UCRL-20030 π N
February 1970

π N PARTIAL-WAVE AMPLITUDES

A COMPILATION

Particle Data Group

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MASTER

Printed in the USA at Lawrence Radiation Laboratory, Berkeley,
and in Europe at CERN, Geneva

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P(LAB)---T(LAB)---INV MASS---P(CMS)---4PILMBR2 (MEV/C) (MEV) (MEV) (MEV/C) (MB)				
0	0	1078	0	
20	1	1079	17	16179.0
40	6	1083	35	4072.1
60	12	1089	52	1829.3
80	21	1096	68	1043.6
100	32	1105	85	679.2
120	44	1116	101	480.6
140	58	1127	117	360.3
160	73	1139	132	281.9
180	88	1152	147	227.7
200	104	1165	161	188.6
220	121	1178	175	159.5
240	138	1192	189	137.1
260	156	1206	202	119.5
280	173	1219	215	105.4
300	191	1233	228	93.9
320	210	1247	241	84.4
340	228	1261	253	76.4
360	247	1274	265	69.7
380	265	1288	277	63.9
400	284	1302	288	58.9
420	303	1315	300	54.5
440	322	1329	311	50.7
460	341	1342	322	47.3
480	360	1356	332	44.3
500	380	1369	343	41.7
520	399	1382	353	39.3
540	418	1395	363	37.1
560	438	1408	373	35.1
580	457	1421	383	33.4
600	476	1434	393	31.7
620	496	1446	402	30.3
640	515	1459	412	28.9
660	535	1472	421	27.6
680	555	1484	430	26.5
700	574	1496	439	25.4
720	594	1509	448	24.4
740	613	1521	457	23.5
760	633	1533	465	22.6
780	653	1545	474	21.8
800	673	1557	482	21.0
820	692	1569	490	20.3
840	712	1580	499	19.7
860	732	1592	507	19.0
880	751	1604	515	18.5
900	771	1615	523	17.9
920	791	1627	531	17.4
940	811	1638	538	16.9
960	831	1649	546	16.4
980	850	1661	554	16.0
1000	870	1672	561	15.5

P(LAB)---T(LAB)---INV MASS---P(CMS)---4PILMBR2 (MEV/C) (MEV) (MEV) (MEV/C) (MB)				
1020	890	1683	569	15.127
1040	910	1694	576	14.742
1060	930	1705	583	14.375
1080	949	1716	591	14.025
1100	969	1726	598	13.690
1120	989	1737	605	13.371
1140	1009	1748	612	13.065
1160	1029	1758	619	12.772
1180	1049	1769	626	12.492
1200	1069	1780	633	12.223
1220	1088	1790	639	11.964
1240	1108	1800	646	11.716
1260	1128	1811	653	11.478
1280	1148	1821	660	11.249
1300	1168	1831	666	11.028
1320	1188	1841	673	10.815
1340	1208	1851	679	10.610
1360	1228	1862	685	10.413
1380	1247	1872	692	10.222
1400	1267	1881	698	10.038
1420	1287	1891	704	9.860
1440	1307	1901	711	9.688
1460	1327	1911	717	9.522
1480	1347	1921	723	9.361
1500	1367	1930	729	9.206
1520	1387	1940	735	9.055
1540	1407	1950	741	8.909
1560	1427	1959	747	8.767
1580	1447	1969	753	8.630
1600	1466	1978	759	8.497
1620	1486	1988	765	8.367
1640	1506	1997	770	8.242
1660	1526	2006	776	8.120
1680	1546	2016	782	8.001
1700	1566	2025	788	7.886
1720	1586	2034	793	7.774
1740	1606	2043	799	7.665
1760	1626	2053	805	7.559
1780	1646	2062	810	7.456
1800	1666	2071	816	7.355
1820	1686	2080	821	7.257
1840	1706	2089	827	7.162
1860	1726	2098	832	7.069
1880	1746	2107	837	6.978
1900	1766	2115	843	6.889
1920	1785	2124	848	6.803
1940	1805	2133	853	6.719
1960	1825	2142	859	6.636
1980	1845	2150	864	6.556
2000	1865	2159	869	6.478

P(LAB)---T(LAB)---INV MASS---P(CMS)---4PILMBR2 (MEV/C) (MEV) (MEV) (MEV/C) (MB)				
2020	1885	2168	874	6.401
2040	1905	2176	879	6.326
2060	1925	2185	885	6.253
2080	1945	2194	890	6.181
2100	1965	2202	895	6.111
2120	1985	2211	900	6.043
2140	2005	2219	905	5.976
2160	2025	2227	910	5.910
2180	2045	2236	915	5.846
2200	2065	2244	920	5.783
2220	2085	2253	925	5.722
2240	2105	2261	930	5.662
2260	2125	2269	934	5.603
2280	2145	2277	939	5.545
2300	2165	2286	944	5.488
2320	2185	2294	949	5.433
2340	2205	2302	954	5.378
2360	2225	2310	959	5.325
2380	2245	2318	963	5.273
2400	2264	2326	968	5.221
2420	2284	2334	973	5.171
2440	2304	2342	977	5.121
2460	2324	2350	982	5.073
2480	2344	2358	987	5.025
2500	2364	2366	991	4.978
2520	2384	2374	996	4.933
2540	2404	2382	1001	4.887
2560	2424	2390	1005	4.843
2580	2444	2398	1010	4.800
2600	2464	2405	1014	4.757
2620	2484	2413	1019	4.715
2640	2504	2421	1023	4.674
2660	2524	2429	1028	4.633
2680	2544	2436	1032	4.593
2700	2564	2444	1037	4.554
2720	2584	2452	1041	4.515
2740	2604	2459	1045	4.477
2760	2624	2467	1050	4.440
2780	2644	2474	1054	4.403
2800	2664	2482	1058	4.367
2820	2684	2490	1063	4.332
2840	2704	2497	1067	4.297
2860	2724	2505	1071	4.262
2880	2744	2512	1076	4.229
2900	2764	2520	1080	4.195
2920	2784	2527	1084	4.162
2940	2804	2534	1088	4.130
2960	2824	2542	1093	4.098
2980	2844	2549	1097	4.067
3000	2864	2556	1101	4.036

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I. INTRODUCTION

This report is a collection of the results of ten partial-wave analyses performed on the elastic $\pi^{\pm}p$ scattering from 0 to 2 BeV/c incident momentum.

(The amplitudes and various parameters deduced from the amplitudes are plotted and tabulated.)

All the necessary definitions are first summarized in Section II; the reader who is familiar with T matrices should skip to Section III.

This report will not deal with the methods used by the different groups in getting a set of partial-wave amplitudes, but will only report the results. It is useful to be able to compare all ten solutions for at least two reasons:

- 1) to see if a resonance is present and if so what its parameters might be,
- 2) to get some idea of the external errors of the solutions.

II. SUMMARY OF T-MATRIX NOTATION

Definition of η and δ , and T matrix*

For a nonpolarized target the differential cross section and polarization of the recoil nucleon are expressed in terms of the non-spin-flip amplitude $f(\theta)$ and the spin-flip amplitude $g(\theta)$ as

$$\frac{d\sigma}{d\Omega} = |f(\theta)|^2 + |g(\theta)|^2,$$

$$\vec{P} \frac{d\sigma}{d\Omega} = 2 \operatorname{Re} [f^*(\theta)g(\theta)] \vec{n}.$$

The $f(\theta)$ and $g(\theta)$ can be expanded as a sum of partial waves. For each value of ℓ , the orbital angular momentum of the system, there are two values of the total angular momentum, i. e., $J = \ell + 1/2$ and $J = \ell - 1/2$ and both terms appear in the summation. The expansion is given by

$$f(\theta) = \lambda \Sigma [(\ell+1) T_{\ell+} + \ell T_{\ell-}] P_{\ell}(\cos \theta),$$

$$g(\theta) = i\lambda \Sigma [T_{\ell+} - T_{\ell-}] P_{\ell}^1(\cos \theta),$$

where $P_{\ell}^1(\cos \theta) = \sin \theta (dP_{\ell}/d \cos \theta)$ are the first associated Legendre functions and $P_{\ell}(\cos \theta)$ are the Legendre polynomials, $\lambda = 1/k$ is the wavelength and $T_{\ell\pm}$ are the partial wave amplitudes, defined by

$$T_{\ell\pm} = \frac{1}{2i} \left(\eta_{\ell \pm 1/2} e^{2i\delta_{\ell \pm 1/2}} - 1 \right). \quad (1)$$

The contribution to the total elastic cross section for one partial wave and one J value is

$$\sigma_{\ell} = 4\pi\lambda^2 (J+1/2) |T_{\ell\pm}|^2. \quad (2)$$

For $\ell_{\pm}$ the convention adopted is S, P, D, F, G for $\ell = 0, 1, 2, 3, 4$ with subscripts 2I and 2J, so D_{13} is $\ell = 2, I = 1/2, J = 3/2$.

Dropping the reference to the IJ^P quantum numbers of the particular partial wave, we write the elastic scattering amplitude as

$$T_e = (\eta e^{2i\delta} - 1)/2i, \quad (3)$$

$$\operatorname{Re} T_e = \frac{\eta}{2} \sin 2\delta, \quad (4a)$$

$$\operatorname{Im} T_e = \frac{1}{2} (1 - \eta \cos 2\delta). \quad (4b)$$

*For proofs or more details see the review articles TRIPP 66 and BARBARO-GALTIERI 68.

In the complex plane, T_e is a vector that lies on (or inside, for $\eta < 1$) a circle of radius $1/2$ and center on the imaginary axis at $i/2$. This circle is called the unitary circle, and the amplitude cannot be outside it because it would violate conservation of probability (the outgoing wave would be larger than the incoming wave). Figure 1 shows the graphical representation of the amplitude and the meaning of the angle 2δ . As the energy of the incident particle is changed, the point T will move on or inside the circle (this graph is called an Argand diagram).

The fact that the circle lies on the upper part of the imaginary axis is determined by the optical theorem which relates the total cross-section (σ_T) to the imaginary part of the forward elastic amplitude. For each partial wave it is

$$\sigma_T = 4\pi\lambda \text{Im}[f(0)] = 4\pi\lambda^2 (J + 1/2) \text{Im}(T_e), \quad (5)$$

which implies that the imaginary part of T_e cannot be negative.

Resonances

A resonant state is metastable at a resonant energy E_R , decaying with a mean life $\tau = \hbar/\Gamma$. The Fourier transform of an amplitude

$$T \propto e^{(-\Gamma/2 - iE_R)t}$$

has the Breit-Wigner energy dependence

$$T \propto \frac{\Gamma/2}{E_R - E - i\Gamma/2}.$$

T is of course a matrix and for the elastic channel it is

$$T_e = \frac{\Gamma_e/2}{E_R - E - i\Gamma/2}, \quad (6)$$

where Γ is the total width of the resonance and Γ_e is the partial width for the elastic channel. For our elastic resonance it is easy to show that the amplitude T_e follows the circular trajectory of Fig. 1 with $\eta = 1$, for $\delta = 45^\circ$, $E = E_R - \Gamma/2$ and for $\delta = 135^\circ$, $E = E_R + \Gamma/2$.

The energy dependence ($E_R - E$) in the denominator of Eq. 6 establishes the sense of rotation in the circular trajectory as being counterclockwise. This behavior agrees with the "Wigner condition." WIGNER 55 has proved that this condition follows from causality, which requires that the outgoing wave should not leave the region of interaction before the arrival of the incoming wave. This fact rules out the opposite sign ($E - E_R$) in Eq. 6. In practice it sometimes happens that the amplitude varies clockwise, but causality is preserved because the change of phase shift

Fig. 1. The elastic scattering amplitude T_e in the complex plane.

is very slow, and the amplitude is not resonant. Wigner's proof applies only to elastic resonances, but DALITZ 63 has proved that it is valid, in general, for inelastic resonances also.

In general, Eq. 6 is written in a more convenient way as

$$T_e = \frac{x_e}{\epsilon - i} \quad (7)$$

with

$$x_e = \Gamma_e / \Gamma \quad \epsilon = \frac{E_R^2 - E^2}{E_R \Gamma_R} \left(\frac{q_R}{q} \right)^{2l+1} \frac{D_l(qr)}{[D_l(qr)]_R}$$

where the more complicated expression ϵ has been substituted for the term $(E_R - E)/(\Gamma/2)$ in order to account for the centrifugal barrier factors $B_l = q^{2l+1} D_l$ and relativistic effects.* The $D_l(qr)$ commonly used are the ones of Blatt-Weisskopf (BLATT 52). Here q is the π (or nucleon) momentum in the πp c.m., and r is the radius of interaction.

To describe a resonance, its nearly constant elasticity x_e is more convenient than η , which varies rapidly. As stated before, for $\eta = 1$ ($x_e = 1$) the resonant amplitude describes a circle of diameter 1, which is the unitary circle. For $x_e \neq 1$ it will describe a smaller circle, inside the unitary circle, of diameter x_e . At resonance the phase is $\delta = 90$ deg for $x \geq 0.5$. Figure 2 illustrates the trajectory of T_e for the two cases $x = 0.75$ and $x = 0.4$. There is no qualitative difference between these two resonances; the phase of the resonant amplitude itself goes through 90 deg in both cases. To conclude, inspection of Fig. 2 shows that at resonance, $\delta_R = 90$ deg or 0 deg, and $\eta_R = |2x_e - 1|$.

Effect of Background

The discussion of the previous section is valid if the scattering amplitude $T_{I,J,P}$ corresponding to a particular set of quantum numbers I, J, P , represents a pure resonant state. It is possible that there is also a slowly varying background amplitude with the same set of quantum numbers. In this case the circular path of the resonant amplitude of Fig. 2 appears considerably distorted.

This problem has been treated by DALITZ 63, and by MICHAEL 63 who has applied his formalism to the S_{11} resonance in the πp system.

Fig. 2. The resonant amplitude for the elastic channel is shown for two different values of the elasticity x . (a) $x = 0.75$ and the phase shift for the amplitude goes through 90 deg at the resonant energy. (b) $x = 0.4$ and $\delta = 0$ deg at the resonant energy. Notice that the phase of the resonant amplitude in the resonance circle goes through 90 deg in both cases.

* For summary of details see TRIPP 66 or BARBARO-GALTIERI 68.

The result of adding background to a resonance is that the circular shape characteristic of a resonance disappears, and only a fraction of a circle may be detected in the amplitude. This fact renders the extraction of resonant parameters very difficult unless a complicated fit to the phase shifts is performed. This is the case for most of the amplitudes as we will see later in Sections V and VI.

III. DISPLAYS OF "SPEED" AND $\sigma_{\text{tot}}^{\ell}$

Argand diagrams of T_{ℓ} and plots of η_{ℓ} and δ_{ℓ} vs $\sqrt{s}$ are quite standard. In addition we have added two other useful curves, $\sigma_{\text{tot}}^{\ell}$ and "speed" vs $\sqrt{s}$.

$\sigma_{\text{tot}}^{\ell}$ is the contribution of each T_{ℓ} to the total cross section, based on the optical theorem, Eq. 5.

"Speed" plots are a useful but slightly less well-known way of displaying resonant-like behavior. (See ROSENFELD 67 or BAREYRE 68)

Consider a resonant amplitude with constant elasticity x_e as in Eq. 7:

$$T = \frac{x_e}{\epsilon - i} . \quad (7)$$

This complex function can be differentiated with respect to $\epsilon = (E_R - E)/(\Gamma/2)$ to give another complex function

$$\frac{dT}{d\epsilon} = - \frac{x_e}{(\epsilon - i)^2} ,$$

and we define "speed" as its modulus $|dT/d\epsilon|$:

$$\left| \frac{dT}{d\epsilon} \right| = \frac{x_e}{(\epsilon - i)(\epsilon + i)} = \frac{x_e}{\epsilon^2 + 1} . \quad (8)$$

Of course we shall plot $\frac{dT}{dE}$ rather than $\frac{dT}{d\epsilon}$. Note four facts:

- 1) At resonance ($\epsilon = 0$), comparing Figs. 7 and 8,

$$\left| \frac{dT}{d\epsilon} \right|_{\text{max}} = x_e = T_{\text{max}} ;$$

of course, if we express speed in units of E rather than $\epsilon = (E_R - E)/(\Gamma/2)$, then

$$\text{Speed}_{\text{max}} = \left| \frac{dT}{dE} \right|_{\text{max}} = \frac{x_e}{\Gamma/2} . \quad (9)$$

Equation 9 is a useful constraint when one is trying to do an "eyeball" fit of resonance parameters $x_e, E_R, \Gamma/2$ to an Argand diagram.

When a group has published parameters $x_e, E_R, \Gamma/2$ we have drawn the line $x_e/(\Gamma/2)$ on the relevant speed plot. In general the constraint is satisfied, but not always.

- 2) The shape $\frac{1}{\epsilon^2 + 1}$ of the speed plot is just the familiar shape of the Breit-Wigner intensity $|T_{\ell}|^2$.
- 3) If there is no background, $\text{speed}(E)$ is identically $\text{Im}[T_{\ell}(E)]$.
- 4) Since speed is invariant to the rotation and displacement caused by background, remarks 1) and 2) are invariant to slowly varying background.

For our displays, the numerical differencing was done as follows:

$$\text{Speed}(i) = \frac{1}{2} \left\{ \frac{|T(i+1) - T(i)|}{E(i+1) - E(i)} + \frac{|T(i) - T(i-1)|}{E(i) - E(i-1)} \right\} ; \quad (10)$$

and for the end points

$$\text{Speed (end)} = \frac{|T(2)-T(1)|}{E(2)-E(1)} . \quad (11)$$

IV. IDENTIFICATION OF THE TEN SOLUTIONS

Since most of the solutions start at an energy of about 1300 MeV, we have included one low-energy (0-500 MeV/c) solution.

