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Book Reviews

Completeness in Science. By Richard Schlegel. Appleton-Century-Crofts, New York (1967). 280 pp. $7.50.

To most engineers and scientists the world of science seems ever enlarging, and—Congress and society willing—their efforts appear to be part of a stream of endeavor with no end in sight. But what of the next centuries or millenniums? Will time, money, and application suffice to achieve completeness of knowledge? To what extent can science describe and explain the natural world?

The answer to this interesting question is a complex one and deserves Schlegel's penetrating and well-organized treatment. The answer depends greatly on how one defines the completeness problem, and accordingly much of the book is concerned with what might be meant by "complete." Suppose that completeness in science means that science has stated every fact about the entities and their interrelationships in its domain. Can inorganic chemistry, or mechanics, or atomic spectroscopy—worlds often cited as having been circumnavigated—be thought complete? Hardly. Inorganic chemists do not know the bulk properties even of the elements over wide ranges of temperature and pressure; the strengths of materials are undetermined under many conditions; and a few spectroscopists continue to measure wavelengths to higher and higher accuracy. As for the distribution of matter in space, cosmological evidence does not reveal any thinning out of the cosmic dust. Thus, we face a pragmatic limitation, and Schlegel doubts that there is any possibility of an awareness or a recording of every detail of the universe.

Aside from the pragmatic limitation, there are the natural limitations of description. What degree of accuracy do we wish to attain in measurement? And the uncertainty principle and the principle of complementarity restrict our knowledge.

We might evade these limitations by accepting a description that satisfies our purposes. Trigonometry may be considered complete in that the principles are known and the values of the trigonometric functions have been determined for sufficient angles and to sufficient significant figures for our needs. Positional astronomy might be considered complete enough to satisfy certain navigational needs, but larger telescopes, or new needs created by the space effort, would reveal the incompleteness of our knowledge. Moreover, our concept of completeness must depend on the meanings we give to "description," "explanation," and "consistency." Although we might despair of accomplishing a complete description of the entirety of nature, we might expect to achieve success in the case of restricted, defined domains of nature, provided we are satisfied with obtainable accuracy of measurement and accept limited goals.

Schlegel approaches the completeness problem from various points of view and with commendable pertinacity. Indeed, his book is the most complete treatise on the subject and brings together an immense amount of relevant material. His desire to explore every alternative, however, can be vexing to the reader who begins to note the frequent occurrence of qualifying words ("however," "and yet," "but," and "on the other hand"), necessary as these may be.

The author provides an early chapter on the philosophy of science. Then he gives a preview of the completeness problem and follows this with chapters on special aspects of the problem, including Gödel's undecidability theorem, the infinity of numbers and of cosmological space, the atomic nature of matter, and quantum physics. Finally, he provides an excellent summary chapter and ends with brief comments on psychology and biology, fields that may well exhibit basic properties of nature not apparent in the physical sciences.

Completeness in Science is a stimulating book that offers insight into the problem and provides engrossing reading for the scientist interested in the philosophy of science.

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About the Reviewer: Robert T. Lagemann is Dean of the Graduate School of Vanderbilt University to which he first came in 1951 as Chairman of the Department of Physics and Astronomy following a professorship of physics at Emory. During World War II Dr. Lagemann contributed significantly to methods of evaluating separating media in the development of the gaseous diffusion process for the uranium isotopes. His undergraduate studies, at Baldwin-Wallace College, led to advanced work in infrared spectroscopy at Vanderbilt and at Ohio State. He is the author of Physical Science *(1963) and co-author of* Physics for the Space Age *(1966).*

The New Age in Physics. By Sir Harrie Massey. Basic Books Publishers (1967). 372 pp. $10.00.

The volume being reviewed is the second edition of a work which was first published in 1960. From among the whole range of contemporary physics, the author has chosen for description a number of theoretical and experimental developments for the purpose of illustrating both the current posture of modern physics and the rapidity with which it has acquired that posture.

The title page cites this book as the "Second edition, revised and enlarged." The enlargement consists in part of sections about the laser, the Mössbauer effect, rotating superfluids, the structure of the proton, spark chambers, resonance particles, symmetry properties of strange particles, the two neutrinos, radar astronomy, aperture synthesis, and quasi-stars. Most of the revision comes in the last two chapters which deal with the use of rockets and satellites for scientific research.

