by macrophages, as well as the possible contributions of these cells to the pathogenesis of disease states, are included. Some emphasis is given to an evaluation of the role of cytophilic antibodies in cell-mediated immunity.

As might be expected, such an extensive coverage in 151 pages of text results in some thin spots; however, 699 references to further reading are provided in the bibliography. In certain instances accuracy seems to have been sacrificed for the sake of brevity. For example, on page 102 the following statement appears: "It is known that nonsensitive cells are recruited to participate in delayed reactions because animals depleted of lymphocytes, by X-irradiation or other means, do not accept passive transfer of delayed sensitivity." This statement is somewhat misleading in its implication that the lymphocytes of the host are the critical participants in such reactions, an unproven point. In addition, the statement is not wholly true, because many procedures, x-irradiation in particular, which effect the depletion of lymphocytes also injure or destroy other cells, including the precursors of monocytes. Where the depletion of host lymphocytes is selective, the adoptive transfer of delayed hypersensitivity has in fact been demonstrated.

Investigators in any field which deals with macrophages will find this monograph a useful source book. Those who are not wholly acquainted with the work or views developed in Weiser's laboratory will find much to interest them.

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Optical Theory

An Introduction to Hamiltonian Optics. H. A. BUCHDAHL. Cambridge University Press, New York, 1970. xvi, 360 pp. $18.50. Cambridge Monographs in Physics.

Some years ago a young man applied to a large U.S. optical firm for a job as a lens designer. He apologized for lack of training, but on announcing that he owned two copies of the classic Conrady *Applied Optics and Optical Design*, one for his office and a second for his bedside table, he was hired on the spot. Perhaps the story will be repeated some day with Buchdahl's *Introduction to Hamiltonian Optics* as a similar credential.

Hamiltonian theory describes with powerful generality the overall properties of optical systems considered as "black boxes," although it does not describe the detailed structure needed to construct the systems that achieve these properties. Buchdahl's book is therefore on the subject of geometrical optics, but it is not about how to design lenses. It is, however, a compact comprehensive account of the fundamentals of the theory written with the lens designer's needs very much in mind. Every lens designer worth his salt has at some time in his career attempted to apply the broad concepts of Hamiltonian optics to the solution of practical problems. Success has been sufficiently rare that the theory, as such, has made little direct contribution to techniques for optical instrument design. The failures have been frustrating because of the obvious fundamental power of the theory and because of its conceptual elegance. The indirect effects have been large, however, both in contributing to an understanding of fundamental principles that govern the overall behavior of optical systems and in pointing the way to other, more practical, theoretical approaches.

Buchdahl approaches the subject not only as a capable mathematical physicist, but as one who with a knowledge of practical optics has made significant contributions to geometrical optical theory. Buchdahl's approach to higher-order aberration theory has over the last decade had a major impact on modern lens design with computers. Thus he brings to this exposition of Hamiltonian optics a familiarity with practical optics not usually found in authors on this subject.

The author claims his book to be nonmathematical, and indeed it might be so viewed by a professional mathematician. From the point of view of many physicists and engineers, it will appear to be quite mathematical. Moreover, this is a tightly written book. The subject matter is developed with precision, and the author expects the reader, at every point, to be master of the preceding exposition. It is thus a book for the scholar, or at least the serious student, and not a book for easy browsing. Problems are included at the end of each chapter. Many readers will be grateful that the author has provided solutions at the end of the book.

Buchdahl has filled a significant gap in the literature with this fine, well-constructed work. It will provide a basis for an understanding of optics by theoretical-minded students, and for an understanding of important optical fundamentals by the engineer. Perhaps it will provide the stimulus that will bring some fresh mind to find a way in which fundamental Hamiltonian theory can be actually used in the solution of actual optical design problems.

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Emissions from the Sun

Introduction to the Solar Wind. JOHN C. BRANDT. Freeman, San Francisco, 1970. xiv, 202 pp., illus. $10. Astronomy and Astrophysics Series.

Nearly a decade has now passed since the first systematic *in situ* observations of the solar wind were made by a spacecraft. Earlier observational evidence for the ejection of charged particles from the sun had been indirect, consisting principally of studies of comet tail orientations and geomagnetic activity. As early as 1958 it had been argued on theoretical grounds that the sun's million-degree corona must expand continuously into space with supersonic velocities near the earth's orbit. But the subject remained in controversy until 1962, when observations from Mariner 2 indicated a plasma outflow from the sun with velocities of the order of 400 kilometers per second and a mean particle density of about 10 per cubic centimeter at the orbit of earth.

The rapid development of solar wind physics during the past decade has been fraught with confusion and frequent misconceptions. Nevertheless, it has been a stimulating period marked with heated controversies, competing theories, imaginative ideas, and new experimental techniques. Unfortunately for the layman or the serious student of solar system astrophysics, much of this excitement is apt to fade when he is faced with tediously searching out the many technical articles on the subject scattered widely throughout the astrophysical and geophysical literature. To be sure, there are many excellent review articles on different aspects of the solar wind, but no single one of these presents a unified picture of the field as a whole.

It is this gap in the literature that John Brandt's book fills with notable success. Intended as an intermediate-level reference text, the book provides a comprehensive but highly readable account of the evolution of present-day ideas about the interplanetary medium and its relation to solar activity. The treatment is self-contained, requiring little or no prior knowledge of interplanetary physics. Pertinent supplementary references are listed after each chapter.

I found one of the most rewarding parts of the book to be the opening chapter, in which Brandt traces the history of early thoughts and theories of the interplanetary medium. In my opinion, even most experts in the field of space physics would benefit from reading this brief account of little-known facts.

The obvious place to begin a discussion of the solar wind is at the sun, and the author sets the stage by summarizing current knowledge of classical solar physics. Probably all of the material in chapter 2 is relevant to an understanding of the origin of the solar wind. Upon completing the book, however, I am left with the impression that little reference is actually made to it in subsequent chapters. This is not so much a fault of the book as it is a reflection of our present lack of understanding of the relation of observed solar wind properties to visible features on the sun (a point which, however, Brandt might well have stressed).

Topically, the chapter devoted to basic theory is complete and up to date. Brandt has succeeded in extracting the important physics from many theoretical analyses and presenting it in a concise manner. Occasionally, completeness of argument has been sacrificed for the sake of brevity, which is an unfortunate situation. I was particularly dissatisfied with the section on subsonic versus supersonic solar wind solutions, a topic of such colorful controversy in the technical journals. Brandt's discussion of the subject leaves me unconvinced (apart from observational evidence) that the supersonic solution is the only physically acceptable one.

In the chapters dealing with observations, the author presents representative facts and figures about the average properties of the solar wind and describes in some detail the experimental techniques by which they are obtained. At the same time, he impresses upon the reader the importance of fluctuations of these properties. An important research problem in the future of solar wind physics will be to relate these fluctuations to the evolution of specific coronal features.

As with any technical book written by an active worker in the field, the book under review shows some tendency to overemphasize the author's own contributions to the subject. I found this to be true especially in the lengthy discussion of ionic comet tails in chapter 4.

Introduction to the Solar Wind is basically an excellent, well-organized text. It correctly delineates the most important aspects of modern solar wind research. In the style with which it was written, the book should appeal to readers with a wide variety of technical backgrounds. Each reader, however, expects something different of a book. For instance, I would have liked to see greatly expanded the final chapter, dealing with the impact of the existence of the solar wind on classical astrophysics. Without enlarging the book significantly, this might have been done by condensing the review of solar physics in chapter 2. Certainly new ideas and directions for future research are stimulated by discussions of the type encountered all too briefly in the last 15 pages of the book.

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