ROPER VIA MOORHOUSE—This is the solution of Roper and Wright

(ROPER 65) which Moorhouse (MOORHOUSE 69) has chosen as being representative of the low-energy phase shift solutions. ($\sqrt{s} = 1080-1320$ MeV)

SACLAY—This solution comes from BAREYRE 68.(1320-2020 MeV)

BERKELEY: BOONE 21, PATH 1, PATH 2—The BOONE 21 solution was

the first solution of JOHNSON 67. PATH 1 and PATH 2 are later solutions that fit the data equally well. We do not have any resonance parameters for any of these solutions.(1290-2020 MeV)

GLASGOW A and B—These are the two energy-dependent solutions of DAVIES 70. The final apportionment between background and resonances depends upon the starting values used in the fits. GLASGOW A starts from their own starting values; GLASGOW B starts from the smooth CERN solution. A "bug" in their program allows some waves to violate unitarity.(1320-1970 MeV)

CERN EXPERIMENTAL and THEORETICAL (CERN I)—These are the two fits from

DONNACHIE 68. The EXPERIMENTAL solution is their phase shift solution; the THEORETICAL solution is an energy-dependent fit to the EXPERIMENTAL solution.(1090-2190 MeV)

CERN KIRSOPP—This is another CERN I solution taken from KIRSOPP 68.(1090-2190 MeV)

For a thorough discussion of each solution, we refer the reader to the original papers and to the review articles.

V. FIGURES

A. Captions and Description of Plots

The solutions are arranged by partial wave. Those solutions coming from an energy-dependent analysis are plotted as a curve without data points. Each solution has a heading giving the partial wave and a "solution ID" (see Section IV for solution ID). The following four plots for each solution appear vertically:

Argand plot--For convenience, scale marks are placed every 50 MeV along the curve. Where possible a few scale marks are labeled with their energies.

η and δ --The left-hand scale is for η ; the right-hand scale is for δ .

Speed--See Section III for definition of the speed plots. Resonance information is only plotted on those waves for which the authors give resonance parameters. The energy at which the speed should touch the horizontal line is indicated by an arrow. The plots should be labeled Speed = dT/dE but by mistake are labeled $dT/d\epsilon$.

σ_{tot} --The contribution of each partial wave to the total cross section.

S31GLASGOW SOLUTION A

S31GLASGOW SOLUTION B

S31SACLAY

S31CERN THEORETICAL FIT.

S31CERN EXPERIMENTAL

S31CERN KIRSOPP

S31RDPER VIA MOORHOUSE.

S31BERKELEY BODNE 24

S31BERKELEY PATH 1

S31BERKELEY PATH 2

P31 GLASGOW SOLUTION A

P31 GLASGOW SOLUTION B

P31 SACLAY

P31CERN THEORETICAL

P31CERN EXPERIMENTAL

P31CERN KIRSOPP

P31ROPER VIA MOORHOUSE.

P31BERKELEY BODNE 21

P31BERKELEY PATH 1

P31BERKELEY PATH 2

P336LAS60W SOLUTION A

P336LAS60W SOLUTION B

P33SACLAY

P33CERN THEORETICAL

P33CERN EXPERIMENTAL

P33CERN KIRSOPP

P33RDPER VIA MORRHOUSE.

P33BERKELEY 800NE 21

P33BERKELEY PATH 1

P33BERKELEY PATH 2

D33GLASGOW SOLUTION A

D33GLASGOW SOLUTION B

D33SACLAY

D33CERN THEORETICAL FIT.

D33CERN EXPERIMENTAL

D33CERN KIRSOPP

D33RDPER VIA MOORHOUSE.

D33BERKELEY BOONE 21

D33BERKELEY PATH 1

D33BERKELEY PATH 2

D35GLASGOW SOLUTION A

D35GLASGOW SOLUTION B

D35SACLAY

D35CERN THEORETICAL FIT.

D35CERN EXPERIMENTAL

D35CERN KIRSOPP

D35R0PER VIA MOORHOUSE.

D35BERKELEY BOONE 21

D35BERKELEY PATH 1

D35BERKELEY PATH 2

F35GLASGOW SOLUTION P

F35GLASGOW SOLUTION E

F35SACLAY

F3SCERN THEORETICAL FIT.

F3SCERN EXPERIMENTAL

F3SCERN KIRSOPP

F3SDOPER VIA MOORHOUSE.

F3SBERKELEY 80ONE 21

F3SBERKELEY PATH 1

F3SBERKELEY PATH 2

F37GLASGOW SOLUTION A

F37GLASGOW SOLUTION B

F37SACLAY

F37CERN THEORETICAL FIT.

F37CERN EXPERIMENTAL

F37CERN KIRSOPP

F37ROPER VIA MOORHOUSE.

F37BERKELEY BOONE 21 —

F37BERKELEY PATH 1

F37BERKELEY PATH 2

G37GLASGOW SOLUTION A

G37GLASGOW SOLUTION B

G37SACLAY

637CERN THEORETICAL FIT.

637CERN EXPERIMENTAL

637CERN KIRSDPP

G37 BERKELEY BODNE 21

G37 BERKELEY PATH 1

G37 BERKELEY PATH 2

639GLASGOW SOLUTION A

G39GLASGOW SOLUTION B

G39SACLAY

G39CERN THEORETICAL FIT.

G39CERN EXPERIMENTAL

G39CERN KIRSOPP

H39CERN EXPERIMENTAL

H39CERN KIRSOPP

H39GLASGOW SOLUTION A

H39GLASGOW SOLUTION B

H31 CERN EXPERIMENTAL

H31 CERN KIRSDPP

H31 GLASGOW SOLUTION A

H31 GLASGOW SOLUTION B

S11GLAS60W SOLUTION A

S11GLAS60W SOLUTION B

S11SACLAY

S11CERN THEORETICAL FIT.

S11CERN EXPERIMENTAL

S11CERN KIRSOPP

S11ROPER VIA MOORHOUSE.

S11BERKELEY BONE 21

S11BERKELEY PATH 1

S11BERKELEY PATH 2

P11GLAS60W SOLUTION A

P11GLAS60W SOLUTION B

P11SACLAY

P11CERN THEORETICAL FIT.

P11CERN EXPERIMENTAL

P11CERN KIRSOPP

F11RDPER VIA MOORHOUSE.

P11BERKELEY BDDNE 21

P11BERKELEY PATH 1

P11BERKELEY PATH_2

P13GLASGOW SOLUTION A

P13GLASGOW SOLUTION B

P13SACLAY

P13CERN THEORETICAL FIT.

P13CERN EXPERIMENTAL

P13CERN KIRSOPP

P13ROPER VIA MOORHOUSE.

P13BERKELEY 800NE 21

P13BERKELEY PATH 1

P13BERKELEY PATH 2

D13GLASGOW SOLUTION A

D13GLASGOW SOLUTION B

D13SACLAY

D13CERN THEORETICAL FIT.

D13CERN EXPERIMENTAL

D13CERN KIRSOPP

D13RORPER VIA MOORHOUSE.

D13BERKELEY EODNE 21

D13BERKELEY PATH 1

D13BERKELEY PATH 2

D15GLASGOW SOLUTION A

D15GLASGOW SOLUTION B

C15SACLAY

DISCERN THEORETICAL FIT.

DISCERN EXPERIMENTAL

DISCERN KIRSOPP

DISROPER VIA MOORHOUSE.

DIS BERKELEY BOONE 21

DIS BERKELEY PATH 1

DIS BERKELEY PATH 2

F15GLASGOW SOLUTION A

F15GLASGOW SOLUTION B

F15SACLAY

F15CERN THEORETICAL FIT.

F15CERN EXPERIMENTAL

F15CERN KIRSOPP

F15ROPER VIA MOORHOUSE.

F15BERKELEY BOONE 21

F15BERKELEY PATH 1

F15BERKELEY PATH 2

F17GLASGOW SOLUTION A

F17GLASGOW SOLUTION B

F17 SACLAY

F17CERN THEORETICAL FIT.

F17CERN EXPERIMENTAL

F17CERN KIRSOPP

F17ROPER VIA MORRHOUSE.

F17 BERKELEY BOJNE 21

F17 BERKELEY PATH 1

F17 BERKELEY PATH 2

617 GLASGOW SOLUTION A

617 GLASGOW SOLUTION B

617 SACLAY

G17CERN THEORETICAL FIT.

G17CERN EXPERIMENTAL

G17CERN KIRSOPP —

G17 BERKELEY BOONE 21

G17 BERKELEY PATH 1

G17 BERKELEY PATH 2

G19GLASGOW SOLUTION A

G19GLASGOW SOLUTION B

G19SACLAY

G19CERN THEORETICAL FIT.

G19CERN EXPERIMENTAL

G19CERN KIRSOPP

G19BERKELEY BODNE 21

G19BERKELEY PATH 1

G19BERKELEY PATH 2

H19CERN EXPERIMENTAL

H19CERN KIRSDPP

H196LASGOW SOLUTION A

H196LASGOW SOLUTION B

H11CERN EXPERIMENTAL

H11CERN KIRSOPP

H11GLASGOW SOLUTION A

H11GLASGOW SOLUTION B

PARTIAL WAVE AMPLITUDES OBTAINED BY THE GLASGOW GROUP

B. Representative Set of Argand Plots

Partial wave analysis results of DAVIES 68. The curves plotted here are the results of the energy-dependent analysis. DAVIES A (solid curves) is obtained by starting from the set of phase shifts best solution of the Glasgow group. DAVIES B (dashed curves) is obtained by starting from the CERN 1 phase shifts. DAVIES B is not shown when it is very close to DAVIES A. Scale marks are shown every 50 MeV. The first large mark is at $M = 1400$ MeV, the last large mark at $M = 1900$ MeV.

VI. TABLES OF RESONANCES

For the reader's convenience we reproduce here some notes and tables from Review of Particle Properties (UCRL-8030, January 1970 edition). In order to avoid confusion we preserve numbering and captions from that report.

A. Mass and Width Comparison Table

Values of masses, widths, and branching ratios can be obtained from phase-shift analyses. We now have complete phase-shift analyses from four different groups, but we are quite far from having reliable masses and widths derived therefrom.

The problem is that the errors on the phase shifts are quite large and it is thus difficult to draw smooth curves on the Argand diagrams. In addition, except for the Glasgow solutions, where an energy-dependent fit to the data and phase shifts is done, the resonance parameters are just the result of an "eyeball" fit with the use of different methods. As a result, different authors using the same phase shifts often estimate different values of M, Γ, x . This is the case for the CERN I solution, from which three sets of parameters have been reported. The Glasgow analysis actually gives two solutions and the Saclay analysis gives two sets of parameters depending on the method used. In order to make the reader aware of this problem we report here a table, Table II, with all the different values for M, Γ, x . On the main table of Baryon Resonances we decided not to quote a value with an error, but to quote a range of masses and widths in order to point out the large indeterminacy of these parameters. So the P'_{11} will be $M = 1435$ to 1505 MeV, $\Gamma = 200$ to 400 MeV, etc.

Table II. Resonance parameters for N^{*} and Δ from phase-shift analyses, as listed by their authors. The $P_{33}(1236)$ is not included because the analyses listed start at higher energy. BAREYRE 68 uses two methods to find resonance parameters:

1—(σ) the energy where the total cross section is maximum, 2—(speed) the energy where the speed of variation of the amplitude in the Argand plot is maximum. CERN quotes only one method, usually where the absorption is maximum, but three different sets of values have been given. The Glasgow group (DAVIES 68) uses Breit-Wigner parameterization; A and B differ in the starting values of the minimization (CERN I solution was used for solution B). For some states no parameters have been quoted by the authors. We report in the M column our evaluation of the status of this resonance as judged on the published Argand plots. Symbols are the same as on Table I.

The "Ind. Ext. Error" written below the average is the "external error" of the individual values, i. e., $\langle \delta x_i \rangle = \sqrt{\frac{1}{N} \sum_i (x_i - \bar{x})^2}$. The error $\bar{x}$ of the mean is of course smaller by another factor $1/\sqrt{N}$ but we avoid giving it because we feel that $\bar{x}, \delta \bar{x}$ have little meaning here.

Table II. (see caption on preceding page)

I = 1/2 States						Method						Method						Method					

B. BARYONS January 1970

Particle or resonance ^a	J ^P	π or K Beam T(GeV) p(GeV/c)		Mass ^b (MeV)	Γ^b (MeV)	$M^2 \pm \Gamma^2$ (GeV ²)	Decay Modes		p or p_{max} (MeV/c)
		$\sigma = 4\pi\chi^2$ (mb)	Partial Mode				Fraction %		
p	1/2(1/2 ⁺)			938.3		0.880	See Stable Particles		
n	1/2(1/2 ⁺)			939.6		0.883			
N ⁺ (1470)	1/2(1/2 ⁺) P ₁₁	T=0.53p p=0.66 $\sigma=27.8$		1435 to 1505	200 to 400	2.16 ± 0.36	N π N $\pi\pi$	60 40	420 368
N ⁺ (1520)	1/2(3/2 ⁺) D ₁₃	T=0.61 p=0.74 $\sigma=23.5$		1510 to 1540	105 to 150	2.31 ± 0.18	N π N $\pi\pi$ N η	50 50 ~0.5	456 410 150
N ⁺ (1535)	1/2(1/2 ⁺) S ₁₁	T=0.64 p=0.76 $\sigma=22.5$		1500 to 1600	50 to 160	2.36 ± 0.18	N π N η N $\pi\pi$	34 66 small	467 182 422
N(1670)	1/2(5/2 ⁺) D ₁₅	T=0.87 p=1.00 $\sigma=15.6$		1655 to 1680	105 to 175	2.79 ± 0.24	N π N $\pi\pi$ Δ K N η	42 58 <.1 <.3	560 525 200 368
N(1688)	1/2(5/2 ⁺) F ₁₅	T=0.90 p=1.03 $\sigma=14.9$		1680 to 1692	105 to 180	2.85 ± 0.21	N π N $\pi\pi$ Δ K N η	60 40 <.1 <.2	572 538 231 388
N ⁺ (1700)	1/2(1/2 ⁺) S ₁₁	T=0.92 p=1.05 $\sigma=14.3$		1665 to 1765	100 to 400	2.89 ± 0.44	N π Δ K N η	70 5 ~3	580 250 340
N ⁺ (1780)	1/2(1/2 ⁺) P ₁₁	T=1.07 p=1.20 $\sigma=12.2$		1750 to 1860	270 to 450	2.17 ± 0.62	N π Δ K N η	34 ~4 ~10	633 353 476
N(1860)	1/2(3/2 ⁺) P ₁₃	T=1.22 p=1.36 $\sigma=10.4$		1840 to 1900	310 to 450	3.46 ± 0.62	N π N $\pi\pi$ Δ K N η	27 ~16 ~4	685 657 437 545
N(1990)	1/2(7/2 ⁺) F ₁₇	T=1.49 p=1.63 $\sigma=8.34$		1980 to 2000	220 to 250	3.96 ± 0.47	N π N $\pi\pi$	11	766 743
N ⁺ (2040)	1/2(3/2 ⁺) D ₁₃	T=1.60 p=1.73 $\sigma=7.70$		2030 to 2060	240 to 290	4.16 ± 0.56	N π N $\pi\pi$	17	797 775
N(2190)	1/2(7/2 ⁺) G ₁₇	T=1.94 p=2.07 $\sigma=6.21$		2000 to 2260	300	4.80 ± 0.65	N π N $\pi\pi$	35	888 868
N(2650)	1/2(?)	T=3.12 p=3.26 $\sigma=3.67$		2650	360	7.02 ± 0.95	N π N $\pi\pi$	(J+1/2) $\times$ =0.45 f	1154 1140
N(3030)	1/2(?)	T=4.27 p=4.41 $\sigma=2.62$		3030	400	9.18 ± 1.21	N π N $\pi\pi$	(J+1/2) $\times$ =0.05 f	1366 1354
Δ (1236)	3/2(3/2 ⁺) P ₃₃	T=0.195(++)1236.0 p=0.304 $\sigma=91.8$ $m_{\pi^0} - m_{\pi^+} = -4.5 \pm 0.85$ $m_{\pi^0} - m_{\pi^+} = -7.4 \pm 0.8$		1236.0 ± 0.6 ± 2	120	1.53 ± 0.15	N π N $\pi^+\pi^-$ N γ	99.4 0 ~0.6	231 89 262
Δ (1650)	3/2(1/2 ⁺) S ₃₁	T=0.83 p=0.96 $\sigma=16.4$		1620 to 1695	130 to 250	2.72 ± 0.25	N π N $\pi\pi$	27 73	547 511
Δ (1670)	3/2(3/2 ⁺) D ₃₃	T=0.87 p=1.00 $\sigma=15.6$		1650 to 1690	175 to 300	2.79 ± 0.40	N π N $\pi\pi$	13	560 525
Δ (1890)	3/2(5/2 ⁺) F ₃₅	T=1.28 p=1.42 $\sigma=9.88$		1840 to 1910	135 to 380	3.57 ± 0.52	N π N $\pi\pi$	17	704 677
Δ (1910)	3/2(1/2 ⁺) P ₃₁	T=1.33 p=1.46 $\sigma=9.54$		1835 to 1935	230 to 420	3.65 ± 0.62	N π N $\pi\pi$	25	716 691
Δ (1950)	3/2(7/2 ⁺) F ₃₇	T=1.41 p=1.54 $\sigma=8.90$		1935 to 1980	140 to 220	3.80 ± 0.39	N π Δ (1236) π Σ K Σ (1385)K Δ (1236)p	45 ~50 2.4 1.4 seen	741 574 460 232
Δ (2420)	3/2(11/2 ⁺)	T=2.50 p=2.64 $\sigma=4.68$		2420	310	5.86 ± 0.75	N π N $\pi\pi$	11 >20	1023 1006
Δ (2850)	3/2(?)	T=3.71 p=3.85 $\sigma=3.05$		2850	400	8.12 ± 1.14	N π N $\pi\pi$	(J+1/2) $\times$ =0.25 f	1266 1254
Δ (3230)	3/2(?)	T=4.94 p=5.08 $\sigma=2.25$		3230	440	10.4 ± 1.4	N π N $\pi\pi$	(J+1/2) $\times$ =0.05 f	1475 1464

* 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, δx , i.e., $\delta x \rightarrow S\delta x$. This convention is still inadequate, since if $S > 1$, the experiments are probably inconsistent, and therefore the real uncertainty is probably even greater than $S\delta x$. See text and ideogram in data card listings.

