

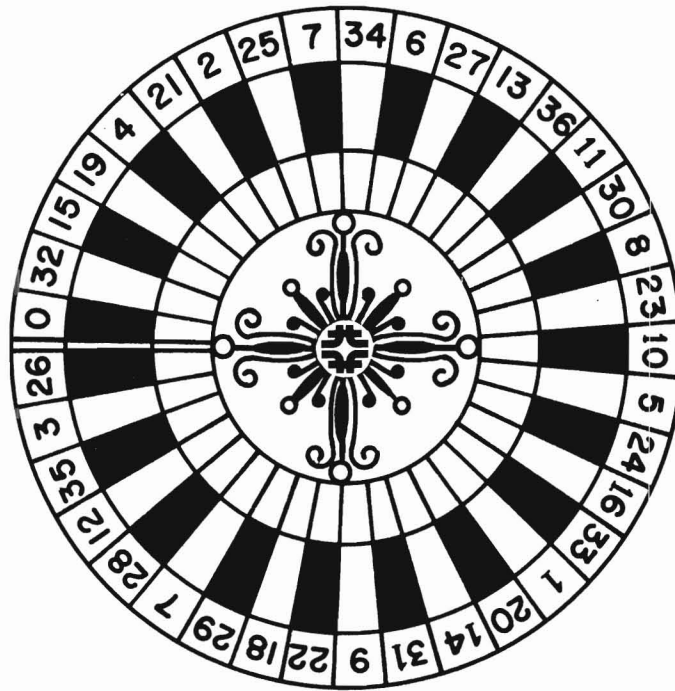
Lepton, Photon Symposium, Fermilab, 1979

Wesley M. Smart

Proceedings Of The 1979 International Symposium On Lepton And Photon Interactions At High Energies

August 23-29, 1979

Editors
T. B. W. Kirk
H. D. I. Abarbanel



Fermi National Accelerator Laboratory
Batavia, Illinois



1979 International Symposium on
Lepton and Photon Interactions at High Energies
Sponsored jointly by the
International Union on Pure and Applied Physics • National Science Foundation
United States Department of Energy • Fermi National Accelerator Laboratory

FOREWORD

This symposium on Leptons and Photons is ninth in the series of biannual meetings which began at Cambridge, Massachusetts, in 1963. Looking back to that time it was already clear that the rapid proliferation of hadron resonances had destroyed the notion that the proton or the pi meson was in any way elementary. In subsequent years, attempts were made to search for the constituents of hadrons. While no direct search has been successful, indirect evidence has accumulated to show that there are point-like constituents within the hadrons. This evidence did not come as a single blinding revelation but rather through the gradual accumulation of experimental detail.

Quantum Chromodynamics, a theory of quarks and gluons, has emerged as the theory which is consistent with what is known about hadrons. At this year's symposium the first evidence for the reality of gluons was presented through the analysis of data

from the PETRA experiments. Data from new measurements of deep inelastic lepton scattering on hadrons and from dilepton pair production in hadron collisions were presented which showed satisfying consistency with QCD calculations. The progress made on theoretical calculations of these reactions was sufficiently encouraging to let one hope that by the next conference QCD will be near to gaining the stature of QED.

No sooner had the quark acquired sufficient experimental reality to be called an elementary particle than its elementarity has been called into question. Theoretical work was reported on grand unification schemes which suggest that quarks and leptons are made of the same stuff. The death of the proton, the most solid member of the family of particles, appears to be an almost inescapable consequence of the unification scheme. It is fair to say that the future promises we will soon understand what we already know and what we don't yet know will contain many exciting surprises.

John Peoples, Jr., Chairman
Symposium Organizing Committee

ACKNOWLEDGMENTS

The success of the 1979 Lepton Photon Symposium at Fermilab and especially the credit for rapid publication of the Proceedings is a direct result of the dedicated efforts of the speakers, their scientific secretaries, and the non-scientific support staff. As editors, we would like to take this opportunity to express our thanks to each of these groups.

First, we wish to thank the speakers whose talks in both spoken and written versions met or exceeded our expectations. We are especially grateful that all the speakers managed to meet the challenging publication deadline we set, while maintaining the quality of the papers in form and content.

To the scientific secretaries, our thanks go, along with the gratitude of the Organizing Committee for their helpful assistance to the speakers and to the Organizing Committee during the symposium and for their careful reading of the submitted manuscripts afterwards. If the published papers are more free of syntactical and typographical error than most, the credit goes largely to the scientific secretaries for their careful proofreading.

