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**U.C. DAVIS PARTICLE PHYSICS RESEARCH
TECHNICAL PROGRESS REPORT - FINAL**

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Physics Department, University of California, Davis, 95616

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ABSTRACT

During the period of this contract, the participants carried out theoretical and experimental researches in high energy particle physics.

The experiment group has been working with both bubble chamber and electronic detectors. The bubble chamber work made use of bubble chambers and particle beams at Lawrence Berkeley Laboratory, Brookhaven National Laboratory, Fermilab, and the Stanford Linear Accelerator Center. The different electronic detectors were the TPC/Two Gamma facility situated at the PEP electron-positron collider at SLAC, the AMY detector at TRISTAN, the electron-positron collider at KEK in Japan, fixed target detectors at Fermilab, and a hybrid bubble chamber/electronic detector at SLAC. Negotiations were also started with the H1 collaboration for a UCD participation at the upcoming Hera electron-proton collider.

The theoretical groups have been engaged in a wide variety of studies. Phenomenological studies of high energy interactions have constituted a major fraction of the effort, particularly those associated with the higgs field, various aspects of supersymmetry, and searches for new physics. Work on reactions associated with ee , ep , and hadron colliders has been extensive and includes many analyses providing tests of QCD. Lattice gauge theory has been a major area of work, and electroweak physics and mathematical physics have also been topics of study. Work has been published on heavy flavor decays and CP noninvariance, super symmetry, Yang-Mills theory and electroweak symmetry breaking as well as string theory.

EXPERIMENT

GENERAL

The experiment faculty members during the period of this report were Winston Ko, Richard Lander, David Pellett, and Philip Yager. Lander was the first faculty member in High Energy Physics at U.C. Davis, arriving in 1967 to start a program. He was joined by Pellett the next year, and by Yager in 1969. Winston Ko was Assistant Research Physicist in 1970 at the start of this contract and became a faculty member in 1972. A large number of post doctoral researchers and graduate students participated in the research over the nearly twenty years of this contract period. 12 Ph.D.'s were granted, many of whom went on to take faculty positions at major research universities or senior positions in research laboratories or industry. A listing is given at the end of the experiment section.

The group carried out experiments involving both bubble chambers and electronic detectors. The different electronic detectors were the TPC/Two Gamma facility situated at the PEP electron-positron collider at SLAC, the AMY detector at TRISTAN, the electron-positron collider at KEK in Japan, fixed target detectors at Fermilab, and a hybrid bubble chamber/electronic detector at SLAC. Preparation for participation in the H1 experiment to study electron-proton collisions at 820 Gev in the center of mass also began in this period.

BUBBLE CHAMBER

The bubble chamber work made use of photos taken at Lawrence Berkeley Laboratory, Brookhaven National Laboratory, Fermilab, and the Stanford Linear Accelerator Center. Although scanning equipment was set up at the start of this period of work, extensive use of the LBL bubble chamber facilities was made initially, including the computers through a remote batch link. Eventually a complete bubble chamber analysis system was installed at Davis as well as dedicated computer facilities.

FERMILAB FIXED TARGET

Neutral particle spectrometer experiments at Fermilab were fixed target experiments that detected inclusively and exclusively produced K-zeros, lambdas, and anti-lambdas. A small collaboration (UCSD, MSU, Carleton University and UCDavis) took data at Fermi Lab in 1977-78. In the first of two

incarnations of the spectrometer, inclusive charge exchange production of K short by K-minus was studied in the triple Regge region. The results are reported in [34] and in more detail in the PhD thesis of Randall Pitt, UCSD 1981. An SU(3) based comparison with inclusive pion exchange is reported in [37]. Triple Regge phenomenology was shown to furnish an accurate description of the two independent experiments using the same parameters. The second incarnation used much of the same apparatus to study polarization of inclusively produced Lamdas and anti Lamdas in P P, Pbar P and K- P collisions. These data were interpreted in terms of the phenomenological model of deGrand and Miettinen and are reported in [52] and in more detail in the PhD thesis of S. A. Gourlay, UCDavis 1986. Specific UCD contributions were in the commissioning of the Cerenkov counter, care of the PWCs, and complete responsibility for the online data acquisition system.

In 1982, a collaboration was formed to study charm and beauty production in a hybrid emulsion spectrometer at Fermi Lab, using the 800 GeV proton beam. The Trigger was to be on prompt muons with a minimum transverse momentum cut. Yager, Lander, three students, and a post-doc designed, built and operated a drift chamber system that tracked muons on either side of a large, thick (1.2m) toroidal magnet. The fast trigger was provided by a muon hodoscope coupled with range-out steel plates. Off-line, the triggering muon was tracked back into the toroid, and then back toward the target, linking up through non tracking detectors to the high resolution drift chambers of the regular spectrometer component of the system. Slopes(2), intercepts(2), momentum magnitude and sign had to match within expectations of multiple scattering to overcome the high primary multiplicities (20 to 30 or more!). There were two running periods for this experiment, E653. The first, using the highest proton energy, 800 GeV, ended in August 1985. The second run used 600 GeV pi-minus which was rightly expected to produce more b-particles was in the 1987-88 fixed target run.

PEP9 & TPC/TWO-GAMMA

PEP9, which later merged into the TPC/Two Gamma collaboration, investigated electron-positron annihilation reactions at 29 GeV. For these collaborations, a set of two-meter by three-meter drift chambers for muon identification in the forward direction was built by UCD. These were fabricated using the silkscreen technique and etching. A forward muon trigger was also designed and installed. For the data analysis, a state-of-the-art software program, OASIS, was developed with UCD leadership and worked

very well in filtering two-photon events from the very large backgrounds. A VAX computer from UCD was set up in the collision hall at PEP to handle the merging of data from the TPC and PEP9.

AMY

The AMY collaboration at TRISTAN in Japan studied electron-positron reactions similar to those of PEP, but at the higher energy of 50 to 60 GeV center of mass. For the AMY collaboration the UCD group played a crucial role in the construction of the electromagnetic shower detector and the inner tracking chamber (ITCh). "Plotted" circuit boards were constructed for the shower detector. This involved the drawing and etching of over 200 8' x 4' double-sided boards. Each layer was adjusted so that the pads lined up in exact tower geometry, requiring 80 different patterns to be drawn. This technique of drawing with acid resistant ink on a large copper-clad board is unique and is described in [63].

The inner tracking chamber of AMY is a high precision drift chamber with minimum material in the path of the particles it tracks. It consists of polycarbonate tubes arranged to form a four-layer close-packed array of drift cells, each layer consisting of 144 tubes. The signals are used to provide a "trigger" for the reactions of interest. The trigger system uses the inherent symmetry to provide fast tracking results. It makes use of a programmable memory (MLU) to identify appropriate patterns in clusters of 12 tubes. The design and fabrication of the system was done at UCD. A system of workstations at UCD and GEANT based fast Monte Carlo and other software for analysis also was set up.

H1 AT HERA

During the period of this report, preparations were made to participate in the H1 collaboration at the Hera electron-proton collider at DESY. Design work on the electronics for the analog readout of the H1 instrumented iron calorimeter was begun. No publications resulted at this time.

INSTRUMENTATION

A number of innovations in instrumentation were developed in this period. Among these was an inexpensive and very fast scintillator-based hodoscope with millimeter resolution that was used at Fermilab for beam tuning. [13] Also, a very flexible method of etching rather than machining large printed circuit boards was developed for the fabrication of the AMY shower counter. [63] Other developments are given in [27, 29, 54, 59]

In addition, development of a silicon pixel detector intended for SSC collider experiments was initiated at LBL near the end of this contract period. UCD participated in this work, although no publications were prepared during this period.

SUMMARY OF RESULTS

The work yielded 65 publications of physics results in refereed journals, of which 40 were in prestigious letters journals. A long series of 20 papers dealt with inclusive reactions, a concept invented by R.P. Feynman near the beginning of this contract period, and on which the experiment group focussed strongly during its early years. The data came primarily from various bubble chamber exposures to beams of different particles and energies at LBL, BNL, and Fermilab, although some streamer chamber experiments were also run at Fermilab. These inclusive papers addressed the question of universality of particle production by different incident particles [18, 24, 28, 66, 30], scaling and factorization [2, 3, 10, 16], correlations [8, 9, 17, 61], fragmentation [33, 83, 56], and multiplicities of secondary particles [14, 20, 23, 69]. All of these contributed to the understanding of the gross features of high energy interactions. A related set of papers investigated off-mass-shell scattering [19, 31, 32] and the Regge pole exchange mechanism [15, 34, 37]. Exploration of the phase space for new physics was described in nine papers [7, 21, 22, 74, 75, 77, 26, 62, 81]. Papers 41, 64, 71 were concerned with the structure function of the photon and were among the earliest attempts to measure this quantity.