- An arrow at the left of the Table indicates a candidate that has been omitted because the evidence for the existence of the effect and (or) for its interpretation as a resonance is open to considerable question. See listings for information on the following: N(1700) D₁₃, N(3245), N(3690), N(3755), Δ (1690) P₃₃, Δ (1960) D₃₅, Δ (2160) P₃₃, Z₀(1865), Z₁(1900), Λ (1330), Λ (1680) P₀₁, Λ (1800) P₀₁, Λ (1860) F₀₇, Λ (2015) F₀₇, Σ (1440), Σ (1480), Σ (1560) P₁₁, Σ (1620), Σ (1690), Σ (1880), P₁₁, Σ (2130) G₁₇, Σ (3000), Ξ (1630), Ξ (1700).
- For the baryon states, the name [such as N(1470)] contains the mass, which shifts by 5 or 10 MeV with each new analysis. The value chosen is the rounded average from Table II of the note on N's and Δ 's in the baryon listings. The convention for using primes in the names is as follows: when there is more than one resonance on a given Argand diagram, the first has been designated with a prime, the second with a double prime, etc. The name (col. 1) is the same as can be found in large print in the listings.
 - See note on N's and Δ 's in baryon listings. For M and Γ we report here an interval instead of an average. Averages are appropriate if each result is based on independent measurements, but inappropriate here where the spread in parameters arises because different models or procedures have been applied to a common set of data.
 - For this column M is the rounded average which also appears in the name column and Γ is the average quoted on Table II of the N's and Δ 's note in the baryon listings.
 - 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 using the averaged central mass values, without taking into account the widths of the resonances.
 - Square brackets indicate a sub-reaction of the previous unbracketed decay mode.
 - This state has been seen only in total cross sections. J is not known; $\times$ is Γ_{el}/Γ .

VII. LISTINGS OF η AND δ VS E

We list below the sets of η and δ used to make the plots. We will be happy to send a tape containing the solutions to anyone who wishes. Please write to

Particle Data Group
University of California
Lawrence Radiation Laboratory
Berkeley, California 94720

ROPER VIA MOORHOUSE.

ENERGY	S31	P31	P33	D33	D35	F35	F37
1083	1.00	-.8 1.00	-.3 1.00	.2 1.00	0.0 1.00	0.0 1.00	0.0 1.00
1104	1.00	-2.9 1.00	-.3 1.00	2.8 1.00	.0 1.00	-.0 1.00	0.0 1.00
1127	1.00	-5.1 1.00	-.8 1.00	7.8 1.00	.0 1.00	-.0 1.00	0.0 1.00
1160	1.00	-8.3 1.00	-1.8 1.00	20.5 1.00	.1 1.00	-.1 1.00	0.0 1.00
1177	1.00	-10.0 1.00	-2.4 1.00	31.5 1.00	.1 1.00	-.2 1.00	0.0 1.00
1197	1.00	-11.8 1.00	-3.1 1.00	48.2 1.00	.2 1.00	-.3 1.00	.0 1.00
1216	1.00	-13.6 1.00	-3.9 1.00	70.6 1.00	.2 1.00	-.5 1.00	.0 1.00
1236	1.00	-15.3 1.00	-4.6 1.00	91.7 1.00	.3 1.00	-.7 1.00	.0 1.00
1254	1.00	-16.9 1.00	-5.3 1.00	108.1 1.00	.5 1.00	-.9 1.00	.0 1.00
1268	1.00	-18.1 1.00	-5.9 1.00	117.7 1.00	.6 1.00	-1.1 1.00	.0 1.00
1291	1.00	-19.7 1.00	-6.6 1.00	127.7 1.00	.7 1.00	-1.5 1.00	.0 1.00
1320	1.00	-21.6 1.00	-7.4 1.00	136.3 1.00	1.0 1.00	-2.0 1.00	.0 1.00

ROPER VIA MOORHOUSE.

ENERGY	S11	P11	P13	D13	D15	F15	F17
1083	1.00	2.8 1.00	-.2 1.00	-.2 1.00	0.0 1.00	0.0 1.00	0.0 1.00
1104	1.00	5.5 1.00	-1.2 1.00	-.2 1.00	.0 1.00	.0 1.00	0.0 1.00
1127	1.00	6.9 1.00	-2.0 1.00	-.4 1.00	.0 1.00	.0 1.00	0.0 1.00
1160	1.00	8.3 1.00	-2.1 1.00	-.9 1.00	.1 1.00	.1 1.00	.0 1.00
1177	1.00	8.9 1.00	-1.5 1.00	-1.1 1.00	.2 1.00	.1 1.00	.0 1.00
1197	1.00	9.5 1.00	-.3 1.00	-1.5 1.00	.4 1.00	.2 1.00	.0 1.00
1216	1.00	10.1 1.00	1.4 1.00	-1.8 1.00	.7 1.00	.3 1.00	.0 1.00
1236	1.00	10.6 1.00	3.5 1.00	-2.1 1.00	.8 1.00	.5 1.00	.1 1.00
1254	1.00	11.2 1.00	6.2 1.00	-2.5 1.00	1.2 1.00	.6 1.00	.1 1.00
1268	1.00	11.8 1.00	8.7 1.00	-2.8 1.00	1.5 1.00	.8 1.00	.2 1.00
1291	1.00	12.6 1.00	13.1 1.00	-3.2 1.00	2.2 1.00	1.1 1.00	.2 1.00
1320	1.00	14.0 1.00	20.4 1.00	-3.7 1.00	3.3 1.00	1.5 1.00	.4 1.00

BERKELEY BOONE 21

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39
1292	1.00	-19.4	1.00	-8.2	1.00	126.6	1.00	.2	1.00
1320	1.00	-21.3	.98	-8.5	1.00	138.1	.94	-.4	1.00
1362	1.00	-24.2	.98	-11.7	1.00	145.7	.96	.0	.97
1390	1.00	-28.0	.96	-14.3	1.00	150.2	.92	-1.1	.99
1443	.93	-28.1	.97	-12.3	1.00	155.7	1.00	3.0	1.00
1470	1.00	-28.0	.85	-18.3	1.00	160.7	.89	-3.0	1.00
1481	.96	-28.0	1.00	-16.8	1.00	160.4	.97	-2.9	1.00
1501	.86	-29.0	1.00	-22.2	.91	166.7	.89	-2.8	1.00
1512	.85	-27.5	.97	-20.6	1.00	165.4	.87	-2.2	1.00
1543	.80	-24.4	.95	-21.1	.99	169.2	.88	.5	.96
1572	.69	-19.5	.87	-27.9	.90	166.8	.93	.8	.93
1601	.67	-24.3	.73	-28.9	.92	172.7	1.00	-.4	.91
1629	.74	-36.9	.68	-28.3	.87	175.7	.98	-.4	.86
1658	.59	-45.2	.97	-23.3	.66	174.6	.85	-.1	.93
1672	.63	-48.2	.91	-21.0	.63	173.2	.91	-.5	.91
1688	.46	-39.6	.82	-32.3	.55	173.2	.95	-1.0	.97
1716	.49	-45.2	.73	-33.1	.52	172.8	.97	-.0	.94
1738	.68	-51.9	.81	-28.3	.62	174.8	.85	-4.6	.88
1769	.77	-60.8	.88	-20.6	.78	177.3	.78	-11.5	.87
1821	.75	-68.0	.65	-15.5	.92	179.5	.79	-16.6	.73
1862	.87	-67.8	.50	-20.0	.93	181.4	.86	-11.9	.60
1903	1.00	-65.7	.41	-18.1	.74	191.9	.83	-16.2	.71
1968	.86	-47.6	.63	-53.4	.67	196.8	.82	-7.8	.70
2025	.70	-58.7	.60	-48.0	.54	185.5	.54	-11.9	.69

BERKELEY BOONE 21

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19
1292	1.00	10.3	.99	10.6	1.00	-3.8	1.00	2.5	1.00
1320	1.00	10.5	.95	20.6	.94	-4.5	1.00	5.1	1.00
1362	1.00	11.7	.81	28.2	.94	-8.5	1.00	8.1	.99
1390	1.00	10.2	.72	36.6	.94	-9.2	1.00	10.9	.96
1443	1.00	19.2	.50	55.1	.91	-6.6	.92	21.1	.91
1470	.93	27.3	.28	85.6	.93	-4.7	.66	28.8	1.00
1481	.75	30.6	.36	100.2	.82	-6.9	.66	29.2	1.00
1501	.70	38.0	.52	106.2	.73	-6.2	.30	38.2	1.00
1512	.48	39.2	.45	110.2	.81	-8.4	.20	53.1	1.00
1543	.46	17.8	.45	123.6	.77	-11.0	.27	122.7	.97
1572	.49	20.0	.36	141.1	.82	-12.1	.51	141.2	.93
1601	.56	31.8	.08	137.9	.81	-3.5	.77	151.7	.77
1629	.79	41.9	.10	110.7	.83	-2.0	.81	157.5	.67
1658	.66	62.7	.09	122.2	.90	-.5	.79	167.1	.32
1672	.42	79.4	.19	95.8	.88	-2.7	.91	163.0	.23
1688	.66	82.0	.13	159.5	.87	-4.1	.73	173.1	.23
1716	.57	90.6	0.00	181.4	.64	-6.3	.88	171.5	.35
1738	.56	103.0	.04	185.9	.62	-9.7	.94	171.5	.52
1769	.55	174.6	.38	189.3	.57	.2	.78	173.1	.75
1821	.68	170.3	.27	174.7	.53	-6.1	.67	177.6	.83
1862	.58	118.6	.04	174.6	.51	-7.9	.76	173.9	.79
1903	.69	127.0	.31	187.8	.36	-8.0	.69	183.1	.92
1968	.67	136.4	.07	183.7	.23	10.3	.56	183.6	.74
2025	.68	145.0	.00	183.5	.54	8.6	.38	173.9	.32

BERKELEY PATH 1

ENERGY	S31		F31		P33		D33		D35		F35		F37		G37		G39	
1292	1.00	-19.4	1.00	-8.2	1.00	126.6	1.00	.2	1.00	-.8	1.00	.0	1.00	.4	1.00	0.0	1.00	0.0
1320	1.00	-20.8	1.00	-8.7	1.00	137.6	.99	-.7	1.00	-.3	1.00	-.3	1.00	1.0	1.00	0.0	1.00	0.0
1358	1.00	-23.8	1.00	-8.9	1.00	145.0	1.00	.8	1.00	-1.4	1.00	.1	1.00	.6	1.00	.0	1.00	.2
1390	1.00	-25.5	1.00	-10.6	1.00	148.3	1.00	.8	.98	-2.4	1.00	.0	1.00	.6	1.00	0.0	1.00	0.0
1442	.87	-29.5	.96	-11.8	1.00	155.4	1.00	3.1	1.00	-3.8	1.00	.9	1.00	.3	1.00	0.0	1.00	0.0
1471	1.00	-28.2	.91	-15.8	1.00	159.5	.94	-2.6	1.00	.0	1.00	.0	1.00	1.2	1.00	.0	.99	.0
1481	1.00	-27.9	.92	-11.9	.95	159.2	.94	-2.5	1.00	.1	1.00	1.7	1.00	.6	1.00	.1	.98	.8
1500	.95	-27.8	1.00	-20.7	1.00	165.5	.87	-1.3	1.00	-.0	.98	.2	1.00	2.4	1.00	-.5	1.00	.1
1513	.88	-23.8	1.00	-24.3	1.00	167.2	.85	-4.0	1.00	-.0	1.00	3.6	1.00	.2	1.00	-.0	1.00	-.2
1524	.81	-24.3	.99	-22.7	1.00	166.3	.90	-2.8	1.00	.2	1.00	1.8	.99	1.9	.99	-.2	.99	.1
1543	.76	-22.7	1.00	-22.5	.97	167.9	.85	-.1	.98	-.3	.99	1.7	1.00	2.8	1.00	.2	1.00	.1
1572	.51	-24.8	.88	-22.1	.99	170.2	.77	-.1	.99	-2.6	.99	1.1	1.00	2.8	1.00	-.0	1.00	-.0
1601	.43	-26.8	.79	-25.0	.98	170.1	.93	1.1	.85	-.1	.93	2.5	1.00	1.9	1.00	1.0	1.00	.3
1614	.39	-43.7	.71	-20.1	1.00	170.5	.89	.1	.82	-.8	.94	3.7	1.00	2.6	1.00	1.7	1.00	-.1
1630	.59	-41.7	.69	-25.9	.97	173.8	.91	.1	.77	-3.9	.90	4.7	1.00	3.9	1.00	1.5	.99	-.1
1658	.59	-45.2	.97	-23.3	.66	174.6	.85	-.1	.93	-4.8	.86	.6	1.00	9.5	1.00	.6	.96	-.0
1672	.56	-40.7	.93	-30.6	.62	176.5	.89	-1.9	1.00	-2.7	.74	-.5	1.00	9.7	1.00	-.3	.98	-.2
1688	.44	-38.5	.88	-33.5	.62	174.0	.90	-3.5	.99	-4.1	.82	1.0	1.00	10.1	.99	.6	.96	-.9
1716	.44	-37.7	.85	-37.6	.63	174.0	.96	-5.1	1.00	-2.4	.73	.0	1.00	11.6	1.00	.2	.98	-1.1
1737	.65	-63.4	.84	-26.4	.84	176.7	.74	-13.1	.77	-.3	.89	2.3	1.00	11.4	1.00	-1.6	.98	-.6
1769	.57	-67.7	.85	-25.2	.99	177.4	.77	-16.2	.79	1.6	.84	2.0	.99	12.5	.90	-.3	.97	-.1
1821	.71	-70.6	.66	-13.4	.88	179.4	.73	-16.8	.76	2.6	.67	.2	.90	16.2	1.00	.0	.91	-2.2
1862	.94	-63.5	.42	-18.0	.88	190.0	.74	-12.8	.77	-.0	.64	.7	.58	21.2	.93	-.7	1.00	-.1
1901	1.00	-65.2	.36	-19.5	.75	192.1	.82	-16.3	.72	-3.7	.56	-4.3	.40	18.0	1.00	.1	.96	-.0
1969	.96	-54.4	.47	-47.5	.69	192.6	.88	-11.3	.72	-8.0	.74	-10.1	.26	-20.3	1.00	.1	.92	-.0
2025	.68	-65.7	.47	-35.5	.40	192.6	.71	-5.1	.61	-3.1	1.00	-12.9	.77	-13.3	.89	.1	.77	-.0

BERKELEY PATH 1

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19									
1292	1.00	10.3	.99	10.6	1.00	-3.8	1.00	2.5	1.00	.8	1.00	.3	1.00	.1	1.00	0.0	1.00	0.0
1320	1.00	11.3	.99	21.2	.96	-4.2	1.00	5.3	1.00	1.2	1.00	1.3	1.00	-.2	1.00	0.0	1.00	0.0
1358	1.00	13.0	.86	29.2	.93	-6.9	.99	7.9	1.00	1.5	1.00	1.8	1.00	-.7	1.00	.3	1.00	-.5
1390	1.00	11.7	.78	38.2	.92	-7.4	.96	9.9	.99	3.0	1.00	2.4	1.00	-1.3	1.00	0.0	1.00	0.0
1442	.93	24.6	.60	47.5	.94	-9.4	.84	17.7	.96	6.6	1.00	2.4	1.00	.8	1.00	0.0	1.00	0.0
1471	.77	40.7	.28	63.8	.98	-6.7	.67	21.5	1.00	7.1	1.00	6.4	.98	.0	1.00	.1	1.00	1.3
1481	.75	41.8	.35	62.6	.86	-8.4	.53	17.7	1.00	9.8	1.00	6.8	1.00	.2	1.00	.1	1.00	2.3
1500	.58	49.7	.32	89.6	.93	-10.5	.29	33.4	1.00	8.4	1.00	7.1	1.00	-1.3	1.00	3.8	1.00	-1.1
1513	.49	43.1	.26	83.4	.94	-7.3	.16	71.0	1.00	6.7	1.00	7.4	1.00	-1.4	1.00	2.8	1.00	-.1
1524	.37	15.1	.14	61.7	.93	-2.1	.42	97.2	1.00	5.3	1.00	8.0	1.00	-1.2	1.00	2.8	1.00	-.2
1543	.27	3.4	.00	1.3	.85	-3.1	.51	128.7	.92	7.5	.98	11.6	1.00	-.7	1.00	4.7	1.00	.1
1572	.52	7.3	.00	1.3	.75	-2.5	.67	138.6	.94	11.1	1.00	14.2	1.00	.5	.95	3.0	.99	-.0
1601	.65	21.7	.00	-52.9	.72	-4.1	.74	147.2	.87	12.8	.99	19.7	1.00	.4	.97	.9	1.00	.5
1614	.62	23.6	.07	78.1	.67	-7.0	.67	154.8	.83	15.3	.96	21.0	1.00	-.5	1.00	1.4	.98	-.1
1630	.83	36.6	.17	69.5	.72	-4.5	.79	153.7	.71	16.1	.85	30.2	.98	-.4	1.00	1.1	.98	-.1
1658	.66	62.7	.09	-77.8	.90	-.5	.79	167.1	.32	15.1	.42	59.2	1.00	.1	1.00	4.2	.96	-.7
1672	.58	72.0	.00	1.1	.83	-3.2	.82	168.5	.24	8.5	.42	67.6	.99	-.6	.99	3.4	.97	-.1
1688	.65	86.7	.15	-17.4	.86	-2.3	.72	166.3	.25	-5.4	.37	91.6	1.00	-1.5	1.00	3.5	.97	-.5
1716	.65	97.3	.14	12.6	.64	-8.3	.87	173.3	.34	-10.6	.30	128.1	1.00	-2.5	1.00	-.0	.97	1.3
1737	.69	104.8	.00	-9.1	.61	-3.0	.86	173.8	.52	-16.6	.50	144.2	1.00	.2	.91	.8	.96	.0
1769	.63	110.9	.19	-3.2	.58	.1	.77	177.0	.70	-14.3	.60	154.1	1.00	.1	.92	2.9	.97	1.4
1821	.67	116.5	.33	-4.6	.46	-4.9	.68	180.0	.81	-10.6	.52	156.2	1.00	-.5	.91	2.1	1.00	-.0
1862	.62	124.7	.00	-6.7	.45	-.0	.57	176.6	1.00	-7.4	.65	159.2	1.00	.1	.78	3.9	1.00	.0
1901	.58	125.2	.34	10.6	.31	-2.9	.64	182.5	1.00	-5.2	.59	166.2	1.00	-.6	.77	5.5	1.00	-.0
1969	.68	129.7	.02	25.7	.39	-1.3	.54	182.8	.84	1.4	.70	175.1	.83	-.3	.79	2.6	.95	-.0
2025	.33	122.9	.44	19.2	.14	-3.0	.55	179.8	.76	-2.9	.70	170.4	.95	-1.5	.62	15.0	.92	-.0

