

A history of women scientists overcoming barriers

Women Scientists in America: Struggles and Strategies to 1940

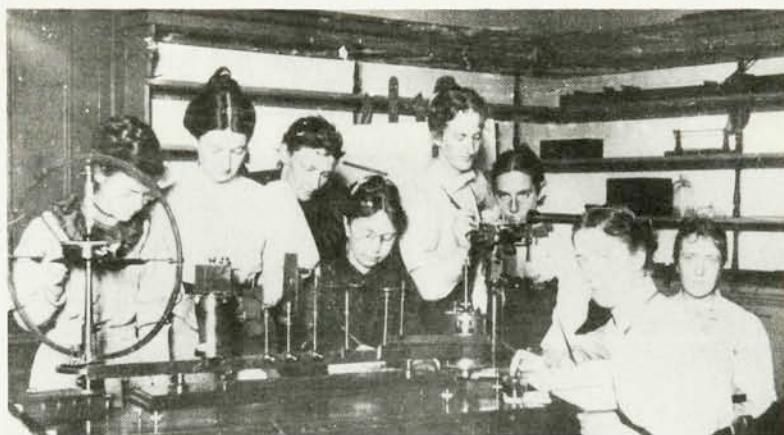
M. W. Rossiter

439 pp. Johns Hopkins U.P., Baltimore, Md., 1983. \$27.50

Reviewed by Melba Phillips

One need not be, by sex, age and profession, a statistic in Margaret Rossiter's history (as this reviewer is) to recognize it as a truly path-breaking book. The only comparable, though quite different, study is the famous *Women in Science* by H. J. Mozans (pseud.), which was first published in 1913 and included only a few Americans. The present work, as the title indicates, is confined to American women, and the subtitle, "Struggles and Strategies to 1940," suggests its character and its limitations. The actual scientific accomplishments are not emphasized in comparison with the trials and troubles and the all-too-rare rewards; a second volume, starting with World War II, is already in preparation.

Rossiter notes the rise of higher education for women in the 19th century: "By mid century this nation led the rest of the world in the amount of public and private education available to its women." Even earlier women had studied informally and contributed significantly to such sciences as botany, natural history, astronomy and geology, often as assistants or co-workers with husbands or male relatives. One does not hear of women in physics, but physics was not much cultivated here in those times. Many school teachers were women (with salaries typically only a fraction of those paid to men teachers). The prestigious men's colleges did not admit women, nor did the early denominational schools, but there were seminaries in the major



Sarah Whiting with her students at Wellesley College in the academic year 1895-96, in a photograph in *Women Scientists in America*. Annie Jump Cannon, who became an important astrophysicist, is here a postgraduate assistant, third from the left. (AIP Niels Bohr Library)

county seats throughout the country. Full collegiate education of women began with the establishment of Vassar in 1865, although Oberlin had been coeducational since its opening in 1833 and most of the new state-supported schools admitted women students. Advanced training in science was—and remained—harder to obtain.

In the 1860s the PhD was imported from Germany, where women were not admitted for graduate degrees, and by 1870 American women were beginning to demand opportunities for advanced study and degrees equal to those becoming available here for men. The first was Ellen Swallow (later Richards), a special student in chemistry at the new Massachusetts Institute of Technology; she was turned down, it was said, because the chemistry department did not want its first graduate degree to go to a woman. But the demands continued, and graduate schools began to admit women—even while they were excluded from undergraduate classes—usually on an individual basis under special circumstances. The women carried their struggle back to the original research

schools, in Germany, where Americans were actually admitted before German women were allowed. The first Göttingen doctorates for women came in 1895, and the first in physics was earned that year by an American, Margaret Maltby. By 1900 the right of women to study and obtain degrees had been essentially won both here and abroad. There were some holdouts: Johns Hopkins University, the first full-scale graduate school in America when it opened in 1876, did not admit women officially until 1907. One of the faculty on record as opposing women applicants and defending their exclusion was Henry A. Rowland.

Women also gained access to scientific societies, from which they had been excluded as regular members if not altogether. In 1899 two women attended the founding of the American Physical Society: Marcia Keith of Mt. Holyoke and Isabelle Stone of Vassar. (The two women who attended the founding of the American Association of Physics Teachers 31 years later were Louise McDowell of Wellesley and Frances Wick of Vassar.) Women had gained the right to become scientists

Melba Phillips is a theoretical physicist and former president of the AAPT. Professor emerita at the University of Chicago, she now lives in New York City.

but had few opportunities for pursuing science. There were some academic jobs in normal schools and seminaries, but women physicists depended on women's colleges for employment. Teaching duties were heavy, and not even the elite schools had adequate facilities for research. Only Bryn Mawr had a graduate school. Rossiter reports that by the 1930s the women's colleges were increasingly replacing women faculty by men. For this she blames mainly a growing stress on "the antifeminist concept of 'prestige.'" One may argue the merits, but in fact the colleges gave higher priority to the perceived good of the students than to the hiring of women in preference over men, who were more able both in teaching and in research. The problem is a thorny one. Just as with the employment of blacks and other minorities, there is, in addition to prejudice, the danger that standards are too low

(only routine) or too high (demands for proved genius). This remains true today, in almost every kind of employment.