Many seminars and talks at conferences were also given, a few of which are included in the publications list.

EXPERIMENT GROUP PERSONNEL

Faculty

W. Ko
R. Lander
D. Pellett
P. Yager

Post Doctoral Researchers (varying periods during the contract)

W. Ko (before attaining faculty status)
J. Klems
K. Maeshima
W. Michael
J. Smith
K. Sparks
W. Wagner
M. C. S. Williams

Ph.D. students obtaining degrees during this period

M. Cain - 84
J. Erwin - 77
S. Gourlay - 85
R. Kass - 78
K. Maeshima - 81
R. Malchow - 89
R. McNeil - 86
A. Mokhtarani - 88
V. Paolone - 90
J. Pearson - 81
G. Shoemaker - 83
C. Zeitlin - 88

LIST OF EXPERIMENT PUBLICATIONS

(A few of those listed appeared shortly after the period of this contact, but the work had been done and the papers submitted earlier. Note: the work for the first publication was completed before the start of this contract.)

1970

1. Search for $T=1$ Bosons Near 1 GeV in the Reaction $pp \rightarrow d + MM$. M.A. Abolins, R. Graven, R. McCarthy, G.A. Smith, A.B. Wicklund, R.L. Lander, and D.E. Pellett. Phys. Rev. Lett. 25:469.

1971

2. Scaling and Factorization in $K^+ + p \rightarrow \pi^- + \text{Anything}$. Winston Ko and Richard Lander. Phys. Rev. Lett. 26:1064.
3. Symmetric π^- Production from $K^+ + p \rightarrow \pi^- + \text{Anything}$ at 12 GeV/c. Winston Ko and Richard L. Lander. Phys. Rev. Lett. 26:1284.
4. Evidence for Splitting in the Q Region of $K^+\pi^+\pi^-$ Mass. A.F. Garfinkel, R.F. Holland, D.D. Carmony, H.W. Clopp, D. Cords, F.J. Loeffler, L.K. Rangan, R.L. Lander, D.E. Pellett, and P.M. Yager. Phys. Rev. Lett. 26:1505.
5. $K^*(890)$ Production in the Charge-Exchange Reaction $K^+n \rightarrow K^+\pi^-p$ at 9 GeV/c. D.D. Carmony, D. Cords, H.W. Clopp, A.F. Garfinkel, R.F. Holland, F.J. Loeffler, H.B. Mathis, L.K. Rangan, J. Erwin, R.L. Lander, D.E. Pellett, P.M. Yager, F.T. Meiere, and W.L. Yen. Phys. Rev. D4:1974.
6. Observation of a New $K_N(1970)$ in the $K\pi$ and $K\pi\pi$ Systems. D.D. Carmony, D. Cords, H.W. Clopp, A.F. Garfinkel, R.F. Holland, F.J. Loeffler, H.B. Mathis, L.K. Rangan, J. Erwin, R.L. Lander, D.E. Pellett, P.M. Yager, F.T. Meiere, and W.L. Yen. Phys. Rev. Lett. 27:1160.
7. Exotic Exchange for Inclusive Reactions for Quasi-Two-Body Processes. Winston Ko, Richard L. Lander, and Clifford Risk. Phys. Rev. Lett. 27:1476.
8. Isotropic Black-Body Boson Production and the Temperature of Hadronic Matter. J. Erwin, W. Ko, R.L. Lander, D.E. Pellett, and P.M. Yager. Phys. Rev. Lett. 27:1534.

1972

9. Rapidity Correlations Between the Negative Pions Produced in the K^+p Interactions. Winston Ko. Phys. Rev. Lett. 28:935.

10. Comparison of the Inclusive π^- Distributions from γp , K^+p , and pp Collisions. William P. Swanson, Winston Ko, Richard L. Lander, Clifford Risk, Ronald R. Ross, and Dennis B. Smith. Phys. Rev. D6:170.

1973

12. S-Wave Structure in the $K\pi$ System. D. Cords, D.D. Carmony, A.F. Garfinkel, F.J. Loeffler, L.K. Rangan, R.L. Lander, D.E. Pellett, P.M. Yager, F.T. Meiere, and W.L. Yen. Nuclear Phys. B54:109.

1974

13. A Gray Code Hodoscope and Fast Buffer for Beam Particle Tagging. D.E. Pellett, J. Erwin, D. Faulkner, W. Ko, R.L. Lander, and P.M. Yager. Nuclear Inst. and Methods 115:135.
14. Multiplicities in 100 GeV/c π^+p and pp Interactions Using a Tagged Beam. J. Erwin, J.H. Klems, W. Ko, R.L. Lander, D.E. Pellett, and P.M. Yager. Phys. Rev. Lett. 32:254.
15. Double-Regge-Pole Analysis of $K^+n \rightarrow K^+\pi^-p$ at 9 GeV/c. W.L. Yen, F.I. Meiere, D.D. Carmony, D. Cords, A.F. Garfinkel, F.J. Loeffler, R.L. McIlwain, L.K. Rangan, R.L. Lander, D.E. Pellett, and P.M. Yager. Phys. Rev. D9:1120.
16. Single-Pion Production at 100 GeV/c: A Detailed Test of Factorization. J. Erwin, Winston Ko, R.L. Lander, D.E. Pellett, P.M. Yager, and M. Alston-Garnjost. Phys. Rev. Lett. 33:1352.
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19. Inclusive Δ^{++} Production in π^+p and pp Interactions at 100 GeV/c and the Average Multiplicity of $\pi^+\pi^-$ Scattering. J. Erwin, R.D. Kass, J.H. Klems, Winston Ko, R.L. Lander, D.E. Pellett, P.M. Yager, and M. Alston-Garnjost. Phys. Rev. Lett. 35:980.

1976

20. Multiplicity Distribution and Double Scattering Effects in π^-d Interactions at 205 GeV. K. Dziunikowska, J. Figiel, D. Kisielewska, P. Malecki, H. Rudnicka, A. Zalewska, S. Csorna, L. Dunn, A. Kocsis, H.J. Lubatti, K. Moriyasu, K. Doroba, S. Otwinowski, R. Sosnowski, M. Szeptycka, A. Wroblewski, A. Zieminski, K. Hayes, J.H. Klems, W. Ko, R.L. Lander, D.E. Pellett, and P.M. Yager. Phys. Lett. 61B:316.
21. A Search for Charmed Particle Production in π^-d Interactions at 200 GeV/c. J.H. Klems, R.L. Lander, D.E. Pellett, P.M. Yager, K. Dziunikowska, D. Kisielewska, H. Rudnicka, P. Stopa, S. Csorna, A. Kocsis, H.J. Lubatti, K. Moriyasu, M. Bardadin-Otwinowska, H. Bialkowska, T. Hofmohl, J. Krolikowski, A. Para, and M. Szczekowski. Acta Physica Polonica B7:497.
22. Search for Correlated Neutral Strange Particles and Muon Production in π^-p Interactions at 225 GeV. V. Cook, S. Csorna, D. Holmgren, A.M. Jonckheere, H.J. Lubatti, P. Malecki, K. Moriyasu, B. Robinson, D. Fournier, P. Heusse, J.J. Veillet, J.H. Klems, W. Ko, R.L. Lander, D.E. Pellett. Phys. Lett. 64B:221.

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23. Extraction of Average Multiplicities of High Energy off-mass-shell $\pi\pi$ and $K\pi$ Scattering. J. Erwin, R.D. Kass, J.H. Klems, Winston Ko, R.L. Lander, D.E. Pellett, P.M. Yager, M. Alston-Garnjost. Phys. Rev. D16:553.
24. Inclusive Neutral Particle Production in π^-d Interactions at 205 GeV. S. Csorna, L. Dunn, H.J. Lubatti, H. Rudnicka, K. Moriyasu, A. Zieminski, H. Abramowicz, H. Bialkowska, J. Krolikowski, S. Otwinowski, A. Para, G. Sinapius, J.H. Klems, W. Ko, R.L. Lander, D.E. Pellett, P.M. Yager, A. Eskreys, J. Figiel, D. Kisielewska, P. Malecki, P. Stopa, A. Zalewska. Nuclear Physics B124:19.
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26. Study of Final States in $\pi^-N \rightarrow p^+p^- + \text{Hadrons}$ at 225 GeV. A.M. Jonckheere, V. Cook, S. Csorna, D. Holmgren, H.J. Lubatti, P. Malecki, K. Moriyasu, B. Robinson, D. Fournier, P. Heusse, J.J. Veillet, J.J. Klems, W. Ko, R.L. Lander, D.E. Pellett. Phys. Rev. D16:2073.

