# Book Reviews

**Science Study Series.** *The Neutron Story.* Donald J. Hughes. 158 pp. *Echoes of Bats and Men.* Donald R. Griffin. 156 pp. *Magnets.* The education of a physicist. Francis Bitter. 155 pp. *How Old Is the Earth?* Patrick M. Hurley. 160 pp. *Soap Bubbles.* And the forces which mould them. C. V. Boys. 156 pp. Doubleday, Garden City, N.Y., 1959 (available to secondary-school students and teachers through Wesleyan University Press, Columbus 16, Ohio). Illus. Paper, $0.95 each; $1.10 in Canada.

These five volumes bring new life and vigor to a field largely dominated by formal textbooks. First in a series of paperback editions, they form a stimulating link between scientists and laymen. Largely dissimilar in subject matter, all the books bear the earmark of the authors' enthusiasm and scholarly competence. The first four books break down the time gap that too often separates textbooks from the latest developments in science. The fifth book, *Soap Bubbles,* is in a class by itself, since it was first published in 1902 by the Society for Promoting Christian Knowledge, of London.

Criticism of the encyclopedic nature of traditional secondary-school physics courses motivated a committee of physicists, high-school teachers, and other specialists meeting at Massachusetts Institute of Technology in 1956 to devise a fresh approach to the teaching and study of high-school physics. A guiding principle of the Physical Science Study Committee, established to develop the new course, is the emphasis on fundamentals rather than on detailed application. The purpose of the "Science Study Series" is to bring specialized fields of physics not only to physics students but to the general public as well. Although the amount of mathematics included is reduced to a minimum, there is real substance in all the books.

In his preface to *The Neutron Story,* Donald Hughes writes: "The Neutron Story, I feel, is scientific fact whose meaning and beauty can be transmitted without higher mathematics or headlines. It is my conviction that in this you will agree—the story has elements of mystery, profundity, and beauty, whose significance can be conveyed to those without technical training who are willing to put their minds to it."

In chapter 1 the versatility of the neutron in nuclear research is related to its penetrating property, which results from the absence of electrical interaction with its subatomic particles. Hughes gives a brief history of our knowledge of the neutron, discussing its discovery in 1932, its role in the fission of uranium (1939), its application in chain reactions and in the production of radioisotopes, and its promise in revealing the innermost structure of matter.

In chapter 2 there is a lucid review of our knowledge of the structure of the atom, beginning with Rutherford's demonstration of the compact nature of the nucleus. The puzzle of nuclear structural differences in isotopes, once explained in terms of pairs of protons and electrons inside the nucleus, is made clear by a nonmathematical reference to wave mechanics. Chadwick's discovery of the neutron is described, as well as evidence leading to the conclusion that "the neutron is actually a fundamental particle, existing in its own right, and constituting a basic component of matter."

In chapter 3 the duality of the neutron is explored, and the wave nature of the particle is related to the speed of the neutron. Again a nonmathematical treatment of quantum mechanics is ably used. Crucial experiments in neutron refraction and reflection are discussed.

Chapter 4 considers the inner structure of the neutron and how it can be altered profoundly. Neutron disintegration, the neutrino, the explanation of the magnetic field of the neutron in terms of the meson, and polarized neutrons are presented.

Striking examples of the nuclear effects of neutrons make up chapter 5. Neutron capture by a stable nucleus may lead to radioactive forms. The function of the moderator in improving neutron capture is related to the wavelength of the neutron. The Gamow neutron-capture theory of the origin of the elements is an intriguing bridge between the infinitesimal and the infinite.

Chapter 6 is a fascinating discussion of neutron experiments in solid-state physics. The use of fast neutron bombardment to produce changes in crystal structure is shown to have wide practical importance.

Chapter 7 discusses "cold" neutrons and how they are used to reveal atomic motions. Chapter 8 concludes the book, with an explanation of the chain reaction in the fission and fusion bomb, in reactors, and in the thermonuclear reactor.

"We have had another revelation of how infinitely intricate are the relationships of subatomic particles, how wondrous the scheme of the universe as revealed in the world of the very small," concludes Hughes.

*Echoes of Bats and Men,* by Donald Griffin, professor of zoology at Harvard, well illustrates the far-ranging values of physics—for example, in solving problems in biology. "A century-old mystery of zoology was largely dispelled by one afternoon in the appropriate physics laboratory," states Griffin.

The theme of the book is accurately expressed in the preface: "Man has been said to 'stand between the atoms and the stars' and between molecules and men are to be found many fascinating applications of physics, broadly conceived. Outstanding among these are ways in which living organisms utilize wave motion of various kinds. Of particular interest is the interplay between sound waves and the animals and men who use them."

Recently perfected sonar and radar techniques for ranging are "old hat" to porpoises and bats. Griffin's descriptions of ingenious experiments devised to uncover the secret of the navigational skill of porpoises and of bats in darkness makes fascinating reading. "To have survived at all required of these animals and their ancestors enormous skills at echolocation, the location of objects by their echoes."

Enough is presented of the principles of sound to make the book understandable to readers who have no background in physics. A number of simple experiments are described in which a toy "clicker" or a tape recorder is used to explore sound ranging at first hand.

Explanations of radar and sonar are given. For the quantitative-minded, an entertaining comparison is made between the echolocation efficiency of an airborne radar system and that of a large and of a small bat.

