The birth of particle physics

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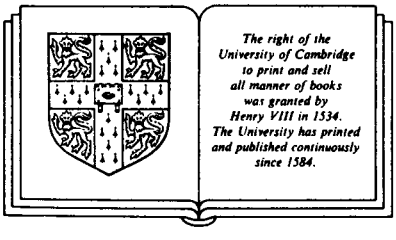

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Foreword

This book is based on the lectures and round-table discussions at the International Symposium on the History of Particle Physics, held at Fermilab in May 1980.

The organizers of the symposium, Laurie Brown and Lillian Hoddeson, argue that elementary particle physics evolved out of cosmic-ray and nuclear physics in the period 1930–50. In this same period, relativistic quantum field theory provided a theoretical structure that could be tested in the atom and extended into the subnuclear domain.

The idea was to explore these issues at a conference at which the participants in these events would reconstruct the happenings with their contemporaries, with following generations of particle physicists, and with historians of science. In planning this symposium, Hoddeson and Brown were guided by the experience and advice of Roger Stuewer, who had organized a successful symposium on the history of nuclear physics several years earlier.

The theoretical underpinnings were addressed by Paul Dirac, Victor Weisskopf, and Satio Hayakawa. Early cosmic-ray discoveries were described by Carl Anderson, Gilberto Bernardini, and Bruno Rossi. Quantum field theory was treated by Julian Schwinger, and the successful application to the atom was described by Willis Lamb, the field theorist who carried out the epochal atomic experiment. Robert Marshak and Robert Serber connected quantum field theory to the subnuclear phenomena observed in the 1940–50 cosmic-ray data and in the early postwar accelerator studies. These then were the principal speakers. Audience participation was very lively; some was sufficiently relevant to be included as short chapters, such as those of Oreste Piccioni and Robert Thompson.

It will be obvious to our readers that our speakers can only be representative of the heroes of the period under study. We are keenly aware that important contributors were not able to attend the symposium. The historians in our symposium called our attention to the omission of many important developments. In partial remedy, the editors have included a number of post-symposium papers. Dmitry Skobeltzyn, H. Victor Neher, Pierre V. Auger, Louis Leprince-Ringuet, Marcello Conversi, Takehiko Takabayasi, Cesare M. G. Lattes, and Julian Schwinger (on Sin-itiro Tomonaga) helped to fill some of the gaps in the symposium's program. We recognize that there are still many omissions; there is room for additional symposia and much need for detailed scholarly work in this seminal period in the history of particle physics.

For the physicists at Fermilab, who tend to be obsessed with the future, the symposium gave us an opportunity to turn away, however momentarily, and pause from the routine – to step away from our fascinations with quarks and gluons and the exotica of constituent physics, to look up from our scintillation counters, microprocessors, wire chambers, Čerenkov counters, and all that regalia – and to renew contact with our culture and listen to the giants on whose shoulders we try to stand. The giants who lectured here also wrote the books we studied and established the physics upon which we base our work. They brushed away the cobwebs that obscured the beautiful theory of quantum electrodynamics, and they *observed*. The style of their observations is our heritage.

In a more personal vein, two of the speakers were my own teachers. Willis Lamb, at Columbia University during the years 1946–51, taught me 80 percent of my graduate courses. In those times we students worked very hard, but so did our professors. In fact (you may not believe this), I remember everything Willis taught me. His chapter reminds us how much the atom taught us about the world.

The second of my teachers present was Gilberto Bernardini. As a visiting professor from Rome, he brought the students at Columbia an insight into the exciting world of cosmic-ray physics. I don't remember anything Gilberto taught me. No, that is not quite true. I do remember something he taught me, and it was an interesting thing: He taught me to be naïve. He taught me to marvel at simple things that are really not so simple. I remember once when we had finished making a counter and were looking at the pulses on an oscilloscope. Yes, in those days we had oscilloscopes! A man off the street looking at the oscilloscope

would see green lines in a broken television tube. But the student of physics was much more sophisticated; when he saw these green lines pulsing up and down, he knew that it signified the passage of a particle, either an α particle or a μ meson. The passage of a particle through a counter happens today at Fermilab. We still look at oscilloscopes here, I'd like to reassure you, and we still see these pulses, and they signify the passage of particles through counters. This abstract happening is accepted very calmly. But Gilberto got hysterical when he saw these pulses. Of course, he is Italian. His excitement at the fact that you can interpret something so abstract as the passage of an ultramicroscopic particle and make that deduction from the green traces on the oscilloscope was a lesson which, generalized, is the essence of the subject with which we are concerned.

