than in the electrical industry, but in both industries conversion to war production created new work processes that had no traditional gender assignment. Yet after the war, though there were protests and conflict over the role of women in industry, the concerns of both unions and management, among them fear of another depression, precluded an effective direct challenge to the traditional ideology of women's work.

Milkman argues that pre-war experiences shaped the positions taken by the unions after the war as the issue of sexual division of labor became part of wider industry-labor conflicts. In the automobile industry, where there was not a history of attempts to replace men with women, the UAW looked to seniority as the means of protecting its male membership's jobs. The UE, by contrast, fearing displacement of its male members by the cheaper labor of women, saw its interest as lying in pay equity between the sexes.

Historians have analyzed the reversion of women to traditional roles after World War II from several perspectives. Some have focused on the role of an ideology of domesticity in convincing women to return to the home, and others have emphasized the role of unions, which used seniority as a way to force women out of their wartime jobs. Milkman believes these arguments provide only a partial explanation. She persuasively argues that, owing to the "weight of tradition" and its perception of labor's ambivalence, management through its control of the hiring process played a central part in restoring the pre-war status of women. Though women union members often fought to maintain the gains that had been made during the war, they were caught between their class interests as union members and their gender interests as women. Unlike blacks, who had the NAACP to support them, women in the 1940s had no outside movement to back their cause. Though the post-war conflicts in the electrical and auto industries differed, the outcome was the same; women could not capitalize on their wartime gains. The traditional roles of women in these industries had been established at the beginning, and management reinforced them after the war.

Milkman's subtle analysis of the industrial structure is a major step forward in understanding the roots of the persistent problem of occupational sex segregation. *Gender at Work* is valuable not only as a historical monograph but as a contribution to theory.

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# Career of a Physicist

**Alvarez**. Adventures of a Physicist. LUIS W. ALVAREZ. Basic Books, New York, 1987. xii, 292 pp. + plates. $19.95.

**Discovering Alvarez**. Selected Works of Luis W. Alvarez, with Commentary by His Students and Colleagues. W. PETER TROWER, Ed. University of Chicago Press, Chicago, 1987. x, 272 pp., illus., + plates. $37.50.

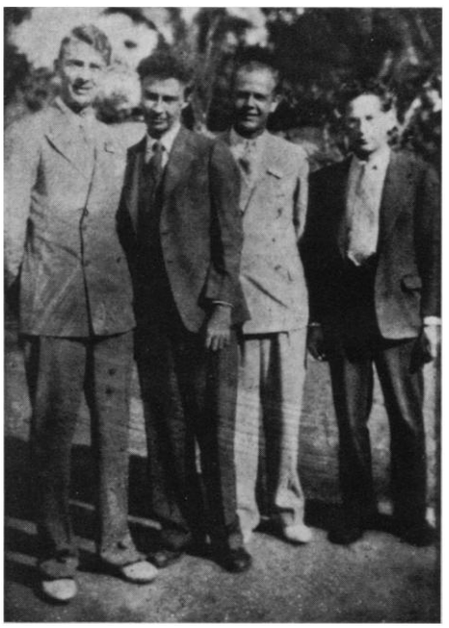
Luis W. Alvarez is one of the most remarkable physicists of the 20th century. During his long career he has made impressive contributions in a surprising variety of fields: nuclear physics; radar development; the atomic bomb; accelerator design; elementary particle research; cosmic ray investigations, including a search for hidden chambers in the pyramid of Chephren using cosmic ray muons to form an "x-ray" image; earth history with the formulation and study of a hypothesis that mass extinctions at the end of the Cretaceous period were caused by impact with Earth of an asteroid or other large extraterrestrial object. The highlights of this career and the stories behind the accomplishments that have marked it are the subject of these two books.

