULAR P.W.ANAL. INCLUDED    1/71
M             . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)
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                 46  Y*1(1915) WIDTH (MEV)

W   A       (50.0)    (20.0)           ARMENTER1 67 DPWA  0 ELASTIC, CH EXCH  11/67
W            52.0      25.0            SMART     68 DPWA -0 K-N TO LAMBDA PI   7/68
W            60.0      20.0            BERTHON   70 DPWA  0 K-P TO LAMBDA PI   7/70
W            75.0      20.0            BERTHON1  70 DPWA  0 K-P TO SIGMA PI   10/70
W           135.0      12.0            BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX   1/71
W            77.0      27.0            COX       70 DPWA -  K-N TO LAMBDA PI   6/70
W            70.0      20.0            GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70
W            70.0      15.0            LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI   6/70
W            70.       15.             LITCHFIE  71 DPWA    K-P TO KBAR N     10/71
W     6    (146.0)    (22.0)           KANE      72 DPWA  0 K-P TO PI SIG     10/71
W           162.0     (25.0)           KANE      74 DPWA    K-P TO PI SIG     12/81*
W            70.       20.             BAILLON   75 IPWA    KBAR N TO LAM PI  11/75
W            85.       15.             HEMINGWA  75 DPWA  0 K- P TO KBAR N    11/75
W           102.       18.             VANHORN   75 DPWA  0 K- P TO LAM PI0   11/75
W           (60.)                      BELLEFON  76 IPWA  0 K- P TO LAM PI     2/77
W     3      75.       14.             CORDEN    76 DPWA  - K- N TO PI- LAM    2/77
W   1       107.       14.             CORDEN1   77       - K- N TO PI SIG    11/77
W   2        85.       13.             CORDEN1   77       - K- N TO PI SIG    11/77
W     4     171. OR 173.               MARTIN    77 DPWA    KBAR N MULTICHNL  11/77
W           130.       10.             RLIC      77 DPWA    KBAR N MULTICHNL   1/76
W           161.       20.             ALSTON    78 DPWA    KBAR N ELASTIC     1/78
W   A    LACK OF DATA PREVENTS FROM DETERMINING UNAMB. THIS AMPLITUDE          11/67
W             . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.9)
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                         46  Y*1(1915) PARTIAL DECAY MODES

                                                              DECAY MASSES
P1      Y*1(1915) INTO N KBAR                                 938+ 493
P2      Y*1(1915) INTO LAMBDA PI                             1115+ 139
P3      Y*1(1915) INTO SIGMA PI                              1189+ 139
P4      Y*1(1915) INTO Y*1(1385) PI P-WAVE                    139+1385
P5      Y*1(1915) INTO Y*1(1385) PI F-WAVE                    139+1385

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                         46  Y*1(1915) BRANCHING RATIOS

R1      Y*1(1915) INTO (KBAR N)/TOTAL                        (P1)
R1  A         (0.12)     (0.01)       ARMENTER1 67 DPWA  0 ELASTIC, CH EXCH 11/67
R1             0.18      (0.02)       BRICMAN1  70 DPWA    SIGTOT,ELAS,CHEX  1/71
R1             0.11      (0.03)       CONFORTO  71 DPWA  0 ELASTIC, CH EXCH  6/70
R1             0.15      (0.04)       LITCHFIE  71 DPWA    K-P TO KBAR N    10/71
R1             0.11      (0.04)       HEMINGWA  75 DPWA  0 K- P TO KBAR N   11/75
R1   4        (0.08)OR   0.08         MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C        (0.05)     (0.03)       RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1   C  (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1             0.14      (0.05)       ALSTON    78 DPWA    KBAR N ELASTIC    1/78
R1   5         0.03      (0.02)       GOPAL     80 DPWA    KBAR N ELASTIC   12/81*
R1   5  MASS AND WIDTH FIXED TO RLIC 77 VALUES DUE TO LOW ELASTICITY.       12/81*

R2      Y*1(1915) FROM KBAR N INTO LAMBDA PI                 SQRT(P1*P2)
R2            -0.08      (0.02)       SMART     68 DPWA -0 K-N TO LAMBDA PI  7/68
R2            -0.1       (0.02)       BERTHON   70 DPWA  0 K-P TO LAMBDA PI  7/70
R2            -0.09      (0.02)       COX       70 DPWA -  K-N TO LAMBDA PI  6/70
R2            -0.11      (0.03)       GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
R2            -0.07      (0.015)      LITCHFIEL 70 DPWA -0 K-N TO LAMBDA PI  6/70
R2            -0.08T     (0.056)      DEVENISH  74       0 FIXED T DISP REL  4/75
R2            -0.06      (0.02)       BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R2            -0.09      (0.02)       VANHORN   75 DPWA  0 K- P TO LAM PI0  11/75
R2            (-0.10)                 BELLEFON  76 IPWA  0 K- P TO LAM PI    2/77
R2   3        -0.10      0.01         CORDEN    76 DPWA -  K- N TO PI- LAM   2/77
R2   4        (-0.05)OR -0.09         MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2            -0.09      (0.03)       RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R3      Y*1(1915) FROM KBAR N INTO SIGMA PI                  SQRT(P1*P3)
R3  A         (0.00)     (0.01)       ARMENTERO 67 DPWA  0 K-P TO SIGMA PI  11/67
R3            -0.13      (0.03)       BERTHON1  70 DPWA  0 K-P TO SIGMA PI  10/70
R3            -0.06      (0.03)       GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70
R3   6        (-0.137)   (0.015)      KANE      72 DPWA  0 K-P TO PI SIG    10/71
R3            -0.15      (0.03)       KANE      74 DPWA    K-P TO PI SIG    12/81*
R3   1        -0.17      0.01         CORDEN1   77       - K- N TO PI SIG   11/77
R3   2        -0.15      0.02         CORDEN1   77       - K- N TO PI SIG   11/77
R3   4        (-0.05)OR -0.05         MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R3            -0.19      (0.03)       RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R3                 . . . . . . . . .
R3  AVG MOD   0.1660     0.0089  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R4      Y*1(1915) FROM KBAR N INTO Y*1(1385) PI P-WAVE   SQRT(P1*P4)
R4            LESS THAN 0.01          CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78

R5      Y*1(1915) FROM KBAR N INTO Y*1(1385) PI F-WAVE   SQRT(P1*P5)
R5   5        +0.039     0.009        CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R5   5  THE SIGN IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST           12/79
R5   5  CONVENTION.                                                          12/79

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                          REFERENCES FOR Y*1(1915)

ARMENTER 67 PL 24B 198          ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
ARMENTE1 67 NP B3 592           ARMENTEROS,FERRO-LUZZI+  (CERN,HEID,SACLAY)
SMART    68 PR 169 1330         W M SMART                           (LRL)IJP

BERTHON  70 NP B20 476          +RANGAN, VRANA, +(COL FRANCE, RHEL, SACLAY)IJP
BERTHON1 70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJ
BRICMAN1 70 PL 33B 511          +FERRO-LUZZI,LAGNAUX                  (CERN)
COX      70 NP B19 61           +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI 70 DUKE CONF 173       A BARBARO-GALTIERI                  (LRL)IJP
LITCHFIE 70 NP B22 269          P J LITCHFIELD               (RUTHERFORD)IJP

CONFORTO 71 NP  B34  41         +LEVI SETTI,LASINSKI..OBERLACK++ (EFI+HEID)IJP
LITCHFIE 71 NP  B30 125         LITCHFIELD,...+LESQUOY,+.. (RHEL+CDEF+SACL)IJP
KANE     72 PR D5 1583          D F KANE                            (LBL)IJP
DEVENISH 74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
KANE     74  LBL-2452           D.F.KANE                            (LBL)IJP

BAILLON  75 NP B94 39           P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
HEMINGWA 75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHORN  75 NP B87 145          A. J. VAN HORN                      (LBL)IJP
    ALSO 75 NP B87 157          A. J. VAN HORN                      (LBL)IJP

BELLEFON 76 NP B109 129         DE BELLEFON,BERTHON                (CDEF)IJP
CORDEN   76 NP B104 382         +COX,DARTNELL,KENYON,ONEALE,SUMOROK+ (BIRM)IJP

CORDEN1  77 NP B125 61          +COX,KENYON,ONEALE,STUBBS,SUMOROK+   (BIRM)IJP
DECLAIS  77  CERN 77-16         +DUCHON,LOUVEL,PATRY,SEGUINOT+  (CAEN+CERN)IJP
MARTIN   77 NP B127 349         MARTIN,PIDCOCK,MOORHOUSE        (LOUC+GLAS)IJP
    ALSO 77 NP B126 266         MARTIN,PIDCOCK                        (LOUC)
    ALSO 77 NP B126 285         MARTIN,PIDCOCK                        (LOUC)IJP
RLIC     77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
ALSTON   78 PR D18 182          +KENNEY,POLLARD,ROSS+       (LBL+MTHO+CERN)IJP
    ALSO 77 PRL 38 1007         ALSTON-GARNJOST,KENNEY      (LBL+MTHO+CERN)IJP
CAMERON  78 NP B143 189         +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159 G.P.GOPAL                             (RHEL)IJP

                          PAPERS NOT REFERRED TO IN DATA CARDS

SMART    66 PRL 17 556          W M SMART,A KERNAN,G E KALMUS,R P ELY (LRL)IJP
    SUPERSEDED BY SMART 68.
CONFORTO 68 NP B8 265           +HARMSEN, LASINSKI, +      (CHICAGO, HEIDEL)
    SUPERSEDED BY CONFORTO 71.
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1915 MEV REGION – PRODUCTION AND σ_{TOTAL} EXP'TS

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                  29  Y*1(1915, JP=    ) I=1       PRODUCTION EXPERIMENTS

                  SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                  SEE THE NOTES TO THE Y*1(1915) AND Y*1(1940), WHICH
                  IMMEDIATELY PRECEDE AND FOLLOW THIS ENTRY.  HERE WE
                  LIST ONLY PARAMETERS OF PEAKS SEEN IN CROSS SECTIONS
   AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-SECTION PEAKS ARE ALMOST
   CERTAINLY ASSOCIATED WITH THE F15 Y*1(1915) SEEN IN PARTIAL-WAVE
   ANALYSES.  THE INVARIANT-MASS PEAKS SEEM MORE LIKELY TO BE ASSOCIATED
   WITH THE D13 Y*1(1940).

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                      29  Y*1(1915) MASS (MEV) (PROD. EXP.)

M         CROSS-SECTION PEAKS --
M           1905.0      5.0          BUGG      68 CNTR     K-P, D TOTAL     11/66
M           1906.0      6.0          BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
M           1912.0     10.0          COOL      70 CNTR     K-P, D TOTAL     10/70
M         INVARIANT-MASS-DISTRIBUTION PEAKS --
M          (1942.0)    (9.0)         BOCK      65 HBC      PBAR P 5.7 GEV/C
M           1940.0     11.0          AGUILAR   70 HBC   +  3.9-4.6 GEV/C K-  5/70
M       42 1979.       14.           BRIEFEL   77 HBC   +  XI K MODE 2.9K-P  1/78
M   B  200(1910.)     (17.)          FERRER    81 OMEG  -  PI-P 9,12 GEV/C   2/8?*
M   B   BACKWARD PRODUCTION IN LAMBDA PI- K+ FINAL STATE.
M         ELASTIC DCS --                                                     2/73
M   1       1931.       9.           DADO      72 HBC    0 K-P ELSTC DCS     2/73
M   1   G7 INDICATED BY LEGENDRE COEFFS..G9 NOT RULED OUT.                   2/73
M                . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

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                      29  Y*1(1915) WIDTH (MEV) (PROD. EXP.)

W         CROSS-SECTION PEAKS --
W             60.0     10.0          BUGG      68 CNTR                      11/66
W             50.0     12.0          BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
W            (30.0)                  COOL      70 CNTR     K-P, D TOTAL     10/70
W         INVARIANT-MASS-DISTRIBUTION PEAKS --
W            (36.0)   (20.0)   (36.0) BOCK     65 HBC
W             90.0     20.0          AGUILAR   70 HBC   +  3.9-4.6 GEV/C K-  5/70
W       42    69.      32.           BRIEFEL   77 HBC   +  XI K MODE 2.9K-P  1/78
W   9  200   (87.)    (25.)          FERRER    81 OMEG  -  PI-P 9,12 GEV/C   2/82*
W         ELASTIC DCS --                                                     2/73
W   1         70.      14.           DADO      72 HBC    0 K-P ELSTC DCS     2/73
W                . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                  29  Y*1(1915) PARTIAL DECAY MODES (PROD. EXP.)

                                                           DECAY MASSES
P1      Y*1(1915) INTO N KBAR                               938+ 493
P2      Y*1(1915) INTO LAMBDA PI                           1115+ 134
P3      Y*1(1915) INTO SIGMA PI                            1189+ 139
P4      Y*1(1915) INTO XI K                                1314+ 493

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                  29  Y*1(1915) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(1915) INTO (KBAR N)/TOTAL                      (P1)
R1         THESE VALUES OF ELASTICITIES ASSUME J=5/2 --
R1            0.06                   BUGG      68 CNTR     ASSUMING J=5/2    6/68
R1            0.07       0.02        BRICMAN   70 CNTR   0 TOTAL AND CH EX   6/70
R1            0.07                   COOL      70 CNTR     K-P, D TOTAL     10/70
R1   1  THIS ELASTICITY ASSUMES J=7/2                                        2/73
R1   1        0.62       0.08        DADO      72 HBC    0 K-P ELSTC DCS     2/73
R1                . . . . . . . . .
R1  AVG       0.10       0.13     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 6.7)

R2      Y*1(1915) INTO (KBAR N)/(SIGMA PI)                 (P1)/(P3)
R2          (0.37) OR LESS           BARNES    69 HBC   +  1 STAN. DEV.     10/69

R3      Y*1(1915) INTO (LAMBDA PI)/(SIGMA PI)              (P2)/(P3)
R3          (0.28) OR LESS           BARNES    69 HBC   +  1 STAN. DEV.     10/69

R4      Y*1(1915) INTO (XI K)/TOTAL                        (P4)
R4       42   SEEN                   BRIEFEL   77 HBC   +  K-P 2.87 GEV      1/78

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                      REFERENCES FOR Y*1(1915) (PROD. EXP.)

BOCK     65 PL 17 166           +COOPER,FRENCH,KINSON, +       (CERN,SACLAY) I
COOL     66 PRL 16 1228         +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466         +GILMORE,KNIGHT,DAVIES+     (BIRM,CAVE,RHEL)I
BARNES   69 PRL 22 479          +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58           AGUILAR-BENITEZ, BARNES, +         (BNL,SYRA)
BRICMAN  70 PL 31B 152          +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887          +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
DADO     72 PRL 29 1695         +BIRMAN,GOLDBERG,WEISS                (HAIF)JP
BRIEFEL  77 PRD 16 2706         +GOUREVITCH,CHANG+        (BRAN+UMD+SYRA+TUFT)
FERRER   81 NP B178 373         +TREILLE,RIVET,VOLTE+ (CERN+CDEF+EPOL+LALO)

                      PAPERS NOT REFERRED TO IN DATA CARDS

PRIMER   68 PRL 20 610          +GOLDBERG,JAEGER,BARNES,DORNAN + (SYRA,BNL)
    SUPERSEDED BY BARNES 69 AND AGUILAR-BENITEZ 70.
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Σ(1940) D_{13}

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           58  Y*1(1940, JP=3/2-) I=1

           SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

           SOME, NOT ALL, PARTIAL WAVE ANALYSES SUGGEST A STATE IN
           THIS REGION.  IT IS PERHAPS ASSOCIATED WITH THE BUMPS
           SEEN IN PRODUCTION EXPERIMENTS NEAR THIS MASS (SEE THE
           PRECEDING ENTRY).  THIS STATE IS NOT REQUIRED IN
           K- NEUTRON TO (PI SIGMA)- ANALYSIS OF GOYAL 77.  KBAR N
           ANALYSIS (GOPAL 80) WITH K- NEUTRON ELASTIC DATA
           DOES NOT REQUIRE THIS STATE.

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           58  Y*1(1940) MASS (MEV)

M          1940.0      50.0            GALTIERI  70 DPWA     K- N TO LAM PI    7/70
M          1940.0      40.0            GALTIERI  70 DPWA     K-P TO SIGMA PI   7/70
M          1940.0      30.0            LITCHFIEL 70 DPWA     K- N TO LAM PI    7/70
M   9     (1985.0)     (5.0)           KANE      72 DPWA   0 K-P TO PI SIG    10/71
M   9   KANE 72 IS SUPERSEDED BY KANE 74.
M   2     (1865.)                      LEA       73 DPWA     MULTICHNL K-NTRX  9/73
M   2   ONLY UNCONSTRAINED STATES FROM TABLE 1 OF LEA73 ARE IN LISTINGS.       9/73
M          1935.0     (80.0)           KANE      74 DPWA     K-P TO PI SIG    12/81*
M          1940.       20.             LITCHFI2  74 DPWA   0 K-P TO L(1520)PI 10/74
M          1950.       20.             LITCHFI3  74 DPWA   0 K-P TO KBAR DEL  10/74
M          1950.       30.             BAILLON   75 IPWA     KBAR N TO LAM PI 11/75
M          1949.       40.       60.   VANHORN   75 DPWA   0 K- P TO LAM PI0  11/75
M   4     (1940.)                      BELLEFON  76 IPWA   0 K- P TO LAM PI    2/77
M   4   SLIGHT BUMP IN MODULUS OF F7 WAVE.                                      2/77
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M    5      1886. OR 1893.             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    5  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    5  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1920.      50.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M           . . . . . . . . . .
M     AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    58  Y*1(1940) WIDTH (MEV)

W           200.0      50.0            GALTIERI  70 DPWA    K- N TO LAM PI    7/70
W           200.0      50.0            GALTIERI  70 DPWA    K-P TO SIGMA PI   7/70
W           280.0      40.0            LITCHFIEL 70 DPWA    K- N TO LAM PI    7/70
W    9     (208.0)    (22.0)           KANE      72 DPWA  0 K-P TO PI SIG    10/71
W    2     (108.9)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
W           330.0     (80.0)           KANE      74 DPWA    K-P TO PI SIG    12/81*
W            60.       20.             LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74
W            70.       30.       20.   LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74
W           150.       75.             BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
W           160.       70.       17.   VANHORN   75 DPWA  0 K- P TO LAM PIO  11/75
W    5      157. OR 159.               MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W           300.       80.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W           170.0      25.0            CAMERON2  78 DPWA    K-P TO K*(890) N 12/79
W           . . . . . . . . . .
W     AVERAGE MEANINGLESS (SCALE FACTOR = 2.3)

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                    58  Y*1(1940) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(1940) INTO N KBAR                              938+ 493
P2      Y*1(1940) INTO LAMBDA PI                          1115+ 139
P3      Y*1(1940) INTO SIGMA PI                           1189+ 139
P4      Y*1(1940) INTO Y*0(1520) PI P-WAVE                 134+1520
P5      Y*1(1940) INTO Y*0(1520) PI F-WAVE                 134+1520
P6      Y*1(1940) INTO KBAR DELTA(1232) S-WAVE             493+1232
P7      Y*1(1940) INTO KBAR DELTA(1232) D-WAVE             493+1232
P8      Y*1(1940) INTO Y*1(1385) PI S-WAVE                 139+1385
P9      Y*1(1940) INTO N K*(890), S3 WAVE                  939+ 891

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                    58  Y*1(1940) BRANCHING RATIOS

R1      Y*1(1940) INTO (KBAR N)/TOTAL                      (P1)               9/73
R1   2      (0.21)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R1   5      (0.14)OR  0.13             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1          LESS THAN 0.04             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1       NO SIGNAL FOR THIS STATE WITH X LARGER THAN ABOUT 0.03 IN THE       11/75
R1       ANALYSIS OF HEMINGWAY 75.                                           11/75

R2      Y*1(1940) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P2)
R2          -0.12      0.04            GALTIERI  70 DPWA    K- N TO LAM PI    7/70
R2          -0.14      0.03            LITCHFIEL 70 DPWA    K- N TO LAM PI    7/70
R2   2     (-0.11)                     LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R2          -0.153     0.070           DEVENISH  74       0 FIXED T DISP REL  4/75
R2          -0.04      0.02            BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R2          -0.05      0.03     0.02   VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75
R2   5     (-0.15)OR -0.14             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2          -0.06      0.03            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R2          . . . . . . . . . .
R2   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)

R3      Y*1(1940) FROM KBAR N INTO SIGMA PI                SQRT(P1*P3)
R3          -0.12      0.03            GALTIERI  70 DPWA    K-P TO SIGMA PI   7/70
R3   9     (-0.093)   (0.006)          KANE      72 DPWA  0 K-P TO PI SIG    10/71
R3   2      NOT SEEN                   LEA       73 DPWA    MULTICHNL K-MTRX  9/73
R3          -0.14     (0.04)           KANE      74 DPWA    K-P TO PI SIG    12/81*
R3   5     (+0.16)OR +0.16             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R3          -0.08      0.04            RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R3          . . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R4      Y*1(1940) FROM KBAR N TO Y*0(1520) PI P-WAVE       SQRT(P1*P4)
R4   1      -0.11      0.04            LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74
R4   1   ASSUMES LAMBDA(1520) ELASTICITY=.45,SIGN RLTV. TO SIG(2030) DECAY.  10/74
R4   6      LESS THAN 0.03             CAMERON   77 DPWA  0 K-P TO L(1520)PI  1/78
R4   6   ASSUMES LAMBDA(1520) ELASTICITY=.46.                                 1/78

R5      Y*1(1940) FROM KBAR N TO Y*0(1520) PI F-WAVE       SQRT(P1*P5)
R5   1      -0.08      0.04            LITCHFI2  74 DPWA  0 K-P TO L(1520)PI 10/74
R5   1   ASSUMES LAMBDA(1520) ELASTICITY=.45,SIGN RLTV. TO SIG(2030) DECAY.  10/74
R5   6      0.062      0.021           CAMERON   77 DPWA  0 K-P TO L(1520)PI  1/78
R5   6   ASSUMES LAMBDA(1520) ELASTICITY=.46.                                 1/78
R5          . . . . . . . . . .
R5   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R6      Y*1(1940) FROM KBAR N TO KBAR DELTA(1232) S-WAVE SQRT(P1*P6)
R6   3      -0.16      0.05            LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74
R6   3   SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74

R7      Y*1(1940) FROM KBAR N TO KBAR DELTA(1232) D-WAVE SQRT(P1*P7)
R7   3      -0.14      0.05            LITCHFI3  74 DPWA  0 K-P TO KBAR DEL  10/74
R7   3   SIGN RELATIVE TO SIGMA(2030) DECAY                                  10/74

R8      Y*1(1940) FROM KBAR N TO Y*1(1385) PI S-WAVE       SQRT(P1*P8)
R8   7      +0.066     0.025           CAMERON   78 DPWA  0 K-P TO S(1385)PI  1/78
R8   7   THE SIGN IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST           12/79
R8   7   CONVENTION.                                                         12/79

R9      Y*1(1940) FROM KBAR N INTO N K*(890), S3 WAVE      SQRT(P1*P9)
R9   8      -0.09      0.32            CAMERON2  78 DPWA    K-P TO K*N       12/79
R9   8   UPPER LIMITS ON THE D1 AND D3 WAVES ARE EACH 0.03.                  12/79

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                    REFERENCES FOR Y*1(1940)

GALTIERI 70 DUKE CONF 173        A BARBARO-GALTIERI                   (LBL)IJP
LITCHFIE 70 NP B22 269           P J LITCHFIELD                (RUTHERFORD)IJP
KANE     72 PR D5 1583           D F KANE                             (LBL)IJP
LEA      73 NP B56 77            +MARTIN,MOORHOUSE+  (RHEL+LOUC+GLAS+AARHUS)IJP

DEVENISH 74 NP B81 330           DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
KANE     74 LBL-2452             D.F.KANE                             (LBL)IJP
LITCHFI2 74 NP B74 19            LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
LITCHFI3 74 NP B74 39            LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
BAILLON  75 NP B94 39            P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145           A. J. VAN HORN                       (LBL)IJP
    ALSO 75 NP B87 157           A. J. VAN HORN                       (LBL)IJP

BELLEFON 76 NP B109 129          DE BELLEFON,BERTHON                  (CDEF)IJP
CAMERON  77 NP B131 399          +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
MARTIN   77 NP B127 349          MARTIN,PIDCOCK,MOORHOUSE        (LOUC+GLAS)IJP
    ALSO 77 NP B126 266          MARTIN,PIDCOCK                      (LOUC)
    ALSO 77 NP B126 285          MARTIN,PIDCOCK                      (LOUC)IJP
RLIC     77 NP B119 362          GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
CAMERON  78 NP B143 189          +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
CAMERON2 78 NP B146 327          +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP

                                 PAPERS NOT REFERRED TO IN DATA CARDS

HEMINGWA 75 NP B91 12            HEMINGWAY,EADES,HARMSEN+    (CERN,HEID,MPIM)IJP
GOYAL    77 PR D16 2746          +SOOD                               (DELHI)
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Σ(2000)

S_{11}

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C2  Y*1(2000, JP=1/2-) I=1

WE LIST HERE ALL REPORTED S11 STATES LYING ABOVE
THE Y*1(1750)

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                    C2  Y*1(2000) MASS (MEV)

M           2004.      40.             VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75
M    1      1755. OR 1834.             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
M    1  THE TWO ENTRIES FOR MARTIN 77 CORRESPOND TO EXTRACTION OF RESONANCE
M    1  PARAMETERS FROM THE T-MATRIX POLE AND FROM A B-W FIT, RESPECTIVELY.
M           1955.      15.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
M           1944.0    (15.0)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                    D2  Y*1(2000) WIDTH (MEV)

W            116.      40.             VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75
W    1       413. OR 450.              MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
W            170.      40.             RLIC      77 DPWA    KBAR N MULTICHNL  1/76
W            215.0    (25.0)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                    C2  Y*1(2000) PARTIAL DECAY MODES

                                                         DECAY MASSES
P1      Y*1(2000) INTO N KBAR                              938+ 493
P2      Y*1(2000) INTO LAMBDA PI                          1115+ 134
P3      Y*1(2000) INTO SIGMA PI                           1197+ 139
P4      Y*1(2000) INTO LAMBDA(1520) PI                     139+1520
P5      Y*1(2000) INTO N K*(890), S1 WAVE                  939+ 891
P6      Y*1(2000) INTO N K*(890), D3 WAVE                  939+ 891

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                    C2  Y*1(2000) BRANCHING RATIOS

R1      Y*1(2000) INTO (KBAR N)/TOTAL                      (P1)               1/76
R1   1      (0.62)OR  0.57             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R1   C      (0.44)    (0.05)           RLIC      77 DPWA    KBAR N MULTICHNL  1/76
R1   C   (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1          0.51      (0.05)           GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

R2      Y*1(2000) FROM KBAR N INTO LAMBDA PI               SQRT(P1*P2)
R2          NOT SEEN                   BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R2          +0.07      0.02     0.01   VANHORN   75 DPWA  0 K-P TO LAM PIO   11/75
R2   1     (-0.19)OR -0.18             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R2           0.08      0.03            RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R3      Y*1(2000) FROM KBAR N INTO SIGMA PI                SQRT(P1*P3)        1/76
R3   1     (+0.26)OR +0.24             MARTIN    77 DPWA    KBAR N MULTICHNL 11/77
R3          +0.20      0.04            RLIC      77 DPWA    KBAR N MULTICHNL  1/76

