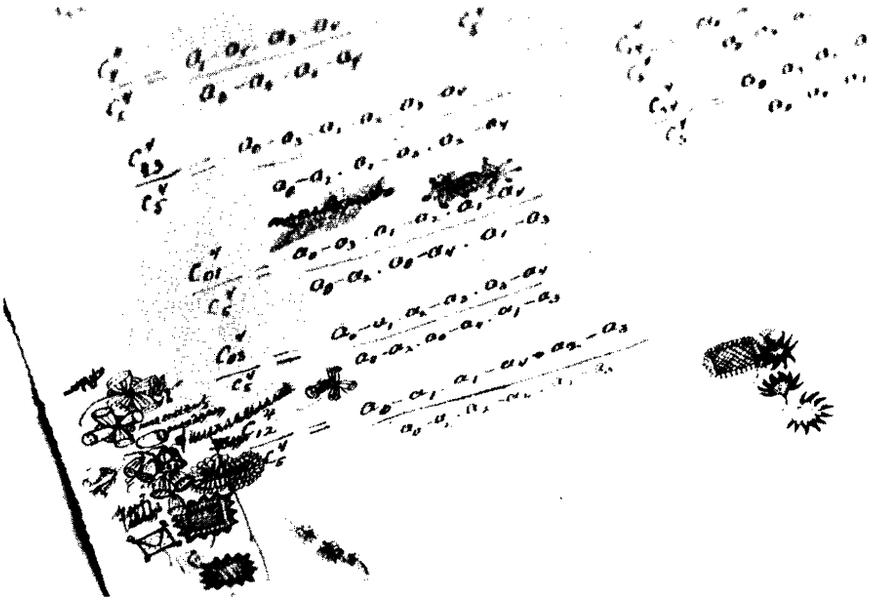
opportunities of western Europe and then offer her total independence, disappearing from her life if she so dictated. After marriage Kovalevskaia decided to study for a career in mathematics rather than medicine, and the Kovalevskiis (whose complicated marriage eventually produced a daughter before ending in separation) moved around western Europe in search of a university and a mathematical adviser for her. Kovalevskaia finally received a doctorate in mathematics in 1874 from Göttingen for work done in Berlin under Weierstrass, whose own university refused even to grant her admission.

Doctorates in hand, the Kovalevskiis soon returned to Russia with expectations of university teaching positions. Their hopes were dashed, however, as old-line Russian academics disapproved of the couple's foreign degrees; in addition, Kovalevskaia found that she, as a woman, was barred from all university positions. Only in 1883, after Kovalevskii's suicide conferred the respectability of widowhood on her, did she obtain a university appointment—an unsalaried one at Stockholm that was converted later into the extraordinary professorship assured by Mittag-Leffler's politics and eventually into a lifetime professorship.

According to Koblitz, nihilism inspired not only Kovalevskaia's commitment to science but her nonscientific activities as well. In the middle of their doctoral studies, for example, the Kovalevskiis spent a month in the Paris Commune of 1871, where Kovalevskaia served as a nurse. Throughout her life, Kovalevskaia supported higher education for women, by signing petitions and offering her own western European apartments as havens for scholarly émigrées. Her literary writings were also political statements; her reminiscences, plays, novels, and essays covered topics in socialism, communism, feminism, and public education.

Thus this biography succeeds in integrating Kovalevskaia's science, radical leanings, and literary writings. Interestingly, however, as Koblitz struggles to achieve this unified portrait, she comes close to slighting her subject's mathematics. The mathematical ideas of Kovalevskaia are, in essence, confined to a 17-page chapter (chapter 13, "Kovalevskaia's mathematics"), which offers lean prose descriptions of Kovalevskaia's ten mathematical papers, supplemented by a few relevant quotations from such leading mathematicians as Weierstrass and Poincaré. Koblitz follows her sketches of the papers with the observation that



"Typical page of Kovalevskaia's mathematical computations, complete with doodles." [From *A Convergence of Lives*; Institut Mittag-Leffler archives—Angela Wanglert photo]

"it is possible . . . Sofia's main importance lies in what she did in a general mathematical sense even more than in what she wrote" (p. 245). But the ensuing discussion of Kovalevskaia's role as a bridge between Russian and western European mathematics and mathematicians is also weak in detail. This section, following the lead of earlier parts of the biography, posits basic differences between Russian and German mathematics. The differences, however, are never delineated beyond the repetitious assertion that Russian mathematicians preferred a "down-to-earth" approach emphasizing problems whereas the Germans engaged in "analysis for analysis' sake." Kovalevskaia, Koblitz's argument continues, was comfortable in both worlds and transmitted ideas between the two. Intriguing and important, this thesis would probably improve with elaboration, refinement, and supporting examples.

Not then a scientific biography of Kovalevskaia and her mathematics, Koblitz's work is recommended as a good popular biography whose strength rests on use of the main Russian and Swedish manuscripts and on successful integration of Kovalevskaia's multiple roles. The biography is especially fine reading for those with a contemporary interest in women in science. These readers will want to note Kovalevskaia's responses to such problems as: juggling a career and motherhood (she temporarily relinquished care of her daughter); coping with success (upon her appointment at Stockholm, Kovalevskaia experienced feelings of inadequacy, which Koblitz attributes to internalized prejudice); and caring for a house (a messy housekeeper, Kovalevskaia once remarked that, if a man, she would marry a pretty housewife!).

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A Life in Astronomy

Cecilia Payne-Gaposchkin. An Autobiography and Other Recollections. KATHERINE HARAMUNDANIS, Ed. Cambridge University Press, New York, 1984. vi, 269 pp., illus. $34.50.

