with the technical vernacular. There are only a few errors in an otherwise well produced book.

LEONID V. AZÁROFF
Director, Material Science Institute
University of Connecticut

Plasma Physics, Vol. 2

By J. L. Delcroix
188 pp. Wiley, New York, 1969. $9.95

Interest in ionized gases began originally in the 1920's with the study of electron discharges. It increased considerably with the efforts to design controlled thermonuclear reactors and, more recently, with the study of ionospheric phenomena.

Following his *Introduction to the Theory of Ionized Gases* (1959), J.L. Delcroix decided to treat his subject in greater depth. The first volume, of a planned three-volume treatise on plasma physics, appeared in 1963 and dealt with the relationship between hydrodynamics and kinetic theory; the third volume will deal with completely ionized gas. All three are based on a course by Delcroix, professor at the Faculty of Science of Paris University, Orsay.

This second volume treats weakly and moderately ionized gases. Their definition depends on whether or not the collision frequency of electrons among themselves, ν_{ee}, is small compared to the frequency with which the electron temperature relaxes toward that of the neutral molecules. These molecules are in turn very much smaller than ν_1, the frequency with which the electron velocity distribution relaxes towards isotropy. Even for the moderately ionized gas ν_{ee} is small compared to ν_1.

The book employs two methods of approach: one using the Boltzmann equation and the other a set of macroscopic equations. The former is applied to the two basic problems of determining electron motion caused by an electric field and that caused by diffusion. The macroscopic theory is, in principle, less exact and, to see how well it can be expected to work, it is applied to the same two problems. Subsequently it is used in more complex problems, such as ambipolar diffusion, positive-column plasmas and the phenomenon of volume recombination and attachment. In the appendix the author has collected some of the most important collision cross sections, with ample source references. Because it is intended as a textbook for students entering the plasma-research field, the book strongly emphasizes theoretical methods, which are presented clearly and concisely. The few applications treated are presented quite briefly and some areas, such as ionospheric physics, wave propagation and radiative transfer, are not touched upon at all.

The proofreading has not been as careful as one would like; the most confusing misprint is in the equation representing the assumption of congruence, where the symbol for velocity is replaced by that for collision frequency. However, the trivial mistakes do not impair the usefulness of this short monograph on theoretical methods of treating transport and other nonequilibrium processes in weakly ionized gases.

ROLF LANDSHOFF
Palo Alto Research Laboratory

Principles and Applications of Underwater Sound

Carl Eckart, *ed.*
295 pp. Department of the Navy, Washington, D. C., 1968. (Reprint of the National Defense Research Committee Report, 1946.)

This book was originally published as one of the reports summarizing the technical work done during World War II by division 6 of the National Defense Research Committee. This division was the largest scientific group in the US after the radar and atomic energy divisions. Its activities were closely correlated with similar work in Canada and the UK, principally through the leadership of the division chief, John T. Tate.

The nature of underwater-sound studies required that they be conducted at many locations throughout the world where proper oceanographic conditions existed. In Canada the work extended from Esquimaux, B. C., to Halifax, N. S., and in the UK from Portland on the English Channel to the laboratories on the land and sea locks in Scotland, especially at Fairlie on the Clyde and at the Firth of Forth. In the US important centers were at New London, Conn., Orlando, Fla., and at Point Loma, Calif. Because of the extremely critical demands to combat the German submarine menace, which continued throughout the war, the allied efforts were directed almost exclusively to practical development work and engineering projects. In all these activities however, it was essential to determine reliable scientific data on the acoustical properties of the ocean, the sea bottom, the surface waves and the many factors affecting echo-ranging gear, listening systems, antisubmarine torpedos and subsurface warfare tactics in general. This volume brings together a major part of these fundamental measurements that were made under the stress of wartime conditions. The measurements have been supplemented by more recent work done under less stringent conditions, but this book is primarily an unusually clear exposition of the war research. Carl Eckart, who spent this period at Point Loma, has edited this volume with great understanding and selectivity.