R4      Y*1(2000) FROM KBAR N TO LAMBDA(1520) PI           SQRT(P1*P4)
R4   2      +0.081     0.021           CAMERON   77 DPWA  0 P-WAVE DECAY      1/78
R4   2   ASSUMES LAMBDA(1520) ELASTICITY=0.46.  THE SIGN IS CHANGED HERE TO  12/79
R4   2   BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.                      12/79

R5      Y*1(2000) FROM KBAR N INTO N K*(890), S1 WAVE      SQRT(P1*P5)
R5   3      +0.10      0.02            CAMERON2  78 DPWA    K-P TO K*N       12/79
R5   3   THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST      12/79
R5   3   CONVENTION.                                                         12/79

R6      Y*1(2000) FROM KBAR N INTO N K*(890), D3 WAVE      SQRT(P1*P6)
R6          -0.07      0.03            CAMERON2  78 DPWA    K-P TO K*N       12/79

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                    REFERENCES FOR Y*1(2000)

BAILLON  75 NP B94 39            P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
VANHORN  75 NP B87 145           A. J. VAN HORN                       (LBL)IJP
    ALSO 75 NP B87 157           A. J. VAN HORN                       (LBL)IJP

CAMERON  77 NP B131 399          +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
MARTIN   77 NP B127 349          MARTIN,PIDCOCK,MOORHOUSE        (LOUC+GLAS)IJP
    ALSO 77 NP B126 266          MARTIN,PIDCOCK                      (LOUC)
    ALSO 77 NP B126 285          MARTIN,PIDCOCK                      (LOUC)IJP
RLIC     77 NP B119 362          GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
CAMERON2 78 NP B146 327          +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL    80  TORONTO CONF 159 G.P.GOPAL                              (RHEL)IJP
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Σ(2030) F_{17}

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47  Y*1(2030, JP=7/2+) I=1

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

THIS ENTRY ONLY INCLUDES RESULTS FROM PARTIAL-WAVE
ANALYSES.  PARAMETERS OF PEAKS SEEN IN CROSS-SECTIONS
AND INVARIANT-MASS DISTRIBUTIONS AROUND 2030 MEV ARE
GIVEN IN THE NEXT ENTRY.  EVENTUALLY THE PARTIAL-WAVE ANALYSES SHOULD
GIVE THE BEST RESULTS, AS THEY ISOLATE THE F17 WAVE.  THIS SUPERIORITY
IS, HOWEVER, PROBABLY NOT YET ATTAINED, AND WE RELY ON BOTH ENTRIES
FOR PARAMETERS GIVEN IN THE MAIN BARYON TABLE.
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47  Y*1(2030) MASS (MEV)

M        (2030.0)  (20.0)       WOHL      66 HBC    0 K-P TO LAM PI0     7/66
M         2032.0     6.0        SMART     68 DPWA -   K-N TO LAMBDA PI   6/68
M         2030.0    10.0        BERTHON   70 DPWA   0 K-P TO LAMBDA PI   7/70
M         2035.0    10.0        BERTHON1  70 DPWA   0 K-P TO SIGMA PI   10/70
M         2027.0     6.0        COX       70 DPWA -   K-N TO LAMBDA PI   6/70
M         2010.0    15.0        GALTIERI  70 DPWA   0 K-P TO LAMBDA PI   7/70
M         2000.0    20.0        GALTIERI  70 DPWA   0 K-P TO SIGMA PI    7/70
M         2022.0     4.0        LITCHFIEL 70 DPWA  -0 K-N TO LAMBDA PI   6/70
M         2025.     15.         LITCHFIE  71 DPWA     K-P TO KBAR N     10/71
M    K   (2034.0)  (14.0)       KANE      72 DPWA   0 K-P TO PI SIG     10/71
M    K   KANE 72 IS SUPERSEDED BY KANE 74.
M         2020.0    (6.0)       KANE      74 DPWA     K-P TO PI SIG     12/81*
M         2025.     10.         LITCHFI1  74 DPWA   0 K-P TO L(1820)PI  10/74
M         2035.     10.         LITCHFI2  74 DPWA   0 K-P TO L(1520)PI  10/74
M         2020.     30.         LITCHFI3  74 DPWA   0 K-P TO KBAR DEL   10/74
M         2035.     15.         BAILLON   75 IPWA     KBAR N TO LAM PI  11/75
M         2038.     10.         HEMINGWA  75 DPWA   0 K- P TO KBAR N    11/75
M         2042.     11.         VANHORN   75 DPWA   0 K-P TO LAM PI0    11/75
M        (2030.)                BELLEFON  76 IPWA   0 K- P TO LAM PI     2/77
M    4    2030.      3.         CORDEN    76 DPWA   - K- N TO PI- LAM    2/77
M    4   PREFERRED SOLUTION 3. SEE CORDEN 76 FOR OTHER POSSIBILITIES.    2/77
M    4   CORDEN 76 INCLUDES THE DATA OF COX 70 AS A SUBSAMPLE.
M    C    2038.     10.         CORDEN2   77          - K- N TO K* N    11/77
M    6    2027. TO 2057.        GOYAL     77 DPWA   - K- N TO SIG PI     1/78
M         2040.      5.         RLIC      77 DPWA     KBAR N MULTICHNL   1/76
M         2036.0    (5.0)       GOPAL     80 DPWA     KBAR N ELASTIC    12/81*
M             . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)
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47  Y*1(2030) WIDTH (MEV)

W        (170.0)                     WOHL      66 HBC    0                    7/66
W         160.0    16.0              SMART     68 DPWA -   K-N TO LAMBDA PI   6/68
W         165.0    30.0    15.0      BERTHON   70 DPWA   0 K-P TO LAMBDA PI   7/70
W         150.0    20.0              BERTHON1  70 DPWA   0 K-P TO SIGMA PI   10/70
W         158.0    16.0              COX       70 DPWA -   K-N TO LAMBDA PI   6/70
W         115.0    15.0              GALTIERI  70 DPWA   0 K-P TO LAMBDA PI   7/70
W         100.0    40.0              GALTIERI  70 DPWA   0 K-P TO SIGMA PI    7/70
W         170.0    15.0              LITCHFIEL 70 DPWA  -0 K-N TO LAMBDA PI   6/70
W         200.     30.               LITCHFIE  71 DPWA     K-P TO KBAR N     10/71
W    K   (118.0)  (12.0)             KANE      72 DPWA   0 K-P TO PI SIG     10/71
W         111.0   (5.0)              KANE      74 DPWA     K-P TO PI SIG     12/81*
W          70. TO 125.               LITCHFI1  74 DPWA   0 K-P TO L(1820)PI  10/74
W         160.     20.               LITCHFI2  74 DPWA   0 K-P TO L(1520)PI  10/74
W         200.     30.               LITCHFI3  74 DPWA   0 K-P TO KBAR DEL   10/74
W         180.     20.               BAILLON   75 IPWA     KBAR N TO LAM PI  11/75
W         172.     15.               HEMINGWA  75 DPWA   0 K- P TO KBAR N    11/75
W         178.     13.               VANHORN   75 DPWA   0 K-P TO LAM PI0    11/75
W        (160.)                      BELLEFON  76 IPWA   0 K- P TO LAM PI     2/77
W    4    201.      9.               CORDEN    76 DPWA   - K- N TO PI- LAM    2/77
W    C    137.     40.               CORDEN2   77          - K- N TO K* N    11/77
W        (260.)                      DECLAIS   77 DPWA     KBAR N TO KBAR N   1/78
W    6    126. TO 195.               GOYAL     77 DPWA   - K- N TO SIG PI     1/78
W         190.     10.               RLIC      77 DPWA     KBAR N MULTICHNL   1/76
W         172.0   (10.0)             GOPAL     80 DPWA     KBAR N ELASTIC    12/81*
W             . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)
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47  Y*1(2030) PARTIAL DECAY MODES

                                                          DECAY MASSES
P1      Y*1(2030) INTO N KBAR                              938+ 493
P2      Y*1(2030) INTO LAMBDA PI                          1115+ 134
P3      Y*1(2030) INTO SIGMA PI                           1189+ 139
P4      Y*1(2030) INTO XI K                               1321+ 497
P5      Y*1(2030) INTO Y*0(1820) PI P-WAVE                 134+1820
P6      Y*1(2030) INTO Y*0(1520) PI D-WAVE                 134+1520
P7      Y*1(2030) INTO Y*0(1520) PI G-WAVE                 134+1520
P8      Y*1(2030) INTO KBAR DELTA(1232) F-WAVE             493+1232
P9      Y*1(2030) INTO KBAR DELTA(1232) H-WAVE             493+1232
P10     Y*1(2030) INTO Y*1(1385) PI F-WAVE                 139+1385
P11     Y*1(2030) INTO N K*(890), F1 WAVE                  939+ 891
P12     Y*1(2030) INTO N K*(890), F3 WAVE                  939+ 891
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47  Y*1(2030) BRANCHING RATIOS

R1      Y*1(2030) INTO (KBAR N)/TOTAL                        (P1)
R1          (0.25)                 WOHL      66 HBC    0 K-P CH EX          7/66
R1  O       (0.11)                 DAUM      68 CNTR     K-P ELA,POL,SIGT   7/70
R1  O    DAUM 68 ASSUMES (J+1/2)*P1 VALUE SEEN IN TOTAL CROSS SECTION.
R1           0.17       0.04       CAMPBELL  71 DBC  -   K- NEUTRON ELAST   1/71
R1           0.18       0.02       LITCHFIE  71 DPWA     K-P TO KBAR N     10/71
R1           0.18       0.03       HEMINGWA  75 DPWA   0 K- P TO KBAR N    11/75
R1          (0.15)                 DECLAIS   77 DPWA     KBAR N TO KBAR N   1/78
R1  C       (0.24)     (0.02)      RLIC      77 DPWA     KBAR N MULTICHNL   1/76
R1  C    (KBAR N)/TOTAL FROM RLIC 77 IS SUPERSEDED BY GOPAL 80.
R1           0.19      (0.03)      GOPAL     80 DPWA     KBAR N ELASTIC    12/81*
R1             . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

R2      Y*1(2030) FROM KBAR N INTO LAMBDA PI            SQRT(P1*P2)
R2          (0.20)                 WOHL      66 HBC    0 K-P TO LAMBDA PI   7/66
R2          +0.21       0.01       SMART     68 DPWA -   K-N TO LAMBDA PI   6/68
R2          +0.2        0.02       BERTHON   70 DPWA   0 K-P TO LAMBDA PI   7/70
R2          +0.19       0.01       COX       70 DPWA -   K-N TO LAMBDA PI   6/70
R2          +0.16       0.03       GALTIERI  70 DPWA   0 K-P TO LAMBDA PI   7/70
R2          +0.20       0.008      LITCHFIEL 70 DPWA  -0 K-N TO LAMBDA PI   6/70
R2          +0.195      0.053      DEVENISH  74          0 FIXED T DISP REL 4/75
R2          +0.18       0.02       BAILLON   75 IPWA     KBAR N TO LAM PI  11/75
R2          +0.20       0.01       VANHORN   75 DPWA   0 K-P TO LAM PI0    11/75
R2          (0.20)                 BELLEFON  76 IPWA   0 K- P TO LAM PI     2/77
R2  4       +0.20       0.01       CORDEN    76 DPWA   - K- N TO PI- LAM    2/77
R2          +0.18       0.02       RLIC      77 DPWA     KBAR N MULTICHNL   1/76

R3      Y*1(2030) FROM KBAR N INTO SIGMA PI              SQRT(P1*P3)
R3  L      (-0.091)    (0.02)      BERTHON1  70 DPWA   0 K-P TO SIGMA PI   10/70
R3          -0.052      0.010      GALTIERI  70 DPWA   0 K-P TO SIGMA PI    7/70
R3          -0.10       0.03       LITCHFIE  71 DPWA     K-P TO SIG PI      3/72
R3  L    LITCHFIELD 71 IS AN UPDATE OF BERTHON1 70                          3/72
R3  K      (-0.086)    (0.014)     KANE      72 DPWA   0 K-P TO PI SIG     10/71
R3          -0.10      (0.01)      KANE      74 DPWA     K-P TO PI SIG     12/81*
R3  A       -0.09       0.01       CORDEN1   77          - K- N TO PI SIG  11/77
R3  B       -0.06       0.01       CORDEN1   77          - K- N TO PI SIG  11/77
R3  A    THE 2 ENTRIES FOR CORDEN1 77 ARE FROM 2 DIFFERENT ACCEPTABLE SLTNS. 11/77
R3  6      (-0.085)    (0.02)      GOYAL     77 DPWA   - K- N TO SIG PI     1/78
R3  6    THIS COUPLING IS EXTRACTED FROM UNNORMALIZED DATA.                 1/78
R3          -0.15       0.03       RLIC      77 DPWA     KBAR N MULTICHNL   1/76
R3             . . . . . . . . . .
R3  AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

R4      Y*1(2030) FROM KBAR N INTO XI K                  SQRT(P1*P4)
R4          (0.05) OR LESS         TRIPP     67 RVUE   0 K-P TO XI K        6/67
R4          (0.05) OR LESS         BURGUN    68 DPWA   0 K-P TO XI K       10/69
R4          (0.023)                MULLER    69 DPWA   0                    7/70

R5      Y*1(2030) FROM KBAR N TO Y*0(1820) PI P-WAVE     SQRT(P1*P5)
R5  1        0.18       0.04       LITCHFI1  74 DPWA   0 K-P TO L(1820)PI  10/74
R5  1    ASSUMES LAMBDA(1820) ELASTICITY=.6                                10/74
R5           0.14       0.02       CORDEN2   75 DBC    - KBAR PI- NUCLEON  11/75
R5             . . . . . . . . . .
R5  AVG      0.148      0.019   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R6      Y*1(2030) FROM KBAR N TO Y*0(1520) PI D-WAVE     SQRT(P1*P6)
R6  2        0.14       0.03       LITCHFI2  74 DPWA   0 K-P TO L(1520)PI  10/74
R6  2    ASSUMES LAMBDA(1520) ELASTICITY=.45                               10/74
R6  3       (0.10)     (0.03)      CORDEN2   75 DBC    - KBAR PI- NUCLEON  11/75
R6  3    UPPER LIMIT                                                       11/75
R6  5       +0.114      0.010      CAMERON   77 DPWA   0 K-P TO L(1520)PI   1/78
R6  5    ASSUMES LAMBDA(1520) ELASTICITY=.46.  THE SIGN IS CHANGED HERE TO  12/79
R6  5    BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.                    12/79
R6             . . . . . . . . . .
R6  AVG      0.1166     0.0095  AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

R7      Y*1(2030) FROM KBAR N TO Y*0(1520) PI G-WAVE     SQRT(P1*P7)
R7  2        0.02       0.02       LITCHFI2  74 DPWA   0 K-P TO L(1520)PI  10/74
R7  2    ASSUMES LAMBDA(1520) ELASTICITY=.45                               10/74
R7  5       +0.146      0.010      CAMERON   77 DPWA   0 K-P TO L(1520)PI   1/78
R7  5    ASSUMES LAMBDA(1520) ELASTICITY=.46.  THE SIGN IS CHANGED HERE TO  12/79
R7  5    BE IN ACCORD WITH THE BARYON-FIRST CONVENTION.                    12/79
R7             . . . . . . . . . .
R7  AVG      0.121      0.050   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 5.6)

R8      Y*1(2030) FROM KBAR N TO KBAR DELTA(1232) F-WAVE SQRT(P1*P8)
R8           0.16       0.03       LITCHFI3  74 DPWA   0 K-P TO KBAR DEL   10/74
R8  3       (0.17)     (0.03)      CORDEN2   75 DBC    - KBAR PI- NUCLEON  11/75
R8  3    UPPER LIMIT                                                       11/75

R9      Y*1(2030) FROM KBAR N TO KBAR DELTA(1232) H-WAVE SQRT(P1*P9)
R9           0.00       0.02       LITCHFI3  74 DPWA   0 K-P TO KBAR DEL   10/74

R10     Y*1(2030) FROM KBAR N TO Y*1(1385) PI F-WAVE     SQRT(P1*P10)
R10 7       +0.153      0.026      CAMERON   78 DPWA   0 K-P TO S(1385)PI   1/78
R10 7    THE SIGN IS CHANGED HERE TO BE IN ACCORD WITH THE BARYON-FIRST    12/79
R10 7    CONVENTION.                                                       12/79

R11     Y*1(2030) FROM KBAP N INTO N K*(890), F1 WAVE    SQRT(P1*P11)
R11         -0.02       0.01       CORDEN2   77            K-D TO K*N      12/79
R11 8       +0.06       0.03       CAMERON2  78 DPWA       K-P TO K*N      12/79
R11 8    THE SIGN HERE IS CHANGED TO BE IN ACCORD WITH THE BARYON-FIRST    12/79
R11 8    CONVENTION.                                                       12/79
R11            . . . . . . . . . .
R11 AVG MOD  0.024      0.012   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.3)

R12     Y*1(2030) FROM KBAR N INTO N K*(890), F3 WAVE    SQRT(P1*P12)
R12         -0.12       0.02       CORDEN2   77            K-D TO K*N      12/79
R12 9       +0.04       0.03       CAMERON2  78 DPWA       K-P TO K*N      12/79
R12 9    THE UPPER LIMIT ON THE G3 WAVE IS 0.03.                           12/79
R12            . . . . . . . . . .
R12 AVG MOD  0.095      0.037   AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.2)

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REFERENCES FOR Y*1(2030)


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WOHL      66 PRL 17 107          C G WOHL, F T SOLMITZ, M L STEVENSON  (LRL)IJP
TRIPP     67 NP B3 10            + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
BURGUN    68 NP B8 447           +MEYER,PAULI,TALLINI +      (SACL+CDEF+RHEL)
DAUM      68 NP B7 19            +ERNE,LAGNAUX,SENS,STEUER,UDO         (CERN)JP
    CONFIRMS THE SPIN-PARITY ASSIGNMENT.
SMART     68 PR 169 1336         W M SMART                              (LRL)IJP
MULLER    69 THESIS,UCRL 19372 R A MULLER                              (LRL)

BERTHON   70 NP B20 476          +RANGAN, VRANA, +(CDL FRANCE, RHEL, SACLAY)IJP
BERTHON1  70 NP B24 417          +VRANA, BUTTERWORTH, + (CDEF, RHEL, SACLAY)IJP
COX       70 NP B19 61           +ISLAM, COLLEY, +     (BIRM,EDIN,GLAS,LOIC)IJP
GALTIERI  70 DUKE CONF 173       A BARBARO-GALTIERI                     (LRL)IJP
LITCHFIE  70 NP B22 269          P J LITCHFIELD                  (RUTHERFORD)IJP

CAMPBELL  71 NP B25 75           +MORTON, NEGUS, GOYAL, MILLER  (GLAS, LOIC)IJP
LITCHFIE  71 NP B30 125          LITCHFIELD....+LESQUOY,+..  (RHEL+CDEF+SACL)IJP
KANE      72 PR D5 1583          D F KANE                               (LBL)IJP

DEVENISH  74 NP B81 330          DEVENISH,FROGGATT,MARTIN(DESY,NORDITA,LOUC)
KANE      74 LBL-2452            D.F.KANE                               (LBL)IJP
LITCHFI1  74 NP B74 12           LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
LITCHFI2  74 NP B74 19           LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP
LITCHFI3  74 NP B74 39           LITCHFIELD,HEMINGWAY,BAILLON,+  (CERN+HEID)IJP

BAILLON   75 NP B94 39           P. BAILLON,P. J. LITCHFIELD     (CERN,RHEL)IJP
CORDEN2   75 NP B92 365          +COX,DARTNELL,KENYON,ONEALE,SUMOROK+ (BIRM)IJP
HEMINGWA  75 NP B91 12           HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
VANHORN   75 NP B87 145          A. J. VAN HORN                         (LBL)IJP
     ALSO 75 NP B87 157          A. J. VAN HORN                         (LBL)IJP
BELLEFON  76 NP B109 129         DE BELLEFON,BERTHON                   (CDEF)IJP
CORDEN    76 NP B104 382         +COX,DARTNELL,KENYON,ONEALE,SUMOROK+ (BIRM)IJP

CAMERON   77 NP B131 399         +FRANEK,GOPAL,KALMUS,MCPHERSON+ (RHEL+LOIC)IJP
CORDEN1   77 NP B125 61          +COX,KENYON,ONEALE,STUBBS,SUMOROK+    (BIRM)IJP
CORDEN2   77 NP B121 365         +COX,KENYON,ONEALE,STUBBS,SUMOROK+    (BIRM)IJP
DECLAIS   77 CERN 77-16          +DUCHON,LOUVEL,PATRY,SEGUINOT+  (CAEN+CERN)IJP
GOYAL     77 PRD 16 2746         D.P.GOYAL,A.V.SODHI              (DELHI UNIV.)IJP
RLIC      77 NP B119 362         GOPAL,ROSS,VAN HORN,MCPHERSON+  (LOIC+RHEL)IJP
CAMERON   78 NP B143 189         +FRANEK,GOPAL,BACON,BUTTERWORTH+(RHEL+LOIC)IJP
CAMERON2  78 NP B146 327         +FRANEK,GOPAL,KALMUS,MCPHERSON,+(RHEL+LOIC)IJP
GOPAL     80 TORONTO CONF 159 G.P.GOPAL                               (RHEL)IJP

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2030 MEV REGION - PRODUCTION AND σ_{TOTAL} EXP'TS

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                 28  Y*1(2030, JP=    ) I=1       PRODUCTION EXPERIMENTS

                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                 SEE THE NOTE TO THE F17 Y*1(2030), WHICH PRECEDES THIS
                 ENTRY.  HERE WE LIST ONLY PARAMETERS OF PEAKS IN CROSS
                 SECTIONS AND INVARIANT-MASS DISTRIBUTIONS.  THE CROSS-
   SECTION PEAKS ARE AT LEAST DOMINANTLY ASSOCIATED WITH THE Y*1(2030),
   BUT MAY CONTAIN A SMALL CONTRIBUTION FROM THE SUGGESTED BUT NOT ESTAB-
   LISHED OTHER RESONANCES IN THIS REGION.

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                 28  Y*1(2030) MASS (MEV) (PROD. EXP.)

M        (2022.0)   (20.0)        BLANPIED  65 CNTR  0 GAMMA P TO K+ Y*
M         2020.0      7.0         BUGG      68 CNTR    K-P, 0 TOTAL      6/68
M         2049.0      4.0         BRICMAN   70 CNTR    TOTAL AND CH EX   6/70
M         2025.0     10.0         COOL      70 CNTR    K-P, D TOTAL     10/70
M        (2025.0)   (20.0)        LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.8)

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                 28  Y*1(2030) WIDTH (MEV) (PROD. EXP.)

W         (120.0)   (20.0)        BLANPIED  65 CNTR  0
W          130.0     10.0         BUGG      68 CNTR                      6/68
W          126.0     11.0         BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
W          165.0                  COOL      70 CNTR    K-P, D TOTAL     10/70
W          (80.0)                 LU        70 CNTR  0 GAMMA P TO K+ Y*  1/71
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 28  Y*1(2030) PARTIAL DECAY MODES (PROD. EXP.)

                                                       DECAY MASSES
P1     Y*1(2030) INTO N KBAR                          938+ 493
P2     Y*1(2030) INTO N KBAR PI                       938+ 497+ 139

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                 28  Y*1(2030) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2030) INTO (KBAR N)/TOTAL                     (P1)
R1        THESE VALUES OF ELASTICITIES ASSUME J=7/2 --
R1          0.131                 BUGG      68 CNTR                      6/68
R1          0.27     (0.02)       BRICMAN   70 CNTR  0 TOTAL AND CH EX   6/70
R1          0.12                  COOL      70 CNTR    K-P, D TOTAL     10/70

R2     Y*1(2030) INTO (KBAR N PI)/TOTAL                  (P2)
R2             SEEN               BOCK         HBC

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                        REFERENCES FOR Y*1(2030) (PROD. EXP.)

BLANPIED 65 PRL 14 741         +GREENBERG,HUGHES,KITCHING,LU,+ (YALE(CEA))
COOL     66 PRL 16 1228        +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
   SUPERSEDED BY COOL 70.
BUGG     68 PR 168 1466        +GILMORE,KNIGHT, +          (RHEL,BIRM,CAVE) I

BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887         +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
LU       70 PR D2 1846         +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

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Σ(2070) → **F''_{15}**

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                 34  Y*1(2070, JP=5/2+) I=1

                 THIS STATE SUGGESTED BY BERTHON 70 NOW FINDS
                 CONFIRMATION IN GOPAL 80 WITH NEW K-P POLARIZATION AND
                 K- NEUTRON ANGULAR DISTRIBUTIONS.  THE VERY BROAD STATE
                 SEEN IN KANE 72 IS NOT REQUIRED IN THE LATER (KANE 74)
                 ANALYSIS OF PI SIGMA.

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                 34  Y*1(2070) MASS (MEV)

M        (2070.)    (10.)         BERTHON1  70 DPWA -  K- P TO SIG PI    1/71
M        (2057.0)                 KANE      72 DPWA    K-P TO SIGMA PI   1/73
M         2051.0    (25.0)        GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                 34  Y*1(2070) WIDTH (MEV)

W         (140.)    (20.)         BERTHON1  70 DPWA -  K- P TO SIG PI    1/71
W        (906.0)                  KANE      72 DPWA    K-P TO SIGMA PI   1/73
W         300.0     (30.0)        GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                 34  Y*1(2070) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     Y*1(2070) INTO N KBAR                        938+ 493
P2     Y*1(2070) INTO SIGMA PI                     1189+ 139

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                 34  Y*1(2070) BRANCHING RATIOS

R1     Y*1(2070) FROM KBAR N TO SIGMA PI                SQRT(P1*P2)
R1         (+0.12)   (0.02)       BERTHON1  70 DPWA -  K- P TO SIG PI    1/71
R1         (+0.104)               KANE      72 DPWA    K-P TO SIGMA PI   1/73

R2     Y*1(2070) INTO (KBAR N)/TOTAL                    (P1)
R2            0.08   (0.03)       GOPAL     80 DPWA    KBAR N ELASTIC   12/81*

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                        REFERENCES FOR Y*1(2070)

BERTHON1 70 NP B24 417         +VRANA,BUTTERWORTH,+     (CDEF,RHEL,SACLAY)IJP
KANE     72 PR D5 1583         D F KANE                                 (LBL)
GOPAL    80 TORONTO CONF 159 G.P.GOPAL                               (RHEL)IJP

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Σ(2080) → **P'''_{13}**

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                 88  Y*1(2080, JP=3/2+) I=1

                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

                 SUCH A RESONANCE IS SUGGESTED BY SOME BUT NOT ALL
                 PARTIAL-WAVE ANALYSES ACROSS THIS REGION.  UNTIL THERE
                 IS MORE EVIDENCE, WE OMIT THIS STATE FROM THE MAIN
                 BARYON TABLE.

