

BOOK REVIEWS

A Selective Survey of Books on Plasma Physics

Reviewed by Ernest P. Gray, Johns Hopkins Applied Physics Laboratory

THERE has been of late a veritable outpouring of books on plasma physics. These include, in addition to the titles below, expanded versions of lectures given at symposia or courses, the usual conference proceedings, and other books dealing principally with such closely related subjects as gas-discharge physics, ionized gases, cosmic electrodynamics, etc., but also containing some chapters on plasma dynamics.

Clearly, this aging subject, which had been considered moribund for some twenty years after Langmuir's pioneering research during the 1920's, has undergone a remarkable renaissance—primarily because of the sudden recognition that an understanding of plasmas holds the key to a future of cheap, abundant energy through the taming of thermonuclear fusion. This promise for the future has impelled an army of physicists, mathe-

maticians, and engineers the world over into a frenzied frontal assault, more often characterized by the reckless optimism of the opportunist than by the healthy skepticism of the scientist. Only after repeated bloodied noses and humiliating retreats has a more mature, less quixotic approach been adopted.

The understanding, so bitterly gained by the experience of the past decade, has started to be digested and expounded by the chroniclers and the more philosophically inclined. The resultant flood of books makes a guide for the bewildered reader desirable. The best single choice from among the available books in any field depends on the particular purpose of the reader. It might surprise the outsider, therefore, that the first task of nearly every aspiring researcher in plasma physics has been a cover-to-cover study of Spitzer's

The books discussed:

Allis, William P., Solomon J. Buchsbaum, and Abraham Bers: **Waves in Anisotropic Plasmas**. 280 pp. M.I.T. Press, Cambridge, Mass., 1963. \$6.00.

Anderson, J. Edward: **Magnetohydrodynamic Shock Waves**. 226 pp. M.I.T. Press, Cambridge, Mass., 1963. \$6.50.

*Bishop, Amasa S.: **Project Sherwood—the U. S. Program in Controlled Fusion**. 216 pp. Addison-Wesley, Reading, Mass., 1958, \$7.50; Anchor (Doubleday), New York, 1960, Paper \$1.45.

Cambel, Ali Bulent: **Plasma Physics and Magnetofluid-Mechanics**. 304 pp. McGraw-Hill, New York, 1963. \$11.50.

Chandrasekhar, S.: **Plasma Physics**. Notes Compiled by S. Trehan. 217 pp. Univ. of Chicago Press, Chicago, Ill., 1960. Paper \$1.75.

Chandrasekhar, S.: **Hydrodynamic and Hydromagnetic Stability**. 652 pp. Oxford Univ. Press, New York, 1961. \$16.80.

Cowling, T. G.: **Magnetohydrodynamics**. 115 pp. Interscience, New York, 1957. Cloth \$3.85, Paper \$1.95.

Delcroix, J. L.: **Introduction to the Theory of Ionized Gases**. Transl. from French by Melville Clark, Jr., David BenDaniel, Judith BenDaniel. 162 pp. Interscience, New York, 1960. Cloth \$4.50, Paper \$2.50.

Harris, Lawson P.: **Hydromagnetic Channel Flows**. 90 pp. M.I.T. Press, New York, 1960. \$3.50.

*Ferraro, V. C. A., and C. Plumpton: **An Introduction to Magnetofluid Mechanics**. 181 pp. Oxford Univ. Press, New York, 1961. \$4.00.

*Glasstone, Samuel, and Ralph H. Lovberg: **Controlled Thermonuclear Reactions**. 523 pp. Van Nostrand, Princeton, N. J., 1960. \$5.60.

Linhart, J. G.: **Plasma Physics** (2nd ed.). 278 pp. North-Holland, Voorburgwal-Amsterdam, 1961. \$7.85.

Pai, Shih-I.: **Magnetogasdynamics and Plasma Dynamics**. 197 pp. Springer-Verlag/Prentice-Hall, Englewood Cliffs, N. J., 1962. Textbook ed. \$10.50.