Leon M. Lederman

Editors' acknowledgments

It is a pleasure to thank all of those who participated in the symposium and contributed to the preparation of this volume. We sincerely regret that we are able to thank individually only a few of those who deserve credit here.

The institutions we want to thank are the following: Fermilab, which is supported by the U.S. Department of Energy and operated by the Universities Research Associates (URA), for generously hosting the symposium and for supplying many varieties of support ranging from office space and secretarial services to sustenance; the Sloan Foundation; the Division of Particles and Fields of the American Physical Society, for supplementary grants; and the Center for History of Physics of the American Institute of Physics, for support for tape recordings.

The committees we would like to thank include the Organizing Committee (Hans Bethe, Leon Lederman, Roger Stuewer, Spencer Weart, Robert R. Wilson, and ourselves), for help in selecting topics and speakers; Fermilab's History Committee (current members Richard Carrigan, chairman, Francis Cole, Thomas Collins, Lillian Hoddeson, Drasko Jovanovic, Lee Teng, Roger Thompson, Donald Young; past members Edwin Goldwasser, Richard Lundy, and Robert R. Wilson), for making the pivotal decision that Fermilab support a symposium on the history of particle physics and for continuing help with the program and arrangements; the Arrangements Committee (Betsy Anderson, Joanie Bjorken, Richard Carrigan, Helen Peterson, and May West), for masterminding the operation of the symposium; and the Exhibit Committee (Saundra Cox, Angela Gonzales, and Jose Poces), for producing an unusual and historically illuminating display of photographs and apparatus gathered from many individuals and institutions.

Many other committees contributed to the symposium in many ways that were not obvious, for example, in authorizing the travel support for individual symposium participants, and we are very grateful to them all.

Among the dozens of individuals whose participation in designing our undertaking was crucial, four stand out: Leon Lederman, May West, Helen Peterson, and Roger Stuewer. Had they not made their essential contributions, the symposium could not have taken place. Lederman, Fermilab's director, consistently provided enthusiastic advice and support, both moral and material. By recognizing and emphasizing publicly that the history of particle physics is part of the cultural heritage of our time, a heritage that deserves to be preserved and understood in detail, he set a precedent for scientific research leadership that has already, since our symposium, been followed at other institutions. May West, of Fermilab's library staff, generously provided necessary support services at every stage: initial invitations to speakers, preregistration and registration, handling telephone calls and symposium correspondence, processing transcripts and manuscripts. To Helen Peterson we are indebted for imaginative and effective supervision of countless essential arrangements: allocation of funds and staff; design of preregistration, registration, and symposium procedures; physical accommodations at the symposium; and the hosting of foreign guests; to name but a few. The seminal role of Roger Stuewer of the University of Minnesota included his support and advice during the early planning of the symposium, deriving from his conception and organization of the first similarly structured symposium on the history of nuclear physics at Minnesota in 1977, our model and guide.

Among the many other Fermilab employees who contributed to the symposium or to this volume, we want to thank especially the following: Richard Carrigan, for general support during the symposium in countless essential functions, including auditorium arrangements and the hosting of guests; Drasko Jovanovic, for a tour of Fermilab during the symposium, help with the exhibits, and financial assistance; Susan Grommes, for months of typing and other support services; Alfred Brenner and John Ingebretsen of the Fermilab computing department, for essential technical assistance in the preparation of this book; Joanie Bjorken, for an excellent spouse-and-friends program and a delightful May-wine garden party that all the participants at the symposium enjoyed; Chris Quigg and the Fermilab theory group for summer support for one of us (L. M. B.) while editing this volume; Roger Thompson,