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                 88  Y*1(2080) MASS (MEV)

M         (2082.0)    (4.0)       COX       70 DPWA -  K- N TO LAM PI    6/70
M         (2070.0)   (30.0)       LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
M    1     2120.      40.         BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
M    1  FROM SOLUTION 1 OF BAILLON 75.                                   1/76
M    2     2140.      40.         BAILLON   75 IPWA    KBAR N TO LAM PI  1/76
M    2  FROM SOLUTION 2 OF BAILLON 75.                                   1/76
M          2140.      30.         BELLEFOI  75 DPWA  0 K- P TO LAM PI0  11/75
M    3     2070. TO 2120.         BELLEFON  76 IPWA  0 K- P TO LAM PI    2/77
M    3  SUPERSEDES BELLEFOI 75.                                          2/77
M    4     2091.       7.         CORDEN    76 DPWA  - K- N TO PI- LAM   2/77
M    4  PREFERRED SOLUTION 3. SEE CORDEN 76 FOR OTHER POSSIBILITIES.     2/77
M    4  INCLUDING A D15 AT THIS MASS.                                    2/77
M    4  CORDEN 76 INCLUDES THE DATA OF COX 70 AS A SUBSAMPLE.
M           . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.6)

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                 88  Y*1(2080) WIDTH (MEV)

W           (87.0)   (20.0)       COX       70 DPWA -  K- N TO LAM PI    6/70
W          (250.0)   (40.0)       LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
W    1      240.      50.         BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
W    2      200.      50.         BAILLON   75 IPWA    KBAR N TO LAM PI  1/76
W           180.      20.         BELLEFOI  75 DPWA  0 K- P TO LAM PI0  11/75
W    3     (100.)                 BELLEFON  76 IPWA  0 K- P TO LAM PI    2/77
W    4      186.      48.         CORDEN    76 DPWA  - K- N TO PI- LAM   2/77
W           . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                 88  Y*1(2080) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     Y*1(2080) INTO N KBAR                        938+ 493
P2     Y*1(2080) INTO LAMBDA PI                    1115+ 139

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                 88  Y*1(2080) BRANCHING RATIOS

R1     Y*1(2080) FROM KBAR N TO LAMBDA PI               SQRT(P1*P2)
R1         (-0.16)   (0.03)       COX       70 DPWA -  K- N TO LAM PI    6/70
R1         (-0.09)   (0.03)       LITCHFIEL 70 DPWA -0 K- N TO LAM PI    6/70
R1   1      -0.13     0.04        BAILLON   75 IPWA    KBAR N TO LAM PI 11/75
R1   2      -0.13     0.04        BAILLON   75 IPWA    KBAR N TO LAM PI  1/76
R1          +0.19     0.03        BELLEFOI  75 DPWA  0 K- P TO LAM PI0  11/75
R1   3     (-0.10)                BELLEFON  76  PWA  0 K- P TO LAM PI    2/77
R1   4      -0.10     0.03        CORDEN    76  PWA  - K- N TO PI- LAM   2/77
R1          . . . . . . . . . .
R1  AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)

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                        REFERENCES FOR Y*1(2080)

COX      70 NP B19 61          +ISLAM, COLLEY, +      (BIRM,EDIN,GLAS,LOIC)IJP
LITCHFIE 70 NP B22 269         P J LITCHFIELD                   (RUTHERFORD)IJP
BAILLON  75 NP B94 39          P. BAILLON,P. J. LITCHFIELD      (CERN,RHEL)IJP
BELLEFOI 75 NP B90 1           DE BELLEFON,BERTHON,BRUNET+      (CDEF,SACL)IJP

BELLEFON 76 NP B109 129        DE BELLEFON,BERTHON                    (CDEF)IJP
CORDEN   76 NP B104 382        +COX,DARTNELL,KENYON,ONEALE,SUMORDK+ (BIRM)IJP

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Σ(2100) → **G_{17}**

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                 26  Y*1(2100, JP=7/2-) I=1

                 SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                 26  Y*1(2100) MASS (MEV)

M        (2060.0)   (20.0)        GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
M        (2120.0)   (30.0)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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                 26  Y*1(2100) WIDTH (MEV)

W          (70.0)   (30.0)        GALTIERI  70 DPWA  0 K-P TO LAMBDA PI  7/70
W         (135.0)   (30.0)        GALTIERI  70 DPWA  0 K-P TO SIGMA PI   7/70

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                 26  Y*1(2100) PARTIAL DECAY MODES

                                                     DECAY MASSES
P1     Y*1(2100) INTO N KBAR                        938+ 493
P2     Y*1(2100) INTO LAMBDA PI                    1115+ 134
P3     Y*1(2100) INTO SIGMA PI                     1139+ 139

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                 26  Y*1(2100) BRANCHING RATIOS

R1     Y*1(2100) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P2)
R1          (-0.07)   (0.02)          GALTIERI  70 DPWA  0 K-P TO LAMBDA PI   7/70

R2     Y*1(2100) FROM KBAR N TO SIGMA PI                  SQRT(P1*P3)
R2          (+0.13)   (0.02)          GALTIERI  70 DPWA  0 K-P TO SIGMA PI    7/70

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                         REFERENCES FOR Y*1(2100)

GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                     (LRL)IJP

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Σ(2250) BUMPS

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            48  Y*1(2250, JP=    ) I=1        PRODUCTION EXPERIMENTS

            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

            THE PARTIAL-WAVE ANALYSIS RESULTS ARE TOO WEAK TO
            WARRANT SEPARATING THEM FROM THE PRODUCTION AND CROSS-
            SECTION EXPERIMENTS.
   LASINSKI 71 IN KBAR N, USING A POMERON+RESONANCES MODEL, AND
 BELLEFONI 76, BELLEFON 77, AND BELLEFON 78 (COLLEGE DE FRANCE-
 SACLAY GROUP) IN DPWA'S OF KBAR N TO LAMBDA PI, SIGMA PI, AND KBAR N,
 RESPECTIVELY, SUGGEST THE PRESENCE OF TWO RESONANCES AROUND THIS
 MASS VALUE.

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                 48  Y*1(2250) MASS (MEV) (PROD. EXP.)

M          (2245.0)                      BLANPIED  65 CNTR    GAMMA P TO K+ Y*
M          (2299.0)    (6.0)             BOCK      65 HBC     PBAR P 5.7 BEV/C
M           2250.0      7.0              BUGG      68 CNTR    K-P, D TOTAL       6/68
M           2280.      14.0              AGUILAR   70 HBC  +  K- 3.9-4.6 GEV/C   5/70
M           2237.0     11.0              BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
M           2255.0     10.0              COOL      70 CNTR    K-P, D TOTAL      10/70
M          (2250.0)   (20.0)             LU        70 CNTR  0 GAMMA P TO K+ Y*   1/71
M    B     (2260.)    (30.)              BELLEFO1  75 DPWA    D5 WAVE           11/75
M    B     (2215.)    (10.)              BELLEFO1  75 DPWA    G9 OR H11 WAVE    11/75
M    B   EVIDENCE FOR 2 RESONANCES IN THIS LAMBDA PI DPWA                       11/75
M     1     2300.      30.               BELLEFO2  75 HBC   0 K- P TO XI*0 KO   11/75
M     V     2251.      30.       20.     VANHORN   75 DPWA  0 K-P TO LAM PI0    11/75
M     V    VANHORN72 VALUE FROM A DPWA THAT FINDS JP=5/2+.
M    2     (2260.)                       BELLEFON  76 IPWA  0 D5 WAVE            2/77
M    2     (2215.)                       BELLEFON  76 IPWA  0 G9 WAVE            2/77
M    2   SUPERSEDES BELLEFO1 75.                                                 2/77
M           2275.      20.               BELLEFON  77 DPWA  0 D5 WAVE           11/77
M           2215.      20.               BELLEFON  77 DPWA  0 G9 WAVE           11/77
M           2270.      50.               BELLEFON  78 DPWA  0 D5 WAVE            1/78
M           2210.      30.               BELLEFON  78 DPWA  0 G9 WAVE            1/78
M           . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 1.4)

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                 48  Y*1(2250) WIDTH (MEV) (PROD. EXP.)

W           (150.0)                      BLANPIED  65 CNTR    GAMMA P TO K+ Y*
W           (21.0)    (17.0)    (21.0)   BOCK      65 HBC     PBAR P 5.7 GEV/C
W           230.0      20.0              BUGG      68 CNTR    K-P, D TOTAL       6/68
W           100.0      20.0              AGUILAR   70 HBE  +  K- 3.9-4.6 GEV/C   5/70
W           164.0      50.0              BRICMAN   70 CNTR  0 TOTAL AND CH EX    6/70
W           (170.0)                      COOL      70 CNTR    K-P, D TOTAL      10/70
W           (125.0)                      LU        70 CNTR  0 GAMMA P TO K+ Y*   1/71
W    B      (100.)    (20.)              BELLEFO1  75 DPWA    D5 WAVE           11/75
W    B      (60.)     (40.)     (20.)    BELLEFO1  75 DPWA    G9 OR H11 WAVE    11/75
W     1      130.      20.               BELLEFO2  75 HBC   0 K- P TO XI*0 KO   11/75
W     V      192.      30.               VANHORN   75 OPWA  0 K-P TO LAM PI0    11/75
W    2      (100.)                       BELLEFON  76 IPWA  0 D5 WAVE            2/77
W    2      (140.)                       BELLEFON  76 IPWA  0 G9 WAVE            2/77
W             70.      20.               BELLEFON  77 DPWA  0 D5 WAVE           11/77
W             60.      20.               BELLEFON  77 DPWA  0 G9 WAVE           11/77
W            120.      40.               BELLEFON  78 DPWA  0 D5 WAVE            1/78
W             80.      20.               BELLEFON  78 DPWA  0 G9 WAVE            1/78
W           . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

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                 48  Y*1(2250) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*1(2250) INTO N KBAR                               938+ 493
P2     Y*1(2250) INTO LAMBDA PI                           1115+ 134
P3     Y*1(2250) INTO SIGMA PI                            1189+ 139
P4     Y*1(2250) INTO N KBAR PI                            936+ 497+ 139
P5     Y*1(2250) INTO XI*1/2(1530) K                      1533+ 497

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                 48  Y*1(2250) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2250) INTO (KBAR N)/TOTAL                      (P1)
R1            0.08      0.02          BELLEFON  78 DPWA  0 D5 WAVE            1/78
R1            0.02      0.01          BELLEFON  78 DPWA  0 G9 WAVE            1/78
R1          . . . . . . . . . .
R1   AVERAGE MEANINGLESS (SCALE FACTOR = 2.7)

R2     Y*1(2250) FROM KBAR N TO LAMBDA PI                 SQRT(P1*P2)
R2          (-0.18)(FOR JP=9/2-)      GALTIERI  70 DPWA    K-P TO LAMBDA PI 10/70
R2   B      (+0.12)   (0.03)          BELLEFO1  75 DPWA    D5 WAVE          11/75
R2   B      (-0.09)   (0.02)          BELLEFO1  75 DPWA    G9 OR H11 WAVE   11/75
R2    V      -0.16     0.03           VANHORN   75 DPWA  0 K-P TO LAM PI0   11/75
R2   2      (+0.11)                   BELLEFON  76 IPWA  0 D5 WAVE           2/77
R2   2      (-0.10)                   BELLEFON  76 IPWA  0 G9 WAVE           2/77
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED

R3     Y*1(2250) FROM KBAR N TO SIGMA PI                  SQRT(P1*P3)
R3          (+0.07)(FOR JP=9/2-)      GALTIERI  70 DPWA    K-P TO SIGMA PI  10/70
R3           +0.06     0.02           BELLEFON  77 DPWA  0 D5 WAVE          11/77
R3           -0.03     0.02           BELLEFON  77 DPWA  0 G9 WAVE          11/77
R3          . . . . . . . . . .
R3   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

R4     Y*1(2250) INTO (KBAR N)/(SIGMA PI)                 (P1)/(P3)
R4          (0.18) OR LESS            BARNES    69 HBC  +  1 STAN DEV LIMIT 10/69

R5     Y*1(2250) INTO (LAMBDA PI)/(SIGMA PI)              (P2)/(P3)
R5          (0.18) OR LESS            BARNES    69 HBC  +  1 STAN DEV LIMIT 10/69

R6     Y*1(2250) FROM K- P TO XI*1/2(1530)0 K0            SQRT(P1*P5)          11/75
R6   1        0.09      0.02          BELLEFO2  75 HBC   0 K- P TO XI*0 K0    11/75
R6   1   SEEN IN D05 WAVE IN NEUTRAL CHANNEL ONLY. ISOSPIN UNDETERMINED.       11/75

R7     Y*1(2250) INTO (KBAR N)/TOTAL                      (J+1/2)*(P1)
R7        J IS NOT DETERMINED IN THESE EXPTS.  THE FOLLOWING IS (J+1/2)*P1.
R7           (0.47)                   BUGG      68 CNTR                        3/78
R7           (0.16)   (0.12)          BRICMAN   70 CNTR  0 TOTAL AND CH EX     3/78
R7           (0.42)                   COOL      70 CNTR    K-P, D TOTAL        3/78

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                         REFERENCES FOR Y*1(2250) (PROD. EXP.)
BLANPIED 65 PRL 14 741        +GREENBERG,HUGHES,KITCHING, +   (YALE(CEA))
BOCK     65 PL 17 166         +COOPER,FRENCH,KINSON, +        (CERN,SACLAY)
BUGG     68 PR 168 1466       +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
BARNES   69 PRL 22 479        +FLAMINIO,MONTANET,SAMIOS +        (BNL+SYRA)

AGUILAR  70 PRL 25 58         AGUILAR-BENITEZ, BARNES, +         (BNL,SYRA)
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)
COOL     70 PR D1 1887        +GIACOMELLI, KYCIA, LEONTIC, LI, +    (BNL) I
GALTIERI 70 DUKE CONF 173     A BARBARO-GALTIERI                   (LRL)IJP
LU       70 PR D2 1846        +GREENBERG, HUGHES, MINEHART, MORI,+ (YALE)

BELLEFO1 75 NP B90 1          DE BELLEFO2,BERTHON,BRUNET+      (CDEF+SACL)IJP
BELLEFO2 75 NC 28A 289        DE BELLEFO2,BERTHON,BILLOIR+     (CDEF,SACL)
VANHORN  75 NP B87 145        A. J. VAN HORN                        (LBL)IJP
    ALSO 75 NP B87 157        A. J. VAN HORN                        (LBL)IJP

BELLEFON 76 NP B109 129       DE BELLEFON,BERTHON                  (CDEF)IJP
BELLEFON 77 NC 37A 175        DE BELLEFON,BERTHON,BILLOIR+     (CDEF+SACL)IJP
BELLEFON 78 NC 42A 403        +BERTHON,BILLOIR,BRUNET+         (CDEF+SACL)IJP

                              PAPERS NOT REFERRED TO IN DATA CARDS

COOL     66 PRL 16 1228       +GIACOMELLI,KYCIA,LEONTIC,LI,LUNDBY,+ (BNL) I
    SUPERSEDED BY COOL 70.
DAUBER   66 PL 23 154         +SCHLEIN, SLATER, STORK, TICHO  (UCLA(LRL)) J
    SUGGESTS J=9/2 RESONANT BEHAVIOR IN SIGMA- PI+, BUT APPEARS
         INCONSISTENT WITH PARAMETERS OF COOL 66.
DAUM     68 NP B7 19          +ERNE, LAGNAUX, SENS, STEUER, UDO    (CERN)JP
LASINSKI 71 NP B29 125        T A LASINSKI                         (EFI)IJP
HEMINGWA 75 NP B91 12         HEMINGWAY,EADES,HARMSEN+   (CERN,HEID,MPIM)IJP
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Σ(2455) BUMPS

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            53  Y*1(2455, JP=    ) I=1        PRODUCTION EXPERIMENTS

            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.
            THERE IS ALSO SOME SLIGHT EVIDENCE FOR Y* STATES IN
   THIS MASS REGION FROM THE REACTION GAMMA + P TO K+ + MISSING MASS --
   SEE GREENBERG 68.

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                 53  Y*1(2455) MASS (MEV) (PROD. EXP.)

M           2455.0      7.0              BUGG      68 CNTR    K-P, D TOTAL       6/68
M           2455.0     10.0              ABRAMS    70 CNTR    K-P, D TOTAL      10/70
M           . . . . . . . . . .
M    AVG    2455.0      5.7     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

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                 53  Y*1(2455) WIDTH (MEV) (PROD. EXP.)

W           100.0      20.0              BUGG      68 CNTR                       6/68
W           140.0                        ABRAMS    70 CNTR    K-P, D TOTAL      10/70

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                 53  Y*1(2455) PARTIAL DECAY MODES (PROD. EXP.)

                                                          DECAY MASSES
P1     Y*1(2455) INTO N KBAR                               938+ 493

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                 53  Y*1(2455) BRANCHING RATIOS (PROD. EXP.)

R1     Y*1(2455) INTO (KBAR N)/TOTAL                      (P1)
R1        J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1          (0.3)                     BUGG      68 CNTR                        6/68
R1           0.39                     ABRAMS    70 CNTR    K-P, D TOTAL       10/70
R1   C      (0.05)    (0.05)          BRICMAN   70 CNTR  0 TOTAL AND CH EX     6/70
R1   C    FIT OF TOTAL CROSS SECTION GIVEN BY BRICMAN 70 IS POOR IN
R1   C    THIS REGION.

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                         REFERENCES FOR Y*1(2455) (PROD. EXP.)

BUGG     68 PR 168 1466       +GILMORE,KNIGHT, +           (RHEL,BIRM,CAVE) I
ABRAMS   70 PR D1 1917        +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152        +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

                              PAPERS NOT REFERRED TO IN DATA CARDS
ABRAMS   67 PRL 19 678        +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
    SUPERSEDED BY ABRAMS 70.
GREENBER 68 PRL 20 221        GREENBERG, HUGHES, LU, MINEHART, +   (YALE)
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Σ(2620) BUMPS

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            54  Y*1(2620, JP=    ) I=1        PRODUCTION EXPERIMENTS

            SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

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                 54  Y*1(2620) MASS (MEV) (PROD. EXP.)

M           2620.0     15.0              ABRAMS    70 CNTR    K-P, D TOTAL      10/70
M           2542.      22.               DIBIANCA  75 DBC     XI K PI            1/76
M           . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.9)

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                    54  Y*1(2620) WIDTH (MEV) (PROD. EXP.)

W          (175.0)                     ABRAMS    70 CNTR    K-P, D TOTAL      10/70
W           221.      81.              DIBIANCA  75 DBC     XI K PI            1/76

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                    54  Y*1(2620) PARTIAL DECAY MODES (PROD. EXP.)

                                                                DECAY MASSES
P1      Y*1(2620) INTO N KBAR                                   938+ 493

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                    54  Y*1(2620) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(2620) INTO (KBAR N)/TOTAL                      (P1)
R1          J IS NOT KNOWN.  THE FOLLOWING IS (J+1/2)*P1.
R1           (0.32)                    ABRAMS    70 CNTR    K-P, D TOTAL      10/70
R1            0.36      0.12           BRICMAN   70 CNTR  D TOTAL AND CH EX    6/70

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                              REFERENCES FOR Y*1(2620) (PROD. EXP.)

ABRAMS   67 PRL 19 678         +COOL,GIACOMELLI,KYCIA,LEONTIC,LI, +  (BNL)
    SUPERSEDED BY ABRAMS 70.
ABRAMS   70 PR D1 1917         +COOL, GIACOMELLI, KYCIA, LEONTIC, +  (BNL) I
BRICMAN  70 PL 31B 152         +FERRO LUZZI, PERREAU,+  (CERN,CAEN,SACLAY)

DIBIANCA 75 NP B98 137         DIBIANCA,ENDORFER                      (CARN)
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Σ(3000) BUMPS →

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59  Y*1(3000, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEE THE MINI-REVIEW AT THE START OF THE Y* LISTINGS.

ENHANCEMENT IN LAMBDA PI AND KBAR N INVARIANT MASS
SPECTRA AND IN MISSING MASS OF NEUTRALS RECOILING
AGAINST KO.  EVIDENCE NOT CONCLUSIVE.  OMITTED FROM
TABLE.

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                    59  Y*1(3000) MASS (MEV) (PROD. EXP.)

M          (3000.0)                    EHRLICH   66 HBC    0 PI-P 7.91 BEV/C   9/66

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                    59  Y*1(3000) PARTIAL DECAY MODES (PROD. EXP.)

                                                                DECAY MASSES
P1      Y*1(3000) INTO N KBAR                                   938+ 493
P2      Y*1(3000) INTO LAMBDA PI                                1115+ 139

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                              REFERENCES FOR Y*1(3000) (PROD. EXP.)

EHRLICH  66 PR 152 1194        R EHRLICH, W SELOVE, H YUTA     (PENN(BNL)) I
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Σ(3170) BUMPS →

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119  Y*1(3170, JP=    ) I=1          PRODUCTION EXPERIMENTS

SEEN BY AMIRZADEH 79 AS A NARROW E.. .TD. DEV.
ENHANCEMENT IN THE REACTION K-P --> Y* PI- USING DATA
FROM TWO INDEPENDENT HIGH STATISTICS BUBBLE CHAMBER
EXPERIMENTS AT 8.25 AND 6.5 GEV/C.  THE DOMINANT DECAY
MODES ARE INTO MULTI-BODY, MULTI-STRANGE FINAL STATES
AND THE PRODUCTION IS VIA I=3/2 BARYON EXCHANGE.  I=1
IS FAVORED.
IN NEED OF CONFIRMATION.  OMITTED FROM TABLES.

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                    118  Y*1(3170) MASS  (MEV) (PROD. EXP.)

M        35 3170.       5.             AMIRZAD   79 HBC  +  K-P TO Y* PI-     12/79

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                    118  Y*1(3170) WIDTH  (MEV) (PROD. EXP.)

W  C     35  (20.)    CR LESS          AMIRZAD   79 HBC  +  K-P TO Y* PI-     12/79
W  C     OBSERVED WIDTH CONSISTENT WITH EXPERIMENTAL RESOLUTION.

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                    118  Y*1(3170) PARTIAL DECAY MODES (PROD. EXP.)

                                                                DECAY MASSES
P1      Y*1(3170) INTO LAMBDA K KBAR + PIONS
P2      Y*1(3170) INTO SIGMA K KBAR + PIONS
P3      Y*1(3170) INTO XI K + PIONS

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                    118  Y*1(3170) BRANCHING RATIOS (PROD. EXP.)

R1      Y*1(3170) INTO (LAMBDA K KBAR + PIONS)/TOTAL       (P1)
R1          SEEN                       AMIRZAD   79 HBC  +  K-P TO Y* PI-     12/79

R2      Y*1(3170) INTO (SIGMA K KBAR + PIONS)/TOTAL        (P2)
R2          SEEN                       AMIRZAD   79 HBC  +  K-P TO Y* PI-     12/79

R3      Y*1(3170) INTO (XI K + PIONS)/TOTAL                (P3)
R3          SEEN                       AMIRZAD   79 HBC  +  K-P TO Y* PI-     12/79

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                              REFERENCES FOR Y*1(3170) (PROD. EXP.)

AMIRZAD  79 PL 89B 125         AMIRZADEH+  (BIRM+CERN+GLAS+MSU+LPNP+CAMB+)I
    ALSO 80 TORONTO CONF. 263 J.B.KINSON+  (BIRM+CERN+GLAS+MSU+LPNP+CAMB+)I
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EXOTIC HYPERON CROSS SECTION LIMITS

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                      THIS IS NOT A COMPLETE LIST.  WE TABULATE
                      ONLY FROM 1970 ON.

CS  UNITS MICROBARNS
CS  G       (20.)   CR LESS            GALTIERI  68 DBC  -- K-N TO SG-PI-PIO  7/70
CS  G  ABOVE LIMIT FOR MASS <  2.15 GEV AND WIDTH <  60 MEV- (2.1 GEV/C K-)   7/70
CS  A       (40.)   OR LESS            GALTIERI  68 DBC  -- K-N TO SG-PI-PIO  7/70
CS  A  ABOVE LIMIT FOR MASS <  2.3 GEV AND WIDTH  < 120 MEV- (2.7 GEV/C K-)   7/70
CS  X       (4.7)   CR LESS  CL=.90    BRIEFEL   75 DBC  -- K-D 2.87 GEV/C    3/79
CS  X   WIDTH < 40 MEV. K-N --> (XI- PI-) K+
CS  Y       (1.4)   CR LESS  CL=.90    BRIEFEL   75 DBC  -- K-D 2.87 GEV/C    3/79
CS  Y   WIDTH < 40 MEV. K-N --> (XI- PI- PIO) K+
CS  Z       (5.4)   CR LESS  CL=.90    BRIEFEL   75 DBC  -- K-D 2.87 GEV/C    3/79
CS  Z   WIDTH < 60 MEV. K-N --> (XI- PI-) K+ PIO
CS  B       (8.6)   CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  B   WIDTH < 60 MEV. K-N --> (SIGMA- PI-) PI+
CS  C      (13.3)   CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  C   WIDTH < 120 MEV. K-N --> (SIGMA- PI-) PI+
CS  D       (6.9)   CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  D   MASS > 2 GEV. WIDTH < 60 MEV. K-N --> (SIGMA- PI-) PI+
CS  E       (7.7)   OR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  E   MASS > 2 GEV. WIDTH < 120 MEV. K-N --> (SIGMA- PI-) PI+
CS  F      (17.)    CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  F   WIDTH < 60 MEV. K-N --> (SIGMA- PI- PIO) PI+
CS  H      (23.)    CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  H   WIDTH < 120 MEV. K-N --> (SIGMA- PI- PIO) PI+
CS  I      (28.)    CR LESS  CL=.90    KATSOUFI  78 DBC  -- K-D 2.87 GEV/C    3/79
CS  I   WIDTH < 80 MEV. K-N --> (SIGMA- PI-) PI- PIO

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                              REFERENCES FOR EXOTIC HYPERONS

GALTIERI 68 PRL 21 573         A.BARBARO-GALTIERI,CHADWICK +     (LRL+SLAC)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+      (BRAN+UMD+SYRA+TUFT)I
KATSOUFI 78 PRD 18 16          KATSOUFIS,CANTER,MANN,SCHNEPS+  (TUFT+BRAN)I
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Note on Ξ^* Resonances

The Ξ^* resonance situation has always been unsettled. This is because: (1) Ξ^*'s can only be produced as a part of a final state, and so the analysis is more complicated than if direct formation were possible; (2) they are produced with small cross sections (typically a few μb); and (3) the final states are topologically complicated and difficult to study with electronic techniques. Thus in the past our knowledge of Ξ^* resonances has come wholly from bubble chamber experiments, where the numbers of events are small.

Until fairly recently only the Ξ(1530) could be considered to be really well established. However, the 1978 edition of this Review[1] saw a major improvement in the situation with the results of GAY 76 and HEMINGWAY 77. The Ξ(1820) and Ξ(2030) were firmly established as narrow states (widths of about 20 MeV), and the spin of the Ξ(1820) was found to be 3/2 (TEODORO 78).

Since then, however, little has changed, although there is some evidence for a new Ξ(2370) (AMIRZADEH 80, HASSALL 81). There is probably at least one other Ξ^* in the 1850–2000 MeV region, and there are indications of several others above 2000 MeV. Indeed, there should be many Ξ^*'s below 2500 MeV, and the broad (and not completely established) Ξ(1940) could well be a mixture of several of them.[2] For now we are forced to group together disparate observations and await new results. The disagreements among experiments are shown in ideograms in the Listings.