*Rose, David J., and Melville Clark, Jr.: **Plasmas and Controlled Fusion**. 493 pp. M.I.T. Press, New York, 1961. \$10.75.

Simon, Albert: **An Introduction to Thermonuclear Research**. 182 pp. Pergamon, New York, 1959. \$5.50.

*Spitzer, Lyman, Jr.: **Physics of Fully Ionized Gases** (2nd ed.). 170 pp. Interscience, New York, 1963. \$4.75.

*Stix, Thomas H.: **The Theory of Plasma Waves**. 283 pp. McGraw-Hill, New York, 1962. \$10.00.

*Thompson, William B.: **An Introduction to Plasma Physics**. 256 pp. Pergamon, New York, 1962. \$7.00.

*Starred books are considered by this reviewer (who has an admitted bias in favor of controlled thermonuclear-fusion research) as the most generally useful and the most readable accounts for the general reader.

slim volume, available until now only in its 1956 edition. Such universal adoption of a "bible" is rare, but, in this case, fully deserved. For not only was this the first, and for a number of years the only modern book on plasmas, but it also is a model for an introduction to any subject. In limiting its choice of subject matter to fundamentals, and pruning all else in its emphasis on physical insight and physical explanation, in its deceptively easy-to-read style, the book is ideally suited as a first introduction.

In view of such praise, it is not surprising that the second edition has been awaited with unusual anticipation. To a remarkable extent, the succinct flavor of the first edition has been retained and in places even heightened. The entire text has been brought up to date. The chapter on plasma waves, previously somewhat unsatisfying, has been completely rewritten in the light of new insight gained from the so-called Allis diagram, and a chapter has been added on the nature and stability of hydromagnetic equilibria. Yet, with all these additions, the book reads as fresh and uncluttered as before.

Besides Spitzer's volume there are three other introductory books on plasma physics with somewhat similar purposes, Cowling's *Magnetohydrodynamics*, Ferraro and Plumpton's *An Introduction to Magneto-Fluid Mechanics*, and Delcroix's *Introduction to the Theory of Ionized Gases*. These books differ widely in approach, emphasis, and scope. The subject of Cowling's excellent little book is magnetohydrodynamics, that important subdivision of plasma physics dealing with the properties of conducting fluids. The emphasis is almost entirely on the principles underlying the behavior of such astro- and geophysical plasmas as sunspots, solar prominences, the earth's liquid core, etc. As in Spitzer's book, the approach is physical and intuitive, with enough mathematical detail to help the reader understand the essentially physical arguments. However, despite its general excellence, the book is overshadowed by Spitzer's.

Ferraro and Plumpton's highly admirable but strangely neglected work, in many ways parallels Spitzer's, and this may be the reason that it has not achieved the attention it certainly deserves. Like Spitzer, Ferraro and Plumpton belong to that able group of astrophysicists whose continuing interests and persistent efforts helped keep plasma physics alive during the doldrums between Langmuir and the first stirrings of controlled-fusion research in the early 1950's. But while Spitzer was already immersed in the study of controlled fusion in 1956, Ferraro and Plumpton's main interests continue to center on astrophysical plasmas. Despite this difference in interest, they have adopted an approach to plasma physics strikingly similar to Spitzer's. It is reflected in the choice of subject matter, in the emphasis on collective as opposed to single-particle behavior, in the skillful interweaving of macroscopic and microscopic descriptions, each illuminating a portion of the subject, but both needed for a fuller understanding of the whole. Most significant, perhaps, is the similarity

