intergalactic space is associated with the formation of matter. The treatment is essentially only qualitative, and at best the book must be taken as one that suggests new approaches rather than as one that gives any kind of detailed development in cosmological or physical theory. Although he ably discusses the limitations of thinking by models in physics, the author (who is a prominent British engineer and educator) often gives model-like treatments that do not do justice to the subtlety and complexity of current physics. It must be said, though, that some interesting and well-reasoned reflections on the problem of the unification of physical science are a strong feature of this book. These discussions, taken with the presentation of the disappearance-of-matter idea, will warrant some attention to the book by the speculatively minded physicist.

The Universe at Large. By Hermann Bondi. 154 pp. (Science Study Series S 14) Doubleday Anchor Books, Garden City, N. Y., 1960. Paperbound $.95. *Reviewed by Otto Struve, National Radio Astronomy Observatory.*

PROFESSOR Bondi, King's College, University of London, is one of the most active theoretical astrophysicists in the world today. He is also one of the most versatile writers of popular and semipopular books and articles on astronomy; his ability to present difficult ideas and problems in simple and novel forms reminds the reader of the popular books by George Gamow. Incidentally, both Bondi and Gamow were "gifts" to the free world by the totalitarian regimes of eastern Europe: Gamow escaped to America from Soviet Russia, while Bondi went to Great Britain just ahead of Hitler's occupation of Austria.

The small book under review appeared originally as a series of articles in the *Illustrated London News*, and has now been published in book form in the "Science Study Series" organized by the Physical Science Study Committee at the Massachusetts Institute of Technology.

Bondi's own interests and views are strongly emphasized in this book. During the past 10 or 15 years he has worked in close association with a number of other British astrophysicists: his wife, Christine Mary Stockman Bondi, Messrs. Hoyle, Gold, Lyttleton, McCrea, and several others. Some years ago I jokingly referred to this group at a symposium as the "British School of Astrophysics" to distinguish it from an equally active and vociferous "Soviet School of Astrophysics" (V. G. Fessenkov, A. G. Massevich, and others). The name has stuck, and the British school has been the butt of many criticisms from the Soviet school.

Bondi's book is an up-to-date version of the theories developed by the British school. He no longer emphasizes the theory of accretion (i.e., the growth of stars of small original mass through the accretion of diffuse interstellar matter) which was the main source of disagreement with the Soviet school at the above-mentioned symposium. But he strongly defends the "steady-state cosmology", according to which "we have no choice but to postulate that there is going everywhere and at all times a continual creation of matter, the appearance of atoms of hydrogen out of nothing. . . . In the whole of the volume of the earth it would amount only to a mass like that of a particle of dust every million years or so."

It may be appropriate to correct here a historical mistake that has become quite frequent in the current astronomical literature. I am referring to what Bondi calls "Olbers' Paradox". In an article entitled "Über die Durchsichtigkeit des Weltraums", dated March 7, 1823, and published in "Bode's Jahrbuch" for 1826, Olbers had suggested that the entire sky would be as bright as the surface of the sun if the universe were infinite in size and populated uniformly with stars of solar type. But essentially the same argument was put forward in 1744 by L. de Cheseaux of Lausanne in an article entitled "Sur la force de la lumière et sur la distance des étoiles fixes", in which he suggested that interstellar space is filled with some kind of "fluid" (ether) which is capable of intercepting the light of distant stars. According to F. G. W. Struve (Etudes d'Astronomie Stellaire, St. Petersburg, 1847, p. 84, Notes, p. 46) it is probable that Olbers was unaware of Cheseaux's earlier work, despite the fact that the copy of the latter's publication in the library of the Pulkovo Observatory (which was used by Struve) had been purchased from Olbers' personal library. I do not advocate that we should, at this late date, substitute the name of Cheseaux for the much better known name of Olbers: this might cause additional confusion. Nevertheless, the contribution of Cheseaux has considerable historical interest.

Physics of the Upper Atmosphere. Edited by J. A. Ratcliffe. 586 pp. Academic Press Inc., New York, 1960. $14.50. *Reviewed by Henry Wise, Stanford Research Institute.*

THE team approach to scientific research, so conspicuous a feature of our present-day society with its crash programs, missiles, and nuclear reactors, has now found its counterpart in the multiple authorship of scientific textbooks. In scientific research the team effort has been justified by the large scope of the field of investigation encompassing many disciplines, and the need for obtaining a solution as quickly as possible. Should similar considerations apply in the writing of a textbook?

A physical picture of the upper atmosphere requires detailed knowledge of the chemistry as well as the dynamics of mass and energy transport of a gas composed of atoms, molecules, excited species, and charged particles influenced by the geomagnetic field. A listing of the chapter headings indicates the range of subjects discussed: (1) The Thermosphere—The Earth's Outermost Atmosphere (Chapman), (2) The Properties and Constitution of the Upper Atmosphere (Nicolet), (3) The Upper Atmosphere Studied by Rockets and Satel-

lites (Newell), (4) The Sun's Ionizing Radiation (Friedman), (5) The Airglow, (6) General Character of Auroras, and (7) The Auroral Spectrum and Its Interpretation (Bates), (8) Radar Studies of the Aurora (Bosher), (9) The Ionosphere (Ratcliffe and Weekes), (10) The Upper Atmosphere and Geomagnetism (Vestine), and (11) The Upper Atmosphere and Meteors (Greenlow and Lovell). Each chapter represents an authoritative, detailed review with an adequate set of references to the important papers published. The advances made during the IGY have led to the addition of a separate chapter in which some of the more recent contributions are described. Consequently, this text is valuable not only to the specialist but also to the worker who wishes to get acquainted with the subject with the least expenditure of effort.

The contents of this book reflect our present state of knowledge or lack thereof. Also, the information presented points to some of the yet unresolved problems, as for example, the chemical kinetics of the species found in the upper atmosphere, which are responsible for such phenomena as the airglow. In this area rapid progress is to be expected during the next decade, stimulated in part by the authors of *Physics of the Upper Atmosphere*. It is hoped that by that time the scientific workers will have come to an agreement on atmospheric nomenclature.

Perhaps one would expect that the contribution of eleven authors to eleven chapters of this book would result in a series of independent, unrelated monographs. Yet due credit must be given to the editor (who is also the author of one chapter) for his skillful fitting together of the individual pieces, so that the book is more than an assemblage of unrelated sections.

Frozen Free Radicals. By G. J. Minkoff. 148 pp. Interscience Publishers, Inc., New York, 1960. $5.00. *Reviewed by Stuart A. Rice, Institute for the Study of Metals, The University of Chicago.*

IN the past few years remarkable progress has been made in the study of unstable atomic and molecular species. One of the most useful techniques has been the matrix isolation of free radicals, the subject to which the book under review is addressed. It has long been apparent that an authoritative treatment of this subject would be extremely valuable. Unfortunately, brief perusal of Minkoff's monograph clearly indicates that such a treatment is still needed.

In almost all respects I have found this book unsatisfactory. The section dealing with experimental methods is over-abbreviated and superficial. For example, the information given on low-temperature technology is insufficient to allow the novice either to build or find in the literature suitable apparatus of general character for work in this region, although the details of some very special apparatus are discussed. The treatment of radical detection would charm a layman, but does not give any real information to the student.

A major fraction of the book is given over to review-