We are especially grateful to the Fermilab technical and secretarial personnel who worked so well together to make the symposium a logistical and esthetic success, as well as a scientific one. Particular thanks go to Helen Peterson for her superb overall organization, to Anne Burwell whose computer record keeping smoothed many details, and to Mary Fisk, Barb Kristen, Laura Sedlacek, and Claudia Slater who turned in enormous amounts of organizational and secretarial work during and after the symposium as well as in the production of this volume.

The efforts of Rene Donaldson and Angela Gonzales to make this book so promptly and so well are appreciated by the editors who stand in debt as well as in awe of the superb work that was done with the design of the book, its organization and typography, and the logistics of its printing.

Finally, our thanks go to the International Union for Pure and Applied Physics, the United States Department of Energy, the United States National Science Foundation, and Fermilab, without whose support there could have been no symposium.

T. B. W. Kirk
H. Abarbanel
Proceedings Editors

PROCEEDINGS OF THE
INTERNATIONAL SYMPOSIUM ON LEPTON AND PHOTON INTERACTIONS
AT HIGH ENERGIES

TABLE OF CONTENTS

	Page
Electron Positron Annihilations Above 9 GeV Session Organizer: E. Lohrmann, DESY	
Summary of the Session E. Lohrmann	1
The First Year of MARK-J at PETRA H. Newman et al.	3
Results from the PLUTO Experiment on e^+e^- Reactions at High Energies. Ch. Berger	19
TASSO Results on e^+e^- Annihilation Between 13 and 31.6 GeV and Evidence for Three Jet Events. TASSO Collaboration, Presented by G. Wolf	34
First Results from JADE. JADE Collaboration, Presented by S. Orito	52
Discussion of the PETRA Papers	70
Report on CESR, The Cornell Electron Storage Ring. B. D. McDaniel	72
Electron-Positron Annihilation Between 3 GeV and 9 GeV Session Organizer: R. F. Schwitters, Harvard University	
Summary of the Session R. F. Schwitters	77
Results from the Mark II Detector at SPEAR SLAC-LBL Collaboration, Presented by V. Lüth	78
Results from the Crystal Ball Detector at SPEAR. Crystal Ball Collaboration, Presented by E. D. Bloom	92
Review of e^+e^- Reactions in the Energy Range 3 to 9 GeV J. Kirkby	107
Muon Scattering and Dimuon Production Session Organizer: E. Gabathuler, CERN	
The EMC Muon Scattering Experiment at CERN H. E. Stier	123
Muon Scattering Into 1-5 Muon Final States. M. Strovink et al.	135
Deep Inelastic Muon Scattering on Carbon at Large Q^2 A. C. Benvenuti et al.	149
Results of the CERN NA3 Experiment on Muon Pair Production in Hadron Collisions CEN Saclay-CERN-Collège de France-E. P. Palaiseau-LAL Orsay Collaboration Presented by W. Kienzle	161

A Review of Continuum Lepton Pair Production by Hadrons . . . . .	.185
James E. Pilcher	

Heavy Quark Resonances
Session Organizer: B. Gittelman, Cornell University

Summary of the Session. . . . .	.195
B. Gittelman	
Theoretical Interpretation of e^+e^- Results . . . . .	.198
H. Harari	
Measurements of the Properties of the Y Family from e^+e^- Annihilation . . . . .	.214
H. Meyer	
Production of Heavy Quark Bound States in Hadron-Hadron Collisions . . . . .	.228
L. Camilleri	
Bound States of Heavy Quarks and Antiquarks . . . . .	.239
C. Quigg	

Weak Interactions
Session Organizer: M. Derrick, Argonne National Laboratory

Summary of the Session. . . . .	.257
M. Derrick	
Review of Experimental Measurements of Weak Neutral-Current Interactions. . . . .	.258
K. Winter	
Further Measurements of Parity Non-Conservation in Inelastic Electron Scattering. . . . .	.271
C. Y. Prescott	
Review of Multilepton Production in Neutrino Nucleon Interactions . . . . .	.277
M. J. Murtagh	
Particle Production by Neutrinos . . . . .	.291
P. Schreiner	

Future Accelerators
Session Organizer: R. R. Wilson, Fermi National Accelerator Laboratory

Present Status of the LEP Project and Some Comments on the Limitations of e^+e^- Storage Rings . . . . .	.305
E. Keil	
Colliding Linacs . . . . .	.314
U. Amaldi	
Fermilab Energy Doubler: $\bar{p}p$ at 2 TeV . . . . .	.327
F. R. Huson	