in the balance struck between the need for mathematical detail and the goal of physical insight to which this should lead. While the mathematical theory is always developed with great care, there is no doubt that both authors consider even more important the physical discussion which is needed to buttress and clarify the formal results. Although Ferraro and Plumpton cover much of the same material as Spitzer, their development is almost always original and thereby doubly valuable. In some cases—for example, their development of plasma dynamics from the Boltzmann equation with a relaxation type of collision term—their treatment is superior; in others—such as waves in plasmas and hydromagnetic equilibria—they are less successful. Inevitably, in a slim volume which covers so much ground, some subjects are treated inadequately or only conventionally; for example, turbulence, shock waves, and adiabatic invariance. Other subjects, such as magnetohydrodynamics, are made beautifully clear. Throughout, one is aware of the skillful pruning that renders the writing pleasantly concise, yet easy to read. Great care has evidently been exercised to attain the utmost accuracy, not only by refraining from careless statements, but also by eliminating anything that might be misleading. One circumstance should be noted which might at first appear somewhat curious. There is only one reference in the entire book to work originating in the controlled thermonuclear fusion effort, probably because much of the material was taken from a lecture series given by Ferraro in 1958, before the American, Russian, and British fusion work had been declassified. The book, then, can be strongly recommended to all who want an education in plasma physics, but whose primary interest is not in controlled thermonuclear fusion.

Delcroix's little tract attempts to complement Spitzer's, in that it is based on the single-particle approach, while Spitzer's emphasizes the collective description. In this effort, the author has been only partially successful. While he has succeeded admirably in describing the noncollective behavior of ions and electrons in electric and magnetic fields, the insight that this behavior should give into that of plasmas is not convincingly demonstrated. The book is at its best in the discussion of weakly ionized plasmas. Despite its shortcomings, it is pleasant to read and could be very useful to some readers.

After Spitzer's book, further choices depend on the reader's interest, background, and taste. We first discuss a group of five books whose clear presentation, over-all excellence, and broad point of view make them particularly suitable for the general reader and the student. Probably the best choice for a self-contained book covering nearly all phases of plasmas of importance for controlled thermonuclear fusion is Rose and Clark's excellent text. The authors start at an elementary level and assume an absolute minimum of previous knowledge on the part of the reader. They discuss from scratch the relevant aspects of the Maxwell and Boltzmann equations, distribution functions, collision cross

sections, etc., subjects which most other books assume as known. This approach enables them to emphasize those aspects pertinent to plasma physics; however it might give the reader the mistaken idea that the background needed for a full understanding can be developed as he goes along. The rapid increase in difficulty and sophistication as he proceeds, however, will soon disabuse him of any such notion. A strong point of this book, like Spitzer's, is the physical insight and understanding it provides of the complicated phenomena described. In addition, the development usually includes an adequate mathematical treatment. A prime example of expository skill is the treatment of the various Coulomb effects—screening of electromagnetic fields, relaxation times, dynamical friction, and runaway electrons. Another is the chapter on radiation losses from a plasma. A nearly unique feature is a detailed consideration, mostly original, of some problems likely to be encountered in designing a thermonuclear reactor, and some possible solutions. As befits a disciple of the MIT school of gas-discharge physics, Rose has included an excellent, brief review of relevant facts in this field. The book is very readable and is subtly spiced with those characteristic witticisms which earmark the senior author's style. Each chapter is supplemented by a large collection of well-chosen problems, making the book ideally suitable as a text. An excellent index helps make it a valuable reference for the specialist, but the bibliography is insufficient for this purpose.

Another exceptional book for learning how to think about plasmas in concrete, physical, rather than formal, mathematical terms is Thompson's recently published volume. It is an expanded version of a lecture series designed to recruit mature scientists for plasma physics, and to help give them a firm grounding in the fundamentals of the subject as expeditiously as possible. Consequently, the treatment is considerably more sophisticated than Rose and Clark's, and is sometimes concise to the point of terseness. On the other hand, the rewards are correspondingly greater from "sinking one's teeth" into the text. The book is full of illuminating observations based on the broad experience of an incisive thinker, and abounds in those invaluable back-of-the-envelope-type calculations which give correct order-of-magnitude answers to complex problems. These and similar devices are designed to enable the knowledgeable physicist to absorb and assimilate the fundamentals of a discipline new to him. The book is at its best in showing how to apply the physical insight gained from solutions of crude, simplified models to the complicated problems of the "real world", but without losing sight of the uncertainties attached to the answers. Particularly fine is the treatment and application of the magnetohydrodynamic approximation, which considers a plasma as a conducting fluid, and which probably has constituted the most fruitful approach to the study of plasmas. Unfortunately, the book is somewhat marred by careless editing characterized by unclear and confusing wording

and sometimes misleading misprints. In addition, both the index and the bibliography are inadequate. Hopefully, these faults will be corrected in a second edition.