BERKELEY PATH 2

ENERGY	S31		P31		P33		D33		D35		F35		F37		G37		G39	
1292	1.00	-19.4	1.00	-8.2	1.00	126.6	1.00	.2	1.00	-.8	1.00	.0	1.00	.4	1.00	0.0	1.00	0.0
1320	1.00	-20.8	1.00	-8.7	1.00	137.6	.99	-.7	1.00	-.3	1.00	-.3	1.00	1.0	1.00	0.0	1.00	0.0
1358	1.00	-23.8	1.00	-8.9	1.00	145.0	1.00	.8	1.00	-1.4	1.00	.1	1.00	.6	1.00	.0	1.00	.2
1390	1.00	-25.5	1.00	-10.6	1.00	148.3	1.00	.8	.98	-2.4	1.00	.0	1.00	.6	1.00	0.0	1.00	0.0
1442	.87	-29.5	.96	-11.3	1.00	155.4	1.00	3.1	1.00	-3.8	1.00	.9	1.00	.3	1.00	0.0	1.00	0.0
1471	1.00	-28.2	.91	-15.3	1.00	159.5	.94	-2.6	1.00	.0	1.00	.0	1.00	1.2	1.00	.0	.99	.0
1481	1.00	-27.9	.92	-11.9	.95	159.2	.94	-2.5	1.00	.1	1.00	1.7	1.00	.6	1.00	.1	.98	.8
1500	.95	-27.8	1.00	-20.7	1.00	165.5	.87	-1.3	1.00	-.0	.98	.2	1.00	2.4	1.00	-.5	1.00	.1
1513	.88	-23.8	1.00	-24.3	1.00	167.2	.85	-4.0	1.00	-.0	1.00	3.6	1.00	.2	1.00	-.0	1.00	-.2
1524	.81	-24.3	.99	-22.7	1.00	166.3	.90	-2.8	1.00	.2	1.00	1.8	.99	1.9	.99	-.2	.99	.1
1543	.76	-22.7	1.00	-22.5	.97	167.9	.85	-.1	.98	-.3	.99	1.7	1.00	2.8	1.00	.2	1.00	.1
1572	.61	-20.6	1.00	-24.6	.96	170.2	.82	-2.1	.91	.1	1.00	.6	1.00	3.2	1.00	-1.4	.99	.6
1601	.79	-12.9	.64	-34.3	.72	168.5	.93	-2.4	.98	.2	1.00	3.5	1.00	1.8	.93	-.5	1.00	1.3
1614	.81	-17.3	.45	-39.2	.69	168.3	1.00	-3.2	.95	-1.0	1.00	5.5	1.00	2.1	.92	.8	1.00	1.1
1630	.76	-19.8	.24	-56.3	.69	169.7	.98	-6.5	.91	-1.5	1.00	4.1	1.00	1.9	1.00	4.4	.96	-.7
1658	.44	-10.2	.34	-48.8	.52	162.6	1.00	-10.5	1.00	-.1	1.00	3.5	1.00	5.0	1.00	2.0	.92	-.2
1672	.48	-20.0	.45	-35.8	.52	162.8	1.00	-11.7	1.00	-1.7	.99	5.9	1.00	6.2	.88	-.5	.95	.8
1688	.36	-22.0	.42	-34.3	.55	163.2	1.00	-14.0	1.00	.3	.98	7.0	1.00	5.8	.95	-1.5	.94	1.4
1716	.32	-50.0	.30	-20.0	.61	163.1	1.00	-16.6	.90	.1	1.00	9.1	1.00	5.3	1.00	-1.8	.94	1.1
1737	.30	-52.2	.15	-30.3	.52	159.8	1.00	-14.8	.82	-.1	1.00	9.8	1.00	6.3	1.00	-2.8	.96	.3
1769	.36	-19.5	.36	-31.1	.40	161.5	1.00	-21.0	1.00	-.1	1.00	7.1	1.00	11.1	.90	-1.2	.88	2.0
1821	.35	-6.6	.08	28.8	.32	158.2	1.00	-24.7	.98	3.9	.87	5.0	.94	13.8	1.00	-.2	.76	.0
1862	.66	-6.2	.08	12.9	.45	137.7	1.00	-17.0	.64	-5.0	.91	4.2	.99	19.3	.99	-.5	.63	-.1
1901	.55	4.3	.00	-1.5	.66	130.6	1.00	-21.2	.63	-.8	.78	5.4	.76	20.5	1.00	-2.0	.74	-3.2
1969	.40	4.0	.36	38.4	.56	136.0	.99	-29.5	.69	-9.8	1.00	-2.3	.68	11.2	1.00	-.8	.61	-6.7
2025	.56	16.7	.19	-3.5	.27	153.9	.52	-44.9	.58	-13.0	1.00	-10.0	.92	-.7	.94	-1.2	.76	-.1

BERKELEY PATH 2

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19									
1292	1.00	10.3	.99	10.6	1.00	-3.8	1.00	2.5	1.00	.8	1.00	.3	1.00	.1	1.00	0.0	1.00	0.0
1320	1.00	11.3	.99	21.2	.96	-4.2	1.00	5.3	1.00	1.2	1.00	1.3	1.00	-.2	1.00	0.0	1.00	0.0
1358	1.00	13.0	.86	29.2	.93	-6.9	.99	7.9	1.00	1.5	1.00	1.8	1.00	-.7	1.00	.3	1.00	-.5
1390	1.00	11.7	.78	38.2	.92	-7.4	.96	9.9	.99	3.0	1.00	2.4	1.00	-1.3	1.00	0.0	1.00	0.0
1442	.93	24.6	.60	47.5	.94	-9.4	.84	17.7	.96	6.6	1.00	2.4	1.00	.8	1.00	0.0	1.00	0.0
1471	.77	40.7	.28	63.8	.98	-6.7	.67	21.5	1.00	7.1	1.00	6.4	.98	.0	1.00	.1	1.00	1.3
1481	.75	41.8	.39	62.6	.86	-8.4	.53	17.7	1.00	9.8	1.00	6.8	1.00	.2	1.00	.1	1.00	2.3
1500	.58	49.7	.33	89.6	.93	-10.5	.29	33.4	1.00	8.4	1.00	7.1	1.00	-1.3	1.00	3.8	1.00	-1.1
1513	.49	43.1	.26	83.4	.94	-7.3	.16	71.0	1.00	6.7	1.00	7.4	1.00	-1.4	1.00	2.8	1.00	-.1
1524	.37	15.1	.14	61.7	.93	-2.1	.42	97.2	1.00	5.3	1.00	8.0	1.00	-1.2	1.00	2.8	1.00	-.2
1543	.27	3.4	.00	1.3	.85	-3.1	.51	128.7	.92	7.5	.98	11.6	1.00	-.7	1.00	4.7	1.00	.1
1572	.45	3.8	.00	-16.6	.78	-3.2	.74	140.9	.92	9.8	.99	15.4	1.00	.5	.97	4.1	1.00	.2
1601	.55	26.1	.17	11.8	.85	-3.9	.72	143.5	.85	13.3	.95	18.5	1.00	-.2	.97	2.6	1.00	.2
1614	.49	29.7	.23	15.9	.81	-6.1	.65	147.7	.83	16.8	.90	19.0	1.00	-1.7	1.00	4.1	.97	.4
1630	.72	43.8	.00	-42.8	.95	-1.2	.76	155.4	.62	14.6	.71	35.0	1.00	.2	1.00	1.0	1.00	-.2
1658	.78	51.6	.15	-8.7	.95	-.6	.62	166.0	.39	17.0	.59	53.5	1.00	-.2	.99	.6	.97	-.8
1672	.56	52.8	.01	5.4	.80	-8.7	.85	156.9	.42	19.3	.55	56.5	.97	-2.1	.89	-1.4	.99	1.4
1688	.66	73.2	.20	-32.7	.87	-7.4	.73	161.2	.25	5.4	.39	73.1	1.00	-2.4	.97	.1	.95	-.9
1716	.44	83.3	.01	-.4	.69	-10.4	.91	169.8	.39	-.4	.21	112.6	1.00	-.0	.93	-4.0	.98	1.1
1737	.47	79.5	.05	-18.9	.63	-13.7	1.00	165.1	.45	-2.3	.16	141.7	1.00	-1.9	.94	-4.5	1.00	.9
1769	.08	95.7	.65	27.2	.54	-29.9	.96	154.1	.52	-1.8	.65	179.9	.96	-8.0	.94	.2	.99	3.2
1821	.22	140.4	.63	27.6	.46	-25.8	.76	156.4	.63	-6.9	.63	175.4	1.00	-6.2	1.00	1.9	.92	3.1
1862	.26	164.6	.52	-.3	.29	-59.6	.65	167.6	.92	-12.8	.90	179.6	.85	-3.2	.93	6.0	.87	-.1
1901	.16	191.4	.42	-.1	.26	-36.7	.82	174.1	.89	-13.3	.99	177.2	.82	-2.2	.87	6.6	.80	-2.0
1969	.74	216.1	.39	2.6	.00	22.6	.59	173.4	.68	-8.4	.70	179.7	.82	-.0	.85	1.1	.95	-2.0
2025	.70	195.6	.19	-23.0	.33	41.8	.33	174.6	.55	-10.7	.89	179.1	.96	-6.8	.69	7.7	.89	2.1

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39
1320	1.00 -20.4	1.00 -9.5	1.00 137.1	1.00 -1.7	1.00 -5.5	1.00 -9.9	1.00 2.0	1.00 0.0	1.00 0.0
1362	1.00 -25.8	1.00 -8.5	1.00 144.5	1.00 0.0	1.00 -1.0	.99 1.1	1.00 -7.7	1.00 0.0	1.00 0.0
1390	.99 -24.0	.96 -11.5	1.00 148.7	1.00 .2	1.00 -1.9	.99 -1.3	1.00 2.3	1.00 0.0	1.00 0.0
1443	.87 -24.7	.99 -10.5	1.00 155.4	1.00 4.3	1.00 -5.3	1.00 .7	1.00 .2	1.00 0.0	1.00 0.0
1470	.92 -28.4	.89 -11.4	.99 158.5	.98 2.4	1.00 -4.7	1.00 -5.5	1.00 1.5	1.00 0.0	1.00 0.0
1501	.89 -27.6	.90 -13.3	.95 161.7	.99 3.7	1.00 -4.5	1.00 .7	1.00 1.4	1.00 0.0	1.00 0.0
1524	.96 -26.9	1.00 -20.5	1.00 166.9	.90 -1.0	1.00 -6.6	.94 -9.9	1.00 3.4	1.00 0.0	1.00 0.0
1543	.91 -25.1	.97 -18.8	1.00 169.8	.76 1.7	1.00 -2.6	.97 1.0	1.00 3.2	1.00 0.0	1.00 0.0
1572	.68 -26.2	1.00 -18.9	.95 169.7	.89 -.3	.99 -3.3	.99 -1.3	1.00 4.8	1.00 -.5	.96 .6
1603	.56 -24.8	.99 -24.8	.94 168.8	.94 1.4	.90 -1.5	.91 .7	1.00 2.0	1.00 -.3	.98 .7
1617	.38 -30.7	.84 -28.7	.93 169.2	.90 3.1	.83 -1.2	.99 2.6	1.00 1.8	1.00 -.1	1.00 .1
1629	.22 -25.5	.81 -28.6	.85 167.8	.92 6.0	.84 -1.7	.99 5.1	1.00 2.0	1.00 2.0	1.00 .1
1658	.46 -42.4	.93 -26.3	.82 169.2	1.00 -1.4	.84 -7.1	.97 2.1	1.00 7.4	1.00 1.8	.93 -1.6
1673	.65 -61.7	.90 -13.2	.73 172.7	.97 -1.6	.76 -6.3	.96 1.7	.99 5.7	1.00 -1.3	1.00 1.6
1688	.64 -55.1	.90 -24.2	.77 173.5	.88 -2.2	.85 -6.8	.92 2.6	1.00 8.3	1.00 1.0	.96 .1
1716	.62 -66.7	.84 -14.2	.66 176.8	.62 -8.5	.92 -2.2	.97 3.8	1.00 9.0	1.00 -.3	1.00 1.2
1738	.82 -56.1	.97 -16.3	.80 171.8	.77 -9.6	.77 -3.4	.87 3.3	.99 11.3	1.00 -3.1	1.00 3.2
1769	.83 -50.5	.97 -26.0	.91 181.0	.90 -12.3	.84 -2.2	.76 -.6	.88 14.9	.91 -.3	1.00 -.3
1822	.83 -65.6	.71 -18.6	.96 178.4	.89 -16.6	.70 1.0	.70 -.5	.90 19.7	.98 -.4	.92 -.8
1862	.87 -72.2	.54 -21.6	1.00 181.5	.79 -14.9	.60 -3.3	.74 1.7	.75 22.6	.93 -1.7	.94 .2
1896	.59 -72.6	.37 -9.5	.84 181.4	.86 -12.6	.47 -6.8	.65 -.7	.66 30.4	1.00 .8	.98 -.6
1968	.49 -48.8	.69 -18.8	.82 169.2	.88 -7.0	.66 -11.5	.87 -4.5	.25 119.6	1.00 -1.6	.95 .4
2021	.60 -1.5	.68 -13.1	.63 146.0	.63 -16.1	.38 -23.6	.67 5.6	.65 193.6	1.00 -3.9	1.00 .3

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19
1320	1.00 12.3	.99 22.2	.96 -3.8	.99 5.7	1.00 1.0	1.00 1.4	1.00 -.9	1.00 0.0	1.00 0.0
1362	.96 12.3	.96 26.5	.98 -7.8	1.00 5.7	1.00 .8	.99 1.2	.98 -2.3	1.00 0.0	1.00 0.0
1390	1.00 12.1	.88 34.3	.91 -7.6	.96 9.7	1.00 3.1	1.00 2.8	.99 -2.1	1.00 0.0	1.00 0.0
1443	.95 26.7	.65 45.4	1.00 -9.3	.83 16.7	1.00 5.7	.98 2.7	.99 -.3	1.00 0.0	1.00 0.0
1470	1.00 23.7	.42 63.9	.91 -8.2	.89 28.9	.93 4.1	.98 4.1	.99 -.2	1.00 0.0	1.00 0.0
1501	.66 30.1	.40 73.5	.79 -17.1	.69 38.3	.90 2.9	.99 2.4	1.00 .6	1.00 0.0	1.00 0.0
1524	.44 38.9	.53 113.9	.80 -11.1	.09 62.8	1.00 6.8	1.00 6.8	.99 -.8	1.00 0.0	1.00 0.0
1543	.20 37.5	.52 131.7	.87 -7.2	.53 141.2	.88 9.9	.99 17.0	1.00 1.4	1.00 0.0	1.00 0.0
1572	.18 25.6	.43 128.3	1.00 -13.8	.61 155.5	.92 16.1	.98 9.6	.92 1.2	.96 2.5	1.00 0.0
1603	.47 29.6	.19 133.7	.73 -8.2	.79 151.1	.78 11.9	1.00 19.7	1.00 -.2	.98 -.4	.99 -.5
1617	.52 27.1	.08 127.4	.77 -8.1	.76 150.6	.81 15.2	.88 22.4	1.00 -1.4	.95 1.6	1.00 .1
1629	.86 37.5	.01 180.0	.74 -10.0	.67 154.0	.72 23.7	.94 22.9	.93 -.3	1.00 2.3	.99 1.3
1658	.63 59.7	.23 129.4	.85 -14.4	.97 152.5	.34 15.2	.44 42.9	.99 -3.9	.99 -.8	.92 -.6
1673	.92 78.1	.11 156.0	.80 -15.5	1.00 164.3	.12 2.7	.19 47.1	1.00 -3.5	.90 -4.1	.97 2.0
1688	.64 76.7	.31 152.8	.83 -10.3	.79 158.5	.20 -3.4	.27 79.3	.99 -2.3	1.00 .9	.94 -1.0
1716	.69 104.8	.33 193.6	.73 7.1	.62 177.5	.43 -15.8	.41 133.5	1.00 1.4	.95 3.6	.96 -.6
1738	.76 109.8	.38 182.4	.67 2.1	.88 165.8	.44 -13.2	.60 149.9	.92 3.8	.99 .9	.94 3.9
1769	.75 118.6	.37 189.0	.48 -4.6	.74 171.4	.81 -16.7	.72 159.7	.94 -.4	.89 4.7	1.00 2.4
1822	.49 116.2	.23 189.0	.45 -4.4	.68 169.3	.97 -14.6	.69 165.6	.82 -1.9	.97 5.9	1.00 2.6
1862	.53 112.3	.25 192.9	.49 -8.5	.76 173.0	.75 -10.7	.59 164.0	1.00 .3	.85 3.4	1.00 -.1
1896	.29 127.2	.27 193.8	.67 -20.2	.76 172.6	.62 -14.2	.53 166.1	.99 4.5	.84 2.4	1.00 1.9
1968	.29 108.0	.45 191.1	.76 -13.9	.78 191.0	.31 -5.4	.98 177.9	.60 -3.3	1.00 3.0	.81 -1.2
2021	.58 204.0	.84 184.6	.10 -18.3	.68 178.4	.34 1.1	.75 187.6	.59 1.0	.99 4.1	.76 -3.2

