Albert A. Michelson as a cadet midshipman, class of 1873, at the U.S. Naval Academy, sketching himself with the aid of a mirror. [Reproduced in *The Master of Light*. Photograph from the Michelson Museum, China Lake, California, courtesy Philip L. Alger]

made some rearrangement of the optics that much improved the accuracy of the method, and in 1878 he published the first of his many papers on improved determinations of the velocity of light. The Navy then sent him for two years to study with Helmholtz in Berlin, where he attempted to measure ether drift (and invented the Michelson interferometer). In 1882 he joined the newly formed Case School of Applied Science, where he remained for seven years. The 1887 Michelson-Morley experiment is the best-known result of that period. In 1889 he joined Clark University, just founded to become, it was hoped, a school for advanced studies. The stellar interferometer and interferometric measurement of the meter date from this period. And in 1894 he was lured away to found the physics department of the new University of Chicago, where he remained until retirement in 1929. He died in Pasadena in 1931, still working at 79 on a velocity-of-light experiment.

Dorothy Michelson Livingston (b. 1905), Michelson's youngest daughter, was not trained in science, but about ten years ago began a "quest for her father." She obtained copies of his correspondence and scientific notebooks; she interviewed relatives and scientific contemporaries; she haunted the Center for History of Physics at the Amercan Institute of Physics. She even took a course in history of science. She knew that her father had had an earlier marriage, and that there had been three other children; but that was a taboo subject in the family and it was not until 1966 that she located her half sister Elsa, then 85, and discovered that her two half brothers were long dead.

From personal recollection, from much reading, and from interviews, Mrs. Livingston has written a well-organized scientific biography of her father that is in the same general style as Silvanus Thompson's life of Lord Kelvin or the fourth Rayleigh's biography of his father.

The scientific material in this book is largely narrative, rather at the level of Michelson's own two books of popular lectures on optics. This should prove no hurdle to an interested lay reader. Some writers assert that the negative result of Michelson's 1887 ether-drift experiment led Einstein to postulate relativity; others say Einstein simply reasoned from first principles. Be that as it may, Michelson's experiment shook most physicists of his day.

In this book the author has attempted not only to discuss his scientific achievements, but also to portray Michelson the man—his personality and character, strengths and foibles. He was dedicated but demanding and could be arrogant, strict, and severe. An interesting part of the book is the portrayal of physics in the United States, as it grew from a handful of individuals working alone in 1880 to the well-developed science scene of 1930. Michelson was involved in the founding of three universities and in the founding of the American Physical Society, the *Astrophysical Journal*, and the National Research Council. The author has assembled a wealth of anecdotes of Michelson interacting with his colleagues and friends.

Michelson disliked administration and left this largerly to such associates as Samuel Stratton, George Hale, and Robert Millikan, all worthy disciples. He once (after he was already famous) threatened to withdraw his application for a grant because he had been asked to fill out a standard form. (They funded him anyway; that was a different world.) He preferred his work to vacations (he did not know how to loaf), but he was also a talented artist and violinist and enjoyed tennis and billiards. Everything he did he did with enthusiasm. This book portrays Michelson not as a legend, but as a real, believable person.

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Roots of Modern Analysis

Functional Analysis in Historical Perspective. A. F. MONNA. Halsted (Wiley), New York, 1973. viii, 168 pp. $16.50.

Some half dozen years ago Michael Bernkopf published in *Archive for History of Exact Sciences* two substantial papers tracing the rise of the concept of function spaces to specific aspects in the earlier history of mathematics. The first paper (vol. 3, No. 1 [1966]) emphasized the role of integral equation theory; the second (vol. 4, No. 4 [1968]) traced the first steps back to the study of infinite linear systems. The present little volume by Monna similarly recognizes these two sources of inspiration for functional analysis, but it adds yet a third source, the problem of moments. The book does not present a chronological arrangement, inasmuch as the author's aim primarily is to provide mathematical perspective rather than "straight" history. Notwithstanding an apology expressed in the foreword "for shortcomings from the point of view of the historian," the exposition will be richly rewarding to a historically minded mathematician with a solid background in modern abstract analysis.