We now come to a book which in my opinion will become a classic: Stix's monograph on plasma waves. It is difficult to fathom how the author has managed to carve out of so ill-understood a subject as plasma physics, so incisive and logically connected an account of the special topic he has chosen. All the loose ends have been neatly tied, giving it the appearance of an elegant summary of a well-established discipline. For the reader who wants insight into one important aspect of plasma physics, presented with clarity and in satisfying detail, this book is the clear choice. The primary accomplishment is the description of the many known types of plasma waves in terms of only a few generic types. These basic categories arise even in the most naive model of a plasma. The structure of this classification can be best appreciated by means of a special mode plot due to Clemmow and Mullaly and championed by Allis. Such a classification scheme describes, in relatively simple terms, even some very sophisticated phenomena. Interesting problems appear at the end of each chapter, but while the book's lucidity makes it well worth reading, its somewhat limited scope would appear to make it unsuitable as a text. The index is reasonably complete; my only carping complaint is an ungenerous bibliography.

All the books so far discussed, while equally appropriate for experimenter and theorist alike, were in fact written from the theorist's point of view. The only available books written by, and primarily for the experimenter are the one by Bishop, and the one by Glasstone and Lovberg. To a large extent, they both represent chronicles of the experimental efforts of Project Sherwood, the AEC's program in controlled fusion. In fact, Bishop, who is a former chief of the AEC's Controlled Thermonuclear Branch, wrote his book specifically as a semitechnical presentation volume for the delegates to the United Nations 1958 Conference on Peaceful Uses of Atomic Energy in Geneva, where the entire subject became declassified in one fell swoop. It is a well-written account on an elementary level, and is enlivened by beautiful, multicolored schematics of all the plasma devices discussed. Surprisingly, the main approaches have not changed much in the intervening five years. Bigger machines have been built and scrapped, replaced by still bigger ones; fond hopes in one or another scheme have been dashed, replaced by equally fond hopes for some new scheme. Only in the understanding gained of the underlying science, and in the realization of the unavoidable need for such understanding, has real progress been made.

Glasstone and Lovberg's book is a complete account of American experiments in plasma physics up to 1960, with only occasional reference to the foreign experience. It is pitched at a low-to-intermediate level of difficulty. It begins with a discussion of fusion and elementary plasma theory, and then proceeds with a detailed description of all the various experiments for

NEW BOOKS

High Pressure Physics and Chemistry

Edited by R. S. BRADLEY

Vol. 1, October 1963, 444 pp., \$15.50
Vol. 2, October 1963, 361 pp., \$12.50

This treatise provides a comprehensive and advanced study of high pressure science, including both theoretical and experimental work on the production and measurement of static and dynamic high pressures. The gaseous, liquid, and solid states are considered in detail, together with discussions on equations of state, phase equilibria, and transport properties.

Electronic Methods

Edited by ERNST BLEULER and
 ROBERT G. HAXBY

Volume 2 of **Methods of Experimental Physics**

Edited by L. MARTON

November 1963, about 825 pp., \$24.00

The volume, written by 28 specialists, gives a concise survey of the theoretical aspects, basic principles, methods, and components used in electronic measurements. It will prove invaluable to the experimental physicists in the choice of the most appropriate system, the construction of apparatus, and the understanding of commercial equipment.

Rarefied Gas Dynamics

*Proceedings of the Third International Symposium on
 Rarefied Gas Dynamics, held at the Palais
 de l'UNESCO, Paris, in 1962*

Edited by J. A. LAURMANN

Supplement 2 of **Advances in Applied Mechanics**

Edited by H. L. DRYDEN and TH. VON KÁRMÁN

Volume 1, 1963, 541 pp., \$16.00

Volume 2, 1963, 529 pp., \$16.00

The work provides a compendium of information on every aspect of rarefied gas dynamics. **Volume 1** discusses fundamental kinetic theory, solutions of the Boltzmann equation, molecular beams, and surface interactions. **Volume 2** presents ionized flows, transition flow theory, transition flow experiment, and experimental methods in rarefied gas flows.