The book is chiefly concerned with the basic principles of underwater sound, including sound propagation in the sea and the oceanographic conditions that determine the transmission, refraction, echoing, scattering and reverberation of sound in the sea. The ocean considered as a medium for sound transmission could hardly be less favorable. In contrast to the almost ideal propagation conditions for radar in the atmosphere, the ocean is highly absorbing, and sound propagation is greatly complicated by surface noise, bottom reflections, volume reverberation and, above all, vertical-temperature gradients, which have a complex and rapidly changing character.

These temperature variations were almost unknown at the beginning of the war but because of the pioneering work of Columbus Iselin and his associates at Wood's Hole Oceanographic Institution and also of the staff at Scripps Institute of Oceanography in La Jolla, Calif., temperature gradients were recognized early as a crucial factor in operating all underwater-sound gear. Another complication was that sound channels, which arise from the temperature gradients and density variations in the ocean, often permit sonic signals to travel great distances, but they also introduce additional hazards that complicate the rapid use of underwater-sound equipment.

This book will be of real interest not only to those specifically concerned with underwater-sound applications for the Navy, but also to others who

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1969. 812 pp. $19.95

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1970. 529 pp. $24.95

PION NUCLEON SCATTERING

Edited by GORDON L. SHAW, University of California at Irvine; and DAVID Y. WONG, University of California at San Diego.

A πN Scattering Conference was held December 1 and 2, 1967 at the University of California, Irvine. It was sponsored by the U. S. Atomic Energy Commission and UCI, and organized by the editors. The book recounts the nine summary talks and the more lengthy parts of the panel discussion by Chew, Dalitz, and Sakurai.

Contents: Introduction (G. Shaw and D. Y. Wong). πp Elastic Scattering: Low Energy Experiments and Phase Shift Analyses (C. Johnson and H. Steiner). πN Phase Shift Analysis and Phenomenological Dispersion Relations (C. Lovelace). N Studies via πp Inelastic Reactions (A. H. Rosenfeld and P. H. Söding). Forward Dispersion Relations—Their Validity and Predictions (S. J. Lindenbaum). Partial Wave Dispersion Relations and N/D Calculations (G. L. Shaw). Structure of the Differential Cross Section at High Energy (M. Ross). Regge Poles and High Energy πN Scattering (S. Frautschi). Current Algebra Determination of Low-Energy Pion-Nucleon Parameters (H. J. Schnitzer). The Relations between PCAC, Axial-Charge Commutation Relations and Conspiracy Theory (S. Mandelstam). Panel Discussion: Excited Nucleons and the Baryonic Supermultiplets (R. H. Dalitz). Panel Discussion: Remarks on Low-Energy πN Scattering (J. J. Sakurai). Panel Discussion: Comments (G. F. Chew). Author Index. Subject Index.

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1968. 497 pp. $19.95

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will find some very interesting examples of wave acoustics, which should relate to various nonmilitary problems. A careful study of the numerous graphs and clear explanations, which Eckart and his associates have provided, will impress the reader with the excellence of the book and will also suggest many areas where additional precise and detailed data should be found. Research in these areas has continued actively since the end of World War II, and I hope that other similar books will be forthcoming. Nevertheless, this book is most welcome and may be the only authoritative one available for many years. It can be highly recommended to all those interested in underwater sound or wave acoustics in general.

ROBERT S. SHANKLAND
Ambrose Swasey Professor of Physics
Case Western Reserve University

Basic Equations and Special Functions of Mathematical Physics

By V. Ya. Arsenin
361 pp. American Elsevier, New York, 1969. $13.50

Although he wrote for physicists, V. Ya. Arsenin maintains a reasonably high level of mathematical precision in this book based on his lectures at Moscow University. It is a concise and up-to-date introduction to the mathematical methods and the special functions that a physicist will encounter in partial-differential equations.