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1980

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32. Study of $\pi^-\pi^-$ Scattering in π^-n Interactions at High Energies. H. Abramowicz, M. Gorski, G. Sinapius, A. Wroblewski, A. Ziemiński, H.J. Lubatti, K. Moriyasu, C.D. Rees. K. Kisielewska, J. Figiel, L. Syszycki, K. Sliwa, W. Ko, J.S. Pearson, P. Yager. Nuclear Physics B166:62.

1981

33. Inclusive Particle Production in π^-n Interactions at High Energies. H. Abramowicz, K. Doroba, R. Kossakowski, S. Tkaczyk, A.K. Wroblewski, A. Ziemiński, D. Kisielewska, B. Muryn, B. Pawlik, W. Zielinski, H.J. Lubatti, K. Moriyasu, C.D. Rees, W. Ko, J.S. Pearson, P. Yager. Z. Physik, Particles and Fields 7:199.

34. Inclusive Kaon Charge Exchange in the Triple-Regge Region at High Energies. P.M. Yager, H.G.E. Kobrak, R.E. Pitt, R.A. Swanson, K.W. Edwards, M. Harrison, M.A. Abolins, W.R. Francis, and D.P. Owen. Phys. Rev. Lett. 46:1358.
35. ARIEL, A Microprocessor-Based Operating System for the Franckensteins. W. Michael, G.L. Harris, and D.G. Knierim, UCD PPL810219.

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43. Computing Requirements at the SSC. J. Ballam, E. Fernandez, A. Firestone, V. Hagopian, D. Imrie, S. Loken, D. Meyer, R. Mount, J. Niederer, D. Pellett, R. Shafer, G. Tzanakos, and G. VanDalen. Proceedings of the 1984 Summer Study on the Design and Utilization of the Superconducting Super Collider. 1984, Snowmass, CO.
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68. Study of η' Formation in Photon-Photon Collisions. TPC/Two-Gamma Collaboration. Winston Ko, R.L. Lander, K. Maeshima, R.R. McNeil, D.E. Pellett, J.R. Smith, W. Wagner, M.C.S. Williams, C. Zeitlin, and others. Phys. Rev. D35:2650.
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79. Formation of Spin-One Mesons by Photon-Photon Fusion. TPC/Two-Gamma Collaboration. D.E. Pellett, J.R. Smith, W. Wagner, C. Zeitlin, and others. Phys. Rev. D38:1.
80. e^+e^- Physics at TRISTAN - The First Year and a Half of AMY. Winston Ko and the AMY Collaboration. Proceedings of the Third Asia Pacific Physics Conference, June 1988, Hong Kong, page 556.
81. Experimental Mass Limit for a Fourth Generation Sequential Lepton from e^+e^- Annihilations at $\sqrt{s} = 56\text{GeV}$. AMY Collaboration. Winston Ko, R.L. Lander, K. Maeshima, R.L. Malchow, J.R. Smith, K. Sparks, M.C.S. Williams, and others. Phys. Rev. Lett. 61:911.
82. $\psi(1285)$ Formation in Photon-Photon Fusion Reactions. TPC/Two-Gamma Collaboration. D.E. Pellett, J.R. Smith, W. Wagner, C. Zeitlin, and others. Phys. Lett. B209:107.
83. Charged Hadron Inclusive Cross Sections and Fractions in e^+e^- Annihilation at $\sqrt{s} = 29\text{ GeV}$. TPC/Two-Gamma Collaboration. D.E. Pellett, J.R. Smith, W. Wagner, C. Zeitlin, and others. Phys. Rev. Lett. 61:1263.

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84. Measurements of Cross Sections and Charge Asymmetry for $e^+e^- \rightarrow \tau^+\tau^-$ and $e^+e^- \rightarrow \mu^+\mu^-$ for $\sqrt{s}$ from 52 to 57 GeV. AMY Collaboration. Winston Ko, R.L. Lander, K. Maeshima, R.L. Malchow, J.R. Smith, K. Sparks, M.C.S. Williams, and others. Phys. Lett. B218:112.
85. Measurements of the e^+e^- Total Hadronic Cross Section and a Determination of M_Z and $\Lambda_{\overline{MS}}$. AMY Collaboration. Winston Ko, R.L. Lander, K. Maeshima, R.L. Malchow, J.R. Smith, K. Sparks, M.C.S. Williams, and others. Phys. Lett. B218:499.
86. Experimental Evidence for the Non-Abelian Nature of QCD from a Study of Multi-Jet Events in e^+e^- Annihilations. AMY Collaboration. Winston Ko, R.L. Lander, K. Maeshima, R.L. Malchow, J.R. Smith, K. Sparks, M.C.S. Williams, and others. Phys. Rev. Lett. 62:1713.

Summary for Task B of the period up to Feb. 1989

ABSTRACT

Research pursued under Task B during this period fell into two broad areas; these continue to characterize our current research even at present.

The first area is a wide-ranging program focusing on extracting testable predictions from theoretical models. Areas in which we made major contributions during the summary period included: High Transverse Momentum Phenomena in Quantum Chromodynamics (QCD); predictions for Low Transverse Momentum Phenomena based on QCD; techniques for computing and explicit tree-level results for complicated processes; Higgs physics; Electroweak-Symmetry-Breaking physics; and Supersymmetry. In these latter three areas, we made extensive contributions to understanding how to discover and study the new physics contained in the theories at future hadron, e^+e^- and ep colliders.

Our second major research area is lattice gauge theory. This is a nonperturbative regularization of field theory which maintains exact gauge invariance. The majority of work in this area during the summary period was related to the Yang-Mills, finite-temperature, deconfining phase transition; the most important result was a direct numerical determination of the universality class of the SU(2), finite-temperature phase transition.

The report is divided into four sections:

1. a list of personnel associated with Task B up to Feb. 1989;
2. a detailed list of the publications of each faculty member, post-doctoral associate and visitor associated with and/or supported by Task B during the summary period;
3. a summary of the numbers of talks given and workshops/conferences attended as far back as records were kept; and,
4. a summary of the research areas to which we contributed, enumerating the papers that were published relating to each area.

PERSONNEL

Faculty members:

1. John F. Gunion: Sept 1, 1975 - Feb. 1989.
2. Robert Cahn: 1978 - 1980 academic years.
3. Joseph E. Kiskis: Sept. 1, 1981 - Feb. 1989.

Post-doctoral associates:

1. K. Tesima: 1985 - 1986 academic year.
2. M. Golterman: 1986 - 1988 academic years.
3. J. Wudka: Sept. 1, 1988 - Feb. 1989.
4. R. Vega: Sept. 1, 1988 - Feb. 1989.

Visitors:

1. D. Boyanovsky: 1986 - 1987 academic year.
2. J. Kalinowski: 1 to 3 month visits in 1980, 1984, 1985, and 1986.
3. A. Turski: Sept. 1, 1988 - Feb. 1989.

Students associated with Task B, who received Ph. D's during the period.

1. D. Jones
2. D. Millers
3. L. Roszkowski
4. A. Tofighi-Niaki
5. K. Sparks
6. R. Narayanan
7. P. Vranas (degree June, 1989)

SUMMARY OF PUBLICATIONS

Here, we summarize publications of the faculty members and postdoctoral associates that were funded by Task B during the period up to Feb. 1989. The listing is given for each individual. As a result, it occasionally happens that a given publication appears twice, once under one name and again under a second name. This is the case for 16 of the publications listed below. Please note that the publications are listed in reverse chronological order. Included are publications that came out slightly after Feb. 1989, but that are based on work that had already been completed at that time.