Results from experiments using electronic techniques are now becoming available. BIAGI 81 used the CERN hyperon beam to study inclusive $\Lambda\bar{K}$ and $\Xi\pi$ mass spectra from 102 and 135 GeV/c Ξ^- incident on hydrogen and deuterium. They saw a large Ξ(1820) signal in $\Lambda\bar{K}$ as well as a peak at about 1700 MeV, which might be associated with the threshold enhancement seen by DIONISI 78. The Ξ(1940) appears as a broad bump in the $\Xi\pi$ mass spectrum, and there is a very clean Ξ(1530) signal. Preliminary results from the Brookhaven multiparticle spectrometer were reported at the Toronto Conference (see Ref. 3). The Ξ(1820) is clearly seen as a narrow object decaying to Ξ(1530)π.

The table below gives our evaluation of the present status of the Ξ^* resonances. For a detailed review, see MEADOWS 80.[3]

References

1. Particle Data Group, Phys. Lett. 75B, 1 (1978).
2. R.J. Hemingway, in Proceedings of the Topical Conference on Baryon Resonances (Oxford, 1976), ed. R.T. Ross and D.H. Saxon.
3. B.T. Meadows, in Proceedings of the IVth International Conference on Baryon Resonances (Toronto, 1980), ed. N. Isgur.

STATUS OF XI* RESONANCES

THOSE WITH AN OVERALL STATUS OF *** OR **** ARE INCLUDED IN THE MAIN BARYON TABLE. THE OTHERS AWAIT CONFIRMATION.
IN THE PAST WE HAVE LOWERED OUR STANDARDS FOR XI* RESONANCES AND TABULATED STATES EVEN THOUGH THEY HAD ONLY BEEN SEEN AT LOW LEVELS OF STATISTICAL SIGNIFICANCE. NOW THAT NEW HIGH STATISTICS DATA IS AVAILABLE, WE HAVE ADOPTED SOMEWHAT STRICTER CRITERIA.

PARTICLE	LIJ	OVERALL STATUS	STATUS AS SEEN IN -- XI PI	LAM K	SIG K	XI* PI	OTHER CHANNELS
XI(1321)	P11	****					WEAK TO LAM PI
XI(1530)	P13	****	****				
XI(1630)		*	*				
XI(1680)		**		*	**		
XI(1820)	13	***	*	***	**	***	
XI(1940)		**	**			**	
XI(2030)	1	***		**	***		
XI(2120)		*		*			
XI(2250)		*					3-BODY DECAYS
XI(2370)	1	**					3-BODY DECAYS
XI(2500)		*		*	*		3-BODY DECAYS

**** GOOD, CLEAR, AND UNMISTAKABLE.
*** GOOD, BUT IN NEED OF CLARIFICATION OR NOT ABSOLUTELY CERTAIN.
** NEEDS CONFIRMATION.
* WEAK.

S=-2 I=1/2 HYPERON STATES (Ξ)

Ξ⁻

22 XI-(1321, JP=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

Ξ⁰

23 XI0(1315, JP=1/2) I=1/2

SEE STABLE PARTICLE DATA CARD LISTINGS

Ξ(1530) — P13

49 XI*1/2(1530, JP=3/2+) I=1/2

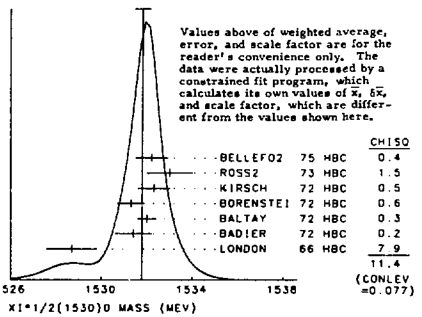
THIS IS THE ONLY WELL-ESTABLISHED XI* WHOSE PROPERTIES ARE ALL AT LEAST REASONABLY WELL-KNOWN. SPIN-PARITY 3/2+ IS FAVOURED BY THE DATA.

WE DO NOT USE DETERMINATIONS OF THE MASS AND THE WIDTH OF THIS STATE UNLESS THEY ARE ACCOMPANIED BY SOME DISCUSSION OF SYSTEMATICS AND RESOLUTION.

49 XI*1/2(1530) MASS (MEV)

M	MIXED CHARGES							
M	20(1535.)		BERTANZA	62	HBC	-0	K-P 2.3 GEV/C	
M	55(1529.0)	(5.0)	PJERROU	62	HBC	-0	K-P 1.8 GEV/C	
M	(1532.0)	(2.0)	BADIER	64	HBC	-0	K-P 3 GEV/C	
M-	NEGATIVE CHARGE ONLY							
M-	38 1535.7	3.2	LONDON	66	HBC	-	K-P 2.24 GEV/C	7/66
M-	334(1534.7)	(1.1)	BALTAY	72	HBC	-	K-P 1.75 GEV	1/73
M-	185 1536.2	1.6	KIRSCH	72	HBC	-	K-P 2.87GEV/C	2/72
M-	1535.3	2.0	ROSS2	73	HBC	-	XI KBAR PI (PI)	2/74
M-	48(1540.)	(3.)	BERTHON	74	HBC	-	QUASI 2 BODY CS	10/74
M-	1534.5	1.2	BELLEFO2	75	HBC	-	K-P TO XI- K PI	11/75
M-	. . . .							
M- AVG	1535.18	0.84	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)					
M- FIT	1534.97	0.63	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)					
M0	NEUTRAL CHARGE ONLY							
M0	76 1528.7	1.1	LONDON	66	HBC	0	K-P 2.24 GEV/C	7/66
M0	59 1531.4	0.8	BADIER	72	HBC	0	K-P AT 3.95GEV/C	10/71
M0	1262 1532.0	0.4	BALTAY	72	HBC	0	K-P 1.75 GEV	1/73
M0	324 1531.3	0.6	BORENSTEI	72	HBC	0	K-P 2.2GEV/C	2/72
M0	286 1532.3	0.7	KIRSCH	72	HBC	0	K-P 2.87GEV/C	2/72
M0	1533.0	1.0	ROSS2	73	HBC		XI KBAR PI (PI)	2/74
M0	97(1533.6)	(1.4)	BERTHON	74	HBC	0	QUASI 2 BODY CS	10/74
M0	1532.2	0.7	BELLEFO2	75	HBC	0	K-P TO XI- K PI	11/75
M0	80(1527.)	(6.)	SIXEL	79	HBC	0	INCL. K-P 10 GEV	1/80
M0	100(1535.)	(4.)	SIXEL	79	HBC	0	INCL. K-P 16 GEV	1/80
M0	I 2700(1532.1)	(0.6)	BAUBILLIE	81	HBC	0	K-P AT 8.25 GEV	2/82*
M0	I FIT TO INCLUSIVE SPECTRUM. RESOLUTION (5 MEV) NOT UNFOLDED.							
M0	450(1530.)	(1.)	BIAGI	81	SPEC	-	HYPERON BEAM	2/82*
M0	. . . .							
M0 AVG	1531.78	0.34	AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.4)					
M0 FIT	1531.80	0.31	FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.3) (SEE IDEOGRAM BELOW)					

WEIGHTED AVERAGE = 1531.78 ± 0.34
ERROR SCALED BY 1.4



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                   45  (XI*-) - (XI*0) MASS DIFFERENCE (MEV)

D              5.7        3.0               PJERROU   65 HBC  -0 1.8-1.95 GEV/C     7/66
D     R       (7.0)      (4.0)              LONDON    66 HBC  -0 2.24 GEV/C         7/66
D              2.0        3.2               MERRILL   66 HBC  -0 1.7-2.7 GEV/C      7/66
D              2.7        1.0               BALTAY    72 HBC  -0 K-P 1.75 GEV       1/73
D     R       (3.9)      (1.8)              KIRSCH    72 HBC  -0 K- P 2.87 GEV/C    2/72
D     R       REDUNDANT WITH DATA IN MASS LISTING.
D             . . . . . . . . . .
D     AVG      2.97       0.91     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)
D     FIT      3.17       0.64   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

                   45  XI*1/2(1530) WIDTH (MEV)

W     MIXED CHARGES
W          29  (35.)   OR LESS              PERTANZA  62 HBC  -0 K-P 2.3 GEV/C

W-    NEGATIVE CHARGE ONLY
W-             7.8        3.5       7.8     BALTAY    72 HBC  -   K-P 1.75 GEV        1/73
W-            16.2        4.6               KIRSCH    72 HBC  -   XI- PI0,XI0 PI-     2/72
W-             9.3        3.6               ROSS2     73 HBC  -   XI KBAR PI (PI)     2/74
W-             9.6        2.8               BELLEFO2  75 HBC  -   K-P TO XI- K PI    11/75
W-            . . . . . . . . . .
W-    AVG     10.1        1.9      AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

W0    NEUTRAL CHARGE ONLY
W0             7.0        2.0               SCHLEIN   63 HBC   0 1.8, 1.95 GEV/C
W0             7.0        7.0               BERGE     66 HBC   0 1.5-1.7 GEV/C      7/66
W0             9.5        3.5               LONDON    66 HBC   0 2.24 GEV/C         7/66
W0            11.0        2.0               BADIER    72 HBC   0 K-P AT 3.95GEV/C  10/71
W0             9.0        0.7               BALTAY    72 HBC   0 K-P 1.75 GEV       1/73
W0             9.4        1.4               BORENSTEI 72 HBC   0 XI- PI+ MODE       2/72
W0            11.0        1.8               KIRSCH    72 HBC   0 XI- PI+            2/72
W0             9.1        2.4               ROSS2     73 HBC   0 XI KBAR PI (PI)    2/74
W0             9.5        1.2               BELLEFO2  75 HBC   0 K-P TO XI- K PI   11/75
W0    R   90  (19.)      (5.)               SIXEL     79 HBC   0 INCL. K-P 10 GEV   1/80
W0    R  100  (14.)      (5.)               SIXEL     79 HBC   0 INCL. K-P 16 GEV   1/80
W0    I 2700  (17.8)     (1.0)              BAUBILLIE 81 HBC   0 K-P AT 8.25 GEV   2/82*
W0    I   FIT TO INCLUSIVE SPECTRUM. RESOLUTION (5 MEV) NOT UNFOLDED.
W0    R   EXPERIMENTAL RESOLUTION OF 15 MEV NOT UNFOLDED.
W0            . . . . . . . . . .
W0    AVG      9.14       0.48     AVERAGE (ERROR INCLUDES SCALE FACTOR OF 1.0)

                   49  XI*1/2(1530) REAL PART OF POLE POSITION               4/75

RE0         1531.6       0.4                LICHTENB  74        0 EXTRAP HARIRI73   4/75
RE-         1536.4       1.1                LICHTENB  74        - EXTRAP HARIRI73   4/75

                   49  XI*1/2(1530) IMAGINARY PART OF POLE POSITION          4/75

IM0            4.45      0.35               LICHTENB  74        0 EXTRAP HARIRI73   4/75
IM-            3.9       1.75       3.9     LICHTENB  74        - EXTRAP HARIRI73   4/75

                   49  XI*1/2(1530) PARTIAL DECAY MODES

                                                                  DECAY MASSES
P1      XI*1/2(1530) INTO XI PI                                   1321+ 139
        OTHER STRONG DECAYS ARE FORBIDDEN BY ENERGY CONSERVATION.
P2      XI*1/2(1530) INTO XI GAMMA                                1321+   0

                   69  XI*1/2(1530) BRANCHING RATIOS (MEV)

R1      XI*1/2(1530) INTO (XI GAMMA)/TOTAL                        (P2)            1/76
R1             (0.04) OR LESS  CL=.90   KALBFLEI  75 HBC  -  K-P AT 2.18 GEV   1/76

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                            REFERENCES FOR XI*1/2(1530)
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PERTANZA 62 PRL 9 180          +ALEXANDER... see below
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PERTANZA 62 PRL 9 180          +ALIISSON,CONNOLLY,GOLDHERG,GRAY,+(BNL+SYRA) IJ
PJERROU  62 PRL 9 114          +BROWSE,SCHLEIN,SLATER,STORK,TICHO   (UCLA) I
SCHLEIN  63 PRL 11 167         +CARMONY,PJERROU,SLATER,STORK,TICHO  (UCLA)IJP
BADIER   64 DUBNA 1 593        +DEMOULIN,GOLDBERG,+     (EPOL+SACLAY+AMST) I
PJERROU  65 PRL 14 275         +SCHLEIN,SLATER,SMITH,STORK,TICHO    (UCLA)

BERGE    66 PR 147 945         +EBERHARD,HUBBARD,MERRILL,B-SHAFER,+  (LRL) I
LONDON   66 PR 143 1034        +RAU,SAMIOS,YAMAMOTO,GOLDBERG,+  (BNL+SYRA) IJ
MERRILL  66 UCRL-16455 THESIS  D W MERRILL                           (LRL) JP

BADIER   72 NP B37 429         +BARRELET,CHARLTON,VIDEAU            (EPOL)
BALTAY   72 PL 42B 129         +BRIDGEWATER,COOPER,GERSHWIN,+  (COLU+BING)
   ALSO  73 NEVIS 199(THESIS)  HABIBI                         (COLUMBIA)
BORENSTE 72 PR D5 1559         BORENSTEIN+DANBURG+KALBFLEISCH++ (BNL+MICH) I
KIRSCH   72 NP B40 349         SCHMIDT+CHANG,HEMINGWAY(BRAN,UMD,SYRA,TUFT) I

ROSS2    73 PURDUE CONF. 355   ROSS+LLOYD+RADOJICIC                (OXFORD)
BERTHON  74 NC 21A 146         BERTHON,TRISTRAM,+      (CDEF+RHEL+SACL+STRB)
LICHTENB 74 PRD 10 3865        D B LICHTENBERG            (INDIANA UNIVERSITY)
   ALSO  74 PRIV. COMM.        D B LICHTENBERG            (INDIANA UNIVERSITY)

BELLEFO2 75 NC 28A 289         DE BELLEFON,BERTHON,BILLOIR+     (CDEF+SACL)
KALBFLEI 75 PRD 11 987         KALBFLEISCH,STRAND,CHAPMAN          (BNL+MICH)
SIXEL    79 NP B159 125        +BOTTCHER,KLEIN+ (AACH+BERL+CERN+LOIC+VIEN)
BAUBILLI 81 NP B192 1          BAUBILLIER+          (BIRM+CERN+GLAS+MSU+LPNP)
BIAGI    81 ZPHY C9 305        +        (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RHEL)

                            PAPERS NOT REFERRED TO IN DATA CARDS

SHAFER   66 PR 142 883         BUTTON-SHAFER,LINDSEY,MURRAY,SMITH    (LRL) JP
   A SPIN-PARITY DETERMINATION.
HABIBI   73 NEVIS 199(THESIS)  HABIBI                                (COLU)
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+    (YALE,FNAL,BNL,PITT)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+     (BRAN+UMD+SYRA+TUFT)
BRIEFEL  77 PRD 16 2706        +GOUREVITCH,CHANG+      (BRAN+UMD+SYRA+TUFT)
MAZZUCAT 81 NP B178 1          MAZZUCATO,PENNINO+      (AMST+CERN+NIJM+OKF)

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Ξ(1630) →

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21  XI*1/2(1630, JP=   ? I=1/2

        SEEN ONLY IN THE XI PI CHANNEL.
        IN NEED OF CONFIRMATION. OMITTED FROM THE TABLES.
        BARTSCH 69 SEE A SMALL, BROAD ENHANCEMENT NEAR
        1650 MEV - IT IS NOT CLEAR THAT IT IS THE SAME
        PHENOMENON AS BRIEFEL 77, WHO FIND CS=2.6+-0.9
        MICROBARNS AT 2.87 GEV/C INCIDENT K- MOMENTUM.
   BORENSTEIN 72 SEE NO EFFECT IN THIS REGION.  THEY FIND
   CS<2 MICROBARNS AT 2.18 GEV/C.
     ROSS 72 ARGUE THAT THE EFFECT THEY SEE IS NOT THE SAME AS THAT
   SEEN BY BRIEFEL 77 (WHOSE PRELIMINARY RESULTS WERE REPORTED IN
   BMST 70), AND FIND CS=2+-1 MICROBARNS AT 3.3 GEV/C.
   BELLEFON 75 FIND A CS OF AROUND 10 MICROBARNS NEAR 2 GEV/C,
   BUT LESS THAN 3 MICROBARNS AROUND 2.3 GEV/C.
     NOT SEEN BY HASSALL 81 IN A HIGH STATISTICS BUBBLE CHAMBER
   EXPERIMENT (46 EVENTS/MICROBARN) AT 6.5 GEV/C.

                   21  XI*1/2(1630) MASS (MEV)

M       29 1606.       6.             ROSS      72 HBC   0 K-P AT 3.1-3.7    3/72
M       34 1633.      12.             BELLEFO2  75 HBC   0 K-P TO XI- K PI  11/75
M       31 1624.       3.             BRIEFEL   77 HBC   0 K-P 2.87 GEV/C    1/78
M         . . . . . . . . . .
M    AVERAGE MEANINGLESS (SCALE FACTOR = 2.0)

                   21  XI*1/2(1630) WIDTH (MEV)

W       29   21.       7.             ROSS      72 HBC   0 XI-PI+ K*0(890)   3/72
W       34   40.      15.             BELLEFO2  75 HBC   0 K-P TO XI- K PI  11/75
W  F    31  (22.5)                    BRIEFEL   77 HBC   0 K-P 2.87 GEV/C    1/78
W  F    GOODNESS OF FIT INSENSITIVE TO VALUES BETWEEN 15 AND 30 MEV.
W  F    THE SIGNIFICANCE OF THE EFFECT IS CLAIMED TO BE ABOUT 3 STD. DEV.
W         . . . . . . . . . .
W    AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

                   21  XI*1/2(1630) PARTIAL DECAY MODES

                                                             DECAY MASSES
P1      XI*1/2(1630) INTO XI PI                              1321+ 139

        SEEN IN K- P TO XI- PI+ X0 AND XI- PI0 K+.

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                            REFERENCES FOR XI*1/2(1630)
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ROSS     72 PL 38B 177         +BURAN,LLOYD,MULVEY,RADOJICIC          (OXF) I
BELLEFO2 75 NC 28A 289         DE BELLEFON,BERTHON,BILLOIR+     (CDEF,SACL)
BRIEFEL  77 PRD 16 2706        +GOUREVITCH,CHANG+      (BRAN+UMD+SYRA+TUFT)
   ALSO  70 DUKE CONF. 317     BMST      (BRANDEIS+MARYLAND+SYRACUSE+TUFTS)

                            PAPERS NOT REFERRED TO IN DATA CARDS

APSELL   69 PRL 23 884         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST 70.
BARTSCH  69 PL 28B 439         +        (AACHEN, BERLIN, CERN, LOIC, VIENNA)
KALBFLEI 70 DUKE CONF 331      G P KALBFLEISCH                        (BNL) I
   SUMMARIZES EVIDENCE FOR ISOSPIN ONE-HALF.
BORENSTE 72 PR D5 1559         BORENSTEIN+DANBURG,KALBFLEISCH++ (BNL+MICH) I
SCHMIDT  73 PURDUE CONF. 363   SCHMIDT                          (BRANDEIS)
HUNGERBU 74 PRD 10 2051        HUNGERBUHLER,MAJKA,+    (YALE+FNAL+BNL+PITT)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+     (BRAN+UMD+SYRA+TUFT)
HASSALL  81 NP B189 397        +ANSORGE,CARTER,NEALE,RUSHBROOKE+(CAMB+MSU)

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Ξ(1680) → S_{11}

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5  XI*1/2(1680, JP=1/2-) I=1/2

        SEEN BY DIONISI 78 AS A THRESHOLD ENHANCEMENT IN BOTH
        THE NEUTRAL AND NEGATIVELY CHARGEC SIGMA KBAR MASS
        SPECTRA FROM THE REACTIONS K-P --> (SIGMA KBAR) K PI
        AT 4.2 GEV/C.  THE DATA FROM THE SIGMA KBAR CHANNELS
        ALONE CANNOT DISTINGUISH BETWEEN A RESONANCE
   INTERPRETATION AND A LARGE SCATTERING LENGTH.
     WEAKER EVIDENCE FOR AN ENHANCEMENT AT THE SAME MASS IS SEEN IN THE
   CORRESPONDING LAMBDA KBAR CHANNELS AND A COUPLED CHANNEL ANALYSIS
   YIELDS RESULTS CONSISTENT WITH A NEW XI*.
     THE HYPERON BEAM EXPERIMENT OF BIAGI 81 OBSERVE AN ENHANCEMENT AT
   1700 MEV IN THE DIFFRACTIVELY PRODUCED LAMBDA K- SYSTEM.  A PEAK IS
   ALSO OBSERVED IN THE LAMBDA K0 MASS SPECTRUM AT 1660 MEV WHICH IS
   CONSISTENT WITH A RESONANCE OF MASS 1720 MEV DECAYING INTO SIGMA0
   K0, WITH THE GAMMA FROM THE SIGMA0 DECAY NOT DETECTED.
   IN NEED OF FURTHER CONFIRMATION.  OMITTED FROM THE TABLES.

                   5  XI*1/2(1680) MASS (MEV)

M0  NEUTRAL CHARGE
M0  F  175(1694.)      (5.)            DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79
M0  C  183(1684.)      (5.)            DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79
M0  F   FROM FIT TO SIGMA+ K- SPECTRUM                                        3/79
M0  C   FROM COUPLED CHANNEL ANALYSIS OF SIGMA+ K- AND LAMBDA K0 SPECTRA      3/79

M-  NEGATIVE CHARGE
M-  K   45(1694.)      (6.)            DIONISI   78 HBC   -  K-P AT 4.2 GEV/C 3/79
M-  K   FROM COUPLED CHANNEL ANALYSIS OF SIGMA0 K- AND LAMBDA K- SPECTRA      3/79
M-  H  150(1700.)     (10.)            BIAGI     81 SPEC  -  HYPERON BEAM     2/82*
M-  H   FIT TO INCLUSIVE SPECTRUM FROM XI-N --> LAM K- X

                   5  XI*1/2(1680) WIDTH (MEV)

W0  NEUTRAL CHARGE
W0  F  175  (44.)     (23.)            DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79
W0  C  183  (20.)     (14.)            DIONISI   78 HBC   0 K P AT 4.2 GEV/C  3/79

W-  NEGATIVE CHARGE
W-  K   45  (26.)      (6.)            DIONISI   78 HBC   -  K-P AT 4.2 GEV/C 3/79
W-  H  150  (47.)     (14.)            BIAGI     81 SPEC  -  HYPERON BEAM     2/82*
              SEE THE NOTES ACCOMPANYING THE MASSES QUOTED
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                    5  XI*1/2(1680) PARTIAL DECAY MODES

                                                           DECAY MASSES
P1      XI*1/2(1680) INTO SIGMA KBAR                       1192+ 497
P2      XI*1/2(1680) INTO LAMBDA KBAR                      1115+ 497
P3      XI*1/2(1680) INTO XI PI                            1314+ 134
P4      XI*1/2(1680) INTO XI*1/2(1530) PI                  1533+ 134
P5      XI*1/2(1680) INTO XI PI PI (INCLUDING P4)          1314+ 134+ 134

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                    5  XI*1/2(1680) BRANCHING RATIOS

R1      XI*1/2(1680) INTO (SIGMA KBAR)/(LAMBDA KBAR)       (P1)/(P2)
R1  Z        (2.7)     (0.9)          DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79
R1  N        (3.1)     (1.4)          DIONISI   78 HBC  -  K-P AT 4.2 GEV/C  3/79
R1  Z   NEUTRAL CHARGE
R1  N   NEGATIVE CHARGE

R2      XI*1/2(1680) INTO (XI PI)/(SIGMA KBAR)             (P3)/(P1)
R2           (0.09) OR LESS           DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79

R3      XI*1/2(1680) INTO (XI- PI+ PI0)/(SIGMA KBAR)       (P5)/(P1)
R3           (0.04) OR LESS           DIONISI   78 HBC   0 K-P AT 4.2 GEV/C  3/79

R4      XI*1/2(1680) INTO (XI- PI+ PI-)/(SIGMA KBAR)       (P5)/(P1)
R4           (0.03) OR LESS           DIONISI   78 HBC  -  K-P AT 4.2 GEV/C  3/79

R5      XI*1/2(1680) INTO (XI*(1530) PI)/(SIGMA KBAR)      (P4)/(P1)
R5           (0.06) OR LESS           DIONISI   78 HBC  -  K-P AT 4.2 GEV/C  3/79

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                    REFERENCES FOR XI*1/2(1680)

DIONISI  78 PL 80B 145        +DIAZ,ARMENTEROS+       (CERN+AMST+NIJM+OXF)I,JP
BIAGI    81 ZPHY C9 305       +       (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RHEL)

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Ξ(1820)

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50  XI*1/2(1820, JP=3/2 ) I=1/2

WE LIST HERE EVERYTHING REPORTED IN THE MASS RANGE
1750-1875 MEV.
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The clearest evidence for this state comes from GAY 76, who saw an 8 standard-deviation peak in ΛK^- as well as signals in $\Xi(1530)\pi$ and $\Sigma\bar{K}$. The peak is narrow ($\Gamma = 21 \pm 7$ MeV), whereas earlier (and much smaller) experiments found widths of up to 100 MeV (see the Listings below).

A spin-parity analysis of the GAY 76 data, but with more events (TEODORO 78), favors spin 3/2 but cannot make a parity discrimination.

BIAGI 81 used the CERN hyperon beam to study Ξ^- interactions in hydrogen and deuterium. The diffractively produced ΛK^- system has a broad peak ($\Gamma = 72 \pm 20$ MeV) at 1830 MeV on top of a substantial background. There is also a smaller peak in the inclusive ΛK^0_S spectrum.

Neither GAY 76 nor BIAGI 81 saw a peak in the $\Xi\pi$ channel. It is possible that $\Xi\pi$ peaks seen in this region by some lower-momentum experiments are at least partly due to the $\Xi(1940)$, with a shape distorted by the limited phase space available (SMITH 65). The situation is further confused because some experiments were forced to add several different channels together to overcome poor statistics (CRENNELL 70, BADIER 71).