CERN KIRSOPP

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39	H39	H31					
1096	1.00	-2.7	1.00	-.3	1.00	1.4	1.00	.0	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1104	1.00	-3.7	1.00	-.4	1.00	2.5	1.00	.0	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1110	1.00	-4.0	1.00	-.5	1.00	3.6	1.00	.0	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1113	1.00	-4.3	1.00	-.7	1.00	4.1	1.00	.0	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1127	1.00	-5.4	1.00	-1.0	1.00	7.6	1.00	-0.0	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1160	1.00	-8.4	1.00	-2.2	1.00	21.2	1.00	.1	1.00	-.1	1.00	.0	1.00	-.0	1.00	-.0
1178	1.00	-9.9	1.00	-2.8	1.00	31.9	1.00	.1	1.00	-.2	1.00	.0	1.00	-.0	1.00	-.0
1186	1.00	-10.6	1.00	-3.2	1.00	37.9	1.00	.1	1.00	-.2	1.00	.0	1.00	.1	1.00	-.0
1195	1.00	-11.5	1.00	-3.6	1.00	45.8	1.00	.1	1.00	-.2	1.00	.0	1.00	.1	1.00	-.0
1202	1.00	-12.1	1.00	-3.9	1.00	54.3	1.00	.1	1.00	-.3	1.00	.0	1.00	.1	1.00	-.0
1213	1.00	-13.0	1.00	-4.4	1.00	65.9	1.00	.2	1.00	-.3	1.00	.0	1.00	.1	1.00	-.0
1217	1.00	-13.3	1.00	-4.5	1.00	69.2	1.00	.2	1.00	-.3	1.00	.0	1.00	.1	1.00	-.0
1231	1.00	-14.6	1.00	-5.2	1.00	85.1	1.00	.2	1.00	-.4	1.00	.0	1.00	.2	1.00	-.0
1235	1.00	-14.9	1.00	-5.4	1.00	89.4	1.00	.2	1.00	-.4	1.00	.0	1.00	.2	1.00	-.0
1247	1.00	-15.9	1.00	-6.0	1.00	100.6	1.00	.3	1.00	-.5	1.00	.0	1.00	.2	1.00	-.0
1253	1.00	-16.3	1.00	-6.2	1.00	105.2	1.00	.3	1.00	-.6	1.00	.0	1.00	.2	1.00	-.0
1255	1.00	-16.5	1.00	-6.3	1.00	107.2	1.00	.3	1.00	-.6	1.00	.0	1.00	.2	1.00	-.0
1259	1.00	-16.8	1.00	-6.5	1.00	109.5	1.00	.2	1.00	-.6	1.00	.0	1.00	.3	1.00	-.0
1275	1.00	-18.2	1.00	-7.4	1.00	119.7	1.00	.1	1.00	-.8	1.00	.0	1.00	.3	1.00	-.0
1292	1.00	-19.4	1.00	-8.2	1.00	126.6	1.00	.2	1.00	-.8	1.00	.0	1.00	.4	1.00	-.0
1320	1.00	-21.5	1.00	-9.3	1.00	135.6	1.00	.1	1.00	-.9	1.00	.0	1.00	.6	1.00	-.0
1362	1.00	-24.5	1.00	-11.6	1.00	144.7	1.00	.2	1.00	-1.2	1.00	-.1	1.00	.9	1.00	-.0
1390	.99	-25.9	1.00	-12.9	1.00	149.3	.99	.2	1.00	-1.4	1.00	-.1	1.00	.9	1.00	-.0
1416	.98	-28.0	1.00	-14.6	1.00	153.3	.98	.5	1.00	-1.7	1.00	-.1	1.00	1.4	1.00	-.0
1443	.93	-28.5	1.00	-15.9	1.00	157.6	.97	.8	1.00	-1.9	1.00	-.2	1.00	1.6	1.00	-.0
1470	.98	-28.8	1.00	-17.2	.98	161.3	.96	.7	1.00	-2.0	1.00	-.2	1.00	1.9	1.00	-.0
1481	.97	-29.2	1.00	-17.8	.97	162.5	.95	1.1	1.00	-2.3	1.00	-.0	1.00	2.3	1.00	-.0
1501	.94	-28.4	.97	-18.6	.96	164.1	.93	1.1	1.00	-2.2	1.00	.0	1.00	2.3	1.00	-.0
1512	.91	-28.1	.98	-19.1	.95	165.6	.92	1.1	1.00	-2.3	1.00	.0	1.00	2.5	1.00	-.0
1524	.89	-28.8	.97	-19.6	.93	165.4	.90	1.0	.99	-2.3	1.00	.1	1.00	2.5	1.00	-.0
1543	.79	-28.8	.97	-19.6	.93	165.4	.88	.9	.99	-2.4	1.00	.2	1.00	3.6	1.00	-.0
1572	.64	-27.2	.98	-21.1	.91	172.2	.82	.5	.99	-2.8	.99	.2	1.00	3.9	1.00	-.0
1601	.49	-32.8	.95	-21.8	.90	174.7	.77	-.4	.98	-3.0	.98	.1	1.00	4.3	1.00	-.0
1617	.47	-37.4	.93	-22.6	.81	171.8	.75	-1.0	.98	-2.5	.96	.5	1.00	5.5	1.00	-.0
1629	.43	-46.8	.93	-23.1	.89	174.3	.73	-1.8	.97	-2.8	.95	.7	1.00	6.1	1.00	-.0
1658	.48	-58.1	.93	-23.6	.83	175.7	.70	-4.2	.94	-2.5	.95	.8	1.00	7.3	1.00	-.0
1672	.53	-61.4	.89	-23.7	.80	177.5	.70	-5.7	.94	-2.8	.93	1.1	1.00	7.6	1.00	-.0
1688	.55	-62.7	.87	-24.3	.78	177.1	.68	-5.7	.93	-2.3	.93	1.3	1.00	8.1	1.00	-.0
1716	.62	-63.2	.84	-23.3	.78	178.1	.68	-9.8	.93	-2.6	.90	1.4	1.00	10.2	1.00	-.0
1738	.70	-65.4	.82	-25.1	.77	177.4	.70	-11.5	.90	-2.7	.90	1.3	1.00	11.5	1.00	-.0
1769	.72	-66.6	.75	-23.5	.80	188.6	.75	-13.3	.90	-2.8	.81	1.4	.93	12.8	1.00	-.0
1821	.87	-65.6	.61	-26.2	.89	182.4	.84	-14.2	.80	-2.2	.71	-1.5	.80	19.7	1.00	-.0
1862	.90	-64.9	.51	-30.5	.92	186.7	.84	-13.8	.74	-3.7	.68	-3.7	.61	23.6	1.00	-.0
1903	.90	-64.5	.43	-37.0	.88	191.4	.86	-14.6	.66	-4.5	.65	-7.3	.39	22.4	.99	-.0
1933	.83	-62.8	.41	-46.2	.91	193.1	.84	-13.7	.66	-6.3	.69	-8.7	.25	13.7	.99	-.0
1968	.77	-61.6	.45	-51.9	.90	192.4	.82	-12.5	.66	-8.5	.68	-8.9	.28	-6.0	.98	-.0
2025	.55	-58.2	.48	-52.1	.77	187.7	.79	-12.1	.63	-12.4	.74	-11.0	.52	-9.9	.95	-.0
2106	.34	-46.1	.72	-51.2	.64	178.2	.78	-14.4	.55	-11.2	.82	-9.9	.73	-8.9	.86	-.0
2163	.21	-68.0	.60	-61.0	.56	172.6	.78	-15.2	.62	-9.7	.81	-8.3	.75	-2.0	.83	-.0
2189	.16	-79.3	.56	-48.6	.51	172.6	.90	-15.8	.57	-8.7	.86	-9.9	.67	-2.2	.78	-.0

CERN KIRSOPP

ENERGY	S11	P11	P13	D13	C15	F15	F17	G17	G19	H19	H11	
1096	1.00	5.5	1.00	-3	1.00	-0	1.00	-0.0	1.00	-0.0	1.00	-0.0
1104	1.00	6.1	1.00	-7	1.00	-0	1.00	-0.0	1.00	-0.0	1.00	-0.0
1110	1.00	6.7	1.00	-7	1.00	-0	1.00	-0.0	1.00	-0.0	1.00	-0.0
1113	1.00	6.5	1.00	-8	1.00	-0	1.00	-0.0	1.00	-0.0	1.00	-0.0
1127	1.00	7.7	1.00	-1.1	1.00	-2	1.00	-0	1.00	-0.0	1.00	-0.0
1160	1.00	8.0	1.00	-1.8	1.00	-6	1.00	-2	1.00	-0.0	1.00	-0.0
1178	1.00	8.4	1.00	-1.0	1.00	-6	1.00	-3	1.00	-0.0	1.00	-0.0
1186	1.00	8.7	1.00	-6	1.00	-5	1.00	-3	1.00	-0.0	1.00	-0.0
1195	1.00	8.8	1.00	-6	1.00	-9	1.00	-4	1.00	-0.0	1.00	-0.0
1202	1.00	9.1	1.00	-1.0	1.00	-1	1.00	-5	1.00	-0.0	1.00	-0.0
1213	1.00	9.2	1.00	-3	1.00	-0.0	1.00	-6	1.00	-0.0	1.00	-0.0
1217	1.00	9.2	1.00	-3	1.00	-5	1.00	-7	1.00	-0.0	1.00	-0.0
1231	1.00	9.1	1.00	1.6	1.00	-2.6	1.00	-9	1.00	-0.0	1.00	-0.0
1235	1.00	9.1	1.00	1.9	1.00	-2.6	1.00	1.0	1.00	-0.0	1.00	-0.0
1247	1.00	9.2	1.00	3.1	1.00	-3.7	1.00	1.2	1.00	-0.0	1.00	-0.0
1253	1.00	9.2	.98	3.8	1.00	-3.3	1.00	1.4	1.00	-0.0	1.00	-0.0
1255	1.00	9.2	1.00	4.0	1.00	-5.2	1.00	1.4	1.00	-0.0	1.00	-0.0
1259	1.00	8.9	1.00	5.6	1.00	-2.8	1.00	1.4	1.00	-0.0	1.00	-0.0
1275	1.00	10.0	.99	7.7	1.00	-2.9	1.00	1.9	1.00	-0.0	1.00	-0.0
1292	1.00	10.3	.99	10.6	1.00	-3.8	1.00	2.5	1.00	-0.0	1.00	-0.0
1320	1.00	10.2	.98	18.9	1.00	-4.8	.97	4.7	1.00	1.1	1.00	.8
1362	1.00	15.6	.74	34.8	1.00	-5.0	.98	7.1	1.00	1.3	1.00	1.4
1390	.97	16.0	.60	45.4	1.00	-5.3	.98	9.0	1.00	1.9	1.00	1.7
1416	.90	19.8	.41	57.4	1.00	-5.4	.96	13.9	1.00	2.4	1.00	2.5
1443	.91	21.8	.36	74.3	1.00	-5.0	.87	20.2	1.00	2.9	1.00	2.8
1470	.71	29.5	.30	99.4	1.00	-6.2	.71	27.8	1.00	4.3	1.00	4.7
1481	.69	36.3	.27	102.9	1.00	-6.6	.62	33.3	1.00	4.6	1.00	5.9
1501	.53	41.7	.37	109.2	1.00	-6.8	.42	46.4	.99	6.3	.96	7.3
1512	.44	40.6	.40	112.2	1.00	-7.2	.33	51.5	.99	7.0	.88	9.2
1524	.47	43.4	.41	115.3	1.00	-6.1	.18	60.5	.97	8.4	.95	10.6
1543	.44	39.9	.44	118.8	1.00	-7.5	.02	129.9	.94	9.3	.91	14.0
1572	.42	34.7	.50	132.8	1.00	-6.6	.45	150.4	.85	13.3	.87	17.2
1601	.38	51.1	.46	144.2	1.00	-5.8	.71	163.3	.67	16.3	.76	22.8
1617	.29	46.9	.46	144.7	.98	-4.2	.71	164.1	.59	17.2	.67	25.7
1629	.49	62.5	.56	149.7	.98	-4.6	.72	164.1	.44	18.8	.55	34.4
1658	.68	77.2	.51	160.2	.95	-4.6	.59	164.5	.22	13.2	.35	58.0
1672	.70	88.5	.38	160.2	.92	-2.6	.71	159.3	.16	-2.0	.36	67.0
1688	.70	89.7	.47	169.7	.90	-2.3	.54	162.1	.20	-15.7	.30	88.1
1716	.67	105.0	.50	172.8	.77	-1.6	.65	165.0	.37	-21.4	.30	127.0
1738	.76	108.5	.31	177.7	.69	-3.9	.77	168.5	.53	-22.2	.45	143.2
1769	.59	117.6	.27	180.4	.63	-5.3	.78	174.1	.69	-17.3	.64	154.7
1821	.52	121.7	.12	187.7	.61	-8.1	.71	174.4	.84	-13.0	.71	160.9
1862	.83	132.5	.04	159.3	.50	-11.9	.75	178.0	.79	-11.5	.78	165.8
1903	.63	132.7	.13	129.4	.53	-11.5	.81	183.6	.85	-10.9	.80	171.1
1933	.63	131.9	.26	131.2	.49	-10.3	.73	185.0	.71	-8.2	.81	177.4
1968	.48	132.7	.39	134.9	.55	-11.2	.87	193.7	.50	-1.9	.83	178.3
2025	.67	143.5	.55	136.6	.46	-2.8	.55	183.4	.44	.8	.77	185.0
2106	.68	174.5	.76	146.2	.38	-12.1	.53	161.4	.34	-14.3	.69	188.4
2163	.60	137.3	.69	174.2	.38	-21.3	.72	164.5	.50	-4.9	.51	175.2
2189	.62	113.9	.53	168.8	.34	-20.0	.73	169.6	.55	-7.7	.52	173.1

CERN EXPERIMENTAL SOLUTION. FROM WAGNER, 1959.