Space Carrier Vehicles

**Design, Development, and Testing of
 Launching Rockets**

By OSWALD H. LANGE and RICHARD J. STEIN

[Supplement 1 of **Advances in Space Science
 and Technology**]

Edited by FREDERICK I. ORDWAY, III

1963, 317 pp., \$12.00

This monograph reflects the various advances in the rapidly growing field of space carrier vehicles. All major areas of the field are covered with emphasis on guidance, control, and propulsion. The key developmental problems within these areas are given special emphasis.

Crystallography and Crystal Perfection

*Proceedings of an International Symposium on Protein
 Structure and Crystallography, Madras, India, 1963*

Edited by G. N. RAMACHANDRAN

October 1963, 374 pp., \$12.00

International experts in the field present the results of the latest researches in such topics as crystal structure analysis (particularly with the phase problem and the use of anomalous dispersion), crystal perfection, and crystal disorder. Also provided is a wealth of data on developments in electron and neutron diffraction and instrumentation.

Nuclear Research Emulsions

By WALTER H. BARKAS

Volume 15 of **Pure and Applied Physics**

Edited by H. S. W. MASSEY

Volume 1, Techniques and Theory
 1963, 509 pp., \$18.00

**Volume 2, Particle Behavior and
 Emulsion Applications**
 In preparation

Volume 1 presents information of a practical nature covering such topics as: emulsion as an instrument of research, the latent image and its development, processing procedures, emulsion microscopy and scanning technique, and ranges and range straggling in emulsion.



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BOOKS ON RADIATION DETECTION FROM

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METROLOGY OF RADIONUCLIDES

Proceedings of an IAEA symposium held at Vienna consisting of 37 papers (with discussions). Subjects: Survey papers on routine radionuclide standardization; New developments in standardization; Neutron-source calibration; High-intensity-source measurements; Microcalorimetry; Photomultipliers; Miscellaneous problems.

480 pp
1960

In USA and Canada: US \$5
Elsewhere: 30s.stg

WHOLE-BODY COUNTING

33 papers and following discussions from an IAEA symposium. Contents: Properties of radiation detectors; Calibration techniques; Typical facilities; Natural and contamination burdens; Data processing; Clinical applications.

529 pp
1962

In USA and Canada: US \$10
Elsewhere: 60s.stg

THE USE OF FILM BADGES FOR PERSONNEL MONITORING

An essay devoted to the following topics: The photographic process, Application to personnel monitoring, Requirements for setting up a service, Examples of procedure.

87 pp
1962

In USA and Canada: US \$1.50
Elsewhere: 9s.stg

NUCLEAR ELECTRONICS (1962)

Proceedings of an IAEA conference held at Belgrade. Contents: (Vol. I) Scintillation and Cerenkov detectors; Intensifier systems, photomultipliers and luminescent chambers; Ionization, gaseous and liquid detectors; Semiconductor detectors. (Vol. II) Amplitude converters, multichannel analysers and data handling; Classical electronics. (Vol. III) Fast electronics, Experimental systems, Accelerators, Monitoring systems and instruments.

Vol. I: 597 pp }
Vol. III: 512 pp }
Vol. II: 459 pp }
1962

In USA and Canada: US \$11
Elsewhere: 66s.stg
In USA and Canada: US \$8
Elsewhere: 48s.stg

MEDICAL RADIOISOTOPE SCANNING

From a seminar jointly organized by IAEA and the World Health Organization. Subjects: theory of isotope scanning; collimation; photo-scanning; basic problems of scintillation counting; scintillation cameras; liver, thyroid and pancreas scanning; bremsstrahlung in vivo; profile counting; coincidence scanning; diagnosis of intracranial lesions.

