

BOOK REVIEWS

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Encyclopedia of Cosmology: Historical, Philosophical, and Scientific Foundations of Modern Cosmology. Edited by Norriss S. Hetherington. 686 pp. Garland Publishing, New York, 1993. Price: \$125 ISBN 0-8240-7213-8. (Reviewed by Yuri V. Balashov.)

The scope of this volume is rightly reflected in its full title. This is a book for everyone and about nearly everything (for the subject of cosmology—the universe—is, by definition, all that exists). By ‘everyone’ I mean not only cosmologists, historians, and philosophers of science, but also beginners in cosmology and those contemplating the ambitious goal of plunging into the depths of this fascinating discipline.

Most articles are self-explanatory. Those that are not require a minimal number of cross references and, in any event, do not presuppose a special background. In fact, one can possibly use the *Encyclopedia* itself as a background for understanding more specialized literature, whether it be historical, philosophical, or scientific. To be sure, it will not make one a professional in any of these areas. But it will provide established cosmologists, say, with a good sense of the philosophical problems involved in their own field (if they are still unaware of them) or with a better acquaintance with its history. Conversely, philosophers interested in cosmology would gather from the *Encyclopedia* some apparatus needed for understanding “primary texts.” The article on “Fundamental Cosmological Parameters,” for example, is an elementary but comprehensive overview of the technical alphabet of modern cosmology (redshift, scale factor, main evolutionary models, standard tests, etc.). On the other hand, a series of historical articles covering the progress of cosmology in the 20th century will be of interest to a general student, as well as to a practicing scientist. Does everybody remember what particular role van Maanen’s observations of proper motions in the spiral “nebulae” played in the establishment of the “island universe” theory in the early 1920s? If not, one should certainly read the relevant articles of the *Encyclopedia*.

The coverage of topics extends from the megalithic to quantum cosmology. Here are some entries in alphabetical order: Aristotle, Big Bang Cosmology, Chaucer’s Cosmology, Chinese Cosmology (coauthored by J. Needham), Cosmic Strings, Creation in Cosmology, Descartes, Galileo, the Herschels, Hubble’s Cosmology, Mesopotamian Cosmology, Multiple Universes, Religion and Cosmology, and Romantic Cosmology. All articles are written by experts in the corresponding fields (i.e., by cosmologists, historians, and philosophers of established reputation). Though a few topics seem to have been specifically tailored to particular experts, this is perhaps not a deadly sin in so wide and multidisciplinary an area (cosmology *on the whole*) with no universally accepted agenda.

In general, the choice of *topics* is very balanced. It is less so with regard to *personalia* which, of necessity, had to be severely restricted. Along with the most prominent figures of the past, one finds a somewhat unsystematic selection of

the founders of the modern physical science of the universe. For instance, there is a rather long and very detailed article on van Maanen and his “observations,” but no articles at all on Friedmann and de Sitter. One might ascribe it to the traditional emphasis on the empirical aspects (as opposed to “theoretical speculations”) characteristic of the entire discipline of the history of astronomy. However, a potential reader should bear in mind that, strictly speaking, this book does not relate to astronomy in the usual sense. It regards “theoretical speculations” most seriously and deals with observational astronomy only insofar as the observations at hand are of a profound cosmological significance.

The readers of this Journal recently had an opportunity to see how philosophical considerations played an essential role in the cosmological controversies around E. Milne’s “kinematic relativity,” the main rival of the standard relativistic cosmology in the 1930s.¹ Such considerations became very important again in the 1950s, when the cosmological scene was dominated by the competition between the big bang and the steady state models. According to the latter, the universe, instead of evolving from a hot and dense state in the remote past, is stationary on the large scale, with new matter being continuously created uniformly in space, in order to make up for its dilution due to cosmic expansion. It is well-known that the steady state theory was practically killed by the 1965 discovery of the microwave background radiation. (See the history of this remarkable discovery in the *Encyclopedia*.) It is less known that the steady state theory was the mainspring of cosmology in the 1950s, and that some decisive theoretical and observational achievements, such as the elaboration of the stellar nucleosynthesis theory and counts of radio-sources, were directly stimulated by the steady state cosmology. It is virtually unknown (however strange it might seem) that there were, in fact, *two* distinct steady state theories, one obtained by F. Hoyle from modified equations of general relativity and another built by H. Bondi and T. Gold on explicitly philosophical foundations that took a form of the “perfect cosmological principle.” Personal recollections of Bondi on the origins of the steady state cosmologies are complemented, in the *Encyclopedia*, with a critical account of their development written by a historian of science, H. Kragh.

Another interesting chapter in the whole story concerns the primordial nucleosynthesis of elements in the hot Big Bang. The original idea goes back to the influential work of G. Gamow. Beginning in 1948, the theory was elaborated in detail by R. A. Alpher and R. Herman, and they themselves tell how it all happened. Again, a reader will have more than enough information for comparing the main protagonists’ description of events with other accounts based on historical reconstructions.

