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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 par-