J.F. Gunion: Publications

1. HIGGS BOSONS IN THE STANDARD MODEL: THE MINIMAL ONE DOUBLET AND EXTENDED ALTERNATIVES.
By J.F. Gunion (UC, Davis). 1989.
Published in Nucl.Phys.Proc.Suppl.16:628-631,1990
2. AN OVERVIEW OF DISCOVERY TECHNIQUES AND EXCLUDED MASS REGIONS FOR THE STANDARD MODEL HIGGS BOSON.
By J.F. Gunion (UC, Davis). 1988.
In *Munich 1988, Proceedings, High energy physics* 942-953.
3. COMPARISON OF HIGGS BOSON CROSS-SECTIONS FROM G G AND V V FUSION AT THE LHC, SSC, AND ELOISATRON.
By J.F. Gunion, R. Vega (UC, Davis). 1988.
In *Erice 1988, Proceedings, INFN ELOISATRON project* 42-45.
4. INTERMEDIATE MASS HIGGS BOSON(S).
By D.M. Atwood, J.E. Brau, J.F. Gunion, G.L. Kane, R. Madaras, D.H. Miller, L.E. Price, A.L. Spadafora (McGill U. & Tennessee U. & UC, Davis & Michigan U. & LBL, Berkeley & Purdue U.). 1987.
Berkeley 1987, Proceedings, Experiments, detectors, and experimental areas for the Supercollider 728-749.
5. HIGGS TRIPLETS IN THE STANDARD MODEL.
By J.F. Gunion, R. Vega, J. Wudka (UC, Davis). UCD-89-13, Dec 1989. 40pp.
Published in Phys.Rev.D42:1673-1691,1990
6. THE SEARCH FOR HIGGS BOSONS OF ANY MASS.
By S. Dawson (Brookhaven), J.F. Gunion (UC, Davis), H.E. Haber, A. Seiden (UC, Santa Cruz), G.L. Kane (Michigan U.). UCD-89-29, Dec 1989. 8pp.
Published in Comments Nucl.Part.Phys.14:259,1990
7. LIMITS ON THE TOP QUARK AND ON THE CHARGED HIGGS BOSON OF A TWO DOUBLET MODEL FROM K^0 - ANTI- K^0 MIXING, $B(D)$ - ANTI- $B(D)$ MIXING AND $B \rightarrow U$ DECAYS.
By J.F. Gunion, B. Grzadkowski (UC, Davis). UCD-89-30, Dec 1989. 12pp.
Published in Phys.Lett.B243:301-307,1990
8. THE SSC: STATUS AND PHYSICS UPDATE.
By J.F. Gunion (UC, Davis). UCD-89-27, Nov 1989. 11pp. To appear in the proceedings of the 1989 European Physical Society Meeting, Madrid, Spain, Sep 6-13, 1989.
Published in Madrid EPS HEP 1989:0672-675 (QCD161:I48:1989)

9. PROBING HIGGS BOSONS / ELECTROWEAK SYMMETRY BREAKING IN PURELY LEPTONIC CHANNELS AT HADRON COLLIDERS.
By J.F. Gunion (UC, Davis). UCD-89-24, Nov 1989. 49pp. To appear in the proceedings of Higgs Particles: Physics Issues and Experimental Searches in High Energy Collisions, 8th, Erice, Italy, Jul 15-26, 1989.
Published in Eloisatron Workshop: Higgs 1989:0333-358 (QCD161:I12:1989)
10. ARE LIGHT HIGGS BOSONS ALLOWED?
By Sally Dawson (Brookhaven), John F. Gunion (UC, Davis), Howard E. Haber (UC, Santa Cruz). UCD-89-12, Jun 1989. 27pp.
Published in Phys.Rev.D41:2844,1990
11. THE HIGGS HUNTER'S GUIDE.
By John F. Gunion (UC, Davis), Howard E. Haber (UC, Santa Cruz), Gordon L. Kane (Michigan U.), Sally Dawson (Brookhaven).
World Scientific Publishing, Singapore (1989).
12. NONMINIMAL HIGGS SECTORS: PROBES AT 'LOW-ENERGY' E^+E^- COLLIDERS AND IN TOP QUARK DECAYS.
By J.F. Gunion (UC, Davis). UCD-89-10, May 1989. 44pp. Meeting on Results and Perspectives in Particle Physics, La Thuile, Italy, Feb 26 - Mar 4, 1989.
Published in La Thuile Rencontres 1989:0495-528 (QCD161:R342:1989)
13. SCREENING OF LARGE SUPERSYMMETRY BREAKING IN LOW-ENERGY PHYSICS.
By J.F. Gunion, A. Turski (UC, Davis). UCD-89-5, Apr 1989. 15pp.
Published in Phys.Rev.D40:2325,1989
14. CORRECTIONS TO HIGGS BOSON MASS SUM RULES FROM THE SFERMION SECTOR OF A SUPERSYMMETRIC MODEL.
By J.F. Gunion, A. Turski (UC, Davis). UCD-89-6, May 1989. 15pp.
Published in Phys.Rev.D40:2333,1989
15. TESTING THE VIABILITY OF THE $E(T)$ (MISSING) SIGNATURE IN GLUINO PRODUCTION AT THE SSC.
By R.M. Barnett (LBL, Berkeley), J. Freeman, R. Raja (Fermilab), J.F. Gunion (UC, Davis), H.E. Haber (UC, Santa Cruz), R. Hollebeek (Penn U.), F.E. Paige (Brookhaven), A.P. White (Florida U.). LBL-26288-mc (microfiche), Jun 1988. 11pp. To appear in Proc. of 1988 Snowmass Summer Study on High Energy Physics in the 1990s, Snowmass, CO, Jun 27 - Jul 15, 1988.
Published in Snowmass: DPF Summer Study 1988:0226 (QCD161:D15:1988)
16. INFN ELOISATRON PROJECT, WORKING GROUP REPORT, ERICE, ITALY, JANUARY 20, 1989.
By A. Ali, W. Bartel (DESY), J. Bartsels (Hamburg U.), P. Binetruy (Annecy, LAPP), R.K. Bock (CERN), M.S. Chanowitz (UC, Berkeley), L. Cifarelli (Naples U. & INFN, Naples), J.F. Gunion (UC, Davis), G. Marchesini (Parma U.), I. Montvay, R. Ruckl (DESY), D. Schildknecht (Bielefeld U.), F. Schrempp (Munich U.), W.J. Stirling (Durham U.), J.J. van der Bij (CERN), R. Vega (UC, Davis), P. Zerwas (Aachen, Tech. Hochsch.), A. Zichichi (CERN). CCSEM-EL-88-1, Dec 1988. 112pp.
17. INTERMEDIATE MASS AND NONMINIMAL HIGGS BOSONS. (MOSTLY TRANSPARENCIES) PROCEEDINGS, WORKSHOP, DAVIS, USA, JANUARY 4-6, 1988.
By J.F. Gunion, (Ed.), L. Roszkowski, (Ed.). 1988. DAVIS, USA: CALIF. UNIV. (1988) 187p.
18. NEW PARTICLE SIGNALS AT THE SSC AND AT AN UPGRADED TEVATRON COLLIDER.
By R. Michael Barnett (LBL, Berkeley), Robert J. Hollebeek (Penn U.), Andrew P. White (Florida U.), John Yoh (Fermilab), Howard A. Baer (Florida State U.), Bruce A. Barnett (Johns