But the letter of the law has changed, if not yet the practice. No longer would Princeton mathematicians need to appeal to Bryn Mawr to find a place for Emmy Noether, already a famous mathematician. And no longer would Robert Millikan feel free to advise the president of Duke University against hiring Hertha Spöner—or any other woman, for that matter. "I might change this opinion if I knew of other women who had the accomplishments and attained to the eminence of Fraulein Meitner." (This was as late as 1936.) Inadequate as the improvement may seem, many advances for women in science have been made since 1940, when the present volume breaks off. One can look forward to a continuation of this readable and scholarly account.

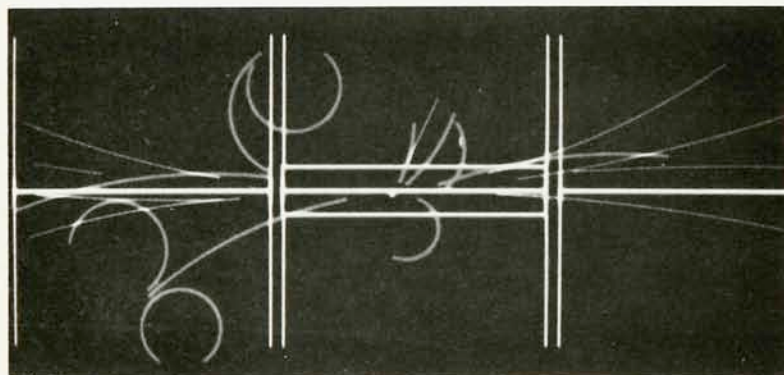
with local non-Abelian gauge invariance, both exact and spontaneously broken; the quantization of gauge fields using path integrals and the resultant graphical rules, including the important fictitious particles named for Ludwig Faddeev and Viktor Popov; the systematic proof of renormalizability preserving gauge invariance and, for the spontaneously broken case, the use of the gauges introduced by Gerard 't Hooft. This formalism could then be illustrated by the standard electroweak theory developed by Sheldon Glashow, Abdus Salam and Steven Weinberg.

The formalism of the renormalization group is also needed, to explain the asymptotic freedom of quantum chromodynamics (QCD) and the possible unification of strong and electroweak interactions. Finally, for QCD, some discussion of nonperturbative techniques, including the lattice approach, is desirable.

One should mention several reviews and books previously written. Ernest Abers's and Benjamin Lee's *Gauge Theories* (1973) educated a generation, but its treatment of renormalization is now obsolete; John C. Taylor's *Gauge Theories of Weak Interactions* (1976) is excellent but somewhat too cryptic; Claude Itzykson's and Jean-Bernard Zuber's *Quantum Field Theory* (1981) is useful and scholarly but unfortunately only the last fifth is dedicated to non-Abelian gauge theory. All three are worth owning; none fits the "ideal" outlined above.

The first of the two books under review is *An Introduction to Gauge Theories and the "New Physics"* by Elliot Leader and Enrico Predazzi. "New physics" is, of course, strongly time-dependent. In this case it means the discovery of new elementary particle phenomena such as the charm and beauty quantum numbers, the τ lepton, and jets. The authors present a great deal of experimental information along with some tricks necessary to calculate observed quantities. These might have proven useful to a student experimentalist; however, in these sections the authors seem more intent to describe the history of high-energy physics in the seventies than to provide a pedagogic exposition of the experimental results obtained during that time. Because of this reportorial approach, these chapters now have limited interest. The book's coverage of experimental topics does not compare with the excellent exposition given in *Introduction to High Energy Physics* by Donald Perkins (Second Edition, 1982).

Leader and Predazzi also devote considerable space to gauge theory formalism. Their discussion of constructing the classical Lagrangian is adequate, but their treatment of quantization is too sketchy. For instance, they do not



One of five intermediate vector boson events detected in January by the UA1 detector group at the proton-antiproton collider at CERN. These events fulfilled a prediction of the Glashow-Salam-Weinberg gauge theory, discussed in the book review below.

An Introduction to Gauge Theories and the "New Physics"

E. Leader, E. Predazzi
498 pp. Cambridge U.P., New York, 1982.
\$65.00 cloth, \$27.50 paper

An Informal Introduction to Gauge Field Theories

I. J. R. Aitchison
174 pp. Cambridge U.P., New York, 1982.
\$22.50

Application of non-Abelian gauge theories to both the strong and the electroweak interactions is now almost universally accepted. Gauge theories of the non-Abelian type are apparently here to stay, along with the Abelian prototype of quantum electrodynamics from which they were generalized. Gauge field theory, now synonymous with high-energy theory, forms the essential part of the graduate education of particle physicists, both experimental and theoretical.

Those teaching and studying particle physics, therefore, need good books on gauge field theories. I recall that for graduate students in 1965 several excellent texts covered quantum electrodynamics: *The Theory of Photons and Electrons* (1955) by Josef Jauch and Fritz Rohrlich, *An Introduction to Relativistic Quantum Field Theory* (1961) by Silvan Schweber, *Relativistic Quantum Mechanics* (1964) and *Relativistic Quantum Fields* (1965) by James Bjorken and Sidney Drell. By studying one or more of these books and occasionally going back to the original literature they cited, one could acquire a good working understanding of quantum electrodynamics.

I am hoping to find a comparable book on non-Abelian gauge theory, one that would not devote half its pages to quantum electrodynamics or to the canonical quantization of scalar field theory. This "ideal" book would discuss as formalism: the general rules of constructing classical Lagrangians