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                    50  XI*1/2(1820) MASS (MEV)

M          (1770.0)                         HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
M       30 1814.0      4.0                  BADIER    65 HBC   0 LAMBDA K0BAR
M       29 1817.0      7.0                  SMITH 1   65 HBC  -0 LAMBDA KBAR
M       40 1830.0     10.0                  ALITTI    69 HBC  -  LAM, SIG KBAR     9/69
M  C    25 1830.0     10.0                  CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   10/70
M  C    FROM FIT TO INCLUSIVE XI PI, XI PI PI AND LAMBDA K- SPECTRA
M   D      (1826.0)   (12.0)                CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   11/77
M   D   FROM FIT TO INCLUSIVE XI PI AND XI PI PI SPECTRA ONLY
M  B    28 1762.0      8.0                  BADIER    72 HBC  -0 XI PI,XI2PI,K Y  10/71
M  B    38 1838.0      5.0                  BADIER    72 HBC   -0XI PI,XI2PI,K Y  10/71
M  B    BADIER 72 ADDS ALL CHANNELS AND DIVIDES PEAK IN LOWER AND HIGHER
M  B    MASS REGIONS. THE DATA CAN ALSO BE FITTED WITH A SINGLE BREIT-
M  B    WIGNER OF MASS 1800 AND WIDTH 150 MEV.
M    1  30 1821.       5.                   ROSSI     73 HBC  -0 LAMBDA K-/KBARO   2/74
M    1  LESS SIGNIFICANT ENHANCEMENTS SEEN IN XI*(1530) PI (M=1825,W=100)
M    1  AND SIGMA KBAR (M=1810+-9,W=16+-11).
M          1807.      27.                   DIBIANCA  75 DBC  -0 XI 2PI, XI* PI    1/76
M      130 1823.0      2.0                  GAY       76 HBC  -  K- P AT 4.2 GEV   2/77
M       74 1797.      19.                   BRIEFEL   77 HBC   0 XI PI (2.87 K-P)  1/78
M       68 1829.       9.                   BRIEFEL   77 HBC  -0 XI(1530) PI       1/78
M       39 1860.      14.                   BRIEFEL   77 HBC  -  SIGMA- K0BAR      1/78
M       44 1870.       9.                   BRIEFEL   77 HBC   0 LAMBDA K0BAR      1/78
M       57 1913.       4.                   BRIEFEL   77 HBC  -  LAMBDA K-         1/78
M    1 300 1830.       6.                   BIAGI     81 SPEC -  HYPERON BEAM      2/82*
M    I  FIT TO INCLUSIVE SPECTRUM FROM XI-N --> LAM K- X
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.1)
                       (SEE IDEOGRAM BELOW )
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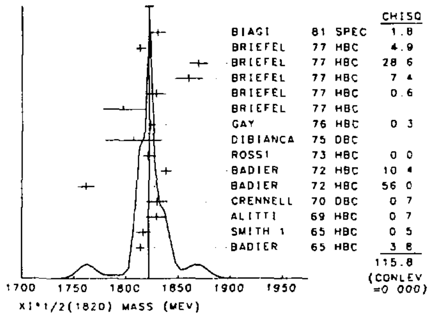


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                    50  XI*1/2(1820) WIDTH (MEV)

M            (80.0) OR LESS                 HALSTEINS 63 FBC  -0 K-FR 3.5 GEV/C
M            (12.0)   (4.0)                 BADIER    65 HBC   0 LAMBDA K0BAR
M             30.0     7.0                  SMITH 2   65 HBC  -0 LAMBDA KBAR
M             55.0    40.0      20.0        ALITTI    69 HBC  -  LAM, SIG KBAR     9/69
M  C         103.0    38.0      24.0        CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   10/70
M   D        (49.0)  (36.0)    (19.0)       CRENNELL  70 DBC  -0 3.6, 3.9 GEV/C   11/77
M  B          51.0    13.0                  BADIER    72 HBC  -0 LOWER MASS       10/71
M  B          58.0    13.0                  BADIER    72 HBC  -0 HIGHER MASS      10/71
M    1  30    12.      4.                   ROSSI     73 HBC  -0 LAMBDA K-/KBARO   2/74
M             85.     58.                   DIBIANCA  75 DBC  -0 XI 2PI, XI* PI    1/76
M      130    21.0     7.0                  GAY       76 HBC  -  K- P AT 4.2 GEV   2/77
M       74    99.     57.                   BRIEFEL   77 HBC   0 XI PI (2.87 K-P)  1/78
M       68    52.     34.                   BRIEFEL   77 HBC  -0 XI(1530) PI       1/78
M       39    72.     17.                   BRIEFEL   77 HBC  -  SIGMA- K0BAR      1/78
M       44    44.     11.                   BRIEFEL   77 HBC   0 LAMBDA K0BAR      1/78
M       57    26.     11.                   BRIEFEL   77 HBC  -  LAMBDA K-         1/78
M    1 300    72.     20.                   BIAGI     81 SPEC -  HYPERON BEAM      2/82*
M  ***               SEE THE NOTES ACCOMPANYING THE MASSES QUOTED ABOVE.
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 2.2)
                       (SEE IDEOGRAM BELOW )
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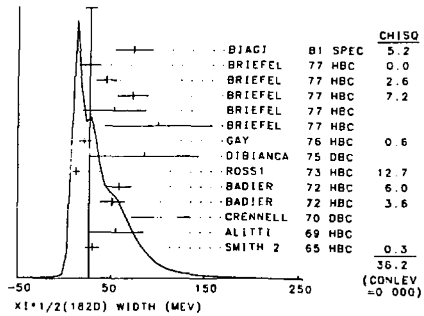

```
                  50  XI*1/2(1820) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XI*1/2(1820) INTO LAMBDA KBAR                       1115+ 497
P2      XI*1/2(1820) INTO XI PI                             1321+ 139
P3      XI*1/2(1820) INTO SIGMA KBAR                        1197+ 497
P4      XI*1/2(1820) INTO XI*1/2(1530) PI                   1533+ 139
P5      XI*1/2(1820) INTO XI PI PI (EXCLUDING P4)           1321+ 139+ 139
```