266 pp
1959

In USA and Canada: US \$4
Elsewhere: 24s.stg

NUCLEAR ELECTRONICS (1959)

Proceedings of a 1958 conference organized by the French Society of Radioelectricians, including 89 papers and the discussions that followed them.

Vol. I, 464 pp Each volume: In USA and Canada: US \$4
Vol. II, 392 pp, 1959 Elsewhere: 24s.stg

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producing, confining, heating, and diagnosing a plasma. While there is virtue in such a complete account, the pace is sometimes so slow as to make the reader impatient. The index as well as the bibliography are admirable. How useful it would be to keep this book up to date by annual or biennial supplements!

All of the next group of books deal with some highly specialized topic in plasma physics, or else a more general topic in a specialized way. The outstanding member of this group is Chandrasekhar's treatise on *Hydrodynamic and Hydromagnetic Stability*. While at least half of the book deals with a subject outside plasma physics (i.e., hydrodynamics), it has nevertheless been included in the present review because of the author's beautiful, authoritative, and crystal-clear presentation of hydromagnetic stability. Chandrasekhar has an international reputation for his ability to convey mathematical ideas and complicated theoretical arguments in a way that makes them appear deceptively simple, which he demonstrates in the present work. The presentation is couched in so artless and unpretentious a style as to lead the reader through difficulties almost before he realizes they are difficult. In addition, he has skillfully interwoven the text with a full account of the relevant experiments, illuminating theory with laboratory experience and interpreting observation with theoretical insight. For those who are automatically scared off by the sight of a thick treatise, this volume should provide an agreeable surprise, because it makes such remarkably pleasant, even engrossing reading. Additional virtues—minor, perhaps, but always welcome—include generous bibliographical notes at the end of each chapter and an excellent subject index. Only an author index is lacking. This book will certainly continue to be an indispensable reference for years to come.

The subject treated so elegantly in Stix's book—waves in plasmas—is discussed in much greater detail by Allis, Buchsbaum, and Bers. The authors' efforts to achieve both completeness and compactness have met with considerable success, but at a price. While their monograph will prove invaluable to the specialist already familiar with, and preferably actively working in the field, it is a difficult book, not suited to the general or casual reader. However, this is appropriate to the stated objective of the MIT series of monographs of which this book is a member; namely, to provide for "the systematic publication of research studies larger in scope than a journal article but less ambitious than a finished book". Accordingly, the subject is discussed in the detail usually found only in the periodical literature. But by keeping their focus squarely on the physical insight which motivates their point of view, the authors make it possible for the reader to integrate the many topics treated into a single body of knowledge. The very abundance of detail, however, has rendered the book somewhat choppy and uneven, in sharp contrast to the elegance and polish of Stix's more superficial treatment. The rather complete bibliography is particularly noteworthy in that it contains

NUCLEAR PHYSICS: An Introduction

By WILLIAM BURCHAM, *University of Birmingham, England*. 739 pages, \$12.00.

A superb new text for undergraduate and graduate courses in nuclear physics. Experimental aspects of the field are stressed, and a great amount of data and expository material are presented lucidly. The text is divided into five parts: the nuclear atom; experimental techniques of nuclear physics; static properties of nuclei; dynamic properties of nuclei; and basic interactions of nuclear physics.

SOLID STATE THEORY

By MENDEL SACHS, *Boston University*. 350 pages, \$10.75.

Designed for a one year graduate course, this text is aimed at students primarily interested in pursuing further research in experimental or theoretical solid state physics, and those whose primary interest is not in solid state physics but who wish to broaden their knowledge of solid state theory. The author exploits a few basic principles in developing in detail some of the general features of solids, rather than trying to cover a lot of ground in less detail.

MICROWAVE SOLID STATE MASERS

By ANTHONY E. SIEGMAN, *Stanford University*. McGraw-Hill Series In Electrical and Electronic Engineering. Off press.

A comprehensive, detailed treatment of the basic physical concepts involved in understanding the solid state maser and an equally detailed review of maser design, performance, and applications. Required quantum mechanical terms are introduced and used in a descriptive fashion, reducing the necessity for mathematical calculation.

