

For tomorrow's intelligent citizen?

Concepts in Physics

By R. K. Adair

785 pp. Academic, New York, 1969.
\$12.50

Reviewed by JOEL A. SNOW

There are compelling reasons why the teaching of physics to nonphysics majors may be the most important single task facing academic physicists. We live in a society in which economic progress, national security and the quality of life are all inextricably linked with science and technology. Physics is the most developed of the sciences, serving as a basic foundation for the other sciences, as a paradigm for their development and as the fundamental underpinning of virtually all of technology. But only one eightieth of one percent of the nation's population are physicists.

It is thus inescapable that our nation's affairs are now, and will be in the foreseeable future, conducted by individuals who are largely unaware of the fundamental base of knowledge on which the future of modern society depends. But surely physicists give the highest of priorities to teaching the 27% of nonphysics majors who do take a physics course or so in college? Surely not, at least as a general rule.

Physics for nonphysicists has been, at most institutions, an academic orphan. In at least a few instances, however, respected and able physicists have recognized the importance and necessity of reaching and teaching nonphysics majors and have undertaken the arduous task of preparing new and appropriate text material. The most recent example is *Concepts in Physics* by Robert K. Adair.

Adair begins with a simple and clear discussion of the philosophical, logical and sociological underpinnings of physics. He eschews flights of rhetoric and the trappings of scholarship but proceeds with economy of language and method to a clear and coherent discussion of observation about falling bodies and accelerated motion as an example of physical law. This one example serves to introduce elementary notions from the calculus,

and such general concepts as boundary conditions, and leads quickly to a discussion of the properties of scalar and vector quantities. This conventional line of development is immediately augmented by emphasizing the arbitrary character of coordinate systems, the notion of covariance and an elegant and simple discussion of Galilean invariance and the principle of equivalence. These simplified discussions of "advanced" concepts in their natural progression occur throughout the book and are one of its particular strengths. Thus a sequence of several short chapters developing the basic concepts of wave motion and optics is followed directly by a discussion of de Broglie waves and quantum mechanics.

The line of development is everywhere internalist and ahistorical. A discussion of the kinetic theory that culminates in a description of the contribution of the quantization of molecular states to the specific heat of

gases, *precedes* the introduction of the second law of thermodynamics, while Lorentz transformations are discussed well before the propagation of electromagnetic waves is introduced.

Two chapters appear to be an unmotivated and unnecessary holdover from more conventional texts. These deal with electric currents and with alternating-current circuits. The reason for including these subjects presumably would be their relevance to such real-world devices as color television and stereo receivers, but the examples and the problems are pedestrian, and no more attempt is made here than anywhere else in the book to make actual contact with technological application.

That Adair's discussion of modern physics (atoms, nuclei, fundamental particles) is simple and a delight is due undoubtedly to his concentration on fundamental concepts rather than detail. He discusses symmetry principles and conservation laws at length

PHOTO BY ROSEMARY GAFFNEY



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but reaction kinetics not at all, and those long charts of nuclear species and accompanying reaction-balancing exercises that abound in most elementary treatments are mercifully absent.

This concentration on fundamental concepts leads ultimately to an exposition of strong-interaction symmetries and classification schemes for elementary particles and reaches its conclusion with a brief discussion of quarks. All this is, to say the least, descriptive and heuristic; but the spirit and basic ingredients of this frontier of modern physics are quite faithfully conveyed. A final chapter on cosmology and cosmological models is straightforward and well done but misses the excitement of recent observational developments, though the cosmic blackbody radiation is described in an aside.

Some of the many exercises that follow each chapter are routine old chestnuts and are hardly likely to illuminate, but others are thought provoking and ingenious. Answers are not given. The mathematics used may, in places, be a bit demanding for underprepared students, but there is little emphasis on formula derivation and symbol manipulation, and the more difficult developments can be explained qualitatively in terms of elementary algebra by an alert instructor.

For the intelligent and well motivated, but scientifically unsophisticated, nonspecialist this account of physics as seen by an able physicist is superbly done.