After displaying a few examples of second-order partial-differential equations in physics, Arsenin devotes the first part of the book to the basic methods for solving the typical equations. The criterion for primary classification is the method (characteristics, separation of variables, Green's functions, potentials, integral equations) rather than the type of equation (elliptical, parabolic, hyperbolic) that is more usual in textbooks. (Of course, the classification according to the type of equation is maintained in the second order.) This approach appears to render good results from the pedagogical point of view, but the success is largely due to the remarkable clarity of the exposition and the excellent quality of the translation.

The second part deals with the properties of special functions involved in solving partial-differential equations in physics: gamma function, cylindrical functions, spherical harmonics and Chebyshev–Hermite and Chebyshev–Laguerre polynomials. An appendix discusses the definition of generalized functions and the delta function, which is freely used in the book. Although it is also clearly and neatly written, the second part does not appear to provide as remarkable an account of its subject as the first. However, this impression may be a matter of personal taste regarding the selection of topics. A noteworthy feature of the book is the large number of problems (150), all of which have full answers.

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Brabant, Belgium

Principles of Quantum Electronics

By William S. C. Chang
540 pp. Addison-Wesley, Reading, Mass., 1969. $17.50

Even more than the invention of the transistor, the advent of masers and lasers has helped establish quantum mechanics in the electrical-engineering curriculum. The term "quantum electronics" has become popular to describe the applications of masers and lasers, nonlinear optics and the resulting new electroöptical devices. It is good to keep in mind that the so called "classical" electronics curriculum included such topics as the photoelectric effect, luminescence and contact rectifiers. The distinction between the new "quantum" and the old "classical" electronics is based more on the greater, current emphasis on discrete energy levels rather than on the properties of quasicontinuous-energy bands.

The title of this book conforms to present fashion and market trends, but a more informative title would have been *Intermediate Quantum Mechanics, Group Theory and Statistical Mechanics with an Application to Lasers.* The book is based on a graduate course for electrical engineers that William Chang developed at Ohio State University. He is now professor and chairman of the electrical-engineering department at Washington University, St. Louis.

His first six chapters are on quantum mechanics, energy levels of atoms and molecules, crystal symmetry and group theory, energy levels of transition-metal ion in crystals, interaction of radiation and matter and quantum-statistical density matrix. These are followed by two chapters on lasers and then twelve appendixes, including one that contains 60 pages of laser bibliography updated to about the beginning of 1967.

The strong point of the book is the condensed, and yet fairly rigorous, exposition of the quantum-mechanical calculation of energy levels of free atoms and ions in crystals, which is accompanied by numerous tables and diagrams. The tables include Clebsch–Gordan coefficients, characters of irreducible representations of point groups, laser wave lengths and operating characteristics of solid-state, semiconductor, atomic, molecular and ionic lasers.

The question is whether a beginning student can really learn quantum theory, group theory and statistical mechanics from such a condensed exposé. If he has taken separate courses in these subjects, the first six chapters may be useful as a refresher and as a reference for standard theorems and equations. He can then turn directly to the last two chapters on lasers. These chapters could, of course, be understood without the preceding detailed knowledge of wave functions, energy levels and crystal-field splittings.

The organization of these two chapters is somewhat rambling. Eigenmodes of the electromagnetic field are discussed at the end of the chapter on basic laser theory instead of before it. Although the amplification of a pulsed signal is treated in the general laser chapter, the pulsed operation of a Q-switched oscillator is postponed to the special section on solid-state lasers. Although the spontaneous-emission probability into a single mode, and into a frequency band df and solid angle $d\Omega$, is carefully distinguished in the chapter on interaction of radiation and matter, this question is confused in discussion of the noise power of a diffraction-limited amplifier. At the end of this section the reader is led to believe that this noise is proportional to f^3. The concept of coherence remains vague in contrast to the mathematical development of other concepts.

The compilation of the large amount of laser material would have been more valuable if it had been better integrated with previously developed theories. Nonlinear coupling of