Particle Physics in Its Early Decades

The Birth of Particle Physics. LAURIE M. BROWN and LILLIAN HODDESON, Eds. Cambridge University Press, New York, 1983. xxii, 412 pp., illus. $44.50. From a symposium, Batavia, Ill., May 1980.

Colloque International sur l'Histoire de la Physique des Particules. International Colloquium on the History of Particle Physics. Some Discoveries, Concepts, Institutions from the Thirties to Fifties. (Paris, July 1982.) Les Editions de Physique, Les Ulis, France, 1982. xxii, 496 pp., illus. Paper, 280 F. Supplement to *Journal de Physique*, no. 12, tome 43.

The history of science was once the history of the dead. But it has begun to catch up with the present and to encompass the history of the living. Scientists have begun to tell their own stories. These two volumes are among the latest manifestations of this trend. Both focus upon the formative early years of elementary physics (roughly, 1930 to 1955), and both derive from meetings at which leading experimenters and theorists of the period gathered to set down their recollections of key events. *The Birth of Particle Physics* grew out of an international symposium held at the Fermilab accelerator center in 1980 and combines the 12 papers presented there with edited transcripts of two round-table discussions between scientists and historians, eight post-symposium contributions, and an introductory essay by the editors. The International Colloquium on the History of Particle Physics was held in Paris in 1982. Its proceedings include 10 extended essays and 21 shorter accounts presented in round-table format (six of the latter are published in French). Fortunately, different scientists discussed different strands of history at the two meetings (the only exception is Julian Schwinger, who gave the same talk twice). The two volumes thus offer complementary accounts of the crosscutting developments that led to the birth of particle physics.

What were those developments? In their introduction to the Fermilab volume, Brown and Hoddeson argue that modern elementary particle physics emerged from the confluence in the 1930's and 1940's of three research traditions: nuclear physics, cosmic ray physics, and quantum field theory. Since the living had already had their say on the early years of nuclear physics (see *Nuclear Physics in Retrospect*, R. H. Stuewer, Ed., University of Minnesota Press, 1979), the emphasis at Fermilab and Paris was on cosmic rays and field theory. The heyday of cosmic ray research, as far as the discovery of elementary particles was concerned, lasted from the late 1920's until the mid-1950's (when a new generation of high-energy particle accelerators took over the lead). During this period, the set of known particles expanded from two—the proton and the electron—to many. Only Chadwick's 1932 discovery of the neutron emerged from the nuclear physics laboratory; cosmic ray experimenters claimed the positron (1932), the muon (1937), the pion (1947), and the first strange particles (1947 onward). Several groups scattered cross Europe and the United States played a significant role in these developments, and many of the experimenters centrally involved contributed to the Fermilab and Paris volumes: Dmitry Skobeltzyn, Carl Anderson, Bruno Rossi . . . the list goes on.

In parallel with the experimental work on cosmic rays, theorists were busy elaborating quantum field theory. Dirac laid the foundations of quantum electrodynamics (QED) in 1927. It was quickly found that the theory had a "disease": infinities appeared when perturbative calculations were extended beyond the leading order. Only in the late 1940's was the disease cured in the "renormalization" program of Feynman, Schwinger, and Tomonaga. By that time, the field theory approach had already been extended to the weak and strong interactions. In 1934, following up a suggestion of Pauli, and modeling his approach on QED, Fermi wrote down his celebrated theory of beta decay. And, in the same year, Yukawa published his theory of the nuclear force. He too modeled his approach on QED, and thus predicted the existence of the pion—a massive, strongly interacting analogue of the photon. Theoretical progress in Europe, the United States, and Japan was recalled at Fermilab by Dirac, Weisskopf, Hayakawa, Serber, and Schwinger. Also included in *The Birth of Particle Physics* is Schwinger's memorial lecture for Sin-itiro Tomonaga, which brings out interesting parallels between Tomonaga's career and his own. Original contributions at Paris on the history of field theory came from Amaldi, Pontecorvo, and Marshak. In addition, Nicolas Kemmer gave an excellent account of the history of the isospin concept, and Murray Gell-Mann did the same for strangeness.

New disciplines are not purely intellectual creations. They grow up within, and are structured by, a network of wider contexts: social, political, economic, and institutional. Some explicit attention was given to such factors at the Paris colloquium—Spencer Weart, the only historian to speak, mapped out "The road to Los Alamos," and a round-table session was devoted to institutional arrangements in the early years of particle physics. The Fermilab volume contains no material organized around comparable "external" themes. But, implicitly at least, both volumes contain much information on the social circumstances of the birth of particle physics.

Above all, the early years of particle research were marked by the rise of fascism and World War II. Much has already been written on the enforced emigration of physicists from Germany and Italy in the 1930's and the consequent shift in the intellectual center of gravity of physics from Europe to the United States. Many of the essays in these collections bear witness to the impact of this process upon the careers of those who left Europe and those who stayed behind. The significance for later developments of war work in Europe, North America, and Japan is also much discussed. In the Fermilab volume, for example, Willis Lamb's fascinating essay traces his route to the 1947 discovery of the "Lamb shift" (which supplied the crucial impetus for the renormalization of QED) back to his wartime work at Columbia on magnetrons. Schwinger notes how, in a different way, magnetron research laid the basis for later work on renormalization theory, his own and, independently, Tomonaga's. In the Paris collection, Frederick Reines reveals the crucial importance of the continuing U.S. atomic weapons program to the experimental demonstration in 1953 of the existence of the neutrino.

One aspect of the impact of World War II upon particle physics was left largely unexamined at Fermilab and Paris: the physicists' rise to political power especially in the United States, through their contribution to the war effort (Edwin Goldwasser touched briefly on this topic in his Paris talk). The principal consequence of this new-found power was massive funding for particle accelerators. But since accelerator physics lay outside the purview of both meetings the omission is understandable.