The mathematics of our time, permeated as it is by notions from topology, differs markedly from that of a hundred years ago, and one of the more palpable changes is an immensely greater generality of viewpoint. A century ago the function concept was all-important in analysis, but now this notion has been subsumed under the concept of a class (or space) of functions in which the study of the individual properties of the elements has given way to the search for a group structure. In his survey of the growth of this new modern analysis Monna recognizes three aspects as having dominated the development: (i) a tendency toward algebraization; (ii) a stream toward results of a structural character; and (iii) the strong influence of topology.

The first of the book's four chapters traces the development of functional analysis from Hilbert space to Banach space. It is with Banach's *Théorie des opérations linéaires* (1932), Monna writes, that "functional analysis began its course," and it was in the Polish school, of which Banach was a member, that "the explosive development of functional analysis started." Although the notion of a linear space is fundamental for functional analysis, it is a concept that belongs to algebra rather than analysis, and perhaps for this reason the author has treated it more or less independently in the second chapter. Here the presentation is more strictly historical and traces the ideas of a linear algebra from Cayley's *n*-dimensional geometry of 1843 to Peano's *Calcolo geometrico* of 1888. Considerable attention is devoted to the influence of the *Ausdehnungslehre* of Grassmann, an important transitional figure whose contributions all too frequently are inadequately recognized. Monna's compact volume closes with two relatively brief additional chapters. Chapter 3, "General analysis," describes the work of the Italian school, which, through the work of Volterra and Pincherle, adumbrated the general analysis of Fréchet and Moore and served as "the starting point for the theory of abstract topological spaces." Commenting on the fact that the results of the Italian school often are overlooked, the author remarks that "a history of the development of the theory of linear spaces is certainly desirable; in particular it would be most interesting to know more about the place of E. Artin and E. Noether in the development." Yet another account highly to be desired, he adds, is "the history of algebraization of geometry into modern times."

Having remarked throughout the volume the tendency toward algebraization of modern analysis, the author in the fourth and last chapter compiles a few instances of this tendency. In a closing section entitled "final remarks" he reiterates that in the course of development there has been a shift in attention from the original objects to structures. "This shift seems to be the main characteristic of the modern approach to mathematics." *Functional Analysis in Historical Perspective* is not easy reading, but it is recommended to serious scholars who wish to know how the modern abstract analysis which preoccupies graduate students today arose from the classical analysis of an earlier generation.

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Compliant Subjects

Obedience to Authority. An Experimental View. STANLEY MILGRAM. Harper and Row, New York, 1974. xx, 224 pp., illus. $10.

For about a decade the stock-in-trade of social science watchers has included an item about some crazy experiment in which a psychologist tried to make college students deliver painful electric shocks to each other—and succeeded. Some of the better-informed spectators know the experimenter's name: Milgram; and the site: Yale; but few know more details. They generally express one of two opinions about the experiment: that it illustrates a particularly callous instance of psychologists' treatment of experimental subjects; or that it exemplifies the trivialization of behavior that occurs in Mickey Mouse psychological experiments, since, surely, college students could not have truly believed they were delivering genuine electric shocks to real subjects. Finally, most social science watchers seem to believe that there was but a single experiment and that all the subjects followed orders completely in administering shocks. It is difficult to recall any other psychological investigation that has aroused so much discussion among nonprofessionals and simultaneously been so incompletely and inaccurately known.

It may be useful to clear up one misconception at once: no punishing shocks were ever delivered in the experiment and no subject suffered physical injury or, apparently, detectable psychological damage. The basic experimental situation is best described in Milgram's own words:

> Two people come to a psychology laboratory to take part in a study of memory and learning. One of them is designated as a "teacher" and the other a "learner." The experimenter explains that the study is concerned with the effects of punishment on learning. The learner is conducted into a room, seated in a chair, his arms strapped to prevent excessive movement, and an electrode attached to his wrist. He is told that he is to learn a list of word pairs; whenever he makes an error, he will receive electric shocks of increasing intensity.
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> The real focus of the experiment is the teacher. After watching the learner being strapped into place, he is taken into the main experimental room and seated before an impressive shock generator. Its main feature is a horizontal line of thirty switches, ranging from 15 volts to 450 volts, in 15-volt increments. There are also verbal designations which range from SLIGHT SHOCK to DANGER—SEVERE SHOCK. The teacher is told that he is to administer the learning test to the man in the other room. When the learner responds correctly, the teacher moves on to the next item; when the other man gives an incorrect answer, the teacher is to give him an electric shock. He is to start at the lowest shock level