An outline of the contents (some comments accompanying) reveals the scope of the work. Chapter 1: a brief historical account of the period 1900-1925, an account of the atomic structure of matter, some methods for determining masses and other properties of atoms and their electrons; Chapter 2: wave mechanics and some of its consequences; Chapter 3: a variety of subjects including the influence electrons exert on the electrical and magnetic properties of solid materials as in vacuum tubes, transistors and ferromagnets, superconductivity, superfluidity, the principles involved in high speed computers, masers, lasers, and the Mössbauer effect. This was one of the most interesting chapters, with particularly cogent accounts of superconductivity, superfluidity, and the Mössbauer effect; Chapters 4 and 5: relativity as applied to macroscopic and to atomic dimensioned bodies, respectively—several topics in these chapters were characterized (perhaps not surprisingly, in this level work) by a lack of clarity such as in the question of the reality of space contraction and time dilation, or by conceptual difficulties as with the topics of zero point field energy, and polarization and field fluctuations in the vacuum; Chapter 6: tools employed in studying the nucleus including accelerators, counters, cloud, bubble and spark chambers, along with some results obtained with their use; Chapter 7: large scale utilization of nuclear energy through the use of uranium fission; Chapter 8: high energy particle physics; Chapter 9: most concerned with neutrinos and conservation relations—in this and the preceding chapter, the challenge of the task of coping with the barrage of entities forthcoming from high energy physics is made amply clear via the author's valiant, but not always successful, struggle for clarity in his own account; Chapter 10: the shift is now to large scale phenomena, beginning here with a very interesting account of the plumbing of radio-astronomy into our galaxy and beyond; Chapter 11: exploration of earth's upper atmosphere; Chapter 12: artificial satellites, lunar and planetary probes.

The book is qualitatively, rather than analytically, descriptive in manner. Although a very few subjects seemed tossed in in a rather sketchy manner (for example, second sound in liquid helium II), and despite the wide range of topics, the work did not seem superficial. An overall impression was received of a closely knit, compact ensemble with not many loose ends dangling. Part of the reason for this is the use of frequent cross referencing within the body of the text to relevant items appearing either earlier or later in the text.

The author employs the cgs system of units and chooses (to the chagrin, and accompanied by the gritting of teeth, of the reviewer) to use centrifugal rather than centripetal force in describing orbital motions.

To specialists who suffer from the occupational hazard of physics tunnel vision or progressive deterioration of perception of peripheral fields of physics, the partial panorama provided by this book could be a refreshing eye-reopener, if they would but maneuver it into their restricted fields of view. To physics and physical science teachers at all levels, the book should prove valuable as a mind stretcher and a perspective broadener, imparting to the mind the sense of quickened living and well-being that in a bodily sense follows a good stretch taken by someone who has been sitting around a lot. Finally, a third but perhaps smaller group to whom this book should appeal is that comprised of bright, curious (and serious) students, from high-school seniors on up.

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About the Reviewer: Roger Clapp is Associate Professor of Physics at the University of South Florida where he has been located since 1963 following several years as a Research Physicist at Redstone Arsenal. Dr. Clapp did his graduate work at the University of Virginia; his research interests are in solid state and surface physics and in thin films.

Sourcebook on Atomic Energy, 3rd ed. By S. Glasstone. D. Van Nostrand Company, Inc. (1967). 856 pp. $9.25.

This book, which is published under the auspices of the Division of Technical Information of the Atomic Energy Commission, has been regarded as a classic in its field for many years. Now appearing in an updated third edition, this encyclopedia of nuclear science remains the most straightforward reference available to the non-specialist. Its role in the past and continuing development of nuclear science and technology is acclaimed by Dr. Glenn T. Seaborg in a foreword which notes that over 100,000 copies of the previous English language editions have been sold since the appearance of the first edition in 1950, plus editions in a number of foreign languages.

If the expansion of successive editions of this book from 532 pages in 1950 to 625 pages in 1958 to 865 pages in 1967 can be taken as a measure of the rate of growth of nuclear energy applications, it would appear that their doubling time is less than 20 years and is decreasing. It is indeed fortunate that the rapid developments of this field have been followed closely and interpreted by one who is so eminently qualified for this role. In describing these developments, Dr. Glasstone has skillfully retained and expounded the underlying theoretical concepts while avoiding all but the most elementary mathematics. Embedded in the narrative is also a concise history of nuclear science up to 1967.

The organization and style of presentation of the third edition is essentially the same as in the preceding editions. The only change of notation is the placement of mass numbers as left superscripts rather than as right superscripts (e.g., ${}^{27}_{13}Al$ rather than ${}_{13}Al^{27}$). The familiar double-column format and the paragraph numbering system have been retained. The latter feature is most helpful in view of the internal cross-referencing which is encountered throughout the book. Footnote explanations are used frequently to supplement the text and accompanying each chapter is an extensive list of references which is a new feature in this edition. A seven-page author index has also been provided in addition to a meticulously complete, 19-page subject index.

A new chapter on elementary particles has been added. In spite of Glasstone's skill at unveiling the bare essentials, this chapter remains an order of magnitude more abstract than the others. However, it is unlikely that a more explicit treatment can be found and we should be thankful to have a mentor who can tell us, even obliquely, what the particle physicists are saying. A separate chapter