VECTOR MECHANICS, Second Edition

By DAN E. CHRISTIE, *Bowdoin College*. Available in January, 1964.

A self-contained, systematic presentation of mechanics using the language of vector algebra and vector calculus. Vectors are introduced and used in detail to help the student in thinking vectorially about geometric and physical situations. The concepts of mechanics are introduced gradually, with dimensional analysis, and are made meaningful by a large number of worked examples and exercises.

INTRODUCTION TO RADIOLOGICAL HEALTH

By HANSON BLATZ, *Director, Office of Radiation Control, The City of New York*. Available in January, 1964.

A sound look at the importance of the various aspects of radiological health and the control of radiation exposure of both radiation workers and the general public. In addition to a detailed discussion of radiation sources, the book covers characteristics of radiation, interaction of radiation with matter, biological effects of radiation, maximum permissible doses and concentrations, radiation detection and measurement, shielding, contamination control, radioactive waste disposal, the control of radiological hazards, legal aspects of radiation control, and guarding against and handling of accidents. The text assumes the student has a working knowledge of nuclear physics and the elements of biology.

GROUP THEORY AND QUANTUM MECHANICS

By MICHAEL TINKHAM, *University of California, Berkeley*. *International Series in Pure and Applied Physics*. Available in January, 1964.

This new volume presents the elements of group theory most pertinent to physical applications and provides a brief but systematic analysis of the quantum mechanics of atoms, molecules, and solids, emphasizing the use of group theoretical techniques. Features: a lucid presentation of the calculation of energy levels and selection rules . . . a treatment of the magnetic groups with illustrative applications to real magnetic groups . . . exercises follow each chapter.

ELECTROMAGNETIC FIELDS

By J. VAN BLADEL, *University of Wisconsin*. *McGraw-Hill Electrical and Electronic Engineering Series*. Available in January, 1964.

A graduate level text which applies certain mathematical methods to the calculation of electromagnetic fields. The book utilizes systematically mathematical techniques such as eigen function methods, variational methods, formulation of problems in terms of integral equations, etc., which are well-known to the mathematical physicist but have only recently become familiar to electrical engineers.

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full references to the Russian work, which is considerable in this area. The index is excellent.

Another specialized book of the same kind (also in the MIT series of monographs) is Anderson's *Magnetohydrodynamic Shock Waves*. Most of the above remarks concerning the virtues and the limitations of such a book also apply. A detailed, comprehensive study of this important subject has previously been lacking, and this volume should go a long way toward filling the gap.

An even more specialized topic is treated in Harris' slim volume on *Hydromagnetic Channel Flows*. The most notable achievement of this book, which is likely to appeal to only a limited audience, is the rather detailed correlation between theory and experiment.

The book by Pai—who reserves the name *magnetohydrodynamics* for incompressible fluids, and uses the more accurately descriptive term *magnetogasdynamics* for the general case—approaches plasma physics from the viewpoint of fluid mechanics. A detailed discussion is presented of the effects of adding electromagnetic interaction terms to the well-known equations of fluid mechanics. All the usual topics of fluid mechanics make their appearance: fluid flow, turbulence, shock waves, boundary layers, dimensional analysis, etc. But the structure and flavor of the work are somewhat reminiscent of the plodding, classical German *Handbuch*, and is unsuited to the needs of the times. The absence of a clear point of view or of a unifying thread, as well as the lackluster style, make it somewhat uninteresting reading.

The remaining books represent less successful efforts, although several have noteworthy features. Linhart's book is a curious collection of diverse subjects in plasma physics. A brave, but not very successful effort has been made to tie these together. It has an excellent chapter on single-particle trajectories, and its treatment of a number of topics, such as the following, are not discussed elsewhere: relativistic plasmas, Čerenkov radiation, the Fokker-Planck equation, magnetohydrodynamic generators, plasma propulsion, and H-bombs.