- Hopkins U.), Estia Eichten, James E. Freeman (Fermilab), Giorgio Gamberini (LBL, Berkeley), J.A. Grifols (Barcelona, Autonomia U.), John F. Gunion (UC, Davis), Howard E. Haber (UC, Santa Cruz), John Haggerty (Brookhaven), Clemens A. Heusch (UC, Santa Cruz), JoAnne L. Hewett (Wisconsin U., Madison), Ian Hinchliffe (LBL, Berkeley), T. Kamon, S. Kim (Tsukuba U.), A. Mendez (Barcelona, Autonomia U.), Jean Pierre Mendiburu (College de France), Sergio F. Novaes (LBL, Berkeley), Frank E. Paige (Brookhaven), Rajendran Raja (Fermilab), Thomas G. Rizzo (Ames Lab & Iowa State U.), Xerxes Tata (Hawaii U. & Wisconsin U., Madison), Jeffrey Woodside (Oklahoma State U.). LBL-26448-mc (microfiche), Jan 1989. 23pp. Presented at Summer Study on High Energy Physics in the 1990s, Snowmass, Colo., Jun 24 - Jul 17, 1988. Published in Snowmass: DPF Summer Study 1988:0159 (QCD161:D15:1988)
19. **EXTENDED HIGGS SECTOR SCENARIOS.**
By J.F. Gunion (UC, Davis). UCD-89-2, Feb 1989. 25pp. To appear in Proc. of Beyond the Standard Model Conf., Ames, IA, Nov 18-20, 1988.
Published in Ames: Standard Model 1988:0072-96 (QCD161:B47:1988)
  20. **HIGGS BOSONS IN LEFT-RIGHT SYMMETRIC MODELS.**
By J.F. Gunion (UC, Davis), J. Grifols, A. Mendez (Barcelona, Autonomia U.), B. Kayser (NSF, Wash., D.C.), F. Olness (Oregon U.). UCD-89-1, Feb 1989. 34pp.
Published in Phys.Rev.D40:1546,1989
  21. **RENORMALIZATION OF HIGGS BOSON MASS SUM RULES AND SCREENING.**
By J.F. Gunion, A. Turski (UC, Davis). UCD-88-42, Dec 1988. 33pp.
Published in Phys.Rev.D39:2701,1989
  22. **USING THE HADRONIC MULTIPLICITY TO DISTINGUISH REAL W'S FROM QCD JET BACKGROUNDS.**
By J.F. Gunion (UC, Davis & Santa Barbara, ITP), G.L. Kane (Michigan U.), H.F.W. Sadrozinski, A. Seiden (UC, Santa Cruz), A.J. Weinstein (Cal Tech), C.P. Yuan (Argonne). UCD-88-38, Nov 1988. 18pp.
Published in Phys.Rev.D40:2223,1989
  23. **AN OVERVIEW OF DISCOVERY TECHNIQUES AND EXCLUDED MASS REGIONS FOR THE STANDARD MODEL HIGGS BOSON.**
By J.F. Gunion (UC, Davis). UCD-88-33, Oct 1988. 11pp. To appear in Proc. of 24th Int. Conf. on High Energy Physics, Munich, West Germany, Aug 4-10, 1988.
  24. **HIGGS BOSONS BEYOND THE STANDARD MODEL.**
By J.F. Gunion (UC, Davis), H.E. Haber (UC, Santa Cruz). UCD-88-36, Oct 1988. 10pp. To appear in Proc. of 24th Int. Conf. on High Energy Physics, Munich, West Germany, Aug 4-10, 1988.
Published in Munich High Energy Physics 1988:1475 (QCD161:H51:1988)
  25. **GLUINO SIGNATURES AND DISCOVERY WHEN R PARITY IS BROKEN.**
By P. Binetruy (Annecy, LAPP), J.F. Gunion (UC, Davis). UCD-88-32, Oct 1988. 11pp. To appear in INFN Eloisatron Project Working Group, 6th Workshop on Novel Features of High Energy Hadronic Collisions, Erice, Italy, Jun 10-30, 1988.
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By Joe Kiskis (UC, Davis). UCD-86-27, Sep 1986. 16pp.
Published in Phys.Rev.D35:1456,1987
170. NUMERICAL RESULTS FOR THE LINE-LINE CORRELATION LENGTH NEAR AN SU(2), DECONFINING PHASE TRANSITIONS.
By Joe Kiskis (UC, Davis). UCD-85-11, Dec 1985. 15pp. Contributed to 23rd International Conference on High-Energy Physics held in Berkeley, CA, 16-23 July 1986.
Published in Phys.Rev.D33:2380,1986
171. T LOG R TERM IN THE QUARK - ANTI-QUARK FREE ENERGY.
By Joe Kiskis (UC, Davis). UCD-85-8, Oct 1985. 19pp.
Published in Phys.Rev.D33:3733,1986
172. AXIAL ANOMALY AND THE AC JOSEPHSON EFFECT IN (1+1)-DIMENSIONAL MODELS.
By Joe Kiskis (UC, Davis). UCD-84-6, Sep 1984. 20pp.
Published in Phys.Rev.D31:2006,1985
Also in ANL Symp.Anomalies 1985:538 (QC20:S96:1985)
173. ILLUSTRATED STUDY OF FLUX PATTERNS IN SU(2) LATTICE GAUGE THEORY.
By Joe Kiskis, Kevin Sparks (UC, Davis). UCD-84-1, Feb 1984. 36pp.
Published in Phys.Rev.D30:1326,1984
174. NUMERICAL STUDY OF FLUX PATTERNS IN NONABELIAN LATTICE GAUGE THEORY.
By Joe Kiskis (UC, Davis). UCD 83-4, Jun 1983. 25pp.
Published in Phys.Rev.D28:2637,1983
175. UNIVERSALITY CLASS OF QUANTUM CHROMODYNAMICS AND SUPERRENORMALIZABLE NONPOLYNOMIAL INTERACTIONS.
By J. Kiskis (UC, Davis). 1981.
Published in Phys.Rev.D24:960-969,1981
176. THE BIANCHI IDENTITY FOR NONABELIAN LATTICE GAUGE FIELDS.
By Joe Kiskis (UC, Davis). UCD 82-2, Feb 1982. 21pp.
Published in Phys.Rev.D26:429,1982
177. TOPOLOGICAL OBSTRUCTIONS TO GAUGE INDEPENDENT DESCRIPTIONS OF BROKEN SYMMETRY.
By Joe Kiskis (UC, Davis). UCD 82-1, Feb 1982. 27pp.
Published in Phys.Rev.D25:3299,1982
178. QUANTUM CHROMODYNAMICS AS EFFECTIVE SHORT DISTANCE FIELD THEORY.
By Joe Kiskis (UC, Davis). UCD 81-1, (Received Apr 1981). 29pp.

M. Golterman: Publications

179. THE QUANTIZATION OF CHIRAL BOSONS COUPLED TO GRAVITY.
By Stefano Bellucci, Maarten F.L. Golterman (UC, Davis), Donald N. Petcher (Florida State U., SCRI). UCD-88-19, May 1988. 14pp.
Published in Phys.Lett.B217:289,1989.
180. A LOCAL INTERACTIVE LATTICE MODEL WITH SUPERSYMMETRY.
By Maarten F.L. Golterman (UC, Davis), Donald N. Petcher (Florida State U., SCRI). UCD-88-08, Feb 1988. 44pp.
Published in Nucl.Phys.B319:307-341,1989.
181. THE PHYSICS OF THE CHIRAL SCHWINGER MODEL: TAMING AN ANOMALOUS THEORY.
By Daniel Boyanovsky (Pittsburgh U.), Ivan Schmidt (Santa Maria U., Valparaiso), Maarten F.L. Golterman (UC, Davis). PITT-87-13, (Received Nov 1987). 57pp.
Published in Annals Phys.185:111,1988.
182. THE EFFECTIVE ACTION FOR $\Omega \rightarrow 3 \pi$, $\Omega \rightarrow \pi \gamma$ AND $\rho \rightarrow \pi \gamma$.
By Maarten F.L. Golterman (UC, Davis). UCD-87-04, (Received May 1987). 19pp.
Published in Nucl.Phys.B309:188,1988.
183. BARYONS AS SOLITONS OF THE π - ρ - Ω - A1 SYSTEM.
By J. Baacke, D.E.L. Pottinger (Dortmund U.), M. Golterman (UC, Davis). DO-TH-86-18, Sep 1986. 16pp.
Published in Phys.Lett.185B:421,1987.

A. Turski: Publications

184. SCREENING OF LARGE SUPERSYMMETRY BREAKING IN LOW-ENERGY PHYSICS.
By J.F. Gunion, A. Turski (UC, Davis). UCD-89-5, Apr 1989. 15pp.
Published in Phys.Rev.D40:2325,1989
185. CORRECTIONS TO HIGGS BOSON MASS SUM RULES FROM THE SFERMION SECTOR OF A SUPERSYMMETRIC MODEL.
By J.F. Gunion, A. Turski (UC, Davis). UCD-89-6, May 1989. 15pp.
Published in Phys.Rev.D40:2333,1989
186. RENORMALIZATION OF HIGGS BOSON MASS SUM RULES AND SCREENING.
By J.F. Gunion, A. Turski (UC, Davis). UCD-88-42, Dec 1988. 33pp.
Published in Phys.Rev.D39:2701,1989
187. PRODUCTION MECHANISMS FOR NONMINIMAL HIGGS BOSONS AT AN $e^+ e^-$ COLLIDER.
By J.F. Gunion, L. Roszkowski, A. Turski (UC, Davis), H.E. Haber (UC, Santa Cruz), G. Gamberini, B. Kayser, S.F. Novaes (LBL, Berkeley), F. Olness (Illinois Tech), J. Wudka (Michigan U.). UCD-88-11, Apr 1988. 39pp.
Published in Phys.Rev.D38:3444,1988