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39	H39	H31					
1096	1.00	-2.6	1.00	-.2	1.00	1.4	1.00	.0	1.00	-.0	1.00	0.0	1.00	0.0	1.00	0.0
1104	1.00	-3.7	1.00	-.4	1.00	2.6	1.00	.0	1.00	-.0	1.00	0.0	1.00	0.0	1.00	0.0
1109	1.00	-4.0	1.00	-.5	1.00	3.6	1.00	.0	1.00	-.0	1.00	0.0	1.00	0.0	1.00	0.0
1113	1.00	-4.3	1.00	-.7	1.00	4.2	1.00	.0	1.00	-.0	1.00	0.0	1.00	0.0	1.00	0.0
1127	1.00	-5.4	1.00	-1.1	1.00	7.5	1.00	-.0	1.00	-.0	1.00	0.0	1.00	0.0	1.00	0.0
1160	1.00	-8.4	1.00	-2.2	1.00	21.2	1.00	.0	1.00	-.1	1.00	.0	1.00	0.0	1.00	0.0
1177	1.00	-9.9	1.00	-2.8	1.00	31.9	1.00	.1	1.00	-.2	1.00	.0	1.00	0.0	1.00	0.0
1185	1.00	-10.6	1.00	-3.2	1.00	37.8	1.00	.1	1.00	-.2	1.00	.0	1.00	0.0	1.00	0.0
1195	1.00	-11.5	1.00	-3.6	1.00	45.9	1.00	.1	1.00	-.2	1.00	.0	1.00	0.0	1.00	0.0
1202	1.00	-12.1	1.00	-3.9	1.00	54.1	1.00	.1	1.00	-.3	1.00	.0	1.00	0.0	1.00	0.0
1212	1.00	-13.0	1.00	-4.4	1.00	65.6	1.00	.2	1.00	-.3	1.00	.0	1.00	0.0	1.00	0.0
1216	1.00	-13.3	1.00	-4.5	1.00	68.5	1.00	.2	1.00	-.3	1.00	.0	1.00	0.0	1.00	0.0
1231	1.00	-14.6	1.00	-5.2	1.00	85.0	1.00	.2	1.00	-.4	1.00	.0	1.00	0.0	1.00	0.0
1235	1.00	-14.9	1.00	-5.4	1.00	89.2	1.00	.2	1.00	-.5	1.00	.0	1.00	0.0	1.00	0.0
1247	1.00	-15.9	1.00	-6.0	1.00	100.5	1.00	.2	1.00	-.5	1.00	.0	1.00	0.0	1.00	0.0
1252	1.00	-16.3	1.00	-6.2	1.00	105.2	1.00	.2	1.00	-.6	1.00	.0	1.00	0.0	1.00	0.0
1254	1.00	-16.5	1.00	-6.3	1.00	107.1	1.00	.2	1.00	-.6	1.00	.0	1.00	0.0	1.00	0.0
1258	1.00	-16.8	1.00	-6.5	1.00	109.2	1.00	.2	1.00	-.6	1.00	.0	1.00	0.0	1.00	0.0
1275	1.00	-18.2	1.00	-7.5	1.00	119.8	1.00	.1	1.00	-.8	1.00	.0	1.00	0.0	1.00	0.0
1291	1.00	-19.4	1.00	-8.2	1.00	127.1	1.00	.2	1.00	-.8	1.00	.0	1.00	0.0	1.00	0.0
1320	1.00	-21.6	1.00	-9.4	1.00	135.7	1.00	-.1	1.00	-1.0	1.00	-.0	1.00	.6	1.00	.1
1362	1.00	-24.4	1.00	-11.6	1.00	144.8	1.00	.2	1.00	-1.3	1.00	-.0	1.00	.8	1.00	.1
1389	1.00	-25.8	1.00	-13.0	1.00	149.4	.99	.3	1.00	-1.4	1.00	-.1	1.00	1.0	1.00	.1
1416	.99	-27.6	1.00	-14.6	.99	153.3	.98	.6	1.00	-1.7	1.00	-.1	1.00	1.4	1.00	.1
1442	.94	-28.3	1.00	-15.9	1.00	157.6	.96	.8	1.00	-1.9	1.00	-.1	1.00	1.7	1.00	.1
1470	.97	-28.6	.94	-17.1	.99	161.2	.95	.8	1.00	-2.0	1.00	-.1	1.00	2.0	1.00	.0
1481	.96	-29.1	1.00	-17.6	.99	162.3	.95	.8	1.00	-2.2	.99	-.1	1.00	2.3	1.00	.0
1500	.93	-28.6	.99	-18.4	.96	164.4	.93	.7	1.00	-2.2	1.00	-.0	1.00	2.4	1.00	-.0
1512	.90	-28.4	.99	-18.8	.95	165.7	.92	.8	1.00	-2.3	1.00	-.0	1.00	2.6	1.00	-.0
1523	.88	-28.8	.99	-19.3	.95	165.6	.91	.6	1.00	-2.3	1.00	.1	1.00	2.8	1.00	-.1
1543	.79	-28.1	.99	-19.9	.93	169.3	.88	.8	.99	-2.4	1.00	.1	1.00	3.3	1.00	-.1
1572	.63	-28.4	.98	-20.9	.91	172.4	.83	.4	.99	-2.6	.99	.2	1.00	3.9	1.00	-.2
1600	.49	-33.0	.95	-21.6	.88	174.6	.77	-.2	.97	-2.8	.98	.4	1.00	4.6	1.00	-.3
1617	.44	-38.3	.93	-22.4	.83	172.5	.75	-.9	.98	-2.4	.98	.7	1.00	5.3	1.00	-.3
1629	.42	-46.2	.94	-23.0	.86	174.6	.72	-1.4	.97	-2.7	.96	.8	1.00	5.9	1.00	-.4
1657	.46	-57.0	.93	-23.6	.82	176.3	.69	-.4	.96	-2.5	.95	1.0	1.00	7.0	1.00	-.5
1671	.49	-60.0	.92	-23.7	.79	177.8	.69	-5.5	.96	-2.7	.94	1.2	1.00	7.4	1.00	-.6
1688	.54	-62.0	.89	-24.0	.77	176.7	.68	-7.0	.95	-2.5	.94	1.0	1.00	7.9	1.00	-.7
1701	.58	-64.5	.88	-24.1	.81	178.3	.69	-8.4	.94	-2.5	.90	1.4	1.00	8.8	1.00	-.7
1715	.62	-64.1	.84	-23.7	.80	177.6	.68	-10.0	.93	-2.4	.90	1.3	1.00	9.8	1.00	-.8
1737	.72	-65.0	.82	-24.7	.79	178.8	.72	-11.7	.91	-1.8	.87	1.0	1.00	11.6	1.00	-.9
1769	.74	-66.1	.76	-23.8	.79	180.6	.76	-12.8	.89	-2.2	.80	1.0	.94	13.5	1.00	-1.1
1795	.83	-66.1	.68	-25.5	.86	183.8	.79	-13.4	.85	-2.3	.76	.6	.88	17.2	1.00	-1.2
1820	.87	-66.6	.60	-26.0	.86	182.8	.82	-14.0	.80	-2.2	.70	-1.1	.80	20.2	1.00	-1.1
1861	.91	-65.5	.50	-31.4	.89	187.7	.82	-13.7	.73	-3.3	.67	-3.5	.59	24.5	1.00	-1.4
1903	.91	-64.6	.42	-37.8	.87	191.2	.84	-14.6	.66	-4.8	.65	-7.1	.38	21.9	.99	-1.5
1932	.83	-62.9	.42	-47.3	.89	192.6	.84	-13.5	.65	-6.2	.69	-8.7	.24	12.6	.99	-1.8
1968	.82	-61.0	.45	-54.2	.89	190.0	.80	-12.4	.70	-9.7	.66	-8.3	.29	-6.1	.98	-1.8
2024	.57	-61.3	.49	-56.7	.66	196.7	.79	-14.1	.66	-10.4	.75	-11.3	.57	-12.7	.96	-1.9
2034	.55	-56.2	.46	-53.0	.78	189.2	.78	-12.1	.59	-12.1	.74	-10.8	.52	-10.6	.95	-1.9
2052	.49	-60.4	.55	-57.2	.60	188.3	.77	-13.1	.59	-10.4	.80	-11.2	.62	-10.1	.93	-1.9
2106	.29	-52.2	.58	-56.4	.58	183.1	.79	-12.6	.59	-12.4	.77	-10.3	.69	-7.4	.89	-1.6
2163	.26	-73.9	.56	-60.2	.55	173.1	.79	-14.9	.60	-10.3	.82	-8.4	.76	-3.5	.83	-1.5
2189	.18	-87.6	.56	-52.9	.46	169.5	.89	-14.8	.54	-10.5	.89	-8.5	.66	-3.9	.80	-1.6

CERN EXPERIMENTAL SOLUTION. FROM WAGNER, 1969.

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19	H19	H11	
1096	1.00	5.8	1.00	-0.3	1.00	-0.0	1.00	0.0	1.00	0.0	1.00	0.0
1104	1.00	6.0	1.00	-0.8	1.00	-0.3	1.00	0.0	1.00	0.0	1.00	0.0
1109	1.00	6.7	1.00	-0.7	1.00	-0.2	1.00	0.0	1.00	0.0	1.00	0.0
1113	1.00	6.5	1.00	-0.9	1.00	-0.4	1.00	0.0	1.00	0.0	1.00	0.0
1127	1.00	8.1	1.00	-1.0	1.00	-0.3	1.00	0.0	1.00	0.0	1.00	0.0
1160	1.00	7.9	1.00	-2.0	1.00	-0.6	1.00	0.1	1.00	0.0	1.00	0.0
1177	1.00	6.8	1.00	-1.0	1.00	-0.2	1.00	0.2	1.00	0.0	1.00	0.0
1185	1.00	8.7	1.00	-0.3	1.00	-0.8	1.00	0.3	1.00	0.0	1.00	0.0
1195	1.00	8.8	1.00	-0.6	1.00	-0.4	1.00	0.4	1.00	0.0	1.00	0.0
1202	1.00	9.2	1.00	-1.5	1.00	-0.7	1.00	0.4	1.00	0.0	1.00	0.0
1212	1.00	10.5	1.00	-0.0	1.00	0.5	1.00	0.5	1.00	0.0	1.00	0.0
1216	1.00	9.4	1.00	-0.3	1.00	0.2	1.00	0.6	1.00	0.0	1.00	0.0
1231	1.00	10.5	1.00	1.7	1.00	-1.5	1.00	0.8	1.00	0.0	1.00	0.0
1235	1.00	10.6	1.00	2.0	1.00	-1.7	1.00	0.9	1.00	0.0	1.00	0.0
1247	1.00	11.1	1.00	3.3	1.00	-3.1	1.00	1.1	1.00	0.0	1.00	0.0
1252	1.00	11.1	1.00	4.1	1.00	-2.4	1.00	1.2	1.00	0.0	1.00	0.0
1254	1.00	10.3	1.00	4.5	1.00	-5.1	1.00	1.3	1.00	0.0	1.00	0.0
1258	1.00	9.0	1.00	6.2	1.00	-2.5	1.00	1.1	1.00	0.0	1.00	0.0
1275	1.00	10.5	.99	8.3	1.00	-2.5	1.00	1.8	1.00	0.0	1.00	0.0
1291	1.00	14.0	.99	11.0	1.00	-3.4	1.00	2.1	1.00	0.0	1.00	0.0
1320	1.00	10.1	.99	19.0	1.00	-4.7	.96	5.1	1.00	1.4	1.00	.9
1362	1.00	16.4	.75	34.3	1.00	-5.1	.98	7.2	1.00	1.2	1.00	1.5
1389	.96	18.4	.62	43.5	1.00	-5.6	.98	8.8	1.00	2.0	1.00	1.6
1416	.98	20.0	.48	55.6	1.00	-5.5	.92	14.8	1.00	2.6	1.00	2.4
1442	.95	20.7	.39	73.6	1.00	-5.1	.81	21.0	1.00	3.9	1.00	2.9
1470	.85	27.3	.31	89.4	1.00	-6.2	.66	31.2	.97	4.8	.97	4.7
1481	.83	30.9	.34	99.7	1.00	-6.1	.53	37.4	1.00	5.4	.93	5.7
1500	.59	53.1	.35	107.2	1.00	-5.3	.23	48.1	.98	7.5	.96	6.5
1512	.49	50.7	.32	109.6	1.00	-5.3	.12	84.4	.98	7.2	.95	7.3
1523	.46	39.9	.45	117.5	1.00	-5.4	.16	97.9	.97	9.0	.97	10.7
1543	.25	33.5	.48	125.5	1.00	-8.2	.38	139.6	.91	9.4	.95	12.1
1572	.48	29.0	.52	131.1	.99	-7.3	.53	151.4	.90	13.3	.91	15.4
1600	.58	37.1	.38	140.2	.98	-6.1	.65	159.0	.75	16.9	.82	22.7
1617	.22	35.0	.40	143.4	.92	-4.3	.72	164.3	.61	18.1	.67	28.0
1629	.66	53.5	.40	147.9	.97	-4.5	.62	164.1	.50	21.0	.68	33.7
1657	.79	71.8	.45	161.8	.93	-4.1	.51	165.9	.24	19.8	.41	55.2
1671	.84	82.4	.46	162.6	.93	-3.4	.47	164.5	.15	8.3	.36	64.6
1688	1.00	87.3	.43	188.9	.75	-1.6	.68	176.5	.20	-29.3	.14	90.3
1701	.63	95.9	.60	170.7	.87	-2.3	.58	164.4	.30	-18.4	.21	104.2
1715	.58	114.1	.65	169.7	.80	-1.3	.65	162.4	.40	-17.4	.38	126.0
1737	.81	113.9	.35	177.5	.61	-1.4	.82	176.0	.54	-18.3	.52	147.5
1769	.39	100.0	.22	184.3	.67	-5.1	.79	172.9	.66	-19.0	.58	158.0
1795	.77	113.2	.17	176.5	.54	1.1	.81	177.6	.75	-17.1	.64	163.5
1820	.43	114.1	.09	178.3	.56	-8.5	.80	177.0	.80	-15.3	.70	164.9
1861	.58	125.5	.06	183.1	.47	-11.6	.73	179.5	.86	-11.4	.68	165.9
1903	.53	126.1	.08	129.4	.53	-11.8	.79	183.0	.85	-11.4	.72	171.3
1932	.48	143.3	.66	131.2	.50	-11.9	.82	199.0	.54	-2.3	.86	177.5
1968	.91	139.2	.34	138.8	.41	-9.2	.74	188.8	.69	-5.6	.85	178.4
2024	.97	146.8	.63	146.3	.33	-5.3	.58	189.9	.52	-1.9	.81	186.5
2034	.61	144.5	.46	148.1	.47	-1.9	.39	181.1	.52	0.2	.69	184.5
2052	.70	157.0	.54	156.1	.41	-13.7	.21	171.2	.55	7.6	.65	181.5
2106	.62	169.7	.53	140.7	.23	-5.4	.39	153.8	.33	-12.9	.72	188.7
2163	.18	154.8	.63	176.2	.31	-20.1	.72	160.6	.53	-5.0	.53	175.1
2189	.13	166.5	.47	181.5	.31	-9.4	.59	167.5	.55	-5.0	.52	176.0

CERN THEORETICAL FIT.

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39
1089	1.00	-2.0	1.00	-1.1	1.00	.6	1.00	0.0	1.00
1096	1.00	-2.7	1.00	-1.3	1.00	1.4	1.00	.0	1.00
1099	1.00	-3.0	1.00	-1.3	1.00	1.8	1.00	.0	1.00
1104	1.00	-3.4	1.00	-1.4	1.00	2.6	1.00	.0	1.00
1110	1.00	-3.9	1.00	-1.5	1.00	3.5	1.00	.0	1.00
1113	1.00	-4.2	1.00	-1.6	1.00	4.3	1.00	.0	1.00
1127	1.00	-5.4	1.00	-1.0	1.00	7.8	1.00	-0.0	1.00
1148	1.00	-7.3	1.00	-1.7	1.00	15.2	1.00	.0	1.00
1160	1.00	-8.4	1.00	-2.1	1.00	21.1	1.00	.1	1.00
1172	1.00	-9.4	1.00	-2.6	1.00	28.3	1.00	.1	1.00
1178	1.00	-9.9	1.00	-2.8	1.00	32.2	1.00	.1	1.00
1186	1.00	-10.6	1.00	-3.2	1.00	38.3	1.00	.1	1.00
1195	1.00	-11.4	1.00	-3.6	1.00	46.6	1.00	.1	1.00
1202	1.00	-12.1	1.00	-3.9	1.00	53.6	1.00	.1	1.00
1213	1.00	-13.0	1.00	-4.4	1.00	65.2	1.00	.2	1.00
1217	1.00	-13.3	1.00	-4.5	1.00	69.5	1.00	.2	1.00
1221	1.00	-13.7	1.00	-4.8	1.00	74.6	1.00	.2	1.00
1231	1.00	-14.6	1.00	-5.2	1.00	85.4	1.00	.2	1.00
1235	1.00	-14.9	1.00	-5.4	1.00	89.4	1.00	.2	1.00
1240	1.00	-15.3	1.00	-5.6	1.00	93.9	1.00	.2	1.00
1247	1.00	-15.9	1.00	-6.0	1.00	100.7	1.00	.3	1.00
1253	1.00	-16.3	1.00	-6.3	1.00	105.1	1.00	.3	1.00
1255	1.00	-16.5	1.00	-6.4	1.00	106.8	1.00	.3	1.00
1259	1.00	-16.8	1.00	-6.5	1.00	109.5	1.00	.3	1.00
1275	1.00	-18.2	1.00	-7.4	1.00	119.6	1.00	.2	1.00
1292	1.00	-19.5	1.00	-8.2	1.00	126.8	1.00	.2	1.00
1320	1.00	-21.6	1.00	-9.7	1.00	135.6	1.00	.1	1.00
1337	1.00	-22.7	1.00	-10.6	1.00	139.5	1.00	.1	1.00
1362	1.00	-24.4	1.00	-11.9	1.00	144.7	1.00	.3	1.00
1390	.99	-26.0	1.00	-13.3	1.00	149.3	.99	.4	1.00
1416	.99	-27.5	1.00	-14.6	1.00	153.4	.98	.6	1.00
1443	.99	-28.4	1.00	-15.9	.99	157.2	.97	.7	1.00
1470	.97	-28.7	1.00	-17.1	.98	161.0	.95	.8	1.00
1481	.96	-28.7	1.00	-17.6	.97	162.4	.95	.9	1.00
1501	.92	-28.5	1.00	-18.4	.96	164.8	.93	1.0	1.00
1512	.88	-28.4	1.00	-18.8	.95	166.2	.92	1.0	1.00
1524	.85	-28.3	.99	-19.2	.94	167.5	.90	1.1	1.00
1543	.77	-28.4	.99	-20.0	.92	169.6	.88	1.0	.99
1572	.63	-29.9	.98	-21.0	.89	172.3	.83	.7	.99
1601	.49	-34.5	.96	-21.9	.86	174.5	.78	-2	.98
1617	.44	-39.4	.95	-22.4	.84	175.6	.75	-1.1	.97
1629	.41	-44.0	.95	-22.7	.83	176.2	.73	-1.9	.97
1644	.41	-49.8	.94	-23.0	.82	176.8	.71	-2.9	.96
1658	.43	-55.2	.93	-23.4	.81	177.3	.70	-4.2	.96
1672	.47	-59.3	.91	-23.6	.81	177.7	.69	-5.5	.95
1688	.53	-62.7	.89	-23.9	.80	178.1	.68	-7.1	.94
1697	.56	-63.9	.88	-24.0	.81	178.2	.68	-7.9	.94
1702	.58	-64.4	.88	-24.1	.81	178.3	.69	-8.4	.94
1716	.64	-65.5	.86	-24.2	.81	178.6	.69	-9.6	.93
1738	.72	-66.2	.82	-24.5	.83	178.9	.71	-11.3	.91
1769	.80	-66.2	.75	-24.9	.85	179.8	.75	-13.0	.88
1795	.85	-65.7	.68	-25.6	.88	180.7	.78	-13.8	.85
1821	.88	-65.0	.61	-26.9	.90	181.8	.81	-14.1	.81
1862	.88	-64.1	.50	-30.7	.91	183.9	.95	-14.0	.75
1903	.85	-63.3	.42	-37.9	.90	186.1	.86	-13.6	.70
1933	.82	-62.9	.41	-44.7	.87	187.5	.86	-13.4	.66
1968	.76	-62.4	.43	-51.7	.81	188.8	.84	-13.2	.64
2025	.63	-61.7	.52	-57.5	.69	189.1	.82	-13.4	.62
2052	.55	-61.5	.57	-58.2	.63	188.2	.81	-13.8	.63
2106	.36	-62.8	.61	-57.4	.52	183.6	.81	-14.4	.62
2163	.16	-77.7	.59	-54.7	.48	175.2	.83	-14.3	.58
2189	.14	-99.7	.56	-53.0	.49	171.2	.85	-13.8	.55

CERN THEORETICAL FIT.