Taken together, *The Birth of Particle Physics* and the proceedings of the International Colloquium make fascinating reading for anyone interested in the intellectual and social formation of elementary particle research. The Fermilab volume is better produced and edited, and Brown and Hoddeson's introduction provides a much-needed synthetic perspective, but the Paris volume covers a wider range of topics. The organizers and speakers at both meetings are to be congratulated. But a caveat is nevertheless in order. On one key point of interpretation, the vision of history offered by the scientists needs to be challenged. It concerns the relationship between theory and experiment in the 1930's and 1940's and, in particular, the sources of theorists' reluctance to countenance the existence of new particles.

Certainly such resistance was manifest. In the mid-1930's, for example, data on the "penetrating component" of the cosmic ray flux were hard to reconcile with QED, but theorists like Bohr and Oppenheimer preferred to ascribe this to a failure of QED rather than to the existence of a new particle (later, the muon). Yukawa's prediction of the pion was at first widely ignored in the West. Eventually the "Yukon" was identified with the penetrating cosmic ray component, despite considerable discrepancies between predictions and observations. There followed a decade of confusion, only resolved in 1947 with the two-meson hypothesis—the idea that there were not one but two new particles, the muon and the pion, and that both were to be found in the cosmic ray flux.

Time and again, at Fermilab and Paris, theorists asked themselves why they had been so reluctant to acknowledge the existence of the muon and the pion. And repeatedly they responded with a doctrine of psychological resistance: we lacked the courage to accept the possibility of new particles. This explanation does not ring true. It is hardly conceivable that the men who advanced quantum mechanics, leaving the foundations of classical physics in tatters behind them, should have been held back from proposing the odd new entity by fear (of what?).

The history of the living seems here to slide into myth. Far more plausible, given the background of the leading theorists of the day, is that the existence of new particles appeared to them at most tangential to their enterprise. They were in the business of building new systems, and, having laid the foundations of quantum mechanics, they felt that it was time to move on. Apparent failures of QED were *welcomed* as clues toward the structure of its successor. Many historical instances of this latter attitude are to be found in the Fermilab and Paris volumes, sitting uneasily alongside assertions of psychological inhibition. And it is noteworthy that the "boldness" of Japanese theorists in proposing the existence of new particles—Yukawa's prediction of the pion was just the beginning—can be directly correlated with the isolation of Japan from the main centers of theoretical authority in Europe and the United States. The Japanese had no Bohrs or Oppenheimers breathing down their necks. (On the positive side, the role of Taketani's Marxist epistemology in encouraging the invention of new particles also deserves attention: see Takabayashi's contribution to *The Birth of Particle Physics*.) The history of the dead has bequeathed us enough myths; we should be wary of new ones offered by the living.

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Newton

In the Presence of the Creator. Isaac Newton and His Times. GALE E. CHRISTIANSON. Free Press (Macmillan), New York, and Collier Macmillan, London, 1984. xvi, 624 pp., illus., + plates. $27.50.

In the wake of Richard S. Westfall's widely acclaimed *Never at Rest* (Cambridge University Press, 1980) comes another, only slightly less massive, biography of Isaac Newton. Since comparisons are tempting, it is important to signal at the outset the essential difference between the two works. Westfall's is a scientific biography. It keeps continuing focus on Newton's science and on the manner in which his ideas arose and matured. A magisterial account, it draws its strength from Westfall's own original contributions to historical scholarship concerning Newton's optics, the development of mechanics from Galileo to Newton, and the relations of science and theology. By contrast, Christianson speaks only second-handedly of Newton's science, turning for judgments in that realm to Westfall and the other scholars who over the past quarter century have done so much to open that solitary genius to critical examination.

In the Presence of the Creator constitutes a popular biography, a "life and times" that uses the stages of Newton's scientific development essentially as points of departure for essays into his personality and into the people, institutions, and locales that surrounded him. Although Christianson offers no new insights, he does present a thoughtful, balanced picture of a genius tortured by self-doubt. The conditions of Newton's birth and his obviously unusual mental powers gave him a sense of special election, while the circumstances of his upbringing and his rigorous and continuing self-criticism engendered a feeling of unworthiness. The resulting tension, as Christianson convincingly illustrates through various episodes and encounters, shaped a man who oscillated between rank arrogance and painful shyness, who craved intimacy while thrusting others from him, who attacked the work of others while resenting (or, rather, fearing) their criticism of his, and who insisted on the priority of his inventions while refusing to publish them. Christianson attempts no facile resolution of these polarities of behavior; rather, he makes them understandable, urging the reader's acceptance of the complexity of Newton's character, in part as a reflection of the complexity of the culture and of the times in which he lived.

Christianson is at his best in conveying the details and circumstances of Newton's life. His many vignettes of the people and events surrounding Newton are both interesting and entertaining, and they offer the reader a revealing sense of time and place. One feels oneself at times in the company of an accomplished tour guide who not only describes the layout of, say, Newton's Woolsthorpe house, or Trinity College, or London, but also fills those places with the people and events that gave them meaning. Christianson has the skilled writer's eye for the telling detail, be it a phrase from a document, an anecdote, or a forgotten custom, that pulls a scene together. Indeed, he does not hesitate every now and then to invoke the novelist's license to imagine what his subjects must have thought or felt at particularly dramatic moments.

Yet the wealth of detail, and the insight it offers, remain throughout the book external to Newton's science, revealing its context, not its content. Hence, the reader who already knows something of the science will find nothing new here, and the reader who is wholly unfamiliar with it will not learn