J. Wudka: Publications

188. VARIATIONAL CALCULATIONS AND BOGOLYUBOV TRANSFORMATIONS.
By Jose Wudka (UC, Davis). UCD-88-39, Sep 1988. 20pp.
Published in Phys.Rev.D39:3000,1989

189. TOPOLOGICAL PHASES AND THE SOLAR NEUTRINO PROBLEM.
By Jose Wudka (UC, Davis), Jorge Vidal (Michigan U.). UCD-88-40, Nov 1988. 8pp.
190. PRODUCTION MECHANISMS FOR NONMINIMAL HIGGS BOSONS AT AN E+ E- COLLIDER.
By J.F. Gunion, L. Roszkowski, A. Turski (UC, Davis), H.E. Haber (UC, Santa Cruz), G. Gamberini, B. Kayser, S.F. Novaes (LBL, Berkeley), F. Olness (Illinois Tech), J. Wudka (Michigan U.). UCD-88-11, Apr 1988. 39pp.
Published in Phys.Rev.D38:3444,1988
191. SEARCH TECHNIQUES FOR CHARGED AND NEUTRAL INTERMEDIATE MASS HIGGS BOSONS.
By J.F. Gunion (UC, Davis), G.L. Kane, Jose Wudka (Michigan U.). UCD-87-28, Sep 1987. 50pp.
Published in Nucl.Phys.B299:231,1988

R. Vega: Publications

192. LIKE CHARGED W PAIR PRODUCTION VIA GLUON EXCHANGE.
By Duane A. Dicus (Texas U.), Roberto Vega (UC, Davis). UCD-88/35, Nov 1988. 14pp.
Published in Phys.Lett.B217:194,1989

D. Boyanovsky: Publications

193. THE PHYSICS OF THE CHIRAL SCHWINGER MODEL: TAMING AN ANOMALOUS THEORY.
By Daniel Boyanovsky (Pittsburgh U.), Ivan Schmidt (Santa Maria U., Valparaiso), Maarten F.L. Golterman (UC, Davis). PITT-87-13, (Received Nov 1987). 57pp.
Published in Annals Phys.185:111,1988
194. COMPLETE SOLUTION OF THE CHIRAL SCHWINGER MODEL HILBERT SPACE, CONSTRAINTS AND WESS-ZUMINO TERMS.
By Daniel Boyanovsky (UC, Davis & SLAC). SLAC-PUB-4198, Feb 1987. 31pp.
Published in Nucl.Phys.B294:223,1987
195. ANOMALOUS CURRENTS INDUCED CHARGE AND BOUND STATES ON A DOMAIN WALL OF A SEMICONDUCTOR.
By Daniel Boyanovsky (SLAC & UC, Davis), Elbio Dagotto, Eduardo Fradkin (Illinois U., Urbana). SLAC-PUB-4152, Dec 1986. 38pp.
Published in Nucl.Phys.B285:340,1987

K. Tesima: Publications

196. HIGHER ORDER CORRECTIONS TO MULTIPLICITIES.
By Kiusau Tesima (UC, Davis & Oregon U.). OITS-348, Jan 1987. 38pp.
197. INTEGRAL EQUATION FOR MULTIPLICITY DISTRIBUTION.
By Tomo Munehisa (Fermilab & Yamanashi U.), Kiusau Tesima (Chicago U., EFI & UC, Davis). UCD-85-12, (Received Feb 1986). 32pp.
Published in Nucl.Phys.B277:575,1986

J. Kalinowski: Publications

198. THEORETICAL REPORT OF THE W/Z/HIGGS SSC WORKING GROUP: PROBING THE W - Z HIGGS SECTOR OF ELECTROWEAK GAUGE THEORIES AT THE SUPERCONDUCTING SUPER COLLIDER.
By John F. Gunion (UC, Davis), A. Savoy-Navarro, G. Alverson, V. Barger, H.U. Bengtsson, P. Lebrun, B. Cox, M.J. Duncan, F. Gilman, J.A. Grifols, J. Hauptman, D. Hedin, M.J. Herrero, J. Kalinowski, G. Kane, B. Kayser, Z. Kunszt, S. Linn, S. Matsuda, A. Mendez, B. Milliken, F. Olness, F. Paige, L. Price, S. Protopopescu, J. Pumplin, H. Reno, W. Repko, T. Sjostrand, W.H. Smith, Y. Takaiwa, W.K. Tung, E. Wang, S.S.D. Willenbrock, P. Grosse-Wiesmann, C. Young (Fermilab & Wisconsin U., Madison & UCLA & Penn U. & SLAC & Barcelona, Autonoma U. & Ames Lab. & UC, Davis & LBL, Berkeley & Warsaw U. & Michigan U. & NSF, Wash., D.C. & Zurich U. & Florida State U. & Kyoto U. & Saclay & Cal Tech & Illinois Tech. & Brookhaven & Argonne & Michigan U. & Lund U. & Nevis Labs, Columbia U. & KEK, Tsukuba). UCD-86-39-mc (microfiche), Oct 1986. 12pp. To appear in Proc. of 1986 Summer Study on the Design and Utilization of Superconducting Super Collider, Snowmass, CO, Jun 23 - Jul 11, 1986.
Snowmass 1986, Proceedings, Physics of the Superconducting Supercollider 142-153 and Calif. Univ. Davis - UCD-86-39 (86,rec.Dec.) 12 p.
199. SIGNALS FOR SUPERSYMMETRY AT THE SSC.
By Supersymmetry Subgroup (R.Michael Barnett et al.). LBL-22497-mc (microfiche), Nov 1986. 15pp. Presented at Snowmass '86 Summer Study on Physics of the Superconducting Super Collider, Snowmass, Colo., Jun 23 - Jul 11, 1986.
Published in Snowmass Summer Study 1986:262 (QCD184:S7:1986)
200. DETECTION OF A HEAVY NEUTRAL HIGGS BOSON IN A HIGGSINO NEUTRALINO DECAY MODE.
By R.Michael Barnett (LBL, Berkeley), J.A. Grifols, A. Mendez (Barcelona, Autonoma U.), John F. Gunion, J. Kalinowski (UC, Davis). UCD-86-20, Sep 1986. 4pp. To appear in Proc. of 1986 Summer Study on the Design and Utilization of Superconducting Super Collider, Snowmass, CO, Jun 23 - Jul 11, 1986.
Published in Snowmass Summer Study 1986:188 (QCD184:S7:1986)
201. COMPARISON BETWEEN AN EXACT $FF \rightarrow FF WW$ CALCULATION FOR THE CHARGED CURRENT SECTOR AND THE EFFECTIVE W APPROXIMATION.
By J.F. Gunion, J. Kalinowski, A. Tofighi-Niaki (UC, Davis), A. Abbasabadi, W. Repko (Michigan State U.). UCD-86-23, Sep 1986. 4pp. To appear in Proc. of 1986 Summer Study on the Design and Utilization of Superconducting Super Collider, Snowmass, CO, Jun 23 - Jul 11, 1986.
Published in Snowmass Summer Study 1986:156 (QCD184:S7:1986)
202. EXACT $FF \rightarrow FF WW$ CALCULATION FOR THE CHARGED CURRENT SECTOR AND COMPARISON WITH THE EFFECTIVE W APPROXIMATION.
By J.F. Gunion, J. Kalinowski, A. Tofighi-Niaki (UC, Davis). UCD-86-19, Aug 1986. 11pp.
Published in Phys.Rev.Lett.57:2351,1986
203. A DIRECT CALCULATION OF THE SIX GLUON SUBPROCESS.
By J.F. Gunion, J. Kalinowski (UC, Davis). UCD-86-01, Feb 1986. 17pp. Contributed to 23rd International Conference on High-Energy Physics held in Berkeley, CA, 16-23 July 1986.
Published in Phys.Rev.D34:2119,1986
204. RESOLVING QCD JETS BEYOND LEADING ORDER: GLUON DECAY PROBABILITIES.
By J.F. Gunion, J. Kalinowski (UC, Davis), L. Szymanowski (Warsaw, Inst. Nucl. Studies). 1985.
Published in Phys.Rev.D32:2303-2321,1985