The book concludes with a review of experiments that explain how blind people are able to find their way around, largely by echolocation. A final question for further research is posed: Why do blind men fail to learn as much from echoes as they theoretically should?

Each of the five books reviewed here has a different emphasis. *Magnets* is essentially the personal story of the education and professional career of Francis Bitter, professor of physics at Massachusetts Institute of Technology. His book will appeal to students and laymen because it presents some of the latest ideas about the origin of magnetism in a largely nonmathematical way. The personal nature of the book, which conveys the author's continuing enthusiasm for research, poses a number of still-unanswered questions in magnetic theory, and shows Bitter's honesty in searching for the truth, may well be an inspiration to student readers.

The viewpoint of the book is revealed by Bitter in the preface: "I shall tell you about magnetism in the most valid way I know—and in an interesting way, I hope—by describing my personal voyage of exploration, and how it felt to me. . . . But you will learn *something* about magnetism, and perhaps quite a lot of a man's life and his absorption in his work."

After a brief description of his childhood, the author reviews several basic principles of magnetism: the inverse square law, magnetic fields, and electromagnetism. Bitter's deep involvement in magnetism began with his doctoral thesis on the magnetic susceptibility of hydrocarbons. It was the era of the application of quantum mechanics to magnetism, and the author conveys the enthusiasm with which experimental verification of quantum predictions was sought.

Bitter then studied ferromagnetism, in the research laboratories of Westinghouse, applying theory to improve the magnetic qualities of iron. Subsequently, at Massachusetts Institute of Technology, he designed electromagnets of very great strength to explore the electronic structure of complex atoms. His work during world War II in degaussing ships led to further application of magnetic principles. Magnetic resonance, one of the most important techniques in studying nuclear structure, is well explained.

Bitter's conclusion of this story about himself and about magnetism is in character. "And finally, have you a feeling that the pursuit of science is a most exciting treasure hunt, and that clearly expressed and reliable knowledge is one of our greatest treasures?"

Through application of our knowledge of radioactivity, vast strides have been taken in all the sciences. In *How Old Is the Earth?,* advances in geophysics are presented for students and for the public. The theme of the book is stated in the preface: "Not only has radioactivity supplied most of the energy for the earth's great geologic events; it also measures the time at which these events have occurred. As we shall see in later chapters, each grain of sand, each minute crystal in the rocks about us is a tiny clock, ticking off the years since it was formed. It is not always easy to read them, and we need complex instruments to do it, but they are true clocks or chronometers. The story they tell numbers the pages of earth history."

This book requires careful reading, for each page offers food for thought. But to read it can be rewarding, for it can lead to an insight into geologic principles. The book opens with a review of the structure of the earth. Seismological methods and the isostasy process are clearly explained. The large amount of energy that is expended in the formation of mountains and in other changes in the interior of the earth requires an almost endless source of energy. Evidence is presented to show that the major source of this energy is the activity of radioactive components of the earth, which are largely concentrated in the near-surface layers. A long chapter is devoted to explaining fundamental principles of radioactivity.

A discussion of the measurement of geologic time by sedimentary strata is followed by a thorough exposition of calculations based on radioactive measurements. Conditions necessary for isotopic studies in crystals are given, together with sample calculations. Carbon-14 dating, its applications and its limitations are described. The book ends with speculations on the origin of the solar system and the elements.

It may seem strange indeed that *Soap Bubbles,* first printed in 1902, should be included in the modern "Science Study Series." And yet the book should be of great interest to students, teachers, and laymen. It is a masterpiece of exposition, discussing the widespread effects of surface tension in molding soap bubbles and explaining some strange natural occurrences.

In the latter part of the 19th century, when the classical foundation of science was being established, there was intense popular interest in the rapidly growing physical sciences. Public science lectures that featured remarkable demonstrations attracted enthusiastic throngs. John Tyndall, the English master of physics demonstrations, said in his preface to *Heat: A Mode of Motion*: "In the following lectures I have endeavored to bring the rudiments of a new philosophy within the reach of a person of ordinary intelligence and culture." Following in Tyndall's footsteps, C. V. Boys presented three lectures before a juvenile audience at the London Institution in 1889. This book is the record of those demonstrations. The style of the book is well illustrated by the opening paragraph: "I do not suppose that there is any one in this room who has not occasionally blown a common soap bubble, and while admiring the perfection of its form, and the marvellous brilliancy of its colours, wondered how it is that such a magnificent object can be so easily produced.'

In the first lecture, experiments are presented which establish the remarkable elastic properties of the "skin of water" (surface tension). "You see that it is quite possible to go to sea in a sieve —that is if the sieve is large enough and the water is not too rough. . . ." Capillarity, the cleaning action of benzene on grease, and the role of ox-gall in promoting the spreading of artists' colors are explained by some of the experiments described.

Lectures 2 and 3 should be studied by science teachers as models of the masterly use of visual aids in demonstration. Microprojection, photographic slides, stroboscopic projection, and action-stopping pulse photography are used to produce startling and inspiring demonstrations. In view of the simple materials needed to perform the experiments and the clarity of the "practical hints" (about 30 pages), this book should be a source of inspiration to students in presenting demonstrations and special reports.

I shall use these and subsequent volumes of the "Science Study Series" in my physics classes at the Bronx High School of Science. Perhaps the comments of one student who read *The Neutron Story* will interest other students: "Excellent . . . in a class by itself . . . first book suitable for high school students with enough details, yet requiring only simple math."

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