It is not really fair to criticize on the same basis as the other books Chandrasekhar's *Plasma Physics*, which consists of unedited course notes taken by one of his students. Not surprisingly, the resulting text is unpolished and does not hang together very well. The emphasis is on the details of the mathematical development of the single-particle approach to plasma physics, and as such, is extremely valuable. In particular, the chapters on first-order orbit theory are excellent, and the detailed treatment of adiabatic invariance is not available in any other book.

The avowed objective of Cambel's book is to provide engineering students and practicing engineers with the knowledge required for the technological exploitation of plasmas. There is a pressing need for such a book, as evidenced by the obvious unsuitability of most if not all the books cited here, and the task is certainly a difficult one. But despite the author's evident dedi-



NOBLE GAS COMPOUNDS

Edited by Herbert H. Hyman. The first true compound of a hitherto inert, or "noble," gas was reported in June, 1962. The announcement of the synthesis of xenon tetrafluoride in September of that year initiated research in an ever increasing number of laboratories and stimulated much serious theoretical speculation. This book is the proceedings of the first conference held on the subject and represents a complete summary of research in this field.

348 pages 18 plates line illus. index \$12.50

THE ELECTRON *Its Isolation and Measurements and the Determination of Some of Its Properties*

Robert Andrews Millikan; edited and with an introduction by Jesse W. M. Du Mond. This classic work describes the many researches which won Professor Millikan the Nobel Prize for Physics. Although revised in 1924 and reissued again in 1935, the original edition is still of immense historical and practical importance and has now been made available again.

Cloth, 384 pages, \$6.00 Paperback edition, \$2.45

PROGRESS IN FAST NEUTRON PHYSICS

Edited by Gerald C. Phillips, Jerry B. Marion, Jacob R. Risser. This book contains the proceedings of the international Conference on Fast Neutron Physics. Experts from many different countries have contributed to this symposium the latest information about the interaction of fast neutrons with atomic nuclei.

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cation, the present attempt is only partially successful. The primary objection concerns the various introductory chapters and sections (about half the book) which precede the material on the engineering applications of plasmas. In this reviewer's opinion, this introductory material, carelessly written and often inaccurate, generally does not serve its purpose. Far too much is attempted in the way of supplying needed background material for the reader, yet far too little care has been exercised to make it clear and accurate or to pinpoint its relevance to the later development. Only in the last half of the book, when the author finally feels free to say what has been on his mind all along, does he begin to meet his objective.

Finally, we come to Simon's book, which contains, almost unchanged, a series of lectures given by the author to members of the staff of Oak Ridge National Laboratory near the beginning of Project Sherwood, in 1955. While it served a purpose at the time of publication, it is by now considerably out of date. Only the last chapter, which deals with plasma diffusion across a magnetic field and contains some of the author's own contributions, has not been superseded in other books.

In conclusion, many good accounts of plasma physics are available, at any level of difficulty desired and from a variety of points of view. As befits a subject still in such a state of flux, however, the definitive book remains to be written.

Heat, Thermodynamics, and Statistical Physics. By Franjo H. Crawford. 700 pp. Harcourt, Brace & World, New York, 1963. \$10.00. Reviewed by Stuart A. Rice, University of Chicago.

DESPITE the long history of the subject, there are still published every year numerous textbooks of thermodynamics. The purposes of these texts vary, as does the level of the treatment.

Heat, Thermodynamics, and Statistical Physics is, in general, a fine book. Its virtues include excellent discussions of the various temperature scales, including samples of high-precision data on gas behavior, and a good discussion of the mechanical equivalent of heat and of the specific heats along various thermodynamic paths. The book is reminiscent of older texts on thermodynamics in that there is considerable space devoted to the description of experiments. Along with its strengths, the book has several weaknesses. For example, the author does not use the modern definition of heat in terms of work and internal energy but instead introduces heat via the heat capacity; there is overemphasis on different cycles, engines, and refrigerators; the Helmholtz and Gibbs functions are introduced by the method of Legendre transformation, but the text does not explain the rationale behind the choice of variables nor the relationship between the slopes, intercepts, and envelopes of families of curves. A very large amount of space is devoted to methods of obtaining various derivations, and there is essentially no

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