205. DEVELOPMENT OF QCD JETS EMITTED BY COLOR SINGLET SOURCES.
By R.K. Ellis (Fermilab), J.F. Gunion (UC, Davis & Oregon U.), Jan Kalinowski (UC, Davis), B.R. Webber (Cambridge U.). FERMILAB-PUB-85-181-T, Mar 1985. 14pp. Oregon Workshop on Super High Energy Physics, Eugene, OR, Mar 18-Aug 15, 1985.
Published in Phys.Lett.165B:171,1985
206. NEXT-TO-LEADING CORRECTIONS TO GLUON JET DEVELOPMENT.
By J.F. Gunion (UC, Davis & Oregon U.), Jan Kalinowski (UC, Davis & Warsaw U.). OITS-291, Mar 1985. 19pp. Presented at Oregon Workshop on Super High-Energy Physics, Eugene, OR, Mar 18 - Aug 15, 1985.
Published in Phys.Lett.163B:379,1985
207. JET CALCULUS BEYOND LEADING ORDER FOR THE GLUON SECTOR.
By J.F. Gunion (UC, Davis), J. Kalinowski (Warsaw U.). UCD-83-4a, (Received Jan 1984). 17pp.
Published in Phys.Rev.D29:1545-1548,1984
208. EVOLUTION OF QCD JETS IN LLA AND BEYOND.
By Jan Kalinowski (Warsaw U. & UC, Davis). Print-80-0894 (UC, Davis), Sep 1980. 13pp. Presented at Conf. on Hadron Structure, Smolenice, Czechoslovakia, Sep 22-26, 1980.
Published in Hadron Structure '80:0103 (QCD161:T8:1980)

R. Cahn: Publications

209. PHOTON - PHOTON CORRELATIONS IN $E^+ E^- \rightarrow F^* \text{ ANTI-}F^* \rightarrow F \text{ GAMMA (1) ANTI-}F \text{ GAMMA (2)}$.
By Robert N. Cahn, Yoav Eylon (UC, Davis), Shmuel Nussinov (Tel Aviv U.). Print-79-0742 (UC, Davis), (Received Oct 1979). 22pp.
Published in Phys.Rev.D21:82,1980
210. GLUON JET PRODUCTION BY THE PROCESS $E^+ E^- \rightarrow E^+ E^- \text{ GLUON - GLUON}$.
By Robert N. Cahn, John F. Gunion (UC, Davis). UCD-79-3, (Received Jul 1979). 32pp.
Published in Phys.Rev.D20:2253,1979
211. HIGGS PARTICLE PRODUCTION BY $Z \rightarrow H \text{ GAMMA}$.
By R.N. Cahn (UC, Davis), M.S. Chanowitz, N. Fleishon (LBL, Berkeley). LBL-8495, Nov 1978. 12pp.
Published in Phys.Lett.82B:113,1979

SUMMARY OF TALKS GIVEN AND WORKSHOPS/CONFERENCES ATTENDED

The talks given and workshops or conferences attended are too numerous to list in detail. Here, we present a simple year-by-year numerical summary beginning with the year 1984. Unfortunately, records were not kept prior to 1984.

- 1988 : J.F. Gunion gave 13 talks and attended 6 workshops/conferences; J. Kiskis gave 1 talk; J. Wudka (postdoc) gave 5 talks.
- 1987 : J.F. Gunion gave 8 talks and attended 7 workshops/conferences; M. Golterman (postdoc) gave 3 talks and attended 5 conferences.
- 1986 : J.F. Gunion gave 10 talks and attended 4 workshops/conferences; J. Kiskis gave 2 talks and attended 2 conferences; M. Golterman gave 1 talk and attended 2 conferences.
- 1985 : J.F. Gunion gave 9 talks and attended 5 workshops/conferences; J. Kiskis gave 1 talk and attended 1 conference.
- 1984 : J.F. Gunion gave 4 talks and attended 3 workshops/conferences; J. Kiskis attended 2 conferences.
- 1983, and earlier: Although records were not kept, the numbers of talks given and conferences or workshops attended were comparable to the numbers above. Of course, J. Kiskis did not join the Task B effort until 1981.

ANNOTATED SUMMARY OF RESEARCH PERFORMED

The research performed prior to Feb. 1989 can be broadly classified into a series of categories. Below, we define the categories and indicate (according to the number given in the publication list earlier), which of the publications had substantial content and impact related to the category of research. A given publication can appear in more than one category.

1. **Higgs Boson Physics**, including the Standard Model Higgs boson, exotic Higgs bosons, and supersymmetric model Higgs bosons. This is an area in which the Task B group had major impact and has come to be regarded as one of the leading groups (if not *the* leading group) in the world.

Relevant publications: 1, 2, 3, 4, 5, 6, 7, 9, 10, 11 (this is the famous Higgs Hunters Guide), 12, 14, 17, 19, 20, 21, 23, 24, 28, 29, 32, 33, 34, 35, 36, 37, 40, 42, 43, 44, 48, 54, 55, 56, 57, 61, 62, 65, 66, 65, 66, 71, 72, 80, 81, 82, 86, 87, 92, 98, 101, 108, 109, 113, 185, 186, 187, 190, 198, 211.

2. **Supersymmetry**. This became a major focus of our Task B research efforts towards the end of the summary period. Especially crucial to the development of the field were our contributions regarding the delineation of the Higgs sector of supersymmetric models, the understanding of cascade decays of gluinos and other heavy supersymmetric particles and the resulting phenomenology at colliders of various types.

Relevant publications: 13, 14, 15, 21, 25, 26, 27, 36, 38, 39, 41, 45, 46, 47, 51, 52, 53, 54, 56, 57, 59, 65, 67, 69, 74, 80, 101, 184, 185, 186, 199, 200.

3. **Hadron Collider physics**, including the Superconducting SuperCollider, the Eloisatron, the Tevatron and the Large Hadron Collider. This is another area where the Task B group has long played a leading role. Our specialty has been understanding how to look for new physics, including a careful consideration of backgrounds.

Relevant publications: 8, 15, 16, 18, 22, 25, 26, 27, 28, 29, 31, 32, 37, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 62, 63, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 80, 81, 82, 86, 87, 92, 93, 94, 98, 103, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 192, 198, 199, 200, 201, 202.

4. **Physics at $\gamma\gamma$ and e^+e^- Colliders**. Task B research has had major impacts in this area, especially in the realm of large Q^2 , higher-twist, and large transverse momentum physics at such colliders.

Relevant publications: 34, 35, 42, 44, 61, 77, 80, 84, 85, 96, 118, 125 (this is the proceedings for a $\gamma\gamma$ conference which we organized), 128, 138, 149, 187, 190, 209, 210, 211.

5. **Physics at an ep Collider**. Some very significant results were obtained in this area, especially with regard to new particle searches and to higher-twist phenomena.

Relevant publications: 59, 106, 117, 120, 122, 126, 130, 131, 132, 139, 140.

6. **Cross sections and amplitudes**. This category refers to research in which exact results were obtained for very important amplitudes and cross sections describing the production of jets, Higgs bosons, *etc.*. Also included are papers related to new techniques for computing such amplitudes.

Relevant publications: 30, 61, 64, 73, 75, 78, 79, 83, 89, 90, 91, 97, 98, 99, 100, 115, 117, 120, 121, 122, 128, 132, 201, 202, 203, 204, 205, 206, 207, 208.

7. **Left-right symmetric models**. Our group led an effort to understand the phenomenology of these models at hadron colliders such as the SSC and LHC.

Relevant publications: 49, 53, 68.

8. **Compositeness models**. We were heavily involved in working out the phenomenological implications of such models for hadron colliders and e^+e^- colliders.

Relevant publications: 85, 93.

9. **New W's and Z's.** Again, we were heavily involved in determining the means and resulting mass reach for discovery of heavy gauge bosons at hadron and e^+e^- colliders.

Relevant publications: 102, 103, 105, 110, 111.

10. **QCD at high transverse momentum and/or high Q^2 .** Task B has been a leader in this field, especially during the years relevant to this summary. Many new results and ideas for precisely computing short-distance processes using QCD were developed and applied to data and predictions for planned colliders of various types.

Relevant publications: 84, 96, 97, 117, 118, 120, 122, 126, 132, 133, 134, 137, 138, 139, 140, 141, 142, 144, 145, 147, 148, 149, 151, 152, 154, 156, 160, 161, 163, 205, 206, 207, 208, 209, 210.

11. **QCD at low transverse momentum.** An early focus of the Task B effort was understanding how to make predictions for low transverse momentum phenomena using Quantum Chromodynamics. Many pioneering results were obtained that have had substantial influence on the field over the years.