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19
1089	1.00	4.2 1.00	.2 1.00	-.0 1.00	0.0 1.00	0.0 1.00	-0.0 1.00	0.0 1.00	0.0
1096	1.00	5.1 1.00	-.3 1.00	-.0 1.00	-0.0 1.00	.0 1.00	0.0 1.00	-0.0 1.00	0.0
1099	1.00	5.5 1.00	-.4 1.00	-.1 1.00	-0.0 1.00	.0 1.00	0.0 1.00	-0.0 1.00	0.0
1104	1.00	6.0 1.00	-.5 1.00	-.1 1.00	-0.0 1.00	.0 1.00	0.0 1.00	-0.0 1.00	0.0
1110	1.00	6.4 1.00	-.7 1.00	-.1 1.00	0.0 1.00	0.0 1.00	0.0 1.00	-0.0 1.00	0.0
1113	1.00	6.7 1.00	-.8 1.00	-.1 1.00	.0 1.00	0.0 1.00	0.0 1.00	-0.0 1.00	0.0
1127	1.00	7.4 1.00	-1.1 1.00	-.2 1.00	.0 1.00	.0 1.00	0.0 1.00	-0.0 1.00	0.0
1148	1.00	8.2 1.00	-1.2 1.00	-.4 1.00	.1 1.00	.1 1.00	-0.0 1.00	0.0 1.00	0.0
1160	1.00	8.5 1.00	-1.2 1.00	-.6 1.00	.1 1.00	.1 1.00	-0.0 1.00	.0 1.00	0.0
1172	1.00	8.7 1.00	-1.1 1.00	-.8 1.00	.2 1.00	.2 1.00	-0.0 1.00	.0 1.00	0.0
1178	1.00	8.8 1.00	-1.0 1.00	-.9 1.00	.3 1.00	.2 1.00	-0.0 1.00	.0 1.00	.0
1186	1.00	8.9 1.00	-.9 1.00	-1.0 1.00	.3 1.00	.2 1.00	-0.0 1.00	.0 1.00	.0
1195	1.00	9.0 1.00	-.5 1.00	-1.3 1.00	.4 1.00	.2 1.00	.0 1.00	.0 1.00	.0
1202	1.00	9.0 1.00	-.2 1.00	-1.4 1.00	.5 1.00	.3 1.00	.0 1.00	.0 1.00	.0
1213	1.00	9.1 1.00	.4 1.00	-1.7 1.00	.6 1.00	.3 1.00	.0 1.00	.0 1.00	.0
1217	1.00	9.1 1.00	.6 1.00	-1.8 1.00	.7 1.00	.3 1.00	.1 1.00	.0 1.00	.0
1221	1.00	9.1 1.00	.9 1.00	-2.0 1.00	.7 1.00	.4 1.00	.1 1.00	.0 1.00	.0
1231	1.00	9.2 1.00	1.6 1.00	-2.3 1.00	.9 1.00	.4 1.00	.1 1.00	.1 1.00	.0
1235	1.00	9.2 1.00	1.9 1.00	-2.4 1.00	1.0 1.00	.4 1.00	.1 1.00	.1 1.00	.0
1240	1.00	9.3 1.00	2.3 1.00	-2.5 1.00	1.0 1.00	.4 1.00	.1 1.00	.1 1.00	.0
1247	1.00	9.3 1.00	3.1 1.00	-2.8 1.00	1.2 1.00	.5 1.00	.1 1.00	.1 1.00	.0
1253	1.00	9.3 1.00	3.7 1.00	-2.9 1.00	1.3 1.00	.5 1.00	.1 1.00	.1 1.00	.0
1255	1.00	9.4 1.00	4.0 1.00	-3.0 1.00	1.4 1.00	.5 1.00	.1 1.00	.1 1.00	.0
1259	1.00	9.4 1.00	4.4 1.00	-3.1 1.00	1.5 1.00	.6 1.00	.1 1.00	.1 1.00	.0
1275	1.00	9.6 1.00	7.0 1.00	-3.6 1.00	1.9 1.00	.7 1.00	.2 1.00	.1 1.00	.1
1292	1.00	9.9 .98	10.3 1.00	-4.0 1.00	2.5 1.00	.8 1.00	.3 1.00	.1 1.00	.1
1320	1.00	10.6 .93	17.7 1.00	-4.6 1.00	3.8 1.00	1.0 1.00	.6 1.00	.1 1.00	.1
1337	1.00	11.3 .87	22.8 1.00	-4.8 1.00	4.6 1.00	1.2 1.00	.7 1.00	.1 1.00	.1
1362	1.00	13.1 .75	32.2 1.00	-5.1 1.00	6.3 1.00	1.5 1.00	1.1 1.00	.1 1.00	.1
1390	.98	16.0 .61	43.8 1.00	-5.5 1.00	9.5 1.00	1.9 1.00	1.7 1.00	.1 1.00	.2
1416	.93	19.9 .49	57.4 1.00	-5.8 .98	14.4 1.00	2.5 1.00	2.5 1.00	.0 1.00	.2
1443	.83	24.5 .40	73.1 1.00	-6.1 .88	20.7 1.00	3.1 1.00	3.5 1.00	0.0 1.00	.2
1470	.69	30.0 .36	90.5 1.00	-6.3 .69	28.3 1.00	4.2 1.00	5.1 1.00	-0.0 1.00	.3
1481	.61	32.1 .36	97.0 1.00	-6.4 .60	31.5 1.00	4.8 1.00	5.9 1.00	-0.0 1.00	.3
1501	.53	30.9 .37	107.7 1.00	-6.5 .41	37.5 .99	6.1 1.00	7.8 1.00	-0.1 1.00	.3
1512	.51	32.6 .38	113.4 1.00	-6.5 .29	41.2 .98	7.1 .99	9.1 1.00	-0.1 1.00	.3
1524	.49	34.6 .38	118.3 1.00	-6.5 .18	45.1 .97	8.2 .98	10.7 1.00	-0.1 1.00	.3
1543	.45	39.0 .40	126.0 1.00	-6.3 .03	129.6 .93	10.3 .94	13.8 1.00	-0.1 1.00	.4
1572	.41	47.5 .42	135.8 1.00	-5.9 .29	146.9 .87	13.7 .85	19.5 1.00	-0.2 1.00	.4
1601	.39	58.2 .44	144.1 .98	-5.3 .48	154.7 .67	16.9 .70	26.4 1.00	-0.3 1.00	.4
1617	.41	65.0 .44	148.6 .97	-4.8 .56	158.8 .56	18.1 .59	31.0 1.00	-0.3 1.00	.4
1629	.42	69.8 .44	151.8 .96	-4.5 .61	161.5 .47	18.3 .50	34.9 1.00	-0.3 1.00	.5
1644	.45	75.2 .44	155.3 .94	-4.1 .64	164.3 .37	17.1 .40	40.2 1.00	-0.3 1.00	.5
1658	.49	80.3 .43	158.8 .92	3.7 .66	166.8 .28	12.9 .29	47.2 1.00	-0.4 .99	.5
1672	.53	84.9 .42	162.1 .90	-3.4 .67	168.9 .22	3.4 .18	58.5 1.00	-0.4 .99	.5
1688	.59	89.9 .41	166.0 .87	-3.0 .68	170.9 .22	-12.4 .12	88.2 1.00	-0.4 .99	.5
1697	.62	92.3 .40	167.9 .85	-2.9 .67	171.7 .26	-18.2 .14	105.6 1.00	-0.3 .98	.6
1702	.63	93.7 .39	169.1 .84	-2.8 .67	172.1 .29	-20.8 .17	113.4 1.00	-0.3 .98	.6
1716	.68	97.3 .38	172.1 .81	-2.7 .67	173.0 .37	-24.4 .26	125.7 1.00	-0.3 .98	.6
1738	.75	102.6 .34	176.7 .76	-2.7 .66	173.7 .51	-25.2 .42	136.5 1.00	-0.1 .97	.6
1769	.82	109.4 .28	182.9 .69	3.3 .68	174.1 .68	-22.5 .61	146.9 .99	.2 .96	.7
1795	.86	114.6 .21	187.2 .64	-4.3 .71	174.8 .79	-19.0 .73	154.1 .97	.4 .95	.7
1821	.88	119.5 .14	189.9 .60	-5.8 .75	176.1 .85	-15.4 .81	160.4 .95	.7 .95	.8
1862	.86	126.6 .04	160.9 .56	-8.6 .80	179.3 .86	-9.8 .86	169.0 .89	.8 .94	.9
1903	.78	133.3 .15	129.6 .54	-11.3 .79	183.2 .78	-5.1 .85	175.9 .83	.1 .93	1.0
1933	.70	137.7 .26	131.9 .53	-12.7 .74	185.6 .70	-2.7 .82	179.5 .78	-1.1 .93	1.1
1968	.59	142.5 .38	136.3 .52	-13.8 .66	187.1 .59	-1.7 .77	182.3 .74	-3.3 .92	1.3
2025	.40	149.0 .55	143.8 .49	-14.6 .52	184.1 .47	-4.6 .73	184.2 .73	-7.2 .89	1.4
2052	.31	151.5 .61	147.2 .47	-14.8 .48	179.6 .45	-7.1 .72	184.7 .75	-8.6 .86	1.4
2106	.16	153.9 .67	153.3 .41	-15.7 .54	170.6 .46	-9.9 .68	185.2 .78	-9.4 .76	1.1
2163	.05	144.8 .66	158.1 .33	-18.8 .69	167.4 .50	-8.4 .59	181.8 .77	-7.9 .61	.79
2189	.03	124.1 .64	159.5 .29	-21.5 .75	167.4 .51	-6.6 .55	176.8 .74	-6.7 .52	.75

GLASGOW SOLUTION A

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39	H39	H31
1320	.99 -22.1	1.00 -8.5	1.00 131.9	1.00 .6	1.00 -1.9	1.00 .5	1.00 .3	1.00 0.0	1.00 -.0	1.00 0.0	1.00 0.0
1340	.97 -23.4	.99 -9.5	1.00 138.5	.99 .5	1.00 -1.9	1.00 .5	1.00 .4	1.00 0.0	1.00 .1	1.00 0.0	1.00 0.0
1360	.95 -24.5	.99 -10.5	1.00 143.7	.99 .3	1.00 -1.9	1.00 .4	1.00 .5	1.00 0.0	1.00 .2	1.00 0.0	1.00 0.0
1380	.94 -25.7	.99 -11.5	.99 148.0	.99 .2	1.00 -1.9	1.00 .3	1.00 .6	1.00 0.0	1.00 .2	1.00 0.0	1.00 0.0
1400	.92 -26.7	.99 -12.5	.99 151.5	.98 .1	.99 -1.9	1.00 .3	1.00 .7	1.00 0.0	1.00 .3	1.00 0.0	1.00 0.0
1420	.90 -27.7	.98 -13.4	.99 154.6	.98 -.0	.99 -1.9	1.00 .2	.99 .9	1.00 0.0	1.00 .4	1.00 0.0	1.00 0.0
1440	.88 -28.6	.98 -14.3	.99 157.4	.97 -.1	.99 -1.9	1.00 .2	.99 1.1	1.00 0.0	1.00 .5	1.00 0.0	1.00 0.0
1460	.86 -29.3	.98 -15.2	.99 159.9	.96 -.1	1.00 -1.9	1.00 .1	.99 1.3	1.00 0.0	1.00 .5	1.00 0.0	1.00 0.0
1480	.84 -29.9	.99 -16.0	1.00 162.1	.95 -.2	1.00 -1.9	1.00 .1	.99 1.6	1.00 0.0	1.00 .6	1.00 0.0	1.00 0.0
1500	.81 -30.2	.98 -16.8	.99 164.1	.94 -.1	1.00 -1.9	1.00 .1	.99 1.9	1.00 0.0	1.00 .6	1.00 0.0	1.00 0.0
1520	.77 -30.3	.97 -17.5	.99 165.8	.92 -.1	1.00 -1.9	.99 .1	.99 2.3	1.00 0.0	1.00 .7	1.00 0.0	1.00 0.0
1540	.71 -30.2	.96 -18.1	.98 167.4	.90 -.0	.99 -1.9	.99 .1	.98 2.7	1.00 0.0	1.00 .7	1.00 0.0	1.00 0.0
1560	.63 -30.0	.95 -18.6	.96 168.9	.87 .0	.99 -1.9	.99 .2	.98 3.1	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1580	.52 -30.6	.94 -19.1	.95 170.3	.84 -.1	.98 -2.0	.99 .3	.98 3.6	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1600	.39 -35.0	.93 -19.4	.93 171.6	.80 -.5	.97 -2.0	.99 .4	.97 4.2	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1620	.33 -47.4	.91 -19.7	.92 172.8	.75 -1.4	.96 -2.0	.98 .5	.97 4.8	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1640	.41 -58.7	.90 -19.9	.90 173.9	.72 -3.2	.96 -2.1	.98 .7	.96 5.5	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1660	.53 -62.2	.88 -19.9	.88 175.0	.70 -5.5	.95 -2.1	.97 .9	.96 6.3	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1680	.64 -62.5	.85 -19.8	.86 175.9	.71 -7.7	.93 -2.2	.96 1.3	.95 7.2	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1700	.72 -62.0	.83 -19.6	.83 176.8	.73 -9.4	.92 -2.2	.95 1.6	.94 8.3	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1720	.77 -61.4	.80 -19.2	.81 177.7	.76 -10.4	.91 -2.3	.94 2.1	.92 9.5	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1740	.82 -60.9	.77 -18.7	.78 178.4	.78 -10.9	.90 -2.3	.91 2.7	.91 10.8	1.00 0.0	1.00 .8	1.00 0.0	1.00 0.0
1760	.85 -60.5	.73 -18.0	.76 179.1	.80 -11.2	.88 -2.4	.88 3.4	.88 12.4	1.00 0.0	1.00 .7	1.00 0.0	1.00 0.0
1780	.88 -60.1	.69 -17.3	.73 179.7	.81 -11.3	.87 -2.5	.83 4.0	.86 14.3	1.00 0.0	1.00 .6	1.00 0.0	1.00 0.0
1800	.92 -59.8	.65 -16.4	.71 180.3	.82 -11.4	.85 -2.6	.75 4.1	.82 16.5	1.00 0.0	1.00 .6	1.00 0.0	1.00 0.0
1820	.95 -59.5	.60 -15.6	.68 180.7	.83 -11.5	.84 -2.7	.66 2.5	.77 19.2	1.00 0.0	1.00 .5	1.00 0.0	1.00 0.0
1840	.94 -59.4	.54 -14.9	.66 181.1	.83 -11.6	.82 -2.8	.60 -1.9	.70 22.5	1.00 0.0	1.00 .4	1.00 0.0	1.00 0.0
1860	.92 -59.3	.48 -14.7	.63 181.5	.83 -11.6	.80 -2.9	.62 -7.2	.61 26.4	1.00 0.0	1.00 .3	1.00 0.0	1.00 0.0
1880	.90 -59.2	.43 -15.2	.61 181.7	.83 -11.7	.79 -3.0	.70 -10.1	.49 31.3	1.00 0.0	1.00 .2	1.00 0.0	1.00 0.0
1900	.87 -58.9	.38 -16.7	.58 181.9	.83 -11.8	.77 -3.1	.78 -10.7	.34 37.5	1.00 0.0	1.00 .0	1.00 0.0	1.00 0.0
1920	.85 -58.6	.35 -19.2	.56 182.0	.83 -11.9	.75 -3.2	.83 -10.5	.15 46.7	1.00 0.0	1.00 -.1	1.00 0.0	1.00 0.0
1940	.82 -58.1	.33 -22.1	.54 182.0	.82 -12.0	.73 -3.3	.87 -10.0	.06 123.5	1.00 0.0	1.00 -.3	1.00 0.0	1.00 0.0
1960	.79 -57.6	.34 -24.3	.52 182.0	.82 -12.1	.71 -3.5	.90 -9.5	.26 140.3	1.00 0.0	1.00 -.5	1.00 0.0	1.00 0.0