FITTED PARTIAL DECAY MODE BRANCHING FRACTIONS

The matrix below is derived from the error matrix for the fitted partial decay mode branching fractions, P_i, as follows: The diagonal elements are $P_i \pm \delta P_i$, where $\delta P_i = \sqrt{\langle \delta P_i \delta P_i \rangle}$, while the off-diagonal elements are the normalized correlation coefficients $\langle \delta P_i \delta P_j \rangle / (\delta P_i \cdot \delta P_j)$. For the definitions of the individual P_i, see the listings above; only those P_i appearing in the matrix are assumed in the fit to be nonzero and are thus constrained to add to 1.

```
        P 1          P 2         P 3         P 4
P 1  .4974+-.0871
P 2   -.7612     .1889+-.0529
P 3    .1335      -.5080     .1463+-.0477
P 4   -.8220       .5613      -.5009     .1674+-.0647
```

```
                  50  XI*1/2(1820) BRANCHING RATIOS

R1      XI*1/2(1820) INTO (LAMBDA KBAR)/TOTAL                   (P1)
R1            0.30      0.15             ALITTI     69 HBC  -  K-P 3.9-5.0 GEV   9/69
R1          . . . . . . . . . .
R1  FIT       0.497     0.087  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.8)

R2      XI*1/2(1820) INTO (XI PI)/TOTAL                         (P2)
R2            0.10      0.10             ALITTI     69 HBC  -  K-P 3.9-5.0 GEV   9/69
R2          . . . . . . . . . .
R2  FIT       0.189     0.053  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.2)

R21     XI*1/2(1820) INTO (XI PI)/(LAMBDA KBAR)                 (P2)/(P1)
R21           0.20      0.20             BADIER     65 HBC   0 K-P AT 3 GEV      7/66
R21         (0.36) OR LESS  CL=.95       GAY        76 HBC  -  K- P AT 4.2 GEV   2/77
R21         . . . . . . . . . .
R21 FIT       0.38      0.16   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.5)

R22     XI*1/2(1820) INTO (XI PI)/(XI*1/2(1530) PI)             (P2)/(P4)
R22           1.5       0.6       0.4    APSELL     70 HBC   0 K-P AT 2.87 GEV   6/70
R22         . . . . . . . . . .
R22 FIT       1.13      0.36   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.0)

R3      XI*1/2(1820) INTO (SIGMA KBAR)/TOTAL                    (P3)
R3          (0.02) OR LESS               TRIPP      67 RVUE                      8/67
R3            0.30      0.15             ALITTI     69 HBC  -  K-P 3.9-5.0 GEV   9/69
R3          . . . . . . . . . .
R3  FIT       0.146     0.048  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R31     XI*1/2(1820) INTO (SIGMA KBAR)/(LAMBDA KBAR)            (P3)/(P1)
R31           0.24      0.10             GAY        76 HBC  -  K- P AT 4.2 GEV   2/77
R31         . . . . . . . . . .
R31 FIT       0.29      0.10   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.1)

R4      XI*1/2(1820) INTO (XI*1/2(1530) PI)/TOTAL               (P4)
R4            0.30      0.15             ALITTI     69 HBC  -  K-P 3.9-5.0 GEV   9/69
R4   S      (0.25) OR LESS               DAUBER     69 HBC     K-P 2.7 BEV/C     9/69
R4   S  USES IN PART THE SAME DATA AS SMITH 65
R4   I        NOT SEEN                   HASSALL    81 HBC     K-P 6.5 GEV/C     ?/82*
R4   I  INCLUDING XI PI PI
R4          . . . . . . . . . .
R4  FIT       0.167     0.065  FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.6)

R41     XI*1/2(1820) INTO (XI*(1530) PI)/(LAM KBAR)             (P4)/(P1)
R41           0.26      0.13             SMITH 1    65 HBC  -0 K-P 2.45-2.70GEV
R41           1.0       0.3              GAY        76 HBC  -  K- P AT 4.2 GEV   2/77
R41         . . . . . . . . . .
R41 AVG       0.38      0.27    AVERAGE (ERROR INCLUDES SCALE FACTOR OF 2.3)
R41 FIT       0.34      0.18   FROM FIT (ERROR INCLUDES SCALE FACTOR OF 1.7)

R51     XI*1/2(1820) INTO (XI PI PI)/(LAMBDA KBAR)              (P5)/(P1)
R51         (0.1)  OR MORE               SMITH 1    65 HBC  -0 K-P 2.45-2.70GEV

R52     XI*1/2(1820) INTO (XI PI PI)/(XI*1/2(1530) PI)          (P5)/(P4)
R52 L       (0.3)     (0.5)              APSELL     70 HBC   0 K-P AT 2.87 GEV   6/70
R52 L   OR LESS. UPPER LIMIT FOR THE 3-BODY DECAY
R52         CONSISTENT WITH ZERO         GAY        76 HBC  -  K-P AT 4.2 GEV   11/77

R53     XI*1/2(1820) INTO (XI PI PI (INCLUDING XI*(1530) PI))/(LAMBDA KBAR)
R53                                                             (P4+P5)/(P1)
R53  C      (0.14) OR LESS               BADIER     65 HBC   0 1 STD.DEV.LIMIT  11/77
R53  C  FOR TH  ? CAY MODE (XI- PI+ PI0) ONLY

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REFERENCES FOR XI*1/2(1820)


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HALSTEIN 63 SIENA CONF 173     HALSTEINSLID,+ (BERGEN,CERN,EPOL,RHEL,LOUC) I
BADIER   65 PL 16 171          +DEMOULIN,GOLDBERG, +    (EPOL,SACLAY,AMST) I
SMITH 1  65 PRL 14 25          +LINDSEY,BUTTON-SHAFER,MURRAY          (LRL)IJP
SMITH 2  65 ATHENS CONF 251    G A SMITH, J S LINDSEY                 (LRL)
TRIPP    67 NP B3 10           + LEITH, +     (LRL,SLAC,CERN,HEIDEL,SACLAY)
    USES DATA OF SMITH 1.

ALITTI   69 PRL 22 79          +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
DAUBER   69 PR 179 1262        +BERGE, HUBBARD, MERRILL, MILLER        (LRL)
APSELL   70 PRL 24 777         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
CRENNELL 70 PR 10 847          +KARSHON, LAI, ONEALL, SCARR, SCHUMANN(BNL)
BADIER   72 NP B37 429         +BARRELET,CHARLTON,VIDEAU              (EPOL)
ROSSI    73 PURDUE CONF. 345   ROSS,LLOYD,RADOJICIC                   (OXFORD)

DIBIANCA 75 NP B98 137         DIBIANCA,ENDORF                        (CARN)
GAY      76 PL 62B 477         +ARMENTEROS,BERGE,GAVILLET+(AMST+CERN+NIJM)IJ
BRIEFEL  77 PRD 16 2706        +GOUREVITCH,CHANG+      (BRAN+UMD+SYRA+TUFT)
   ALSO  70 DUKE CONF. 317     BMST       (BRANDEIS+MARYLAND+SYRACUSE+TUFTS)
BIAGI    81 ZPHY C9 305        +         (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RHEL)
HASSALL  81 NP B189 397        +ANSORGE,CARTER,NEALE,RUSHBROOKE+(CAMB+MSU)
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PAPERS NOT REFERRED TO IN DATA CARDS


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SMITH    64 PRL 13 61          +LINDSEY,MURRAY,BUTTON-SHAFER+          (LRL) IJP
MERRILL  68 PR 167 1202        D W MERRILL, J BUTTON-SHAFER            (LRL)
    WEAK EVIDENCE CONCERNING JP.
APSELL   69 PRL 23 884         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
    SUPERSEDED BY BRIEFEL 77.
SCHMIDT  73 PURDUE CONF. 363   SCHMIDT                             (BRANDEIS)
BRIEFEL  75 PRD 12 1859        +GOUREVITCH,KIRSCH+     (BRAN+UMD+SYRA+TUFT)
TEODORO  78 PL 77B 451         +DIAZ,DIONISI,BLOKZIJL+(AMST+CERN+NIJM+OXF)  JP
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Ξ(1940)

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52  XI*1/2(1940, JP=    ) I=1/2

WE LIST UNDER XI(1940) EVERYTHING REPORTED IN THE MASS
RANGE 1875-2000 MEV.
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                  52  XI*1/2(1940) MASS (MEV)

M        35 1933.0      16.0            BADIER     65 HBC   0 XI- PI+
M        27 1930.0      20.0            ALITTI     68 HBC   0 XI- PI+          11/68
M        66 1894.0      18.0            DAUBER     69 HBC  -  XI PI            11/68
M        21 1955.0      14.0            GOLDWASSE  70 HBC  -  XI PI            10/70
M        29 1956.0       6.0            BADIER     72 HBC     XI PI,XI2PI,K Y  10/71
M        25 1952.       11.             ROSSI      73         (XI PI)-          2/74
M           1900.       12.             DIBIANCA   75 DBC     XI PI             1/76
M       139 1961.       18.             BRIEFEL    77 HBC   0 XI-PI+(2.87 K-P)  1/78
M        44 1936.       22.             BRIEFEL    77 HBC  -  XI0PI-(2.87 K-P)  1/78
M        56 1964.       10.             BRIEFEL    77 HBC  -0 XI(1530) PI       1/78
M     I 150 1937.        7.             BIAGI      81 SPEC  0 HYPERON BEAM      2/82*
M    I  FIT TO INCLUSIVE SPECTRUM FROM XI-N --> XI- PI+ X
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.8)
                       (SEE IDEOGRAM BELOW )
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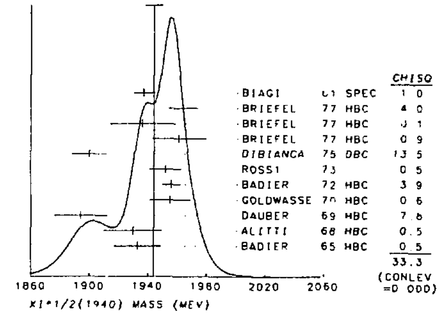


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                  52  XI*1/2(1940) WIDTH (MEV)

W        35  140.0      35.0            BADIER     65 HBC   0 XI- PI+
W        27   80.0      40.0            ALITTI     68 HBC   0 XI- PI+          11/68
W        66   98.0      23.0            DAUBER     69 HBC  -  XI PI            11/68
W        21   56.0      26.0            GOLDWASSE  70 HBC  -  XI PI            10/70
W        29   35.0      11.0            BADIER     72 HBC     XI PI,XI2PI,K Y  10/71
W             38.       10.             ROSSI      73         (XI PI)-          2/74
W             63.       78.             DIBIANCA   75 DBC     XI PI             1/76
W       139  159.       57.             BRIEFEL    77 HBC   0 XI-PI+(2.87 K-P)  1/78
W        44   87.       26.             BRIEFEL    77 HBC  -  XI0PI-(2.87 K-P)  1/78
W        56   60.       39.             BRIEFEL    77 HBC  -0 XI(1530) PI       1/78
W     I 150   60.        8.             BIAGI      81 SPEC  0 HYPERON BEAM      2/82*
W          . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)
                       (SEE IDEOGRAM BELOW )
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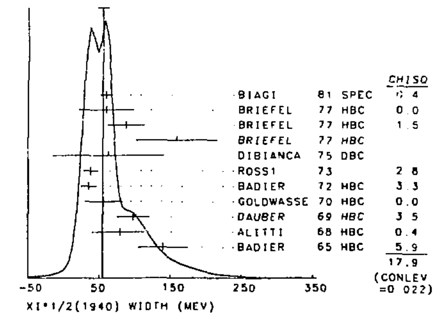

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                    52  XI*1/2(1940) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      XI*1/2(1940) INTO XI PI                                1321+ 139
P2      XI*1/2(1940) INTO XI*(1530) PI                         1533+ 139
P3      XI*1/2(1940) INTO XI PI PI (EXCLUDING P2)              1321+ 139+ 139
P4      XI*1/2(1940) INTO XI0 PI-                              1314+ 139
P5      XI*1/2(1940) INTO XI- PI0                              1321+ 136
P6      XI*1/2(1940) INTO SIGMA KBAR                           1197+ 497

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                    52  XI*1/2(1940) BRANCHING RATIOS

      THE XI(1940) IS SEEN MAINLY IN XI PI AND SOME IN XI(1530) PI.  IT
   HAS BEEN LOOKED FOR IN OTHER CHANNELS BUT ONLY OBSERVED BY HASSALL 81
   WHO SEE A 3 SIGMA EFFECT IN SIGMA KBAR.

R1      XI*1/2(1940) INTO (XI PI)/(XI*1/2(1530) PI)      (P1)/(P2)
R1           2.8       0.7       0.6   APSELL    70 HBC   0                  6/70

R2      XI*1/2(1940) INTO (XI PI PI)/(XI*1/2(1530) PI)   (P3)/(P2)
R2           0.0       0.3             APSELL    70 HBC   0                  6/70

R3      XI*1/2(1940) INTO (XI0 PI-)/(XI- PI0)            (P4)/(P5)           2/74
R3    1  25     2.6       6.        1.6   ROSSI     73         (XI PI)-       2/74
R3    1  THIS BR IS 2.0(0.5) FOR AN I=1/2(I=3/2) XI*(1940).                 2/74

R4      XI*1/2(1940) INTO (SIGMA KBAR)/TOTAL             (P6)
R4       IT   POSSIBLY SEEN              HASSALL   81 HBC  -  K-P AT 6.5 GEV/C  2/82*

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                         REFERENCES FOR XI*1/2(1940)

BADIER    65 PL 16 171          +DEMOULIN,GOLDBERG, +     (EPOL,SACLAY,AMST) I
ALITTI    68 PRL 21 1119        +FLAMINIO,METZGER,RADOJICIC,+(BNL,SYRACUSE) I
DAUBER    69 PR 179 1262        +BERGE, HUBBARD, MERRILL, MULLER       (LRL) I
APSELL    70 PRL 24 777         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS) I
GOLDWASS  70 PR 10 1960         E L GOLDWASSER, P F SCHULTZ       (ILLINOIS)
BADIER    72 NP B37,429         +BARRELET,CHARLTON,VIDEAU              (EPOL)
ROSSI     73 PURDUE CONF. 345   ROSS,LLOYD,RADOJICIC                 (OXFORD)

DIBIANCA  75 NP B98 137         DIBIANCA,ENDORF                        (CARN)
BRIEFEL   77 PRD 16 2706        +GOUREVITCH,CHANG+      (BRAN+UMD+SYRA+TUFT)
   ALSC   70 DUKE CONF. 317     BMST      (BRANDEIS+MARYLAND+SYRACUSE+TUFTS)
BIAGI     81 ZPHY C9 305        +       (BRIS+CAMB+GEVA+HEID+LAUS+LOQM+RHEL)
HASSALL   81 NP B189 397        +ANSORGE,CARTER,NEALE,RUSHBROOKE+(CAMB+MSU)

                         PAPERS NOT REFERRED TO IN DATA CARDS

APSELL    69 PRL 23 884         +      (BRANDEIS, MARYLAND, SYRACUSE, TUFTS)
   SUPERSEDED BY BMST  70.
SCHMIDT   73 PURDUE CONF. 363   SCHMIDT                            (BRANDEIS)
BRIEFEL   75 PRD 12 1859        +GOUREVITCH,KIRSCH+     (BRAN+UMD+SYRA+TUFT)

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Ξ(2030)

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69  XI*1/2(2030, JP=5/2 OR GREATER) I=1/2

THE EVIDENCE FOR THIS STATE HAS BEEN MUCH IMPROVED
BY HEMINGWAY 77, WHO SEE AN 8 STD. DEV. ENHANCEMENT
IN SIGMA KBAR AND A WEAKER COUPLING TO LAMBDA KBAR.
ALITTI 68 AND HEMINGWAY 77 OBSERVE NO SIGNALS IN THE
XI PI PI (OR XI*(1530) PI) CHANNEL, IN CONTRAST TO DIBIANCA 75. THE
DECAY INTO LAMBDA/SIGMA KBAR PI REPORTED BY BARTSCH 69 IS ALSO NOT
CONFIRMED BY HEMINGWAY 77.
A MOMENTS ANALYSIS OF THE HEMINGWAY 77 DATA INDICATES THAT THE SPIN
IS GREATER THAN OR EQUAL TO 5/2 AT A LEVEL OF 3 STD. DEVIATIONS.

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                    68  XI*1/2(2030) MASS (MEV)

M       42 2030.0      10.0              ALITTI    69 HBC  -  K-P 3.9-5 BEV/C   9/69
M       40 2058.0      17.0              BARTSCH   69 HBC  -0 K-P 10 GEV/C      9/69
M       15 2019.        7.               ROSSI     73 HBC  -0 SIGMA KBAR        2/74
M          2044.        9.               DIBIANCA  75 DBC  -0 XI 2PI, XI* PI    1/76
M      200 2024.        2.               HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77
M          . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.5)
                        (SEE IDEOGRAM BELOW )
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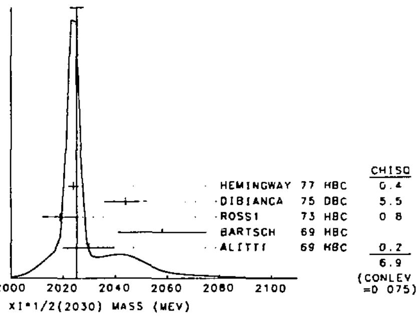


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                    68  XI*1/2(2030) WIDTH (MEV)

W            45.0      40.0      20.0   ALITTI    69 HBC  -  K-P 3.9-5 BEV/C   9/69
W            57.0      30.0             BARTSCH   69 HBC  -0 K-P 10 GEV/C      9/69
W       15   33.       17.              ROSSI     73 HBC  -0 SIGMA KBAR        2/74
W            60.       24.              DIBIANCA  75 DBC  -0 XI 2PI, XI* PI    1/76
W      200   16.        5.              HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77
W            . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.2)
                        (SEE IDEOGRAM BELOW )
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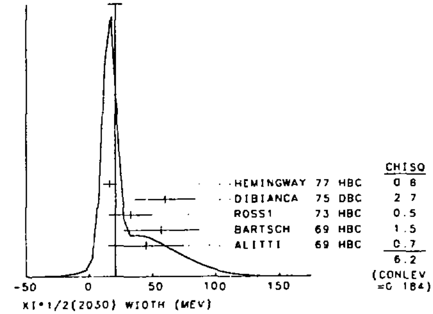


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                    68  XI*1/2(2030) PARTIAL DECAY MODES

                                                               DECAY MASSES
P1      XI*1/2(2030) INTO XI PI                                1321+ 139
P2      XI*1/2(2030) INTO LAMBDA KBAR                          1115+ 497
P3      XI*1/2(2030) INTO SIGMA KBAR                           1197+ 497
P4      XI*1/2(2030) INTO XI*1/2(1530) PI                      1533+ 139
P5      XI*1/2(2030) INTO XI PI PI (EXCLUDING P4)              1321+ 139+ 139
P6      XI*1/2(2030) INTO LAMBDA KBAR PI                       1115+ 497+ 139
P7      XI*1/2(2030) INTO SIGMA KBAR PI                        1189+ 497+ 139

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                    68  XI*1/2(2030) BRANCHING RATIOS

R1      XI*1/2(2030) INTO (XI PI)/(MODES P1 TO P4)        (P1)/(P1+P2+P3+P4)
R1           (0.30) OR LESS             ALITTI    69 HBC  -  1 STD DEV LIMIT    9/69

R11     XI*1/2(2030) INTO (XI PI)/(SIGMA KBAR)            (P1)/(P3)
R11          (0.19) OR LESS  CL=.95     HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77

R2      XI*1/2(2030) INTO (LAM KBAR)/(MODES P1 TO P4)     (P2)/(P1+P2+P3+P4)
R2           0.25     0.15              ALITTI    69 HBC  -  K-P 3.9-5 BEV/C   9/69

R21     XI*1/2(2030) INTO (LAMBDA KBAR)/(SIGMA KBAR)      (P2)/(P3)
R21          0.22     0.09              HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77

R3      XI*1/2(2030) INTO (SIG KBAR)/(MODES P1 TO P4)     (P3)/(P1+P2+P3+P4)
R3           0.75     0.20              ALITTI    69 HBC  -  K-P 3.9-5 BEV/C   9/69

R4      XI*1/2(2030) INTO (XI* PI)/(MODES P1 TO P4)       (P4)/(P1+P2+P3+P4)
R4           (0.15) OR LESS             ALITTI    69 HBC  -  1 STD DEV LIMIT    9/69

R41     XI*1/2(2030) INTO (XI PI PI INCLUDING XI* PI)/(SIGMA KBAR)
R41                                                       (P4+P5)/(P3)
R41  C       (0.11) OR LESS  CL=.95     HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77
R41  C  FOR THE DECAY MODE (XI- PI+ PI-) ONLY

R6      XI*1/2(2030) INTO (LAMBDA KBAR PI)/TOTAL          (P6)
R6           SEEN                       BARTSCH   69 HBC     K-P AT 10 GEV    11/77

R61     XI*1/2(2030) INTO (LAMBDA KBAR PI)/(SIGMA KBAR)   (P6)/(P3)
R61          (0.32) OR LESS  CL=.95     HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77

R7      XI*1/2(2030) INTO (SIGMA KBAR PI)/TOTAL           (P7)
R7           SEEN                       BARTSCH   69 HBC     K-P AT 10 GEV    11/77

R71     XI*1/2(2030) INTO (SIGMA KBAR PI)/(SIGMA KBAR)    (P7)/(P3)
R71  C       (0.04) OR LESS  CL=.95     HEMINGWAY 77 HBC  -  K-P AT 4.2 GEV   11/77
R71  C  FOR THE DECAY MODE (SIGMA+- K- PI-+) ONLY

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                         REFERENCES FOR XI*1/2(2030)

ALITTI    69 PRL 22 79          +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH   69 PL 28B 439         +        (AACHEN, BERLIN, CERN, LOIC, VIENNA)
ROSSI     73 PURDUE CONF. 345   ROSS,LLOYD,RADOJICIC                 (OXFORD)

DIBIANCA  75 NP B98 137         DIBIANCA,ENDORF                        (CARN)
HEMINGWA  77 PL 68B 197         HEMINGWAY,ARMENTEROS+  (AMST+CERN+NIJM+OXF) IJ
   ALSO   76 PL 62B 477         GAY,ARMENTEROS,BERGE+       (AMST+CERN+NIJM)

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Ξ(2120)

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103  XI*1/2(2120, JP=   ) I=1/2

THIS EFFECT IS REPORTED IN GAY 76 AS A
FOUR STANDARD DEVIATION ENHANCEMENT IN
LAMBDA K-. AN ANALYSIS OF THE SAME DATA BY
HEMINGWAY 77, BUT WITH ADDITIONAL STATISTICS,
POINTS OUT THAT THE SIGNIFICANCE OF THE ENHANCEMENT IS GREATLY REDUCED
IF A RESTRICTIVE FOUR-MOMENTUM CUT (U-CUT) IS MADE. THIS SUGGESTS
AN ANOMALOUS PRODUCTION MECHANISM IF THE STATE IS GENUINE.
CHLIAPNIKOV 79 REPORT A BUMP OF 18 EVENTS AT 2137 MEV IN AN INCLUSIVE
ANTI-LAMBDA K+ SPECTRUM FROM K+P INTERACTIONS AT 32 GEV/C.  THE K+ ARE
NOT UNIQUELY IDENTIFIED. BUMPS WITH LOWER NUMBERS OF EVENTS ARE ALSO
REPORTED AT 2240, 2830, AND 2540 MEV.
IN NEED OF CONFIRMATION. OMITTED FROM TABLES.

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                    103  XI*1/2(2120) MASS (MEV)

M          2123.0      7.0          GAY       76 HBC  -  K- P AT 4.2 GEV   2/77
M        18(2137.)    (4.)          CHLIAPNIK 79 HBC  +  ANTI-LAMBDA K+    1/80

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                    103  XI*1/2(2120) WIDTH (MEV)

W          25.0       12.0          GAY       76 HBC  -  K- P AT 4.2 GEV   2/77
W       18 (20.)    OR LESS         CHLIAPNIK 79 HBC  +  ANTI-LAMBDA K+    1/80

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                    103  XI*1/2(2120) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XI*1/2(2120) INTO LAMBDA KBAR                     1115+ 497

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                    103  XI*1/2(2120) BRANCHING RATIOS

R1      XI*1/2(2120) INTO (LAMBDA KBAR)/TOTAL              (P1)
R1            SEEN                  GAY       76 HBC  -  K- P AT 4.2 GEV   2/77

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                          REFERENCES FOR XI*1/2(2120)

GAY       76 PL 62B 477        +ARMENTEROS,BERGE,GAVILLET+(AMST+CERN+NIJM)I
HEMINGWA  77 PL 68B 197        HEMINGWAY,ARMENTEROS+  (AMST+CERN+NIJM+OXF)
CHLIAPNI  79 NP B158 253       CHLIAPNIKOV,GERDYUKOV+      (SERP+BELG+MONS)

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Ξ(2250)

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22  XI*1/2(2250, JP=    )

THE EVIDENCE FOR THIS STATE IS WEAK.  BARTSCH 69 SEE
A BUMP OF NOT MUCH STATISTICAL SIGNIFICANCE IN LAMBDA-
KBAR-PI, SIGMA-KBAR-PI, AND XI-PI-PI MASS SPECTRA.
GOLDWASSER 70 SEE A NARROWER BUMP IN XI-PI-PI AT A
HIGHER MASS.  NOT SEEN BY HASSALL 81 WITH 45
EVENTS/MICROBARN AT 6.5 GEV/C.

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                    22  XI*1/2(2250) MASS (MEV)

M       35 2244.0     52.0          BARTSCH   69 HBC     K-P 10 GEV/C      9/69
M       18 2295.0     15.0          GOLDWASSE 70 HBC  -  K-P 5.5 GEV/C    10/70
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 1.0)

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                    22  XI*1/2(2250) WIDTH (MEV)

W          130.0      80.0          BARTSCH   69 HBC                       9/69
W        LESS THAN   30.0          GOLDWASSE 70 HBC  -  K-P 5.5 GEV/C    10/70

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                    22  XI*1/2(2250) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XI*1/2(2250) INTO XI PI PI                         1321+ 139+ 139
P2      XI*1/2(2250) INTO LAMBDA KBAR PI                   1115+ 497+ 139
P3      XI*1/2(2250) INTO SIGMA KBAR PI                    1197+ 497+ 139

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                          REFERENCES FOR XI*1/2(2250)

BARTSCH   69 PL 28B 439        +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)
GOLDWASS  70 PR 1D 1960        E L GOLDWASSER, P F SCHULTZ      (ILLINOIS)

                          PAPERS NOT REFERRED TO IN DATA CARDS

HASSALL   81 NP B189 397       +ANSORGE,CARTER,NEALE,RUSHBRCOKE+(CAMB+MSU)

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Ξ(2370)

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131  XI*1/2(2370, JP=    ) I=1/2

SEEN BY AMIRZADEH 80 AND HASSALL 81 IN THE CHARGED AND
NEUTRAL LAMBDA/SIGMA KBAR PI MASS SPECTRA FROM THE
REACTIONS K-P --> XI* K AND XI* K PI. AMIRZADEH 80 ALSO
OBSERVE A SMALL EFFECT AT THE SAME MASS IN THE OMEGA- K
MASS SPECTRUM.  KINSON 80 RE-ANALYSE THE DATA OF AMIRZADEH 80 BUT WITH
50 PER CENT MORE STATISTICS.
IN NEED OF FURTHER CONFIRMATION.  OMITTED FROM TABLES.

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                    131  XI*1/2(2370) MASS (MEV)

M       94 2373.       6.           AMIRZAD   80 HBC  -0 K-P AT 8.25 GEV   1/80
M       50(2370.)                   HASSALL   81 HBC  -0 K-P AT 6.5 GEV/C  2/82*

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                    131  XI*1/2(2370) WIDTH (MEV)

W       94  80.       25.           AMIRZAD   80 HBC  -0 K-P AT 8.25 GEV   1/80
W       50 (80.)                    HASSALL   81 HBC  -0 K-P AT 6.5 GEV/C  2/82*

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                    131  XI*1/2(2370) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XI*1/2(2370) INTO LAMBDA KBAR PI (INCL. P4+P6)     1115+ 497+ 139
P2      XI*1/2(2370) INTO SIGMA KBAR PI (INCL. P5+P6)      1197+ 497+ 139
P3      XI*1/2(2370) INTO OMEGA- K                         1672+ 497
P4      XI*1/2(2370) INTO LAMBDA K*BAR(892)                1115+ 891
P5      XI*1/2(2370) INTO SIGMA K*BAR(892)                 1197+ 891
P6      XI*1/2(2370) INTO Y*1(1385) KBAR                   1385+ 497

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                    131  XI*1/2(2370) BRANCHING RATIOS

R1      XI*1/2(2370) INTO (LAMBDA KBAR PI)/TOTAL           (P1)
R1            SEEN                  AMIRZAD   80 HBC  -0 K-P AT 8.25 GEV   1/80

R2      XI*1/2(2370) INTO (SIGMA KBAR PI)/TOTAL            (P2)
R2            SEEN                  AMIRZAD   80 HBC  -0 K-P AT 8.25 GEV   1/80

R3      XI*1/2(2370) INTO (LAMBDA/SIGMA KBAR PI)/TOTAL     (P1+P2)
R3       50   SEEN                  HASSALL   81 HBC  -0 K-P AT 6.5 GEV/C  2/82*

R4      XI*1/2(2370) INTO (OMEGA- K)/TOTAL                 (P3)
R4            0.09      0.04        KINSON    80 HBC  -  K-P AT 8.25 GEV   2/82*

R5      XI*1/2(2370) INTO (LAMBDA/SIGMA K*BAR(892))/TOTAL (P4+P5)
R5            0.22      0.13        KINSON    80 HBC  -  K-P AT 8.25 GEV   2/82*

R6      XI*1/2(2370) INTO (Y*1(1385) KBAR)/TOTAL           (P6)
R6            0.12      0.08        KINSON    80 HBC  -  K-P AT 8.25 GEV   2/82*

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                          REFERENCES FOR XI*1/2(2370)

AMIRZAD   80 PL 90B 324        AMIRZADEH+          (BIRM+CERN+GLAS+MSU+LPNP)I
   ALSO   80 KINSON
KINSON    80 TORONTO CONF. 263 J.B.KINSON+         (BIRM+CERN+GLAS+MSU+LPNP)I
HASSALL   81 NP B189 397       +ANSORGE,CARTER,NEALE,RUSHBRCOKE+(CAMB+MSU)

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Ξ(2500)

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95  XI*1/2(2500, JP=    ) I=1/2

IT IS QUITE POSSIBLE THAT THE REASON THE EXPERIMENTS
DISAGREE ABOUT THE MASS AND WIDTH IS THAT THEY ARE
SEEING DIFFERENT XI*S.  FOR NOW, HOWEVER, WE GROUP
THEM TOGETHER.

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                    99  XI*1/2(2500) MASS (MEV)

M       30 2430.0     20.0          ALITTI    69 HBC  -  K-P 4.6-5 GEV/C   9/69
M       45 2500.0     10.0          BARTSCH   69 HBC  -0 K-P 10 GEV/C      9/69
M          2392.      27.           DIBIANCA  75 DBC       XI 2PI          1/76
M            . . . . . . . . . .
M   AVERAGE MEANINGLESS (SCALE FACTOR = 3.2)