Relevant publications: 58, 60, 64, 88, 89, 90, 95 (proceedings of a conference on Multiparticle Dynamics that we organized), 100, 104, 112, 114, 115, 116, 119, 121, 123, 124, 127, 128, 129, 130, 131, 135, 136, 143, 144, 146, 150, 153, 155, 158, 159, 162, 192, 196, 197.

12. **Chiral symmetry and QCD.** A new phenomenology for the chiral symmetry condensate in QCD was developed and other interesting results regarding effective Lagrangians were obtained.

Relevant publications: 157, 164, 179, 182, 183.

13. **Mathematical physics.** A few interesting results in the mathematical physics arena were obtained, relating to topological solutions, anomalies, gravity and the chiral Schwinger model.

Relevant publications: 172, 177, 181, 188, 193, 194, 195.

14. **Neutrino physics.** One paper related to neutrino physics was written.

Relevant publications: 189.

15. **Lattice gauge theory.** This has been a second major branch of the Task B research effort over the years, with a large variety of interesting and influential results obtained. Most important during the summary period was the progress made regarding nonperturbative aspects of gauge theories and the Yang-Mills, finite-temperature, deconfining phase transition. It included a formulation of the lattice Bianchi identity. This identity is a fundamental topological relation in any gauge theory. Another project used numerical simulation to investigate ways in which the distribution of flux in a non-Abelian theory differs from that in an Abelian theory. Also, a local lattice theory with supersymmetry is described. Another important series of papers showed that the $SU(2)$ phase transition is second-order and that nonperturbative, nontrivial results from the renormalization group can be used to characterize the universality class of the transition.

Relevant publications: 165-171, 173, 174, 176, 180. Lattice gauge theory research in this period was also included in Ph.D. theses by Kevin Sparks and Rajamani Narayanan.

Summary for Task E of the period up to Feb. 1989

Later in the period of this contract, task E was added for additional theoretical researches in high energy particle physics by Professor Ling-Lie Chau and collaborators. The topics ranged widely and are reflected in the titles of the publications listed below. Invited talks are included in this list, which includes publications by post doctoral scholars and visitors on this task.

1) IN SEARCH FOR THE BEYOND.

By L.L. Chau (UC, Davis). 1987.

In *Santa Monica 1987, Proceedings, The fourth family of quarks and leptons* 303-318.

2) A SURVEY ON GEOMETRICAL INTEGRABILITY AND A UNIFYING DESCRIPTION OF EQUATIONS OF MOTION IN PHYSICS.

By L.L. Chau (UC, Davis). 1987.

In *Uppsala 1987, Proceedings, High energy physics, vol. 1* 400-401.

3) STANDARD MODEL - QUARK MIXING AND ALL THAT.

By L.L. Chau (UC, Davis & Brookhaven). 1986.

In *Thessaloniki 1986, Proceedings, Antiproton 86* 3-17.

4) STATUS AND FRONTIERS IN HEAVY QUARK DECAYS, MIXING AND CP NONINVARIANCE.

By L.L. Chau (UC, Davis). 1988.

In *Hong Kong 1988, Proceedings, Physics, vol. 1* 450-484. (see Conference Index).

5) GEOMETRICAL INTEGRABILITY PROPERTIES OF CLASSICAL FIELD THEORIES IN PHYSICS.

By L.L. Chau (UC, Davis). 1988.

In *Swansea 1988, Proceedings, Mathematical physics* 346-349. (see Conference Index).

6) GEOMETRICAL INTEGRABILITY CONSTRAINTS AND EQUATIONS OF MOTION IN FOUR PLUS EXTENDED SUPERSPACES.

By L.L. Chau (UC, Davis & Brookhaven). 1986.

IN *BERKELEY 1986, PROCEEDINGS, HIGH ENERGY PHYSICS, VOL. 1* 394-

7) PHYSICS OF QUARK MIXING AND CP NONINVARIANCE: THE USES OF THE QUARK DIAGRAM SCHEME.

By L.L. Chau (UC, Davis). 1987.

IN *LES ARCS 1987, PROCEEDINGS, THE STANDARD MODEL, THE SUPERNOVA 1987A, VOL. 1* 327-336.

8) SUMMARY TALK.

By L.L. Chau (UC, Davis). 1987.

IN *LES ARCS 1987, PROCEEDINGS, THE STANDARD MODEL, THE SUPERNOVA 1987A, VOL. 1* 767-784.

9) A GENERALIZED BACKLUND TRANSFORMATION FOR THE (SUPERSYMMETRIC) SELFDUAL YANG-MILLS FIELDS.

By L.L. Chau, J.C. Shaw, H.C. Yen (UC, Davis). UCD-88-28, (Received Dec 1988). 20pp. Published in Int.J.Mod.Phys.A4:2715,1989

10) B MESONS, A BEAUTIFUL SOURCE OF NEW PHYSICS.

By L.L. Chau (UC, Davis). 1987.

IN *LOS ANGELES 1987, PROCEEDINGS, LINEAR COLLIDER B ANTI-B FACTORY CONCEPTUAL DESIGN* 192-218.

11) GEOMETRICAL INTEGRABILITY AND EQUATIONS OF MOTION IN PHYSICS: A UNIFYING VIEW.

By Ling-Lie Chau (UC, Davis). UCD-87-38, (Received Sep 1988). 93pp.

In *Song, X.C. (ed.): Integrable systems* 71-151. (see Book Index).

12) $D = 10$ SUPERSPACE GEOMETRY AND HETEROTIC SUPERSTRING THEORY. 1.

By S. Bellucci (UC, Davis). UCD-88-27, Aug 1988. 12pp.

Published in Mod.Phys.Lett.A3:1775-1784,1988

13) THE QUANTIZATION OF CHIRAL BOSONS COUPLED TO GRAVITY.

By Stefano Bellucci, Maarten F.L. Golterman (UC, Davis), Donald N. Petcher (Florida State U., SCRI). UCD-88-19, May 1988. 14pp.

Published in Phys.Lett.B217:289,1989

14) CP NONINVARIANCE AND WEAK DECAYS AFTER NA31.

By Ling-Lie Chau (UC, Davis). UCD-88-20, Mar 1988. 25pp. Presented at 23rd Rencontres de Moriond Conf.: Electroweak Interactions and Unified Theories, Les Arcs, France, Mar 6-13, 1988.

Published in Moriond 1988: Electroweak:0353 (QCD161:R4:1988:V.1)

15) COMMENTS ON QCD SUM RULE CALCULATIONS OF EXCLUSIVE TWO BODY DECAYS OF CHARMED MESONS.

By Ling-Lie Chau (UC, Davis), Hai-Yang Cheng (Taiwan, Inst. Phys.).

UCD-88-10, (Received Jun 1988). 7pp. Published in Mod.Phys.Lett.A4:877,1989

16) EVIDENCE FOR THE W ANNIHILATION DIAGRAM IN EXCLUSIVE TWO BODY CHARMED MESON DECAYS.

By Ling-Lie Chau (UC, Davis), Hai-Yang Cheng (Taiwan, Inst. Phys.).

UCD-88-9, (Received Jun 1988). 6pp.

17) $D = 10$, $N=1$ SUPERSPACE SUPERGRAVITY AND THE LORENTZ CHERN-SIMONS FORM.

By S. Bellucci (UC, Davis), S.James Gates, Jr. (Maryland U.). UMDEPP-88-182, Mar 1988. 12pp. Published in Phys.Lett.208B:456,1988

18) B DECAYS WITHOUT FINAL STATE CHARM PARTICLES AND CP NONINVARIANCE.

By L.L. Chau (UC, Davis), H.Y. Cheng (Indiana U.). 1987.

Published in Phys.Rev.Lett.59:958-961,1987

19) EVIDENCE FOR THE W ANNIHILATION DIAGRAM IN EXCLUSIVE TWO BODY CHARMED MESON DECAYS.

By Ling-Lie Chau (UC, Davis), Hai-Yang Cheng (Taiwan, Inst. Phys.).

UCD-88-09, (Received Apr 1988). 6pp.

20) GAUGING SYMMETRIES OF TWO-DIMENSIONAL CONFORMALLY INVARIANT MODELS.

By W. Nahm (UC, Davis). UCD-88-02, (Received Apr 1988). 8pp.

21) LINEAR SYSTEMS AND CONSERVATION LAWS IN $D = 10$, $N=1$ SUPERGRAVITY.

By Ling-Lie Chau (UC, Davis), B. Milewski (Microsoft, Redmond).

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