GLASGOW SOLUTION A

ENERGY	S11		P11		P13		O13		C15		F15		F17		G17		G19		H19		H11	
1320	.95	11.1	.88	18.1	1.01	-5.5	.98	3.4	1.00	.9	1.00	.5	1.00	-.0	1.00	.1	1.00	-.0	1.00	-0.0	1.00	-.0
1340	.93	12.7	.80	22.8	1.01	-5.7	.96	4.4	.99	1.4	.99	.8	1.00	.1	1.00	.2	1.00	.0	1.00	-.0	1.00	.0
1360	.91	14.5	.72	28.2	1.01	-5.9	.93	5.6	.99	1.9	.93	1.2	1.00	.1	1.00	.2	1.00	.1	1.00	-.0	1.00	.1
1380	.89	16.5	.64	34.4	1.02	-6.1	.90	7.1	.99	2.5	.98	1.7	1.00	.2	1.00	.4	1.00	.2	1.00	-.0	1.00	.1
1400	.87	18.8	.57	41.3	1.02	-6.4	.86	9.0	.99	3.2	.97	2.2	1.00	.3	1.00	.5	1.00	.2	1.00	-.0	1.00	.2
1420	.86	21.5	.50	49.1	1.02	-6.5	.81	11.6	.98	4.0	.97	2.7	1.00	.4	1.00	.6	1.00	.3	1.00	-.0	1.00	.2
1440	.85	24.9	.44	57.8	1.02	-6.7	.74	15.2	.98	4.8	.97	3.4	1.00	.4	1.00	.7	1.00	.3	1.00	-.0	1.00	.3
1460	.86	29.8	.39	67.4	1.02	-6.9	.63	20.4	.97	5.7	.97	4.1	1.00	.5	1.00	.9	1.00	.4	1.00	-.0	1.00	.3
1480	.87	38.7	.35	77.6	1.01	-7.0	.46	28.2	.96	6.8	.97	4.9	1.00	.6	.99	1.0	1.00	.5	1.00	-.1	1.00	.4
1500	.64	59.2	.32	88.0	1.01	-7.1	.19	42.1	.95	8.1	.97	5.9	1.00	.7	.99	1.2	1.00	.5	1.00	-.1	1.00	.4
1520	.13	43.5	.30	98.2	1.01	-7.1	.15	127.0	.93	9.6	.95	7.2	1.00	.8	.99	1.4	1.00	.6	1.00	-.1	1.00	.4
1540	.28	27.5	.28	107.7	1.00	-7.1	.42	143.0	.91	11.4	.92	8.8	1.00	.8	.99	1.6	1.00	.7	1.00	-.1	1.00	.5
1560	.34	31.9	.27	116.4	1.00	-7.1	.58	151.5	.88	13.8	.89	10.8	1.00	.9	.99	1.9	1.00	.7	1.00	-.1	1.00	.5
1580	.35	37.4	.26	124.0	.99	-7.0	.67	157.1	.83	16.7	.84	13.4	1.00	1.0	.98	2.1	1.00	.8	1.00	-.2	1.00	.5
1600	.34	43.5	.24	130.6	.98	-6.8	.72	161.1	.76	20.8	.78	17.2	1.00	1.1	.98	2.4	1.00	.9	1.00	-.2	1.00	.6
1620	.33	50.4	.22	136.2	.97	-6.6	.74	163.9	.63	26.4	.69	22.6	1.00	1.2	.97	2.6	1.00	1.0	1.00	-.2	1.00	.6
1640	.33	58.1	.20	140.5	.95	-6.3	.75	166.1	.44	34.4	.57	31.4	1.00	1.3	.97	3.0	1.00	1.1	1.00	-.3	1.00	.6
1660	.33	66.6	.18	143.1	.94	-5.9	.75	167.8	.15	48.8	.39	47.7	1.00	1.3	.96	3.3	1.00	1.2	1.00	-.3	1.00	.7
1680	.35	75.2	.16	143.7	.91	-5.5	.75	169.3	.19	136.2	.27	83.8	.99	1.4	.95	3.6	1.00	1.3	1.00	-.3	1.00	.7
1700	.38	83.5	.14	142.1	.88	-4.9	.75	170.5	.46	148.8	.40	119.6	.99	1.5	.94	4.0	1.00	1.3	1.00	-.4	1.00	.7
1720	.42	91.1	.14	139.3	.85	-4.3	.74	171.5	.64	156.5	.56	136.8	.99	1.6	.93	4.4	1.00	1.4	1.00	-.4	1.00	.7
1740	.47	97.9	.16	137.5	.81	-3.6	.74	172.5	.74	162.0	.64	146.6	.99	1.7	.92	4.8	1.00	1.5	1.00	-.5	1.00	.7
1760	.52	103.8	.19	137.7	.76	-2.8	.73	173.3	.80	165.9	.68	152.7	.99	1.8	.90	5.1	1.00	1.7	1.00	-.6	1.00	.7
1780	.57	109.0	.22	139.7	.71	-2.0	.73	174.1	.83	168.9	.68	156.8	.99	1.8	.88	5.5	1.00	1.8	1.00	-.6	1.00	.8
1800	.61	113.6	.25	143.2	.65	-1.3	.72	174.9	.85	171.2	.67	159.7	.99	1.9	.86	5.7	1.00	1.9	1.00	-.7	1.00	.8
1820	.65	117.7	.27	147.6	.58	-.6	.71	175.5	.86	172.0	.65	161.8	.98	2.0	.83	5.8	1.00	2.0	1.00	-.8	1.00	.8
1840	.69	121.2	.29	152.6	.51	-.2	.71	176.2	.86	174.6	.63	163.4	.98	2.1	.80	5.7	1.00	2.1	1.00	-.8	1.00	.8
1860	.71	124.2	.30	158.1	.43	-.2	.70	176.8	.86	176.0	.61	164.7	.98	2.2	.77	5.3	1.00	2.2	1.00	-.9	1.00	.8
1880	.73	126.7	.31	164.1	.36	-.8	.69	177.5	.85	177.1	.59	165.7	.98	2.2	.74	4.6	1.00	2.3	1.00	-1.0	1.00	.7
1900	.74	128.9	.30	170.7	.28	-2.5	.69	178.1	.85	178.2	.57	166.5	.98	2.3	.72	3.6	1.00	2.5	1.00	-1.1	1.00	.7
1920	.75	130.6	.29	178.1	.22	-6.1	.63	178.7	.84	179.2	.55	167.2	.97	2.4	.71	2.3	1.00	2.6	1.00	-1.2	1.00	.7
1940	.75	132.0	.27	187.0	.16	-12.9	.63	179.2	.83	180.0	.53	167.8	.97	2.5	.71	1.0	1.00	2.7	1.00	-1.3	1.00	.7
1960	.75	133.1	.25	198.4	.13	-24.1	.67	179.8	.82	180.9	.51	168.3	.97	2.5	.72	-.1	1.00	2.9	1.00	-1.4	1.00	.6

GLASGOW SOLUTION B

ENERGY	S31	P31	P33	D33	D35	F35	F37	G37	G39	H39	H31
1320	.99 -18.1	.99 -8.3	1.00 133.2	1.00 -.1	1.00 -1.5	1.00 .1	1.00 .2	1.00 .0	1.00 -.0	1.00 .0	1.00 -.0
1340	.98 -19.6	.99 -9.3	1.00 139.6	1.00 -.2	1.00 -1.5	1.00 .1	1.00 .3	1.00 -.0	1.00 .0	1.00 -.0	1.00 .0
1360	.97 -21.0	.99 -10.3	1.00 144.6	.99 -.3	1.00 -1.4	1.00 .0	1.00 .5	1.00 -.0	1.00 .1	1.00 -.0	1.00 .0
1380	.97 -22.4	.98 -11.3	.99 148.6	.99 -.4	1.00 -1.4	.99 -.0	1.00 .6	1.00 -.0	1.00 .1	1.00 -.0	1.00 .0
1400	.96 -23.8	.98 -12.3	.99 152.0	.99 -.4	1.00 -1.4	.99 -.0	1.00 .8	1.00 -.0	1.00 .2	1.00 -.0	1.00 .0
1420	.95 -25.1	.98 -13.3	.98 154.9	.99 -.5	1.00 -1.4	.99 -.1	.99 1.0	1.00 -.0	1.00 .2	1.00 -.0	1.00 .0
1440	.93 -26.3	.97 -14.3	.98 157.4	.98 -.5	.99 -1.4	.99 -.1	.99 1.2	1.00 -.0	1.00 .2	1.00 -.0	1.00 .0
1460	.92 -27.3	.97 -15.3	.97 159.7	.98 -.5	.99 -1.3	.99 -.1	.99 1.5	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1480	.90 -28.3	.97 -16.3	.97 161.8	.97 -.4	.99 -1.3	.99 -.2	.99 1.8	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1500	.88 -29.1	.97 -17.3	.97 163.7	.96 -.3	.98 -1.4	.99 -.2	.99 2.2	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1520	.84 -29.7	.96 -18.2	.96 165.5	.95 -.2	.98 -1.4	.99 -.2	.99 2.6	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1540	.79 -30.1	.96 -19.1	.95 167.2	.93 -.1	.97 -1.4	.99 -.2	.98 3.0	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1560	.72 -30.4	.96 -20.0	.95 168.9	.90 .0	.96 -1.4	.99 -.2	.98 3.5	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1580	.63 -31.2	.96 -20.9	.94 170.4	.87 .1	.96 -1.5	.98 -.2	.98 4.0	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1600	.51 -34.3	.94 -21.6	.94 171.9	.83 -.2	.95 -1.5	.98 -.1	.97 4.6	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1620	.42 -42.5	.93 -22.3	.93 173.4	.78 -1.1	.94 -1.6	.97 -.0	.97 5.3	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1640	.45 -52.9	.91 -22.9	.93 174.8	.74 -2.9	.93 -1.7	.96 .1	.96 6.0	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1660	.54 -58.3	.89 -23.4	.92 176.3	.72 -5.5	.92 -1.8	.95 .2	.96 6.8	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1680	.64 -59.9	.86 -23.9	.91 177.6	.73 -7.9	.91 -1.9	.94 .4	.95 7.7	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1700	.70 -60.2	.82 -24.2	.91 179.0	.76 -9.5	.90 -2.0	.92 .7	.94 8.8	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1720	.75 -60.1	.78 -24.5	.90 180.3	.79 -10.4	.89 -2.1	.90 1.1	.92 9.9	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1740	.78 -60.0	.73 -24.7	.89 181.7	.82 -10.9	.88 -2.2	.87 1.5	.91 11.2	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1760	.79 -60.0	.67 -25.0	.89 183.0	.84 -11.1	.86 -2.4	.83 2.0	.89 12.7	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1780	.80 -60.0	.60 -25.7	.88 184.3	.85 -11.2	.85 -2.6	.78 2.5	.86 14.3	1.00 -.0	1.00 .5	1.00 -.0	1.00 .0
1800	.81 -60.0	.52 -27.3	.87 185.6	.86 -11.3	.83 -2.7	.71 2.7	.82 16.2	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1820	.81 -60.0	.44 -30.7	.87 186.8	.87 -11.4	.82 -2.9	.63 1.9	.78 18.3	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1840	.81 -59.9	.38 -36.5	.86 188.1	.87 -11.5	.81 -3.2	.55 -1.1	.71 20.6	1.00 -.0	1.00 .4	1.00 -.0	1.00 .0
1860	.81 -59.8	.37 -43.8	.85 189.4	.87 -11.6	.79 -3.4	.51 -6.7	.63 23.0	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1880	.81 -59.6	.40 -49.8	.84 190.6	.87 -11.8	.77 -3.6	.54 -11.6	.52 25.1	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1900	.80 -59.3	.45 -53.4	.84 191.9	.87 -11.9	.76 -3.9	.60 -14.1	.40 25.9	1.00 -.0	1.00 .3	1.00 -.0	1.00 .0
1920	.80 -58.9	.50 -55.2	.83 193.1	.86 -12.1	.74 -4.2	.65 -14.9	.27 21.6	1.00 -.1	1.00 .2	1.00 -.1	1.00 .1
1940	.79 -58.3	.54 -56.0	.82 194.4	.86 -12.3	.73 -4.5	.69 -15.0	.20 5.3	1.00 -.1	1.00 .1	1.00 -.1	1.00 .1
1960	.79 -57.7	.56 -56.3	.81 195.6	.85 -12.5	.71 -4.8	.71 -14.9	.28 -9.0	1.00 -.1	1.00 .1	1.00 -.1	1.00 .1

GLASGOW SOLUTION 8

ENERGY	S11	P11	P13	D13	D15	F15	F17	G17	G19	H19	H11									
1320	1.02	3.8	.92	15.6	.99	-5.7	.97	2.7	1.00	.8	1.00	.6	1.00	-.0	1.00	-.0	1.00	-.0	1.00	-.0
1340	1.01	4.5	.74	22.5	.99	-5.7	.95	4.2	.99	1.4	.99	.9	1.00	.1	1.00	.2	1.00	.1	1.00	.1
1360	1.01	5.3	.60	31.3	.99	-5.7	.92	5.9	.99	2.0	.99	1.3	1.00	.3	1.00	.4	1.00	.3	1.00	.2
1380	1.01	6.1	.50	42.5	.99	-5.7	.89	8.1	.99	2.7	.99	1.8	.99	.4	1.00	.6	1.00	.4	1.00	.3
1400	1.04	7.1	.43	56.3	.98	-5.6	.84	10.8	.98	3.4	.99	2.4	.99	.6	1.00	.8	1.00	.5	1.00	.4
1420	1.03	8.8	.39	71.9	.98	-5.6	.78	14.2	.98	4.2	.98	3.0	.99	.7	1.00	1.0	1.00	.7	1.00	.5
1440	1.00	11.4	.40	87.5	.98	-5.5	.70	18.8	.98	5.0	.98	3.7	.99	.9	1.00	1.2	1.00	.8	1.00	.6
1460	.97	16.0	.42	101.0	.98	-5.4	.58	25.3	.98	5.9	.97	4.6	.99	1.0	1.00	1.4	1.00	.9	1.00	.7
1480	.88	24.9	.44	112.3	.97	-5.3	.40	35.3	.97	7.0	.96	5.6	.99	1.1	1.00	1.6	1.00	1.0	1.00	.8
1500	.54	39.2	.45	121.4	.97	-5.2	.18	57.2	.95	8.1	.95	6.8	.99	1.3	1.00	1.8	1.00	1.1	1.00	.8
1520	.18	30.6	.46	128.9	.96	-5.0	.20	117.0	.94	9.5	.93	8.3	.99	1.4	1.00	2.0	1.00	1.1	1.00	.9
1540	.22	12.6	.45	135.1	.95	-4.9	.41	137.0	.91	11.1	.91	10.2	1.00	1.6	.99	2.3	1.00	1.2	1.00	1.0
1560	.25	16.9	.44	140.3	.95	-4.7	.57	147.1	.88	13.1	.88	12.4	1.00	1.7	.99	2.5	1.00	1.2	1.00	1.0
1580	.27	26.8	.42	144.6	.94	-4.4	.66	153.8	.83	15.6	.83	15.4	1.00	1.8	.99	2.7	1.00	1.3	1.00	1.0
1600	.30	40.0	.40	148.3	.93	-4.2	.70	158.7	.75	19.0	.77	19.3	.99	2.0	.98	2.9	1.00	1.3	1.00	1.0
1620	.38	53.9	.38	151.6	.91	-3.9	.73	162.3	.62	23.4	.68	24.9	.99	2.1	.98	3.2	1.00	1.3	1.00	1.0
1640	.51	66.8	.35	154.4	.90	-3.6	.74	165.2	.42	28.8	.54	33.2	.98	2.2	.97	3.4	1.00	1.3	1.00	1.0
1660	.66	78.9	.33	156.9	.88	-3.2	.74	167.5	.14	28.0	.34	47.8	.98	2.3	.96	3.6	1.00	1.2	1.00	1.0
1680	.76	90.1	.30	159.2	.86	-2.8	.73	169.5	.21	-28.5	.19	85.6	.97	2.4	.96	3.9	1.00	1.2	1.00	1.0
1700	.78	99.2	.27	161.3	.83	-2.4	.72	171.2	.45	-25.6	.34	125.0	.96	2.5	.95	4.1	1.00	1.1	1.00	.9
1720	.74	105.6	.25	163.5	.79	-2.1	.71	172.7	.61	-20.7	.53	140.7	.95	2.6	.94	4.3	1.00	1.0	1.00	.9
1740	.68	109.7	.22	165.7	.75	-1.8	.70	174.0	.70	-16.3	.65	149.9	.95	2.7	.93	4.6	1.00	.9	1.00	.8
1760	.62	111.9	.19	168.2	.71	-1.7	.69	175.2	.75	-14.0	.72	156.2	.94	2.8	.92	4.8	1.00	.8	1.00	.7
1780	.57	112.9	.17	171.1	.65	-2.0	.68	176.3	.77	-12.0	.75	160.8	.93	2.9	.91	5.1	1.00	.6	1.00	.6
1800	.53	112.9	.15	174.6	.60	-2.9	.66	177.3	.78	-10.6	.77	164.3	.91	3.0	.90	5.3	1.00	.4	1.00	.4
1820	.49	112.3	.13	178.8	.54	-4.7	.65	178.3	.79	-9.6	.77	167.1	.90	3.0	.89	5.5	1.00	.2	1.00	.3
1840	.45	111.2	.12	183.4	.49	-7.7	.64	179.2	.78	-8.9	.77	169.5	.89	3.1	.88	5.8	1.00	-.0	1.00	.1
1860	.43	109.6	.11	187.5	.47	-11.8	.62	180.1	.77	-8.4	.76	171.5	.88	3.1	.86	6.0	1.00	-.3	1.00	-.1
1880	.40	107.7	.11	190.4	.47	-16.2	.61	181.0	.76	-8.1	.75	173.3	.87	3.1	.85	6.2	1.00	-.6	1.00	-.3
1900	.38	105.5	.12	191.2	.50	-20.0	.60	181.8	.75	-8.0	.73	175.0	.85	3.2	.84	6.5	1.00	-.9	1.00	-.5
1920	.36	103.0	.12	189.7	.55	-22.6	.58	182.5	.74	-8.0	.72	176.5	.84	3.2	.82	6.7	1.00	-1.3	1.00	-.8
1940	.34	100.3	.12	185.4	.59	-24.2	.57	183.3	.72	-8.2	.70	178.0	.82	3.2	.81	6.9	1.00	-1.7	1.00	-1.1
1960	.33	97.4	.11	177.4	.64	-25.0	.56	184.0	.71	-3.5	.69	179.4	.81	3.2	.80	7.2	1.00	-2.1	1.00	-1.4

VIII. ACKNOWLEDGMENTS

We wish to thank Drs. Herb Steiner and Clay Johnson for freely giving us their data and display programs to get us started on this project. We also wish to thank Dr. LeRoy Price without whose advice this report would never have been put into a printable format.

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PARTIAL WAVE AMPLITUDES OBTAINED BY THE GLASGOW GROUP

Representative Set of Argand Plots

Partial wave analysis results of DAVIES 68. The curves plotted here are the results of the energy-dependent analysis. DAVIES A (solid curves) is obtained by starting from the set of phase shifts best solution of the Glasgow group. DAVIES B (dashed curves) is obtained by starting from the CERN 1 phase shifts. DAVIES B is not shown when it is very close to DAVIES A. Scale marks are shown every 50 MeV. The first large mark is at $M = 1400$ MeV, the last large mark at $M = 1900$ MeV.

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