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                    99  XI*1/2(2500) WIDTH (MEV)

W          150.0      60.0    40.0  ALITTI    69 HBC  -                    9/69
W           59.0      27.0          BARTSCH   69 HBC  -0                   9/69
W           75.       69.           DIBIANCA  75 DBC       XI 2PI          1/76
W            . . . . . . . . . .
W   AVERAGE MEANINGLESS (SCALE FACTOR = 1.1)

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                    99  XI*1/2(2500) PARTIAL DECAY MODES

                                                            DECAY MASSES
P1      XI*1/2(2500) INTO XI PI                            1321+ 139
P2      XI*1/2(2500) INTO LAMBDA KBAR                      1115+ 497
P3      XI*1/2(2500) INTO SIGMA KBAR                       1197+ 497
P4      XI*1/2(2500) INTO XI*1/2(1530) PI                  1533+ 139
P5      XI*1/2(2500) INTO LAMBDA (OR SIGMA) KBAR PI        1115+ 497+ 139
P6      XI*1/2(2500) INTO XI PI PI                         1321+ 139+ 139

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                    99  XI*1/2(2500) BRANCHING RATIOS

R1      XI*1/2(2500) INTO (XI PI)/(MODES P1 THRU P4)       (P1)/(P1+P2+P3+P4)
R1           (0.5)   OR LESS        ALITTI    69 HBC       1 STD DEV LIMIT  9/69

R2      XI*1/2(2500) INTO (LAM KBAR)/(MODES P1 THRU P4)    (P2)/(P1+P2+P3+P4)
R2            0.5       0.2         ALITTI    69 HBC  -                    9/69

R3      XI*1/2(2500) INTO (SIG KBAR)/(MODES P1 THRU P4)    (P3)/(P1+P2+P3+P4)
R3            0.5       0.2         ALITTI    69 HBC  -                    9/69

R4      XI*1/2(2500) INTO (XI* PI)/(MODES P1 THRU P4)      (P4)/(P1+P2+P3+P4)
R4           (0.2)   OR LESS        ALITTI    69 HBC       1 STD DEV LIMIT  9/69

R5      XI*1/2(2500) INTO (LAMBDA (OR SIGMA) KBAR PI)/TOTAL
R5                                                         (P5)
R5            SEEN                  BARTSCH   69 HBC  -0                   9/69

R6      XI*1/2(2500) INTO (XI PI PI)/TOTAL                 (P6)
R6            SEEN                  BARTSCH   69 HBC  -0                   9/69

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                          REFERENCES FOR XI*1/2(2500)

ALITTI    69 PRL 22 79         +BARNES,FLAMINIO,METZGER, +  (BNL,SYRACUSE) I
BARTSCH   69 PL 28B 439        +      (AACHEN, BERLIN, CERN, LOIC, VIENNA)

DIBIANCA  75 NP B98 137        DIBIANCA,ENDORF                       (CARN)

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S=−3 I=0 HYPERON STATE (Ω)

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Ω^-

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24  OMEGA-(1675, JP=3/2+) I=0

SEE STABLE PARTICLE DATA CARD LISTINGS

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CHARMED BARYONS

Λ_c^+

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33  LAMBDA/C+(2282, JP=  )

SEE STABLE PARTICLE DATA CARD LISTINGS
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$\Sigma_c(2450)$ →

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104  SIGMA/C(2450, JP=  )

THE SIGMA/C DECAYS TO LAMBDA/C PI, AND THE SCHISM IN
MASSES HERE REFLECTS THAT IN MEASUREMENTS OF THE
LAMBDA/C MASS (THE HIGHER MASSES ARE PRESENTLY
FAVORED). THE IMPRESSIVE AGREEMENT ON THE SIGMA/C-
LAMBDA/C MASS DIFFERENCE STRONGLY INDICATES THIS TO
BE THE CASE, RATHER THAN THAT TWO STATES (THE SIGMA/C AND Y*/C)
ARE BEING OBSERVED.

     THIS PARTICLE IS AT ABOUT THE 2-AND-1/2-STAR LEVEL.  A DEFINITIVE
EXPERIMENT IS NEEDED.
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                   104  SIGMA/C(2450) MASS  (MEV)

M      1  2426.0     12.0          CAZZOLI    75 HBC  ++ NU P IN BNL 7-FT   3/77
M      9 (2460.0)                  KNAPP      76 SPEC -  GAMMA BE          11/81*
M      1 (2439.)   OR MORE         BARISH     77 DBC  ++ NU D IN 12-FT      3/77
M      6  2425.0     10.0          BALTAY     79 HLBC ++ NU NE-H IN 15-FT  12/79
M      1  2457.0      4.0          CALICCHIO  80 HBC  +  NU P IN BEBC-TST  11/81*
M      1  2454.0      5.0          BOSETTI    82 HBC  ++ NU P IN BEBC       3/82*
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                   104  (SIGMA/C)-(LAMBDA/C+) MASS DIFFERENCE  (MEV)

D      1   166.0     15.0          CAZZOLI    75 HBC  ++ NU P IN BNL 7-FT  11/81*
D      6   168.0      3.0          BALTAY     79 HLBC ++ NU NE-H IN 15-FT  12/79
D      1   168.0      3.0          CALICCHIO  80 HBC  +  NU P IN BEBC-TST  11/81*
D      1   166.0      1.0          BOSETTI    82 HBC  ++ NU P IN BEBC       3/82*
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                   104  SIGMA/C(2450) PARTIAL DECAY MODES

                                                            DECAY MASSES
PI     SIGMA/C(2450) INTO LAMBDA/C+ PI                      2282+ 139
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                              REFERENCES FOR SIGMA/C(2450)

CAZZOLI   75 PRL 34 1125        +CNOPS,CONNOLLY,LOUTTIT,MURTAGH, +      (BNL)
KNAPP     76 PRL 37 882         +LEE,LEUNG,SMITH, +     COLU+HAWA+ILL+FNAL)
BARISH    77 PR D15 1           +DERRICK,DOMBECK,MUSGRAVE, +       (ANL+PURD)
BALTAY    79 PRL 42 1721        +CAROUMBALIS,FRENCH,HIBBS, +       (COLU+BNL)I
CALICCHI  80 PL 93B 521         + (BARI+BIRM+BRUX+CERN+EPOL+RHEL+SACL+LOUC)
BOSETTI   82 PL 109B 234        +GRAESSLER, +     (AACH+BONN+CERN+MPIM+OXF)

                              THEORY AND REVIEW

DERUJULA  75 PR D12 147         +GEORGI,GLASHOW                        (HARV)
LEE       77 PR D15 157         +QUIGG,ROSNER                          (FNAL)
TRILLING  81 PRPL 75 57         G H TRILLING                            (LBL)
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BOTTOM (BEAUTY) BARYON

Λ_b^0 →

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40  LAMBDA/B0(5500, JP=  )

SEE STABLE PARTICLE DATA CARD LISTINGS
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Note on Dibaryon Resonances

(by L.D. Roper, Virginia Polytechnic Institute and State University)

The first modern theoretical discussion of dibaryon resonances was probably by Oakes.[1] The first experimental hint of them was in a Λp invariant mass distribution by Dahl,[2] and in NN partial-wave analyses by Arndt[3] for the $^1D_2$ state in a pp partial-wave analysis. [The notation is $^{(2S+1)}L_J$, where S is the total spin, L is the orbital angular momentum, and J is the total angular momentum.]

Dibaryon popularity rose dramatically in 1977 when strong energy dependence was unexpectedly observed in pp polarization experiments at Argonne.[4] Also, in that year and the next, Hoshizaki claimed the existence of dibaryon resonances in a pp partial-wave analysis.[5] In the same year Jaffe gave a detailed theoretical treatment of multi-quark states.[6]

Since the last issue of this Review some new pp and np polarization experiments[7] have been reported which, along with other new and old NN scattering data, have been newly partial-wave analyzed.[8] There are also partial-wave analyses (given in the Listings) of πd elastic, $\pi d \to \pi pn$, $pp \to \pi d$, and $\gamma d \to pn$ scattering. Most of these strongly indicate the existence of dibaryon resonances in the $^1D_2$ and $^3F_3$ nucleon-nucleon states, and some indicate possible resonances in the $^1S_0$, $^3S_1$, $^3P_1$, $^3P_2$, $^3D_3$, $^1F_3$, or $^1G_4$ states.

The Pauli principle restricts two nucleons to be in one of the following states:

$$I=0:\quad (^3S_1, {}^3D_1), {}^1P_1, {}^3D_2, (^3D_3, {}^3G_3), {}^1F_3, {}^3G_4, \ldots$$

$$I=1:\quad {}^1S_0, {}^3P_0, {}^3P_1, (^3P_2, {}^3F_2), {}^1D_2, {}^3F_3, (^3F_4, {}^3H_4), \ldots$$

Here the states that couple together (same J^P) are enclosed in parentheses. Similarly, only certain quantum number sets are allowed for $\Lambda\Lambda$, etc.

In the Listings below, we separate the determinations of pole positions and Breit-Wigner parameters. To be a resonance, the pole must occur on the second sheet for the elastic channel; it may be a bound state or resonance for inelastic channels. The advantages of pole parameters over Breit-Wigner parameters are discussed briefly in the "Note on N's and Δ's."

The idea that exotic resonances are really 'pseudo-resonances'[9] has recently taken a new turn.[10] The idea is that box diagrams (e.g., involving NΔ in NN scattering) create resonance-like loops in the Argand diagram without resonance poles actually existing. The question is whether poles would be created when one unitarized the box diagrams in order to calculate physical scattering amplitudes. Kloet and Tjon[10] have recently shown that a model exists in which, indeed, that is the case. However, resonance hunters should definitely report pole positions rather than looping Argand diagrams in the future. All who still suggest that the NN $^1D_2$ or $^3F_3$ resonance-like structure is due to some dynamics other than resonances must take their case to the world collection of NN scattering data in the form of a detailed partial-wave analysis.

The dinucleon resonances also communicate with the γd and πd channels. There is not much γd data, and the multipole analysis does not yield much certainty about which dibaryons are involved. In the πd case, uncertainties abound and the partial-wave analysis yields poor fits compared to the analyses of NN data. Nevertheless, the existence of dibaryons appears to be corroborated by the γd and πd data.

Only a few papers about strange dibaryon states have appeared since the last issue of this Review. It appears that the S=-1 dominant resonance is in the $^3S_1$ state, an SU(3) partner of the deuteron. An excellent review of the S=-1 situation is given by Dalitz,[11] who concludes that the S=-1 $^3S_1$ resonance pole probably exists.

For a more detailed recent review of dibaryons, see Hoshizaki.[12]

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DIBARYONS

S=0 DIBARYONS

106 BARYON NUMBER 2, STRANGENESS 0 STATES

IN THIS SECTION WE USE THE FOLLOWING ABBREVIATIONS FOR TYPES OF ANALYSES--

GDPN	GAMMA D -> P N PARTIAL-WAVE ANALYSIS RESONANCE PARAMETRIZATION
NN	FIT TO NN ELASTIC PARTIAL-WAVE ANALYSIS RESULTS
NNF	FIT TO NN FORWARD AMPLITUDES
PID	PI- D ELASTIC PARTIAL-WAVE ANALYSIS RESONANCE PARAMETRIZATION
PIDI	PI- D -> PI- P N AMPLITUDE ANALYSIS RESONANCE PARAMETRIZATION
PPPD	P P -> PI- D PARTIAL-WAVE ANALYSIS RESONANCE PARAMETRIZATION

NN(2170) I=1, $^1D_2$

106 B=2, S=0, 1D2 -- BREIT-WIGNER MASS (MEV)

BREIT-WIGNER MASS APPROXIMATELY EQUALS RE(POLE POSITION).

M		(2170.)	HOSHIZAKI	79	NN	1D2 ASSUMED BCDGRND	1/82*
M		(2180.)	ARVIEUX	80	PID	1D2	1/82*
M	A	(2185.)	KAMO	80	PPPD	1D2	1/82*
M		(2170.)	HOFTIEZE	81	PIDI	1D2	1/82*
M	B	(2140.)	KANAI	81	PID	1D2 SOL. B AND C	1/82*

M

M A KAMO 80 DID NOT TRY FITS WITH FEWER THAN SIX RESONANCES. 1/82*
M B KANAI 81 FIT WITH NO RESONANCES WAS VERY POOR AND DID NOT TRY 1/82*
M B OTHER FITS WITH FEWER THAN FOUR RESONANCES. 1/82*

106 B=2, S=0, 1D2 -- BREIT-WIGNER WIDTH (MEV)

BREIT-WIGNER WIDTH APPROXIMATELY EQUALS 2 TIMES IM(POLE POSITION).

W		100. TO 150.	HOSHIZAKI	79	NN	1D2 ASSUMED BCKGRND	1/82*
W	A	(134.)	KAMO	80	PPPD	1D2	1/82*
W		(T5.)	HOFTIEZE	81	PIDI	1D2	1/82*
W	B	(56.)	KANAI	81	PID	1D2 SOL. B	1/82*
W	B	(54.)	KANAI	81	PID	1D2 SOL. C	1/82*

106 B=2, S=0, 1D2 -- BREIT-WIGNER ELASTICITY

BREIT-WIGNER ELASTICITY APPROXIMATELY EQUALS ABS(RESIDUE OF POLE)/IM(POLE POS.).

R1	(0.1)	HOSHIZAKI	79	NN	1D2	1/82*

106 B=2, S=0, 1D2 -- RE(POLE POSITION) (MEV)

RE(POLE POSITION) APPROXIMATELY EQUALS BREIT-WIGNER MASS.

RE		(2045.)	BHANDARI	81	NN	1D2 K-MATRIX FIT	1/82*
RE		(2135.)	BHANDARI	81	NN	1D2 M-MATRIX FIT	1/82*
RE		(2150.)	EDWARDS	81	NN	1D2 K-MATRIX FIT	1/82*
RE	C	(2153.)	KLOET	81	NN	1D2 POT. MODEL FIT	1/82*

RE C KLOET 81 DOES NOT SHOW GOODNESS OF FIT TO 1D2. 1/82*

106 B=2, S=0, 1D2 -- IM(POLE POSITION) (MEV)

IM(POLE POSITION) APPROXIMATELY EQUALS BREIT-WIGNER WIDTH DIVIDED BY 2.

IM		(110.)	BHANDARI	81	NN	1D2 K-MATRIX FIT	1/82*
IM		(90.)	BHANDARI	81	NN	1D2 M-MATRIX FIT	1/82*
IM		(56.)	EDWARDS	81	NN	1D2 K-MATRIX FIT	1/82*
IM	C	(46.)	KLOET	81	NN	1D2 POT. MODEL FIT	1/82*

106 B=2, S=0, 1D2 -- ABS(RESIDUE)/IM(POLE POSITION)

ABS(RES)/IM(POLE POSITION) APPROXIMATELY EQUALS BREIT-WIGNER ELASTICITY.

RES	(0.175)	BHANDARI	81	NN	1D2 K-MATRIX FIT	1/82*
RES	(0.2)	BHANDARI	81	NN	1D2 M-MATRIX FIT	1/82*
RES	(0.29)	EDWARDS	81	NN	1D2 K-MATRIX FIT	1/82*

NN(2250) $I=1,\ {}^3F_3$

106 B=2, S=0, 3F3 -- BREIT-WIGNER MASS (MEV)

M	D	(2390.)		GREIN	78	NNF	3F3	1/82*
M		(2220.)		HOSHIZAKI	78	NN	3F3 ASSUMED BCKGRND	1/82*
M		(2240.)		ARVIEUX	80	PID	3F3	1/82*
M	E	2260. (FIXED)		IKEDA	80	GDPN	3F3 SOL. A	1/82*
M		2296.	11.	IKEDA	80	GDPN	3F3 SOL. A'	1/82*
M		2307.	12.	IKEDA	80	GDPN	3F3 SOL. B''	1/82*
M	A	(2185.)		KAMO	80	PPPD	3F3	1/82*
M	B	(2265.)		KANAI	81	PID	3F3 SOL. B AND C	1/82*

M D GREIN 78 SEES NO 1D2 RESONANCE. 1/82*
M E IKEDA 80 GIVES TWO OTHER SOLUTIONS WITH POORER FITS TO DATA. 1/82*

106 B=2, S=0, 3F3 -- BREIT-WIGNER WIDTH (MEV)

W	D	(290.)		GREIN	78	NNF	3F3	1/82*
W		50. TO 100.		HOSHIZAKI	78	NN	3F3 ASSUMED BCKGRND	1/82*
W	E	200. (FIXED)		IKEDA	80	GDPN	3F3 SOL. A	1/82*
W		177.	32.	IKEDA	80	GDPN	3F3 SOL. A'	1/82*
W		213.	54.	IKEDA	80	GDPN	3F3 SOL. B''	1/82*
W	A	(81.)		KAMO	80	PPPD	3F3	1/82*
W	B	(181.)		KANAI	81	PID	3F3 SOL. B	1/82*
W	B	(171.)		KANAI	81	PID	3F3 SOL. C	1/82*

106 B=2, S=0, 3F3 -- BREIT-WIGNER ELASTICITY

R1	(0.2)	HOSHIZAKI	78	NN	3F3	1/82*

106 B=2, S=0, 3F3 -- RE(POLE POSITION) (MEV)

RE	(2190.)	BHANDARI	81	NN	3F3 K-MATRIX FIT	1/82*
RE	(2215.)	BHANDARI	81	NN	3F3 M-MATRIX FIT	1/82*
RE	(2185.)	EDWARDS	81	NN	3F3 K-MATRIX FIT	1/82*
RE	(2175.)	KLOET	81	NN	3F3 POT. MODEL FIT	1/82*

106 B=2, S=0, 3F3 -- IM(POLE POSITION) (MEV)

IM	(65.)	BHANDARI	81	NN	3F3 K-MATRIX FIT	1/82*
IM	(70.)	BHANDARI	81	NN	3F3 M-MATRIX FIT	1/82*
IM	(70.)	EDWARDS	81	NN	3F3 K-MATRIX FIT	1/82*
IM	(43.)	KLOET	81	NN	3F3 POT. MODEL FIT	1/82*

106 B=2, S=0, 3F3 -- ABS(RESIDUE)/IM(POLE POSITION)

RES	(0.15)	BHANDARI	81	NN	3F3 K-MATRIX FIT	1/82*
RES	(0.15)	BHANDARI	81	NN	3F3 M-MATRIX FIT	1/82*
RES	(0.30)	EDWARDS	81	NN	3F3 K-MATRIX FIT	1/82*

OTHER NN →

106 B=2, S=0 MISCELL. -- BREIT-WIGNER MASS (MEV)

M		(2250.)		GREIN	80	NNF	3S1 OR 3D3	1/82*
M		(2190.)		HASHIMOTO	80	NN	1F3 ASSUMED BCKGRND	1/82*
M		(2352.)	(69.)	IKEDA	80	GDPN	3S1 SOL. A	1/82*
M		2380. (FIXED)		IKEDA	80	GDPN	3S1 SOL. A'	1/82*
M		(2290.)	(14.)	IKEDA	80	GDPN	3P2 SOL. C	1/82*
M		2380. (FIXED)		IKEDA	80	GDPN	3S1 SOL. C	1/82*
M		(2377.)	(17.)	IKEDA	80	GDPN	3D3 SOL. B''	1/82*
M	A	(2100.)		KAMO	80	PPPD	1S0	1/82*
M		(2117.)		KAMO	80	PPPD	3P2	1/82*
M	F	(2148.)		KAMO	80	PPPD	3F2	1/82*
M		(2159.)		KAMO	80	PPPD	3P1	1/82*
M	D	(2290.)		KANAI	81	PID	3P2 SOL. B	1/82*
M		(2300.)		KANAI	81	PID	3P2 SOL. C	1/82*
M		(2510.)		KANAI	81	PID	1G4 SOL. B	1/82*
M		(2530.)		KANAI	81	PID	1S0 SOL. C	1/82*

M F 3F2 RESONANCE INDICATES 3P2 RESONANCE BECAUSE THEY ARE COUPLED. 1/82*

106 B=2, S=0 MISCELL. -- BREIT-WIGNER WIDTH (MEV)

W		(100.)		GREIN	80	NNF	3S1 OR 3D3	1/82*
W		(50.)		HASHIMOTO	80	NN	1F3 ASSUMED BCKGRND	1/82*
W		(342.)	(69.)	IKEDA	80	GDPN	3S1 SOL. A	1/82*
W		200. (FIXED)		IKEDA	80	GDPN	3S1 SOL. A'	1/82*
W		(263.)	(55.)	IKEDA	80	GDPN	3P2 SOL. C	1/82*
W		200. (FIXED)		IKEDA	80	GDPN	3S1 SOL. C	1/82*
W		(214.)	(52.)	IKEDA	80	GDPN	3D3 SOL. B''	1/82*
W	A	(315.)		KAMO	80	PPPD	1S0	1/82*
W		(58.)		KAMO	80	PPPD	3P2	1/82*
W	F	(5.)		KAMO	80	PPPD	3F2	1/82*
W		(51.)		KAMO	80	PPPD	3P1	1/82*
W	B	(139.)		KANAI	81	PID	3P2 SOL. B	1/82*
W	B	(150.)		KANAI	81	PID	3P2 SOL. C	1/82*
W	B	(122.)		KANAI	81	PID	1G4 SOL. B	1/82*
W	B	(66.)		KANAI	81	PID	1S0 SOL. C	1/82*

106 B=2, S=0 MISCELL. -- BREIT-WIGNER ELASTICITY

R1	(0.12)	HASHIMOTO	80	NN	1F3 ASSUMED BCKGRND	1/82*

REFERENCES FOR B=2, S=0 STATES

GREIN	78 NP B137 173	W.GREIN, P.KROLL	(KARL+WUPP)
HOSHIZAK	78 PTP 60 1796	N.HOSHIZAKI	(KYOT)
HOSHIZAK	79 PTP 61 129	N.HOSHIZAKI	(KYOT)
ARVIEUX	80 NP A350 205	J.ARVIEUX, A.S.RINAT	(GREN+REHO+SACL)
GREIN	80 PL 96B 176	W.GREIN, A.KRONIG, P.KROLL	(SIN+WUPP)
HASHIMOT	80 PTP 64 1693	K.HASHIMOTO, N.HOSHIZAKI	(KYOT)
IKEDA	80 NP B172 509	+ARAI, FUJII, FUJII, IWASAKI+	(TOKY+KEK+INUS)
KAMO	80 LNC 29 289	H.KAMO, W.WATARI	(OSAK)
ALSO	80 PTP 64 2144	KAMO, WATARI, YONEZAWA	(OSAK+HIRO)
BHANDARI	81 PRL 46 1111	+ARNDT, ROPER, VERWEST	(VPI+TAMU)
EDWARDS	81 PR D23 1978	B.J.EDWARDS	(ANL)
HOFTIEZE	81 PR C23 407	+BAKER, CLEMENT, DRAGOSET+	(RICE+HOUS+BONN)
KANAI	81 PTP 65 266	+MINAKA, NAKAMURA+	(TMU+KAGO+TMAS+SAGA)
KLOET	81 PL 106B 24	W.M.KLOET, J.A.TJON	(RUTG+UTRE)

PAPERS NOT REFERRED TO IN DATA CARDS

HIDAKA	77 PL 70B 479	+BERETVAS, NIELD, SPINKA+	(ANL)
FRASCARI	80 PL 91B 345	+BRISSAUD, DIDELEZ, PERRIN+	(IPN+GREN+NEUC)
KUBODERA	80 JPG 6 171	+LOCHER, MYHRER, THOMAS	(SIN+NORD+TRIU)
ARGAN	81 PRL 46 96	+AUDIT, DEBOTTON, FAURE, MARTIN	(SACL)
ARVIEUX	81 PL 103B 99	J.ARVIEUX	(GREN+SACL)
BOLGER	81 PRL 46 167	+BOSCHITZ, PROBSTLE, SMITH	(KARL+SIN+ERLA+)
GREIN	81 JPG 7 1355	W.GREIN, M.LOCHER	(SIN)
HOLT	81 PRL 47 472	+SPECHT, STEPHENSON, ZEIDMAN+	(ANL+LASL+)
KLOET	81 NP A364 346	W.KLOET, R.SILBAR	(RUTG+LASL)
RINEHART	81 PRL 46 1185	+BOSWELL, DAVIS, DAY, MCCARTHY+	(VIRG+LASL)
MIZUTANI	81 PL 107B 177	+FAYARD, LAMOT, NAHABETIAN	(LYON+REGE)
RINAT	81 PL 104B 182	A.RINAT, J.ARVIEUX	(GREN+REHO+SACL)
TAMAS	81 NP A358 347	G.TAMAS	(SACL)

S=−1 DIBARYON

107 BARYON NUMBER 2, STRANGENESS -1 STATES

IN THIS SECTION WE USE THE FOLLOWING ABBREVIATIONS FOR TYPES OF ANALYSES--

LPIM	LAMBDA-P INVARIANT MASS
LNIM	LAMBDA-N INVARIANT MASS
SPIM	SIGMA-P INVARIANT MASS
BB	BARYON-BARYON SCATTERING COMBINED AMPLITUDE ANALYSIS

ΛN(2130) $I=1/2,\ {}^3S_1$

107 B=2, S=-1 -- BREIT-WIGNER MASS (MEV)

BREIT-WIGNER MASS APPROXIMATELY EQUALS RE(POLE POSITION).

M	I	2098.	6.	COHN	64	LNIM	Q=0	1/82*
M	H	(2126.)		CLINE	68	LPIM 3S1	Q=1	1/82*
M	H	(2130.)		ALEXANDER	69	LPIM	Q=1	1/82*
M	J	(2130.)		JAIN	69	LPIM	Q=1	1/82*
M	H	2128.7	0.2	TAN	69	LPIM	Q=1	1/82*
M	H	(2138.8)	(0.7)	TAN	69	LPIM	Q=1	1/82*
M	H	(2129.)		EASTWOOD	71	LPIM	Q=1	1/82*
M	K	2127.	1.	SIMS	71	LPIM LNIM	Q=0,1	1/82*
M	L	2125.2	2.5	SHAHBAZI	73	LPIM	Q=1	1/82*
M	L	(2251.4)	(3.9)	SHAHBAZI	73	LPIM	Q=1	1/82*
M	M	(2115.)		SODHI	75	LPIM	Q=1	1/82*
M	H	2129.0	0.4	BRAUN	77	LPIM	Q=1	1/82*
M	N	(2130.)		GOYAL	78	LPIM	Q=1	1/82*
M	O	(2320.)		GOYAL	80	SPIM	Q=0	1/82*

M I SIGMA- D TO LAMBDA N T. 1/82*

M J GOYAL 71 RAISES DOUBTS ABOUT THE EXPERIMENTAL PROCEDURE USED 1/82*
M J IN JAIN 69. JAIN STUDIED K- EMULSION TO LAMBDA P. 1/82*

M K K- D TO PI- LAMBDA P, PI- LAMBDA PI+ N, AND PI- LAMBDA PI0 P. 1/82*

M L N P TO LAMBDA P X FOR P IN CARBON 12. 1/82*

M M K- D TO PI- PI0 LAMBDA P. 1/82*

M N GOYAL 78 SEES ANOTHER UNCERTAIN PEAK AT 2195-2210 MEV. 1/82*
M N K- D TO 2PI- PI+ LAMBDA P. 1/82*

M O K- D TO PI+ PI- SIGMA- P. 1/82*

Data Card Listings

For notation, see key at front of Listings.

107 B=2, S=-1 -- BREIT-WIGNER WIDTH (MEV)

BREIT-WIGNER WIDTH APPROXIMATELY EQUALS 2 TIMES IM(POLE POSITION).

W	I	20.	10.	COHN	64 LPIM		Q=0		1/82*
W	H	10. OR LESS		CLINE	68 LPIM	3S1	Q=1		1/82*
W	J	(20.)		JAIN	69 LPIM		Q=1		1/82*
W	H	7.0	0.5	TAN	69 LPIM		Q=1		1/82*
W	H	(9.1)	(2.4)	TAN	69 LPIM		Q=1		1/82*
W	H	(10.)		EASTWOOD	71 LPIM		Q=1		1/82*
W	K	5.	1.	SIMS	71 LPIM		Q=1		1/82*
W	L	20.6	5.2	SHAHBAZI	73 LPIM		Q=1	2125 PEAK	1/82*
W	L	(21.1)	(5.4)	SHAHBAZI	73 LPIM		Q=1	2251 PEAK	1/82*
W	M	(150.)		SODHI	75 LPIM		Q=1		1/82*
W	H	5.9	1.6	BRAUN	77 LPIM		Q=1		1/82*
W	O	(25.)		GOYAL	80 SPIM		Q=0		1/82*

107 B=2, S=-1 -- RE(POLE POSITION) (MEV)

RE(POLE POSITION) APPROXIMATELY EQUALS BREIT-WIGNER MASS.

RE	G	(2132.)	NAGELS	79 BB	3S1	Q=1	1/82*
RE	G	(2137.)	NAGELS	79 BB	3S1	Q=0	1/82*
RE	H	(2129.)	DOSCH	80 LPIM	3S1	Q=1	1/82*
RE		(2127.)	TAKAHASHI	80 BB	3S1	Q=0,1,2	1/82*
RE		(2148.)	TAKAHASHI	80 BB	1P	Q=0,1,2	1/82*

RE G NAGELS 79 REPORTS POLE POSITION FOR TWO DIFFERENT 3S1 CHARGE STATES. 1/82*
RE H K- D TO PI- LAMBDA P. 1/82*

107 B=2, S=-1 -- IM(POLE POSITION) (MEV)

IM(POLE POSITION) APPROXIMATELY EQUALS BREIT-WIGNER WIDTH DIVIDED BY 2.

IM	G	(2.4)	NAGELS	79 BB	3S1	Q=1	1/82*
IM	G	(2.6)	NAGELS	79 BB	3S1	Q=0	1/82*
IM	H	(5.)	DOSCH	80 LPIM	3S1	Q=1	1/82*
IM		(9.)	TAKAHASHI	80 BB	3S1	Q=0,1,2	1/82*
IM		(8.)	TAKAHASHI	80 BB	1P	Q=0,1,2	1/82*

REFERENCES FOR B=2, S=-1 STATES

COHN 64 PRL 22 668 — H.O.COHN,K.H.BHATT,W.M.BUGG (ORNL+TENN)
CLINE 68 PRL 20 1452 — D.CLINE,R.LAUMANN,J.MAPP (WISC)
ALEXANDE 69 PRL 22 483 — ALEXANDER,HALL,JEW,KALMUS,KERNAN (LBL+UCR)
JAIN 69 PR 187 1816 — P.L.JAIN (BUFF)
TAN 69 PRL 23 395 — T.H.TAN (SLAC)
EASTWOOD 71 PR D3 2603 — +FRY,HEATHCOTE,ISLAM+ (BIRM+EDIN+GLAS+LOIC)
SIMS 71 PR D3 1162 — +O'NEAL,ALBRIGHT,BRUCKER,LANUTTI (FSU)
SHAHBAZI 73 NP B53 19 — B.SHAHBAZIAN,A.TIMONINA (JINR)

SODHI 75 NP B97 403 — A.SODHI,D.GOYAL (DELH)
BRAUN 77 NP B124 45 — +GRIMM,HEPP,STROEBELE,THOEL+ (HEID+MPIM)
GOYAL 78 PR D18 948 — D.GOYAL,A.SODHI (DELH)
NAGELS 79 PR D20 1633 — M.NAGELS,T.RIJKEN,J.DESWART (NIJM)
DOSCH 80 ZPC 3 249 — H.DOSCH,I.STAMATESCU (HEID)
GOYAL 80 PTP 64 700 — D.GOYAL,J.MISRA (DELH)
TAKAHASH 80 NP A336 347 — TAKAHASHI,IWAMURA,KIMURA,KUME (TOKY)

PAPERS NOT REFERRED TO IN DATA CARDS

[illegible] — .A.PIROUE (PRIN)
ALEXANDE 68 PR 173 1452 — +KASHDAN,SHAPIRA+ (REHO+HEID)
BUNNEL 70 PR D2 98 — +DERRICK,FIELDS,HYMAN,KEYES (NWES+ANL)
GOYAL 71 PR D3 1259 — D.P.GOYAL (DELH)
KADYK 71 NP B27 13 — +ALEXANDER,CHAN,GAPDSCHKIN,TRILLING (LBL)
DOSCH 78 PR D18 4071 — H.G.DOSCH,V.HEPP (HEID)
MIZUNO 79 PTP 62 1691 — T. MIZUNO (TOKY)
ROOSEN 79 NC B49 217 — +VANDERVELDE-WILQUET,WICKENS+ (LOUC+BRUX)
D'AGOSTI 81 PL 104B 330 — (ROMA+SACL+VAND)
KIMURA 81 PTP 65 649 — M.KIMURA,Y.IWAMURA,Y.TAKAHASHI (TOKY)
TOKER 81 NP A362 405 — G.TOKER,A.GAL,J.EISENBERG (HEBREW+TELA)

S=-2 DIBARYON

108 BARYON NUMBER 2, STRANGENESS -2 STATES

IN THIS SECTION WE USE THE FOLLOWING ABBREVIATIONS FOR MEASURED QUANTITIES--

XPIM — XI-P INVARIANT MASS
LLIM — LAMBDA-LAMBDA INVARIANT MASS

108 B=2, S=-2 -- MASS (MEV)

M	P	(2367.)	(4.)	BEILLIERE	72 LLIM	Q=0	GAUSSIAN FIT	1/82*
M	Q	(2365.3)	(9.6)	SHAHBAZIA	73 LLIM	Q=0		1/82*
M	R	(2440.)		GOYAL	80 XPIM	Q=0		1/82*

M P K- D TO XI- P K0. 1/82*
M Q N P TO LAMBDA LAMBDA X AND PI- P TO LAMBDA LAMBDA X FOR P IN CARBON 12. 1/82*
M R GOYAL 80 ALSO SEES A SHOULDER AT 2360 MEV. 1/82*

108 B=2, S=-2 -- WIDTH (MEV)

W	P	(15.)	(4.)	BEILLIERE	72 LLIM	Q=0	GAUSSIAN FIT	1/82*
W	Q	(47.0)	(15.7)	SHAHBAZIA	73 LLIM	Q=0		1/82*

REFERENCES FOR B=2, S=-2 STATES

BEILLIER 72 PL 39B 671 — BEILLIERE,MAYEUR+ (BRUX+CERN+TUFT+LOUC)
SHAHBAZI 73 NP B53 19 — B.SHAHBAZIAN,A.TIMONINA (JINR)
GOYAL 80 PR D21 607 — D.GOYAL,J.MISRA,A.SODHI (DELH)

PAPERS NOT REFERRED TO IN DATA CARDS

CARROLL 78 PRL 41 777 — +CHIANG,JOHNSON,KYCIA,KI,+ (BNL+PRIN)

Appendix I

TEST OF $\Delta I = 1/2$ RULE FOR HYPERON DECAYS

O. E. Overseth
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1. Nonleptonic decay Amplitudes

In this edition we again use the new convention for the amplitudes A and B adopted in 1973. Some theorists have suggested that *dimensionless amplitudes are more useful to them than the ones* appearing in the literature. Berge[1] used a convention with A and B in units of $\sec^{-1/2}$. Samios[2] used a convention which gave A and B in units of $(\text{MeV-sec})^{-1/2}$. Following is the convention suggested by Jackson[3], which gives dimensionless A and B.

The effective Lagrangian density for nonleptonic hyperon decays $(B_1 \to B_2 + \pi)$ can be written

$$L_{eff} = G\mu_c^2[\bar{\psi}_2(A+B\gamma_5)\psi_1]\phi_\pi \ ,$$

where $G = 10^{-5} m_p^{-2}$ is a *coupling constant characteristic of first-order* weak decays, μ_c is the charged pion mass, and A and B are *dimensionless* complex numbers giving the relative amplitudes of the parity-violating and parity-conserving decays, respectively. The matrix γ_5 is to be taken in the Pauli form, $\gamma_5 = \begin{pmatrix} 0 & -I \\ -I & 0 \end{pmatrix}$. The invariant amplitude for the decay is

$$M = G\mu_c^2[\,\bar{u}(p)(A+B\gamma_5)u(P)\,],$$

where P is the 4-momentum of the decaying hyperon of mass M, and p is the 4-momentum of the baryon decay product of mass m. With the normalization convention, $\bar{u}_i u_i = 2m_i$, the Pauli form of the matrix element in the rest frame of the decaying hyperon is

$$M = G\mu_c^2 \langle \chi_2 |\, \sqrt{2M(E+m)}A + \sqrt{2M(E-m)}B\vec{\sigma}\ .\ \hat{q}\,| \chi_1 \rangle ,$$

where E is the total energy of the final baryon and $\hat{q}$ is a unit vector in the direction of motion of the final baryon. Comparison with Sec. VI D of the text shows that the amplitudes s and p defined there are proportional to A and B:

$$\frac{p}{s} = \left(\frac{E-m}{E+m}\right)^{1/2} \frac{B}{A} = \left[\frac{(M-m)^2-\mu^2}{(M+m)^2-\mu^2}\right]^{1/2} \frac{B}{A} .$$

Here μ is the mass of the pion entering the decay. The parameters α, β, and γ can therefore be expressed in terms of A and B, rather than s and p, if desired.

The decay rate for $B_1 \to B_2 + \pi$ is

$$\Gamma = \frac{G^2\mu_c^4}{8\pi}\, q \left\{ \left[\frac{(M+m)^2-\mu^2}{M^2}\right] |A|^2 + \left[\frac{(M-m)^2-\mu^2}{M^2}\right] |B|^2 \right\},$$

where q is the c.m. momentum of the decay products. For reference, the dimensionless constant in this expression has the value $(G^2\mu_c^4/8\pi) = 1.9488 \times 10^{-15}$.

Table I summarizes the amplitudes A and B for the nonleptonic decays of the Λ, Σ, and Ξ hyperons. These amplitudes have been calculated by using the experimental data for mean lives, branching ratios, and the decay asymmetry α given in the Stable Particle Table of this Review. Time-reversal invariance is assumed and final-state interactions are neglected, so A and B are taken to be relatively real. The subscript on the hyperon refers to the sign of the decaying pion. The statistical correlation coefficient