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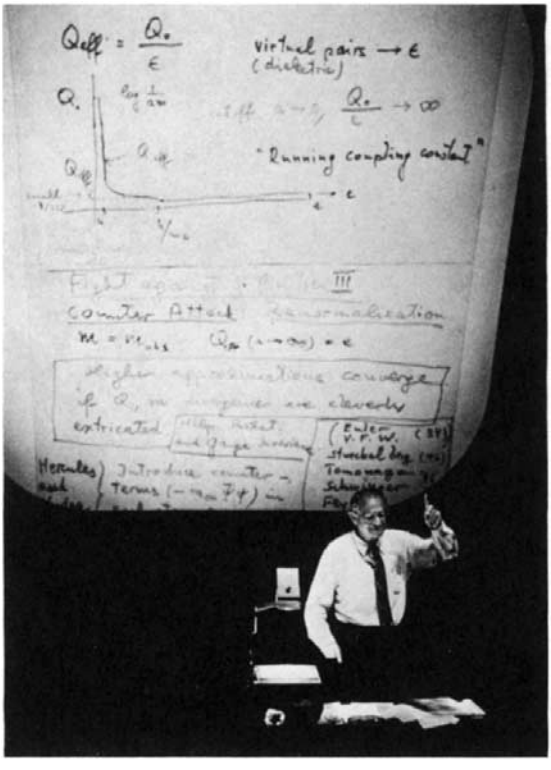
Photographs of the symposium

At May wine buffet, left to right: Laurie Brown, Julian Schwinger, Lillian Hoddeson, Peter Galison, Satio Hayakawa, Bruno Rossi (credit: Ryuji Yamada).

Paul A. M. Dirac (credit: Fermilab Photography Department).



Victor Weisskopf delivering his talk at the symposium (credit: Fermilab Photography Department).

Left to right: Satio Hayakawa, Abraham Pais, Robert Marshak (credit: Fermilab Photography Department).

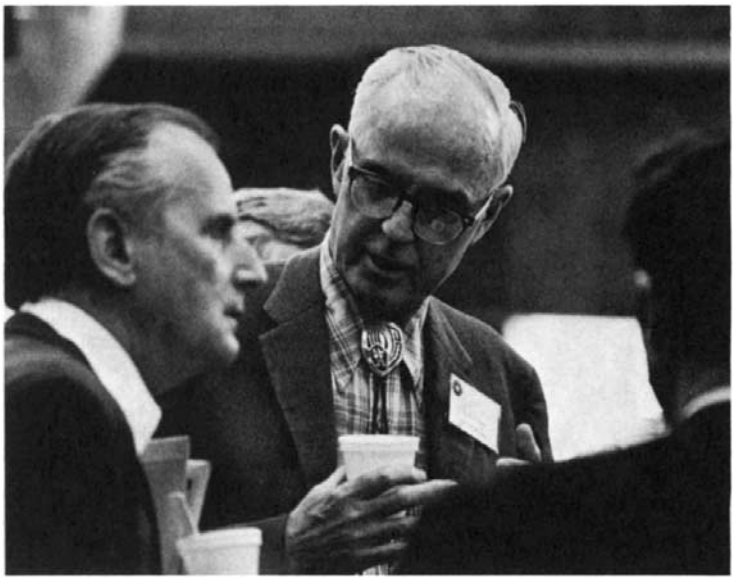
Left to right: Gilberto Bernardini and his former graduate student Leon Lederman (credit: Kathy Johnson).

Panel discussion, left to right: Herbert Anderson, Samuel Schweber, Victor Weisskopf, Paul Dirac, Gilberto Bernardini, Robert Seidel (credit: Fermilab Photography Department).

Panel discussion, left to right: Dudley Shapere, Charles Weiner, Robert Serber, M. G. K. Menon, Bruno Rossi, Satio Hayakawa (credit: Fermilab Photography Department).

Yoichiro Nambu and Takehiko Takabayasi (credit: Kathy Johnson).

Spencer Weart, Robert Wilson and M. G. K. Menon, conversing at symposium coffee break (credit: Fermilab Photography Department).



Willis Lamb conversing with participant at the symposium (credit: Fermilab Photography Department).

Part of symposium Planning Committee in the Milton G. White History of Accelerators Room at Fermilab, left to right: Richard Carrigan, Brigitte Brown, Laurie Brown, Donald Moyer, May West, Joan Bjorken, and Lillian Hoddeson (credit: Fermilab Photography Department).