Nucleon Structure
Session Organizer: C. Baltay, Columbia University

Recent Experimental Measurements of the Neutrino Charged Current Cross Sections . . . . .	.337
D. Theriot	
Recent Measurements of Nucleon Structure Functions from Neutrino Scattering . . . . .	.343
A. Para	
Recent Results on the Hadronic Final State in Charged Current Neutrino and Antineutrino Reactions . . . . .	.359
N. Schmitz	
The Nucleon Structure Functions as Derived from Lepton-Nucleon Scattering. . . . .	.384
W. S. C. Williams	

Theoretical Developments I
Session Organizer: J. D. Bjorken, SLAC and Fermilab

Weak Interactions and Gauge Theories . . . . .	.397
M. K. Gaillard	
Status of Perturbative QCD. . . . .	.412
J. Ellis	
Unification of Fundamental Forces . . . . .	.437
F. Wilczek	

Photoproduction and Low Energy Electron-Positron Annihilation
Session Organizer: A. Wattenberg, University of Illinois at Urbana

Summary of the Session. . . . .	.447
A. Wattenberg	
Photoproduction: Total Cross Sections and Vector Mesons . . . . .	.448
A. M. Eisner	
Recent Photoproduction Results from the Fermilab Broad Band Beam . . . . .	.460
M. F. Gormley	
Results from High Energy Photoproduction at the CERN SPS . . . . .	.469
F. Richard	
Recent Results of Experiments at VEPP-2M . . . . .	.490
V. Sidorov	
A Study of e^+e^- Annihilation into Hadrons in the 1550-2200 MeV Energy Range with the Magnetic Detector DM1 at DCI. . . . .	.499
B. Delcourt et al.	
Multihadron Production at ADONE . . . . .	.506
M. Spinetti	

Theoretical Developments II
Session Organizer: H. Abarbanel, Fermi National Accelerator Laboratory

Review of Recent Results on QCD and Confinement. . . . .	.513
S. Mandelstam	
Models and Mechanisms in Gauge Theories . . . . .	.520
A. M. Polyakov	
High Masses Triggered by J/ψ . . . . .	.524
Y. Lemoigne	
Quarks and Leptons; What Next? . . . . .	.529
M. Veltman	

Measurement of Charm Particle Lifetimes
and Evidence for Charm Production in Hadron Collisions
Session Organizer: W. Fry, University of Wisconsin at Madison

Observations of Charmed Baryon Production at the CERN Intersecting Storage Rings . . . . .	.535
A. Kernan	
Recent Data on Prompt Single Lepton Production in Hadron-Nucleus Collisions . . . . .	.541
H. Wachsmuth	
Observation of Short Lifetime Particles in Track Chambers. . . . .	.553
D. D. Reeder	

The Neutrino Production and Weak Decay of Charmed Hadrons. . . . .	.563
J. D. Prentice	
A Review of Recent Measurements of Charmed Particle Lifetimes Using Emulsions . . . . .	.569
L. Voyvodic	
Exercise in Nostalgia . . . . .	.575
L. M. Lederman	
Special Session on Prompt Photon Production and Other Current Topics	
Session Organizer: T. Ferbel, University of Rochester	
Direct Photon Production at ISR Energies. . . . .	.589
P. Mouzourakis	
Search for Direct Photon Production at Large p_T in Proton-Proton Collisions at $\sqrt{s} = 62.4$ GeV . . . . .	.594
M. J. Tannenbaum	
A Search for Direct Photon Production at Fermilab Energies and Comparison with Direct Photon Measurements at ISR Energies . . . . .	.602
B. Cox	
Direct Photons from $\psi(3100)$ Decay . . . . .	.610
M. T. Ronan	
Pion and Kaon Dissociation in the Nuclear Coulomb Field . . . . .	.617
T. Jensen et al.	

List of Registrants

Electron Positron Annihilations Above 9 GeV 

Electron-Positron Annihilation Between 3 GeV and 9 GeV 

Muon Scattering and Dimuon Production 

Heavy Quark Resonances 

Weak Interactions 

Future Accelerators 

Nucleon Structure 

Theoretical Developments I 

Photoproduction and Low Energy Electron-Positron Annihilation 

Theoretical Developments II 

**Measurement of Charm Particle Lifetimes and
Evidence for Charm Production in Hadron Collisions** 

Special Session on Prompt Photon Production and Other Current Topics 