$$C_{AB} = \frac{\langle \Delta A \Delta B \rangle}{\sqrt{\langle \Delta A^2 \rangle \langle \Delta B^2 \rangle}}$$

is also given. The absolute signs of A and B have been assigned, using the following convention. Taking $A(\Lambda^0_-)$ as positive, the other S-wave decay amplitudes are chosen to give an approximate fit to the triangular relationships

$$\sqrt{2}A(\Sigma^+_0) + A(\Sigma^+_+) = A(\Sigma^-_-) \text{ and } \sqrt{3}A(\Sigma^+_0) + A(\Lambda^0_-) = 2A(\Xi^-_-) .$$

The signs of the B amplitudes relative to those of the corresponding A amplitudes are determined by the sign of the appropriate α decay parameter.

Table I

M	$\to m + \mu$	A	B	C_{AB}
Λ^0_-	$\to p + \pi^-$	1.47 ± 0.01	9.98 ± 0.24	-0.289
Λ^0_0	$\to n + \pi^0$	-1.07 ± 0.01	-7.14 ± 0.56	-0.740
Σ^+_+	$\to n + \pi^+$	0.06 ± 0.01	19.07 ± 0.07	-0.038
Σ^+_0	$\to p + \pi^0$	1.48 ± 0.05	-12.04 ± 0.58	0.982
Σ^-_-	$\to n + \pi^-$	1.93 ± 0.01	-0.65 ± 0.07	0.003
Ξ^0_0	$\to \Lambda + \pi^0$	1.55 ± 0.03	-5.56 ± 0.33	-0.148
Ξ^-_-	$\to \Lambda + \pi^-$	2.04 ± 0.01	-7.49 ± 0.28	0.237

2. Tests of the $\Delta I = 1/2$ Rule

(a) Λ Decay

For Λ decay the $\Delta I = 1/2$ rule predicts that $\Gamma_0/\Gamma_- = 0.50$ and $\alpha_0 = \alpha_-$. In order to determine the magnitude of possible $\Delta I = 3/2$ amplitudes present we write the linear expressions[4] for the $\Delta I = 3/2$ A- and B-wave amplitudes in terms of $\Delta\alpha$, where $\Delta\alpha$ is the measured value of α_0/α_- minus the predicted value, and in terms of $\Delta\Gamma$ similarly defined. Evaluating these we find

$$\Delta\alpha = -1.54\ (A_3/A_1) + 1.61(B_3/B_1),$$

$$\Delta\Gamma = 1.84\ (A_3/A_1) + 0.25(B_3/B_1).$$

Here the $\Delta I=3/2$ amplitudes are expressed relative to the $\Delta I=1/2$ amplitudes. The numerical values of the coefficients depend on the ratio B/A. The uncertainties in the coefficients are small compared to the uncertainties in $\Delta\alpha$ and $\Delta\Gamma$. Final-state πN interactions have been included in these relations but have a very small effect. From the Stable Particle Table,

$$\Delta\alpha = 0.006\pm0.066,\quad \Delta\Gamma=0.058\pm0.012\ ,$$

and hence

$$(A_3/A_1) = 0.027\pm0.008$$

and

$$(B_3/B_1) = 0.030\pm0.037\ .$$

The possible 3% $\Delta I=3/2$ A-wave amplitude is due to the disagreement of decay rates with prediction. At this level the results are sensitive to electromagnetic corrections. However, in Λ decay the phase space correction and the other radiative corrections appear to be about equal in magnitude and have opposite signs,[5,6] and hence cancel each other in the correction to the decay rates.

(b) Ξ Decay

The analysis for Ξ decay is very similar to that for Λ decay. If the $\Delta I=1/2$ rule is valid, $\Gamma_0(\Xi^0)/\Gamma_-(\Xi^-) = 0.50$ and $\alpha_0 = \alpha_-$. For this case the expressions linear in $\Delta I=3/2$ A- and B-wave amplitudes are[4]

$$\Delta\alpha = 1.35(A_3/A_1) - 1.35(B_3/B_1)\ ,$$

$$\Delta\Gamma = -1.43(A_3/A_1) - 0.07(B_3/B_1)\ .$$

From the Stable Particle Table,

$$\Delta\alpha = -0.05\pm0.06,\quad \Delta\Gamma = 0.066\pm0.020,$$

and we find

$$(A_3/A_1) = -0.046\pm0.014$$

and

$$(B_3/B_1) = -0.01\pm0.04.$$

(c) Σ Decay

The traditional test of the $\Delta I=1/2$ rule in Σ decay is that the amplitudes satisfy the relationship

$$\sqrt{2}\Sigma_0^+ + \Sigma_+^+ - \Sigma_-^- = 0\ .$$

Graphically this is equivalent to closing the Σ triangle when the amplitudes are plotted on A, B axes. Including $\Delta I\geq 3/2$ amplitudes in Σ decay analysis, the "Σ triangle" relationship becomes

$$\sqrt{2}\ A_0 + A_+ - A_- = -3\sqrt{2/5}\ A_3 + \frac{2}{\sqrt{15}}\ A_5\ ,$$

where A_3 and A_5 are $\Delta I=3/2$ and $\Delta I=5/2$ amplitudes, respectively. There is a similar equation for the B amplitudes. From Table I,

$$\sqrt{2}\ A_0 + A_+ - A_- = 0.22\pm0.09$$

and

$$\sqrt{2}\ B_0 + B_+ - B_- = 2.7\pm1.0\ .$$

If we neglect the $\Delta I=5/2$ amplitudes and assume all amplitudes to be real we can solve for possible $\Delta I=3/2$ amplitudes. The result is

$$\frac{A_3}{A_-} = -0.061\pm0.024$$

and

$$\frac{B_3}{B_+} = -0.074\pm0.027\ .$$

Thus for hyperon decay, present experimental data limit $\Delta I=3/2$ amplitudes to less than about 5%.

3. *The Lee-Sugawara Relation*

From Table I the Lee-Sugawara relation,[7,8] $\sqrt{3}\Sigma_0^+ + \Lambda_-^0 - 2\Xi_-^- = 0$, is satisfied to -0.05 ± 0.11 for the A amplitudes, and to 4.1 ± 1.8 for the B amplitudes.

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$$\frac{\Gamma_0}{\Gamma_-} \approx \frac{1}{2}\left\{1+3\sqrt{2} \times \left[\frac{S_{11}S_{33}\cos(\delta_1-\delta_3)+P_{11}P_{33}\cos(\delta_{11}-\delta_{31})}{S_{11}^2+P_{11}^2}\right]\right\}.$$

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Appendix II

A. SU(3) CLASSIFICATION OF BARYON RESONANCES

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It is established that a symmetry higher than SU(3) is necessary to classify the known baryon resonances. However, many higher-symmetry schemes have been proposed, and even for SU(6) various versions exist (for a review see Dalitz[1]). Since it is not clear which one of these schemes best fits the data, we do not review them here, but we report once again fits of baryon states into SU(3) multiplets.

For the reader's convenience, we collect here the relevant formulae.

Exact SU(3) symmetry predicts that all the members of a multiplet should have the same mass and the same couplings for decays into other multiplets. It has been found, however, that the members of the octet of stable baryons lie within 20% of their mean mass; therefore a symmetry-breaking interaction has been introduced by Gell-Mann and Okubo independently.[2] In addition, for the isospin-0 vector mesons (ω and ϕ), an additional symmetry-breaking interaction has been introduced by Sakurai[3] to take care of octet-singlet mixing. The relevant formulae for masses and decay rates are given below.

Mass Formulae

Broken SU(3) gives:

Decuplet	$\Delta - \Sigma = \Sigma - \Xi = \Xi - \Omega$	GMO	(1)
Octet	$2(N+\Xi) = 3\Lambda+\Sigma$	GMO	(2)
Octet-singlet mixing	$\sin^2\theta = \dfrac{\Lambda - M_8}{\Lambda - \Lambda'}$	Mixing angle[4]	(3)
	$M_8 = \dfrac{2(N+\Xi) - \Sigma}{3}$	GMO	(4)

Here GMO stands for the Gell-Mann-Okubo formula; the particle symbol indicates its mass. The formulae would be the same if squared masses were used. For the nonet case, Λ is the "mostly-octet" particle, Λ' is the "mostly-singlet" particle.

Decay Rates

In terms of a relativistically invariant matrix element T, the decay rate for 2-body decay of a resonance of mass M_R is

$$\Gamma \propto \frac{|T|^2 R_2}{M_R}, \tag{5}$$

where $R_2 = k/M_R$ is the 2-body phase space factor. Since the numerator is an invariant, and since Γ must transform as 1/E, we introduce the denominator M_R.[5]

For *meson* decays (see below) the rates are calculated according to Eq. (5); for *baryon* resonance decays into $1/2^+$ baryons and 0^- mesons, one next takes into account the fact that spin sums in $|T|^2$ introduce another factor M_R, canceling the $1/M_R$. We are then left with

$$\Gamma = \frac{|T|^2 k}{M_R} M_N, \quad \text{for baryons} \tag{5'}$$

$$= \frac{|T|^2 k}{M_R^2} M_N^2, \quad \text{for mesons.} \tag{5''}$$

The powers of the nucleon mass M_N or M_N^2 have been introduced so that we can treat $|T|$ as dimensionless.

$|T|^2$ contains centrifugal barrier factors, which we call B_ℓ. We then have

Decuplet, Singlet:
$$\Gamma = (cg)^2 B_\ell(k) \frac{M_N}{M_R} k \tag{6}$$

Octet:
$$\Gamma = (c_D g_D + c_F g_F)^2 B_\ell(k) \frac{M_N}{M_R} k \tag{7}$$

Octet-singlet mixing:
$$\Lambda = G_8 \cos\theta + G_1 \sin\theta$$
$$\Lambda' = -G_8 \sin\theta + G_1 \cos\theta \tag{8}$$

with
$$G_8 = c_D g_D + c_F g_F$$
$$G_1 = c_1 g_1. \tag{9}$$

Here c_i are the SU(3) coefficients with the sign convention adopted in this article [see note in the Table of SU(3) Isoscalar Factors and Fig. 2 in the text]. M_N is the nucleon mass, M_R is the resonance mass for which Γ is calculated, k is the center-of-mass momentum for the channel being considered, and g_i are the relevant couplings. For the case of singlet-octet mixing, Eq. (8) has to be used in conjunction with (6) and (7). G_8 and G_1 represent the couplings for the multiplet, and Λ and Λ' represent the couplings for the physical states.

The relation between g_D, g_F, and the parameter α is

$$\alpha = \left[1 + \frac{\sqrt{5}}{3} \frac{g_F}{g_D}\right]^{-1}. \tag{10}$$

Exact SU(3) predicts that the couplings g_i for all the members of a multiplet are the same; however, since the symmetry is broken for the masses, it is probably broken for the widths. In the case of the $3/2^+$ decuplet, *broken SU(3)* sum rules have been derived by Becchi,[6] Gupta,[7] and Konuma[8] independently. The form derived by Gupta relates the g_i for the members of the decuplet by the relation

$$2(\Delta + \Xi) = 3\Sigma^*(\Lambda\pi) + \Sigma^*(\Sigma\pi), \tag{11}$$

where $\Sigma^*(\Lambda\pi)$ is the coupling for the $\Sigma(1385) \to \Lambda\pi$ decay and $\Sigma^*(\Sigma\pi)$ is the coupling for the decay $\Sigma(1385) \to \Sigma\pi$.

As mentioned in the text (Sec. IV B) the determination of the *relative signs* of resonant amplitudes can be useful in making an SU(3) assignment of resonances. In fact the resonant amplitude $T \propto \sqrt{x_e x_i} \propto G_e G_i$, where the subscript e refers to the elastic channel and the G_e, G_i are the couplings of Eqs. (6) through (9). Assuming that all g_i are positive, the sign of the G_i are dependent upon the sign of the Clebsch-Gordan coefficients c_i. Once a sign convention is adopted (we use the Levi-Setti[9] convention, see Fig. 2 in the text) and the signs for a Σ state (I=1) and a Λ state (I=0) of known SU(3) assignment have been chosen for reference, the signs of all the other amplitudes can be useful in determining multiplet assignments. For *exact SU(3)* all the decays of members of a decuplet have the same sign. For octets the relative sign depends upon the value of g_D/g_F and the mixing angle, as seen from Eqs. (7) through (9).

Fits to the Data

Fits of baryon decay rates within SU(3) can be found in, among others, papers by Tripp,[10,11] Levi-Setti,[9] Samios,[12] and Plane.[13] More recent fits were made by Barbaro-Galtieri[14] and Samios.[15] A fit of the decay rates within $SU(6)_w$ may be found in Litchfield et al.[16] Analysis of the baryon mass spectrum using the quark shell model has been done by Jones et al.[17] An analysis of baryon couplings in a quark model with chromodynamics has been done recently by Koniuk and Isgur.[18]

For our SU(3) analysis in fitting the data a choice for B_ℓ has to be made. Plane[13] tried two forms for B_ℓ:

(a) The form $B_\ell = (kr)^\ell D_\ell(kr)$, r being the radius of interaction and D_ℓ the polynomials in kr given by Blatt and Weisskopf.[19] Usually r is taken to be 1 fermi.[10]

(b) The form $B_\ell = k^\ell$.

However, for final results form (b) was chosen. A discussion of the differences among these two forms has been given by Barbaro-Galtieri.[20] As shown in Ref. 20, not only the values of the couplings, g_i, depend upon the form used for B_ℓ, but also the value obtained for the mixing angle. For the 3/2⁻ singlet, $\Lambda(1520)$, and the isospin-0 member of the octet, $\Lambda(1690)$, the mixing angles obtained in the two cases were

$$\theta_a = (-16.1^{+1.4}_{-1.3})^\circ,\ \theta_b = (-27.5^{+3.6}_{-3.4})^\circ,$$

in disagreement by a few standard deviations. However, if a radius of interaction of r = 0.15 fermi was used for form (a), the two values of θ agreed. This value of r does not fit resonance shapes when used in the Breit-Wigner resonant form. Samios[15] used form (b) for B_ℓ.

Table I is a summary of the fits made by us (update of Barbaro-Galtieri[14]) using the barrier factor form (a) and exact SU(3). The values of the masses, widths, and amplitudes used in the fits are taken from this edition's Tables and Listings.

$1/2^-$ Nonet (Baryon-Eta Resonances)

For this nonet Eq. (7) was multiplied by the factor

$$\left[\frac{M_R - M_B}{\overline{M}_R - \overline{M}_B}\right]^2,$$

where M_B is the decay baryon and $\overline{M}_R-\overline{M}_B$=568 MeV is the difference of the mean $1/2^-$ and $1/2^+$ baryon octet masses. This kinematic factor comes from PCAC arguments (i.e., the assumption that the axial

Table I. SU(3) baryon multiplets with two or more known members. Values of θ and α [defined by Eqs. (8) and (10)] are the result of fits made to all the measured 2-body decay rates of each mutiplet.

J^P	Octet members[a]				Singlet	θ(deg)[b]	α
$1/2^-$	N(1535)	Λ(1670)	Σ(1750)	[Ξ(1737)]	Λ(1405)	-31 ± 7	{0.50 ± .06} [c]
				[Ξ(1850)]		-22 ± 11	{0.56 ± .11}
$3/2^-$	N(1520)	Λ(1690)	Σ(1670)	[Ξ(1819)]	Λ(1520)	-21 ± 3	0.31 ± .04
$5/2^-$	N(1675)	Λ(1830)	Σ(1775)				1.18 ± .04
$5/2^+$	N(1680)	Λ(1820)	Σ(1915)	[Ξ(2069)]	Λ(2110)	22 ± 5	0.70 ± .03
	Decuplet members[d]				g_{10}		
$3/2^+$	Δ(1232)	Σ(1385)	Ξ(1530)	Ω⁻	1.0–1.5	χ^2/DF=58/3	
$7/2^+$	Δ(1950)	Σ(2030)					

[a] Masses in parentheses are the nominal masses used in the Baryon Table. The Ξ members have masses as calculated by using Eqs. (1) and (2) with the mixing angle θ derived from the decay widths.

[b] See text for a discussion of the $1/2^-$ mixing angle.

[c] The first values of θ and α are obtained by using a plus sign for the amplitudes of both $N(1535) \to N\eta$ and $\Lambda(1670) \to \Lambda\eta$. The second values use a minus sign for the second amplitude. Both fits, however, have a bad χ^2, mostly due to the two baryon-η amplitudes.

[d] Coupling constants updated from Ref. 14, using new Ξ(1530) data.

vector current remains an octet in the presence of symmetry breaking) and it was advocated by Graham.[21] For the $1/2^-$ nonet it was used in this form first by Gell-Mann.[22] The couplings for the Λ(1405) to the $N\bar{K}$ and $\Sigma\pi$ channels are the same as those used in Ref. 14.

$3/2^+$ *Decuplet*

The agreement among the coupling constants obtained for the four rates in this decuplet is very bad. The fit made using form (a) for B_ℓ has $\chi^2=58$ for 3 degrees of freedom; the one made with form (b) for B_ℓ has $\chi^2/DF=13/3$. The broken SU(3) relation (11), however, is very well satisfied.

B. SU(3) CLASSIFICATION OF MESON RESONANCES

All of the discussion above applies, except that for bosons the GMO formula is usually applied to the *square* of the masses, as opposed to the first power for fermions. Thus for example, Eq. (2) becomes

$$4\hat{K} = 3\hat{\eta} + \hat{\pi}\,. \qquad (2')$$

The symbol $\hat{K}$ was introduced by Glashow and Socolow[4] for the *square* of the K mass, etc.

Because of the difference between Eqs. (5′) and (5″), there is also an extra factor of (M_N/M_R) in Eqs. (6) and (7). The three established nonets (0^-, 1^-, 2^+) and their mixing angles are listed at the bottom of the Meson Table.

C. FLAVOR SYMMETRY BREAKING IN A UNITARY MIXING SCHEME

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Because of unitarity, the GMO formula is an approximation, which breaks down especially for broad resonances. The imaginary part of the mass matrix M^2 is related to the widths, and for mesons is of the form[23–25]

$$\text{Im}\, M_{ij}^2(s) = \text{Im}\, \Pi_{ij}(s) = \sum_{ab} g_{iab} g_{jab} k_a^{2\ell+1} s^{-1/2} F(k_a) \qquad (12)$$

where i and j are resonance indices, Π the hadronic self-energy diagram, g_{iab} the coupling constant for the channel $i \to ab$, and F a hadronic form factor. Only the real part of M^2 approximately satisfies the GMO mass formula. More generally, one can assume Re M^2 to be given by quark masses in a bare-mass term plus a hadronic mass shift Re $\Pi_{ij}(s)$ satisfying analyticity constraints. In general, $\Pi_{ij}(s)$ is non-diagonal and breaks flavor symmetry through the different threshold positions. It is diagonalized by a complex orthogonal matrix which determines the generally complex mixing angles. The imaginary part of a mixing angle is related to the overlap between the resonance.[23] The masses and widths are given respectively by the real and imaginary parts of the eigenvalues of M^2.

In this way one can, using both masses and widths as data, within the same framework, determine[26] both the deviation δ from ideal mixing (i.e., $\theta = 35.3° + \delta$) and the Q_A-Q_B mixing angle ϕ listed at the end of the Meson Table.

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Appendix III

GROWTH OF INFORMATION

From time to time we have presented figures demonstrating the amount of experimental work which has gone into spectroscopy, and the amount of new information available as a result. The 1982 versions of these figures are shown as Figs. 1 and 2.

Figure 1 is a simple count of the number of meson resonances listed in the Tables, categorized as those "understood" -- i.e., all quantum numbers are believed known -- and those simply "listed". A rapid recent increase in both of these categories occurred because of the discovery of the J/ψ and related particles.

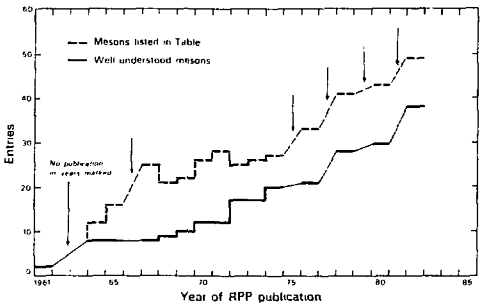

Fig. 1. Number of meson resonances listed in the Tables (dashed line) and those for which all quantum numbers are known (solid line), as a function of year of publication of the Review of Particle Properties.

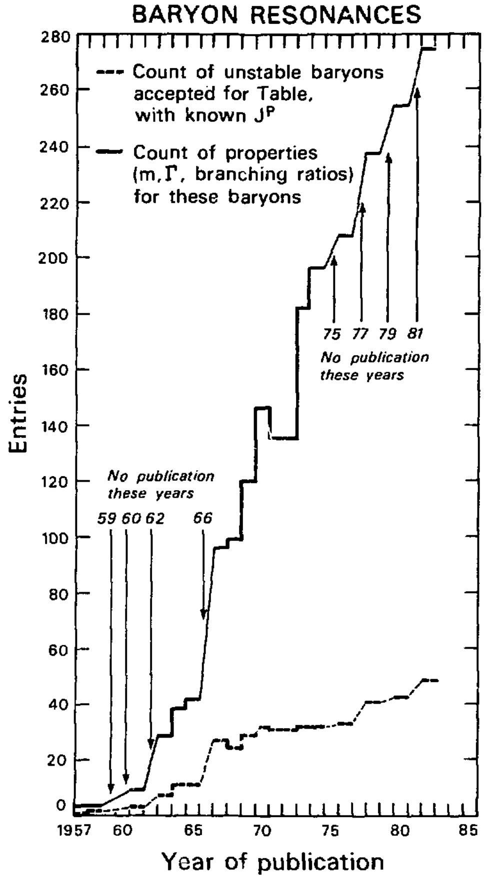

Fig. 2. Total amount of information (mass + width + branching ratios) on baryon resonances listed in the Tables, restricted to those with well-established J^P (solid line). Dashed line shows numbers of such resonances listed. Abscissa shows year of publication of Review of Particle Properties.

In Figure 2 we present similar information for the baryon resonances, but concentrate here on the "growth of understanding". That is, the *number* of known baryons (we include for this figure only those with known J^P) has grown only very slowly with time (dashed line); the real progress has been in the measurement of the *properties* of those baryons. Therefore we show as the solid line a count of the number of baryonic properties -- mass, width, and branching ratios. Most of these results are from partial-wave analyses.

A history of the values of some of the constants in the Review of Particle Properties is presented in Figs. 3-7. It may be said that one can estimate the age of a high energy physicist by asking him or her the mass of the Λ. If the answer is 1115.44 MeV, he probably was deep into his graduate training in 1965.

A history of this sort has more than whimsical value. We may use it as a guide to develop a "feel" for the reliability of current values. In Fig. 3 we show how the generally accepted values for the speed of light and a couple of other constants have changed with time. The "generally accepted value" is usually an average over several experiments, performed by a compiler (in Fig. 3, the compiler is other than the Particle Data Group in all cases, although we do quote the compiled results). The abscissa on all these figures is the date of publication of the value shown. Clearly there is a general progression toward better understanding -- at least as measured by the size of the error bars. However, the size of the error bars does not tell the full story, as we can see by the frequency with which the "best" value has changed by more than one standard deviation. Changes in these values can come from several sources: a new experimental measurement, re-evaluation of an old measurement (which can come about if a previously unrecognized source of bias is discovered and corrected, or if a new value for one of the input constants, e.g. the electric charge, is available), or a change in the averaging procedure.

In Fig. 4 we show the history of some masses (including the Λ, for radioactive Λ dating of your colleagues), based on averages which we ourselves performed. These are adapted from those originally presented by Rosenfeld[1] in 1975. The publication date refers to the publication of the Review of Particle Properties.

In Fig. 5 we show the best estimates for the lifetimes of some of the particles stable against strong decay. These and subsequent figures have been compiled since publication of the Rosenfeld article.[1] In Fig. 6 we show the widths of some of the resonances, and in Fig. 7, the values of some of the branching fractions. All values are taken from the Tables. Before 1964, very few branching fractions were listed in the Tables. In all cases, a representative sample is chosen, usually from those with a lot of activity (a limited number of special requests for a more complete set of such figures may be honored, for those seriously interested in the history of the "best" values of physical constants). In each figure, the heavy inner error bar represents the statistical error computed in the averaging procedure, and the thin outer error bars, when present, indicate the increase in the error due to the "scale factor". The scale factor is described in the introductory text, Sec. VII. It represents an attempt to quantify the increase in the uncertainty which is present in the case of experiments which disagree by more than a certain amount. In the case where the error represents an "educated guess," rather than a calculation, the inner error bar is absent.

On the whole, the number of times the values have changed by more than one standard deviation over the years is remarkably few. Even those branching fractions which involve rare decays and which are therefore presumably difficult to measure (Fig. 7) are, for the most part, within one or two standard deviations in 1978 of their value in any year since 1960. This is in spite of the vast amount of new experimental input, and indicates the general reliability of the results.

Of course, the data points for a given quantity are hardly independent of each other, but those differing by several years frequently have quite different experimental input. The relative lack of change is a comment both on the experiments and on the averaging procedures. We, of course, are responsible only for the averages (except Fig. 3). These averages entail considerable exercise of judgment: there are conflicting experiments, experiments with impossibly small errors, "preliminary" results, and so forth. Statistical procedures will tell us that two experiments do not agree; they do not give a clue as to which (if either) is a good representation of the truth. Major decisions, and their motivations, are usually discussed on a case-by-case basis in the Data Card Listings; general comments may be found in Sec. II of the text and in Rosenfeld[1]. Note that, occasionally, the error bars increase from one publication to the next. This is usually the result of decision making by the compiler, e.g., to cease using a particular result, or because of new results in poor agreement with the old results.

We show these figures not only to demonstrate that there is not much change in these averages in the usual case, but also to show that there exist cases with relatively large changes. There is a psychological danger in preparing tables of "right" answers. The old joke about the experimenter who fights the systematics until he or she gets the "right" answer (read "agrees with previous experiments"), and then publishes, contains a germ of truth (presumably, those who compile and average experimental results are also not immune to this disease). A result can disagree with the average of all previous experiments by five standard deviations, and still be right. Hence, perhaps it is of value to show that large changes can (and do) sometimes occur.

Reference

1. A. H. Rosenfeld, Ann. Rev. Nucl. Sci. **25**, 555 (1975).

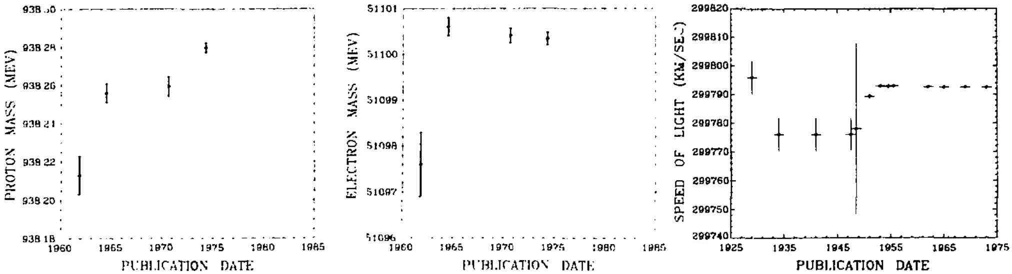

Fig. 3. The "generally accepted values" of the proton mass, the electron mass, and the speed of light, as a function of the publication date of the compilation used (not done by the Particle Data Group). Data for the speed of light plot courtesy of E. R. Cohen, Rockwell International Science Center. See the Stable Particle Data Card Listings for references on proton and electron masses.

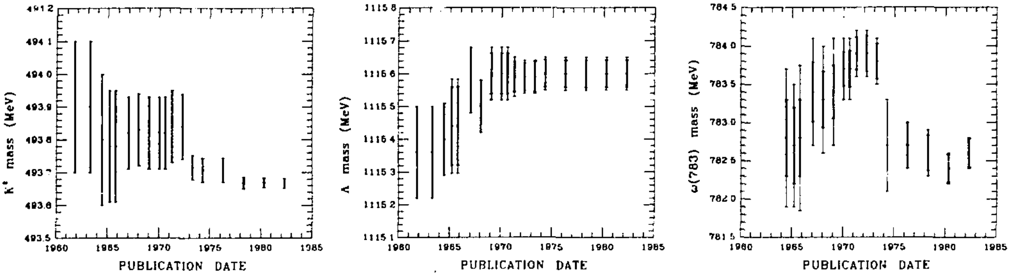

Fig. 4. Particle Data Group averages of the masses of various particles, as a function of date of publication of Review of Particle Properties (Adapted, with permission, from *Annual Review of Nuclear Science*, Volume 25. Copyright 1975 by Annual Reviews, Inc. All rigbts reserved). Full error bar indicates quoted error; thick-lined portion indicates quoted error with "scale factor" removed (see Sec. VII of introductory text).

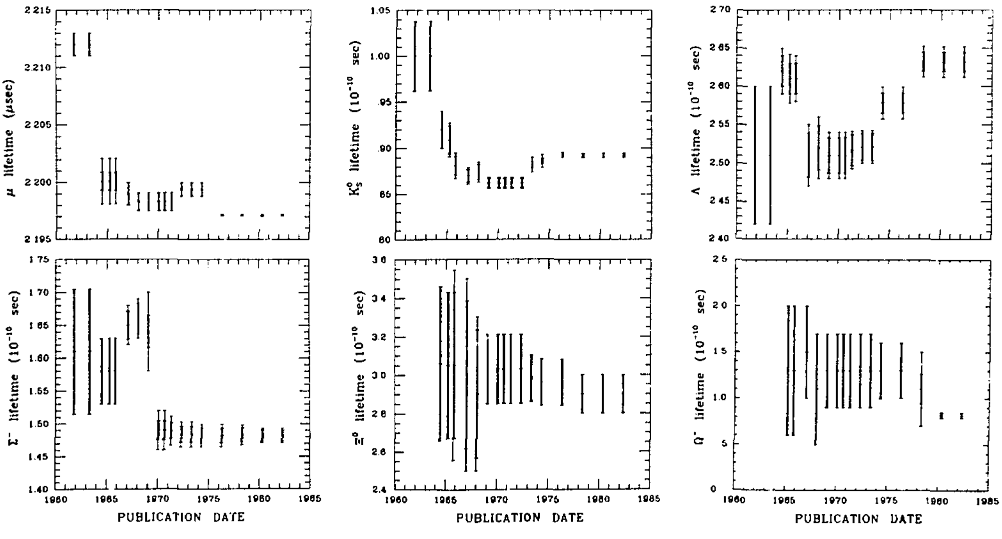

Fig. 5. Particle Data Group averages of the lifetimes of various particles, as a function of publication date of RPP.

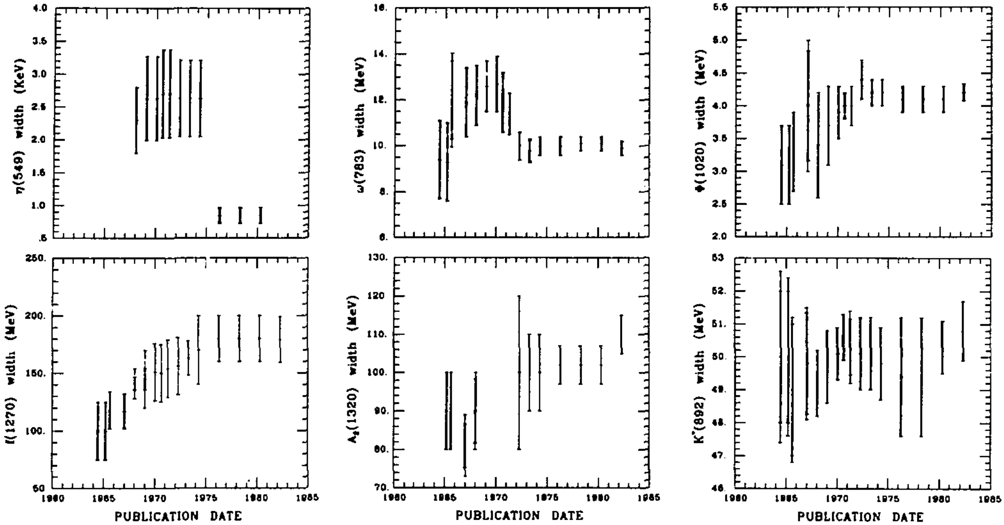

Fig. 6. Particle Data Group averages of the widths of various resonances, as a function of date of publication of RPP. The gap in the A_2 data indicates the years when the A_2 was thought to be split.

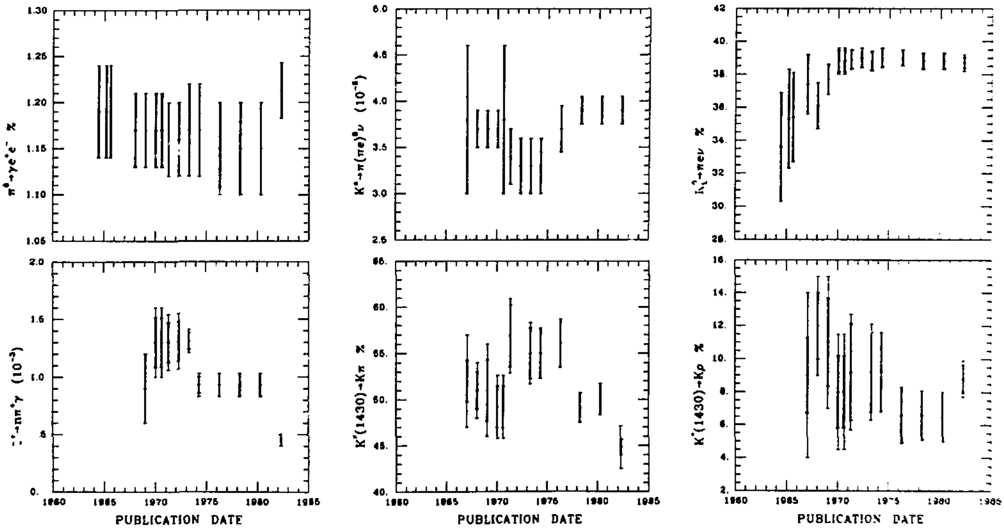

Fig. 7. Particle Data Group averages of various branching fractions, as a function of date of publication of RPP.