While he was a student at the University of Chicago in the early 1930s Alvarez worked in optics and cosmic ray physics, the latter under Arthur Holley Compton. He then went to Berkeley and began his long association with Ernest O. Lawrence and the Radiation Laboratory. During the first four-and-a-half years there he carried out several outstanding experiments in nuclear physics. These included pioneering work on K-electron capture by nuclei, a remarkable measurement, made with Felix Bloch, of the magnetic moment of the neutron using the magnetic resonance technique with a neutron beam, and a study of helium and hydrogen isotopes of mass 3 showing that, contrary to then-current assumptions, $^3$He is stable and $^3$H radioactive.

Then, in late 1940, he departed for the Massachusetts Institute of Technology to join the new radar project, and he contributed much to its spectacular success. During this period he invented and developed with Larry Johnston the ground-controlled approach (GCA) system for landing aircraft in bad weather. Later he joined the atomic bomb project at Chicago and Los Alamos, where he made a crucial contribution regarding simultaneous detonation of many explosive lenses for the implosion bomb. At the end of the war Alvarez and a few colleagues flew on the Hiroshima mission in order to make measurements of the blast wave using equipment they had developed. The experiences during war work in both the radar and the atomic bomb projects were exciting indeed, and the descriptions of this period, by Alvarez in the autobiography and by Johnston in *Discovering Alvarez*, are highlights of both books.

After the war Alvarez returned to Berkeley and to his work in physics, invention, accelerator design and building, and the other diverse enterprises mentioned at the beginning of this review. The work for which he has received the most acclaim, including the 1968 Nobel Prize in physics, was the development and construction of the large hydrogen bubble chamber, together with the complex measuring equipment necessary to utilize it effectively, and his leading role in the large experimental effort devoted to exploiting this powerful technique. This program was extraordinarily productive; during a period of several years in the late '50s and early '60s it produced many of the most important results in elementary particle physics.

In a chapter of his autobiography entitled "Scientific detective work" Alvarez describes two examples of how he applied his powers of observation and analysis to reach unexpected conclusions. One was finding a very ingenious "conventional" explanation for a cosmic ray event found by a Berkeley colleague who had interpreted it as a magnetic monopole. If true this would have been a fantastic discovery, but after Alvarez's analysis no one believed it was true. The other example was an analysis of evidence concerning the Kennedy assassination, primarily that contained on an eight-millimeter film taken by Abraham Zapruder. Although the film had been examined by experts for the Warren Commission, Alvarez was able to reach new and important conclusions from it. Although these incidents represent relatively minor accomplishments in Alvarez's career, they illustrate an approach to problems and methods of attack that are characteristic of much of his work. Many scientific problems require the same sort of scientific detective work for their solution. We could hardly find a better example than the puzzle presented by the geological sample from the Cretaceous-Tertiary boundary near Gubbio, Italy. This sample, shown to Alvarez by his son Walter, led eventually to the impact hypothesis for explaining the extinctions at the end of the Cretaceous. The fascinating



"Four future presidents of the American Physical Society," photographed in 1938. *Left to right*, Luis W. Alvarez, J. Robert Oppenheimer, William A. Fowler, and Robert Serber. [From *Discovering Alvarez*]

story of the development of this hypothesis is recounted in both books. The extraterrestrial cause of the extinctions is widely but not universally accepted (see, for example, the article by A. Hallam in *Science* 27 November 1987). In any case, the original article by Alvarez *et al.* has stimulated an enormous amount of work and thought on the subject, and it has also raised the issue of a possible nuclear winter resulting from nuclear war.

*Discovering Alvarez* is a splendid book in which students and colleagues take us beyond what is printed in the technical publications to explain how a number of experiments and projects were conceived, developed, and carried out. These commentaries not only make clear what Alvarez's contributions to these programs have been, especially in basic ideas, but they also show the admiration and affection with which he is regarded by most of the contributors to this volume.