The first quarter of this century brought with it swift developments in atomic and chemical physics. Astronomy rapidly changed from its purely mathematical emphasis to stressing its physical bases and recognizing the importance of preserving carefully collected observational data. Harvard Observatory was a major force in the advancement of astronomy during this period, when Harlow Shapley gathered around him gifted young researchers. The astronomer Cecilia Payne-Gaposchkin (1900–1980) played substantial roles both in the interfacing of modern physics with astronomy, notably in her acclaimed Ph.D. thesis on stellar atmospheres (1925), and in the sustenance of the heady intellectual climate at Harvard. Katherine Haramundanis (Payne-Gaposchkin's astronomer daughter) has put together an unusual memorial in this book.

There are four sections to the book; the primary *raison d'être* is Payne-Gaposchkin's autobiography, "The Dyer's Hand." This is preceded by personal recollections by Haramundanis of her parents and brothers and her view of the cast of characters at Harvard Observatory. The two introductions are interesting in providing two different perspectives of Payne-Gaposchkin and her work. The first, by Jesse L. Greenstein, draws in bold strokes a picture of physics in the early 1920's. The emerging view of the atom and the uncertain chemical origins of Earth, Sun, and stars were united in one thesis, in which Payne-Gaposchkin brilliantly demonstrated that all stars had nearly constant compositions. In addition, she found that stellar atmospheres showed enormously larger amounts of hydrogen and helium compared with abundances found in meteorites. Her superiors held a conservative view, however, and she wrote in her thesis that "the enormous abundance derived . . . is almost certainly not real," thus bowing to authority and doubting her own remarkable results. She was of course vindicated within five years. Greenstein, himself an eminent astrophysicist, describes Payne-Gaposchkin as an "extraordinary figure" with a deep "intuition as to what was important in astronomy."

The second introduction is by science historian Peggy A. Kidwell, who focuses on the thesis years 1923–1925. Kidwell has dredged up original letters of reference written to Shapley by Payne-Gaposchkin's Cambridge University mentors Eddington and Comrie. They spoke glowingly of her "wide knowledge" and enthusiasm. Curiously, Comrie added that "she would not want to run away after a few years training to get married." To present-day opinion this seems a questionable statement, but in 1923 it could only have been meant as a compliment. She accepted the small stipend offered by Shapley and thus began the half-century-long association with Harvard. Kidwell writes of Payne-Gaposchkin's earliest months of "utter bewilderment" as she struggled to understand her new data and of how, two years later, she had written six papers and the monograph on the ionization potentials of many elements and the temperatures, spectra, and abundances in the atmospheres of OB stars. The great Henry Norris Russell wrote of her that she was "quite the best of the young folks" in astrophysics, though even this was not enough for a young woman to get a job in those days. Kidwell airs a letter from Payne-Gaposchkin's unhappy years as she moved "upward" into teaching and lecturing at Harvard. She wrote, "I cannot appear in the catalogues; I do give lectures, but they are not announced in the catalogue, and I am paid for (I believe) as 'equipment.' " Shapley did make some improvements in her salary and working conditions, but the president of Harvard refused her the listing as instructor. It was not until she was 56 that she achieved an appointment as full professor, the first woman to obtain this rank at Harvard.

In "The Dyer's Hand" Payne-Gaposchkin writes, "If I have made a contribution, it has been by collecting, turning over in my hands, comparing and classifying the data of astronomy." Clearly, she had a genius for assimilating and unifying great masses of data, whether they concerned the atmospheres of massive stars, light curves and orbital elements of variable stars, or spectrophotometry of novae. Her autobiography, written in her 70's, consists of a long look backward, with much detail lavished on her childhood and early education in England, her life at Harvard under Shapley, and her passion for science. We find her enthralled upon hearing a lecture by Eddington on his verification of Einstein's theory of relativity; we sense her idolization of Shapley (though she presents a realistic view of him). We see her grow from a shy, highly talented child inspired to learn botany to the much honored scientist emerita.

As the book progresses, one wishes that the later chapters were as detailed as the first ones. One feels that they existed as notes to be worked in somewhere when they were fully developed. In spite of this, there are many gems strewn throughout the book; these from one who overcame vexing obstacles and who has illuminated with starlight the path for many scientists to come.

Cecilia Payne at Radcliffe College, 1924. [From *Cecilia Payne-Gaposchkin: An Autobiography and Other Recollections*]

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Scientific Educations

Four Lives in Science. Women's Education in the Nineteenth Century. LOIS BARBER ARNOLD. Schocken, New York, 1983. xii, 179 pp., illus. $14.95.

When Maria Martin (later Bachman) collaborated with John Audubon, drawing flowers and plants as background for his bird illustrations, she demonstrated not only her artistic talent but also a thorough knowledge of natural history. Lois Barber Arnold examines the lives of Martin and three other women whose lives typified their generations, but whose accomplishments were exceptional. Her assumption is that the history of education, in the spirit of current work at Columbia University initiated by Lawrence Cremin, must go beyond school teaching to the total environment from childhood into adulthood. Rather than stress the larger limitations placed on women interested in science, she uncovers the informal opportunities that a few enterprising women mobilized into productive contributions. Each woman's life follows a distinct pattern, one consistent with her own time and place.

Maria Martin was surrounded by discussions of natural history in the Charleston household where she helped an invalid sister raise a family. She accompanied her brother-in-law, the active naturalist and Lutheran minister John Bachman, on field excursions and learned to describe plants and animals in scientific terms. Her opportunity came when Audubon visited for months at a time in the 1830's in order to work on southern examples for his *Birds of America*. Having learned scientific illustration assisting Audubon, she put this skill to use on John E. Holbrook's five-volume *North American Herpetology*. Private, informal study, acquired through family connections rather than systematic schooling, provided some women interested in science the requisite skills. In a fascinating footnote (note 47, p. 149) the author points out recent work in experimental psychology that suggests a link