A comprehensive history of 20th century cosmology has yet to be written. One reason to do it is that cosmology now, as well as before, is not only a scientific, but also a cultural phenomenon having far-going implications for history, philosophy, and religion. The present book leaves no doubt in this connection.

A discouraging fact is that the spiritual value of the book's subject is matched by the book's price. Being aware of the frustrating effect this price might have on potential individual readers, the publishers collected the bulk of the original articles in a far less expensive package;² the paperback version of the collection is unquestionably a good buy.

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¹G. Gale and J. Urani, "Philosophical midwifery and the birthpangs of modern cosmology," *Am. J. Phys.* **61**(1), 66-73 (1993).

²*Cosmology: Historical, Literary, Philosophical, Religious, and Scientific Perspectives*. Edited by Norriss S. Hetherington. 631 pp. Garland Publishing, New York, 1993. Price: \$85.00 (cloth) ISBN 0-8153-1085-4; \$18.95 (paper) ISBN 0-8153-0934-1.

Light and Color in the Outdoors. Marcel G. J. Minnaert. (Translated and revised by Len Seymour.) 417 pp. Springer-Verlag, New York, 1993. Price: \$44.50 ISBN 0-387-97935-2. (Reviewed by Robert Greenler.)

Minnaert's book is a gem! I first became aware of it in 1954 when I was a graduate student and Dover Publications brought out a paperback reprinting of the first English translation, *The Nature of Light and Colour in the Open Air*, which had been published in 1940. In the intervening years I have recommended it to hundreds of people. It is a wonderful book that should be known by everyone who has an interest in the natural visual world. It has enriched my life and the lives of many people whom I know.

The subject of the book is a wide collection of optical effects in the world around us that can be observed with the naked eye. It includes effects of light and shadows, of the refraction and reflection of light, of mirages, and of the wide variety of atmospheric effects caused by scattering and the interaction of light with ice crystal and water droplets. It also deals with effects that result from the characteristics of the eye, including afterimages, contrast effects, and the perception of motion. The theme of the book is described by Minnaert in his preface to the original edition: "The phenomena described in this book are partly things you can observe in everyday life, and partly things as yet unfamiliar to you, though they may be seen at any moment if only you will touch your eyes with that magic wand called 'knowing what to look for'. And then there are those rare, remarkable wonders of nature that happen only once in a lifetime, so that even trained observers may wait year after year to see them. When they do see them, they are filled with a sense of extraordinary and deep happiness."

My volume of this book has been the Dover reprint of the translation of the first Dutch edition, published in 1937. Minnaert made corrections and additions up to the fifth Dutch edition, published in 1968, and the current edition by Springer-Verlag is described as a new translation that "...closely follows the latest Dutch edition." So what is

new in this edition, compared with the Dover reprint that most of us (English speakers) have known?

There are several advertised changes: (1) It is a new translation of an edition revised by the author. (2) It includes 80 new photographs, over half in color. (3) The chapter entitled *Rainbows, Halos, and Coronas* has been updated with the incorporation of new material. (4) Additional notes and references are gathered in an Appendix and (5) A short biographical sketch of Minnaert and an Appendix on *Photographing Natural Phenomena* have been added.

I will give my impression of the significance of these changes:

- (1) By a number of spot comparisons of the new text with the old, I see minor additions and slightly different wordings but no significant change in the content of the book or the feel of the translation.
- (2) The photos are great! In addition to a number of new black and white photos, 32 color pages display 52 beautiful photos. Altogether, 34 of these are by Pekka Parviainen of Finland, who is photographer extraordinaire of scenes atmospheric and astronomical. Others are by members of the very active Finnish Halo-Observing Network. The presence of the major contribution of Finnish photographers gives a hint to the history of this particular volume. A Finnish translation was published in 1987. That Finnish edition introduced the new photographs and some of the new material that is included in the present English edition.
- (3) I can understand the dilemma of the translator in dealing with a section of the book where there have been many new developments in the 25 years since Minnaert was involved. The decision to be made is whether to translate Minnaert's book, or whether to write a new book that reflects the present state of understanding. The compromise that was made seems to me to be rather unsatisfactory. Sometimes, along with old explanations, a brief mention is made of new results, but without sufficient discussion to make them understandable or without references to direct the reader to their sources.
- (4) The additional references are to old papers. I count only nine references to works published after 1945.
- (5) The biographical sketch of Marcel Minnaert is appropriate and interesting to those of us who have appreciated his work. The comments on photography (which I assume are the comments of Pekka Parviainen) are of interest to those motivated to try to capture some of these beautiful effects on film.

So, for me, the main attraction of this volume is the charm of Minnaert's original book, enhanced by a set of beautiful photographs to illustrate the effects he discusses. But what is the value of reading a scientific book, on which the main work was done over 50 years ago? One answer is that, although some of the material is outdated by subsequent investigations, much of it is not. This book is still the best reference to many visual effects in nature that the observant person may discover and a source of "new" effects for such a person to look for. Another answer is a very personal one for me. It has to do with an attitude toward Science and a way of communicating scientific ideas to others.

When I was a student, trying to learn how to be a sci-