For me, this book conveys better than the autobiography the impressive nature of Alvarez's scientific work. One reason, perhaps, is that the colleagues who wrote commentaries were not inhibited from bestowing praise on their subject. Another, however, is the reluctance of Alvarez himself to include much technical matter in the autobiography. In the introduction he writes, "Parts of the book may be too technical for some readers; such parts can be easily skipped"—as he himself did when reading Abraham Pais's biography of Einstein, *Subtle Is the Lord*. But there is no comparison in this regard. Pais's book is full of highly technical material, which most readers will not really understand, but it is a marvelous book, not in spite of this material but partly because of it. In contrast, Alvarez has been overly successful in keeping his book from becoming too technical. I think if he had taken the opportunity to explain a little more of the physics behind some of his experiments, especially in the early sections, the book would have been improved for readers having an interest in science (and surely these make up the bulk of potential readers). In any case, a desire to learn more about the technical aspects of the experiments or programs can be satisfied by referring to *Discovering Alvarez*.

These books provide many insights for answering an inevitable question raised by Alvarez's career: how was one person able to accomplish so much? We obviously cannot answer that question, but some factors contributing to his success are easy to identify, besides the obvious ones of exceptional intelligence and a capacity for hard work. He has an acute observational skill coupled to a well-developed curiosity about how and why things happen the way they do. He has a great analytical ability and a willingness to use it. He is original in his thinking, questioning conventional wisdom. He knew when to leave work to others and when to do it himself. He was lucky in obtaining the requisite funding for his projects with a minimum of delay and red tape. In his autobiography he explains his disdain of our present peer review system for funding and recommends that funding decisions be based on the applicant rather than on the proposal. This is the way his programs were funded; when he asked E. O. Lawrence for help in obtaining $2.5 million for the 72-inch bubble chamber project Lawrence told him that it was too large an extrapolation and that he didn't believe in the big chamber, but "I do believe in you, so I'll help you get the money." Finally, another important factor for success was the attention paid to the advice of his father, who emphasized very early the value of thinking about the importance of what one is working on; in particular, "he advised me to sit every few months in my reading chair for an entire evening, close my eyes, and try to think of new problems to solve. I took his advice very seriously and have been glad ever since that I did." When reading these books it is interesting to speculate about which of Alvarez's ideas were a direct result of following his father's advice.

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## A Biochemist in America

**In Quest of Panacea.** Successes and Failures of Yellapragada SubbaRow. S. P. K. GUPTA with EDGAR L. MILFORD. Evelyn, New Delhi, India, 1987 (available from Preethi Kiran, 260 Avon Road, Devon, PA). 311 pp. $15.

Yellapragada SubbaRow (1895–1948), characterized in his obituary in *Science* as an "India-born biochemist," made his way to the United States as a young man, obtained a Ph.D. at Harvard, and ultimately became the leader of a productive research group in the American pharmaceutical industry. The author of this valuable account of his career is a journalist whose interest in SubbaRow was aroused during the 1940s by Paul de Kruif's articles in the *Reader's Digest*. After SubbaRow's death, Gupta collected extensive material about him from published and archival sources and interviewed many individuals who had known him. Among these people were SubbaRow's relatives and friends in India, his colleagues at the Harvard Medical School (where he had worked from 1923 until 1940), and his associates in the Lederle Laboratories of the American Cyanamid Company, where he had spent the remaining years of his life. The book that has emerged from Gupta's painstaking efforts was long in the making, and its publication appears to have been beset by difficulties. The New Delhi address of the publisher is the same as that of the author, and the book was printed in Moscow at a time when Gupta was a press correspondent there. Clearly, for the author SubbaRow has been a source of inspiration and national pride, but hagiography has been blended with frank recognition of some of the less attractive features of SubbaRow's complex personality. Despite its modest format and somewhat disjointed organization, as well as a plenitude of typographical errors, this book merits the attention of historians of American science.

From the book we learn that SubbaRow had been a rebellious young man and that, four years after his marriage of convenience in India, he left his 16-year-old wife to study public health at Harvard, where he became associated with Cyrus Hartwell Fiske (1890–1978), a member of the medical school department of biochemistry. Fiske assigned SubbaRow the problem of improving the then-available method for the determination of the phosphate content of biological fluids. By assiduous effort, and in the face of many personal difficulties, SubbaRow succeeded and thereby won recognition as a promising young biochemist. Then followed (in 1927) the identification by Fiske and SubbaRow of creatine phosphate