books

Millikan: a conservative in revolutionary times?

The Rise of Robert Millikan: Portrait of a Life in American Science
R. Kargon
205 pp. Cornell U. P., Ithaca, N.Y., 1982. $22.50

Reviewed by John L. Michel

Robert A. Millikan sending instruments aloft in Bismarck, North Dakota, in 1938 in his investigations of "cosmic rays." (Photograph from the AIP Niels Bohr Library, reproduced with the permission of the California Institute of Technology Archives.)

A systematic reorganization of the large collection of papers and memorabilia of Robert Millikan (1868–1953), begun at the California Institute of Technology in 1965, has attracted a number of historians of modern physics to study the life and work of one of America's most prominent physicists. This portrait by Robert Kargon is the first, albeit brief, overview of the rise of Millikan from an Iowa minister's son to Nobel laureate, administrative head of Caltech, and celebrated spokesman of American science. It is also the first treatment of the declining influence and prestige in scientific and government circles he suffered in his later years.

Kargon, a historian of science at Johns Hopkins University, has written neither a full biography nor a synthesis of what has recently been learned about Millikan. He presents instead a "very selective essay" on Millikan's career and on modern American science for a general audience. By focusing on selected personalities and episodes in Millikan's life, Kargon hopes to illuminate both Millikan's achievements and the effects of his rise to prominence on American science in his lifetime.

Kargon emphasizes the influences of the new American university laboratory training in the sciences and of Albert Michelson during Millikan's formative years. Michelson's refined presence and the patience, diligence, and ingenuity with which he exactly determined the speed of light did set some personal and professional standards of excellence that Millikan admired. Still, both Ogden Rood, Millikan's adviser, and Walter Nernst, under whom Millikan conducted research on dielectric contants, strongly embodied the same personal virtues and the esteem that Michelson had for precision measurement. Moreover, exactitude in experimentation was no less valued by European physicists than by their American colleagues.

Concentrating on the two influences—laboratory training in America and Michelson—Kargon neglects other important components of Millikan's education. He presents little about what Millikan learned of physical theories (especially on the electrical phenomena related to his later research program) from his teachers at Oberlin and Columbia and in Europe. To illustrate graduate physics training, Kargon discusses the physics department at Johns Hopkins more than the program at Columbia, where Millikan earned his doctoral degree.

The extent to which Millikan adopted and even personally identified with the importance of precision measurement contributed to his renowned research efforts at the University of Chicago. Kargon depicts his exacting determinations of the elementary charge of electricity and Planck's constant (from a study of the photoelectric effect) as the efforts of a "conservative" scientist in the midst of revolutionary times to establish "secure benchmarks" that would preserve existing conventions as much as possible. This conservative attitude he finds in Millikan's belief in the stable evolutionary progress of science, in his defense of the electromagnetic wave theory of light against Einstein's radical concept of light quanta, and even in his political, social, and aesthetic outlooks.

This conservative image is inconsistent, however, with several important aspects of Millikan's lectures and investigations at Chicago and later at Caltech. In 1910 Millikan offered to teach the first course on quantum theory in America, based on Max Planck's *Wärmestrahlung*. Millikan's research and class notes reveal, furthermore, that between 1912 and 1916 he sought to reconcile the wave–particle duality of light by some modification of Planck's quantum theories. Unlike the rest of the physics faculty at Chicago, Millikan strove to make fundamental contributions to the new electron and quantum physics. Millikan's students and colleagues regarded his work as advancements on the frontiers of physics rather than as a restraint on the "excesses of modernity."

Kargon views the research on the electron charge and the photoelectric effect that won Millikan the Nobel prize as the product, not of creative genius, but of his gift for bringing to existing established research fields his technical ingenuity and meticulous error analysis. This cautious style, Kargon notes, is an example of "convergent thinking—channeled and controlled effort toward the unique answer." By focusing on the results of Millikan's investigations rather than on the decision-making processes—formulating questions, devising solutions, and carrying them out—Kargon portrays the convergent instead of the divergent (creative) elements of Millikan's experimental efforts. He neglects Millikan's ability to offer new and unconventional solutions to theoretical as well as experimental problems, demonstrated again at Caltech in the 1920s and 1930s. Millikan's enthusiastic interest in the new physics led to the discovery of new regions of ultraviolet spectra and of radiation that deeply penetrated the Earth's atmosphere. His interpretation of the latter phenomena as "cosmic rays," which were photons from stellar, atom-building processes, was not supported by others and became the focus of intense controversy.