But many of the needs with which this discussion began are left unmet. The book will not repay careless or hurried study, it will not catch the attention of the unmotivated and will be difficult going, despite Adair's colloquial style, for individuals of only moderate mental acuity. There is precisely no discussion of the way in which the practice of physics is embedded in our society and is influenced by external social forces.

Although the student learns wonderfully well what physicists think about when they are thinking physics, he learns almost nothing that will enhance his understanding of the meaning of physics for everyone else. That the historical development and cultural concomitants of physics are left out entirely runs precisely counter to the belief that these are the essential ingredients of physics for the nonspecialist. (That belief made much more sense, however, when college enrollments were smaller and more elite,

and nonspecialists were likely to become academic scholars.) More compelling is that no effort is made to show the linkage of scientific activity generally and physics in particular with critical problems of the modern world. It is easy to argue that such efforts belong in some other course. But the other course usually does not exist.

In a cursory discussion of nuclear fission, Adair ignores nuclear weaponry and the nuclear balance of terror that has held the world in strategic stasis for the past 20 years. In discussing fusion he gives little indication of the benefits that might accrue to an energy-hungry world were fusion power to become a reality. The world of solid-state physics, (an *application*, after all, of quantum mechanics) is not even mentioned, despite its vast and continuing contribution to the complexities of modern technology. Adair's world of physics remains dry and sterile—in a word, academic. The modest paragraphs on the meson and baryon octets give no hint that these were discovered over a number of years through the expenditure of perhaps \$1000 million of public funds, provided in the general expectation that better power sources or more powerful weapons would result. Adair gives no indication that the externalities of his science today are any different than they were in the days of Lord Kelvin. This failing is shared, in whole or in part, by virtually all his competition, and Adair's book, despite its many virtues as an exposition of science, still falls short of providing the education in physics needed by tomorrow's intelligent citizen.

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The reviewer's interest in "physics for the nonphysicist" developed from a three-year stint of teaching nuclear physics to officers and enlisted men bound for duty in nuclear submarines. He is presently head of the Office of Interdisciplinary Research at the National Science Foundation.

Through Rugged Ways To the Stars

By Harlow Shapley
180 pp. Scribner's, New York, 1969.
\$6.95

After Harlow Shapley retired from the directorship of the Harvard College Observatory in 1952, he was ap-

proached by Charles Scribner's Sons about writing his autobiography. Shapley had kept no written material except his technical books and papers, which were hardly sufficient for an autobiography. However, several years before he had spent two days being interviewed about his life and these interviews were tape recorded. This book is the result of transcribing these taped interviews, and therefore has an informal and lively conversational style that is truly entertaining.

Shapley received his PhD in astronomy in 1913 from Princeton, under the direction of Henry Norris Russell, and was then appointed to a position at Mt Wilson Observatory at Pasadena, Calif. He began his work just as the famous 100-inch reflecting telescope at Mt Wilson was being brought into use and was one of its original users. His career extends from then to the present when astronomy has become space science, utilizing such tools as radio astronomy.

After describing Shapley's childhood, the first chapter briefly outlines his precollege experience as a reporter for small newspapers in southwestern Missouri and southeastern Kansas, but is principally concerned with his experiences at the University of Missouri, which he entered in 1907. He intended to study journalism, but found that the school was not yet open, so he examined other courses. He could not pronounce a-r-c-h-e-o-l-o-g-y but could pronounce a-s-t-r-o-n-o-m-y; he graduated in 1910 with an AB in astronomy.

He then went to Princeton with a Thaw Fellowship in Astronomy. His dissertation was a basic contribution to the understanding of the Cepheid variable stars.

In chapter four the author reminisces about his work at the Mt Wilson Observatory. He was appointed to the staff in 1914, and his research there was concerned almost from the first with the distances of the Cepheid variables, which resulted in an outline of the structure of the universe. In this chapter appears a number of the great astronomers of the time, among them George Ellery Hale, W. W. Campbell and Edwin P. Hubble.

Also, during this time Shapley became interested in ants, and wrote some papers on them, but he is much better known as an astronomer than as a student of ants.

Chapter six is titled "The Great Debate." Heber D. Curtis of the Lick