Kargon's portrait of Millikan succeeds in illuminating many of the complex personal and institutional relationships involved in Millikan's rise to prominence in science, such as his associations with George Hale and the National Research Council. Some important features of Millikan as a personality and as a scientist are delineated for the first time. But care must be taken with this well-written, selective sketch. A few of Kargon's thought-provoking interpretations do not encompass several significant aspects of Millikan's life and work.

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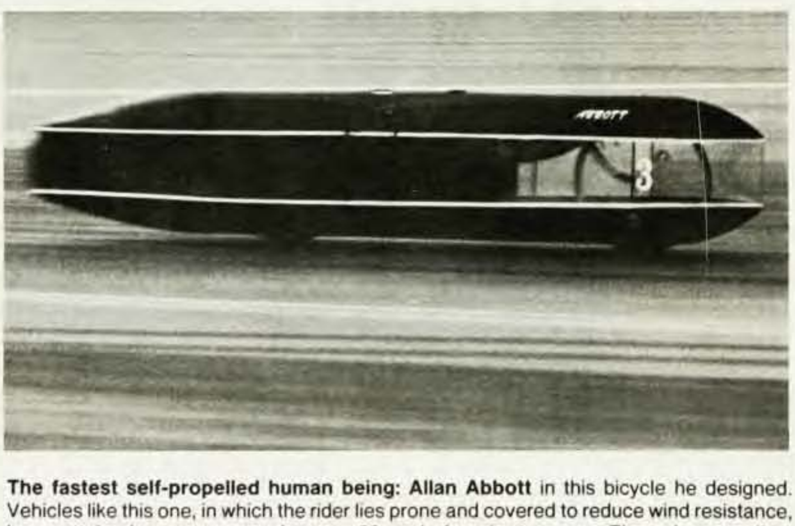

The fastest self-propelled human being: Allan Abbott in this bicycle he designed. Vehicles like this one, in which the rider lies prone and covered to reduce wind resistance, have attained average speeds over 60 mph for short races. The advances they incorporate follow the introduction, fairly recently, of multiple gearing and the innovations of a century earlier—rubber tires and ball bearings—made a few decades after bicycles were invented.

Bicyling Science (Second Edition. F. R. Whitt, D. G. Wilson. 364 pp. MIT P., Cambridge, Mass, 1982. $19.95 cloth, $9.95 paper) treats the physics and physiology of bicycling in depth. Written (and thoroughly revised) by a mechanical and a chemical engineer who are cyclists, the book is intended for mechanically inquisitive bicyclists, engineers, inventors and students and teachers of physics and physiology, for whom the book is suggested as a teaching tool. There are chapters on such topics as wind resistance, the wheel, friction, braking, balancing and steering, materials, as well as one of history, and a final one on human-powered vehicles in the future, from which the illustration is taken. (Photo courtesy Chester Kyle.)

Gauge Fields

N. Konopleva, V. Popov
Harwood Academic, New York, 1982. $75.00

A non-Abelian gauge theory of the Yang–Mills variety is considered these days, by the majority of particle physicists, to be the quantum field theory most likely to succeed in accounting for fundamental natural processes. The consensus about these models, which generalize Maxwell's electrodynamics and Einstein's gravity theory to explain nuclear forces and β-decay, has understandably engendered extensive research. In particular, investigation of the model's formal properties has put some physicists in touch with some mathematicians, because both have realized during the last decade that each had arrived from different starting points at a study of the same abstract structure: The physicists' non-Abelian gauge fields are nothing but the mathematicians' principal fibre bundles. Coincidence between physics and mathematics, ordinarily rare, always heralds exciting progress in both fields. Calculus emerged with modern mechanics; differential geometry ushered in the invention of general relativity; matrix and group theory gave the proper setting to quantum mechanics; development of distribution theory (generalized functions) accompanied modern field theory. The present convergence of interest highlights the geometrical basis for our physically motivated particle theories; it is aesthetically pleasing and gives reason for hoping that a truly unified description of all forces is within reach.

On a more practical level, the realization that mathematicians and physicists are interested in the same problem has enriched and informed both fields. Mathematical facts and techniques allow elegant answers to physically relevant questions (for example, classification and construction of solitons/monopoles and of instantons); conversely, the physicists' viewpoint leads mathematicians to new formulations and unexpected resolutions of issues that interest them (for example, discovering a multiplicity of diffeomorphic structures on R_4). Nevertheless the truly physical results that have thus far been established (existence of unexpected soliton/monopole quantum states; existence of further states with unconventional quantum numbers when Dirac particles couple to solitons;