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and the lucid style and insight have resulted in an excellent survey of the physical principles and elements of electroacoustics.

After an introductory discussion of mechanical and electrical oscillations and the analogies between them, the various stresses in matter produced by electric and magnetic fields are analyzed. The equations describing the coupling between the fields and the resulting motion of the medium are obtained and illustrated by simple examples. The utilization of these phenomena for the electromechanical transduction is then explored and the characteristics of different types of transducers are compared. A unified treatment of transducers in terms of electric-circuit analogs follows, and, after a chapter dealing with sound radiation from vibrating surfaces, the efficiency and sensitivity of the various transducers are determined. In the remaining chapters, basic questions of importance in the design of transducers related to (energy) transfer characteristics of the transducers are discussed. Thus, one chapter is devoted to the electrical and mechanical input impedances and others to the sensitivity and calibration of transducers.

The treatment is concise and clear and more systematic than in most texts in the field. In regard to the choice of subject matter, the only omission apparent to this reviewer is a discussion of the special problems involved in the generation and detection of very-high-frequency sound ("hypersound", frequencies above 10^8 cps).

The book should prove of interest not only to the newcomer who wants to know "what it is all about", but also to the specialist who feels that he is due for a concentrated, systematic review of the basic principles of electroacoustics. The extensive set of references that is given to books and original articles may also prove helpful.

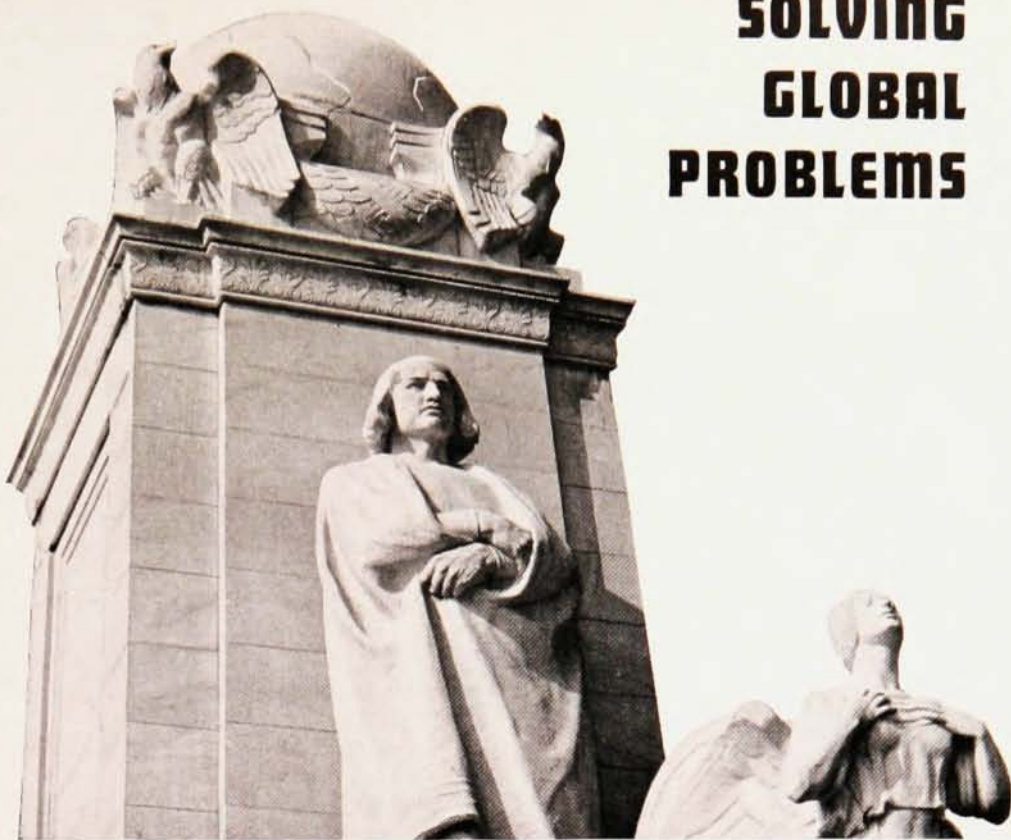
Diffraction: Structure des Images. Influence de la Cohérence de la Lumière. Vol. 2 of Part 1, La Formation des Images, of *Traité d'Optique instrumentale*. By André Maréchal and Maurice Francon. 204 pp. Editions de la Revue d'Optique théorique et instrumentale, Paris, 1960. Paperbound \$7.52.

Théorie et Calcul des Figures de Diffraction de Revolution. By Albéric Boivin. 573 pp. Centre de Recherches en Physique, Université Laval, Québec, Canada, 1960. \$12.00. Reviewed by Nicholas Chako, Queens College.

CALCULATIONS of the image-formation properties of optical instruments are based mostly on the principles of geometrical optics. The theory, as well as its applications to the design of optical systems, is available in a systematic and unified form in several excellent treatises.¹ Although wave theory, based on the Kirchhoff-Fresnel theory, or its modified form,

¹ Herzberger, M. *Modern Geometrical Optics*, N.Y. (1958); Chretien, H. *Calcul des Combinaisons Optiques*, Paris (1959); Buchdahl, H. *Optical-Aberration Coefficients*, Oxford U. Press (1954).

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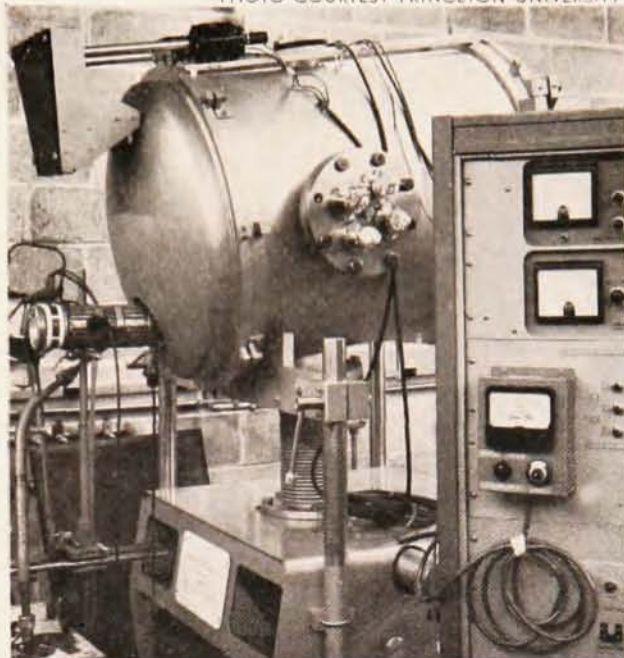
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gives a better understanding and more accurate analysis of the image-formation properties of optical systems, it has only recently found favor among research workers and designers of optical instruments.

The first book under review approaches the subject from the wave theory of light. The authors present systematically those aspects of the diffraction theory which are related to the problem of image formation. The task of presenting the theory of optical images, in a coherent form, has been facilitated not only by the modern developments of the theory of diffraction of aberrations, and a better understanding of the role played by coherent and partially coherent light in image formation, but also by recent advances in such fields as information and communication theory, which bear close analogy with optical systems.

Starting with the Huygens-Fresnel principle and the essentials of Fourier transformation, the authors proceed to formulate the relationship between object and image for both coherent and incoherent illumination using Fourier methods. The intensity distribution in image space is analyzed and discussed for several types of objects, including the properties of the image under various degrees of illumination (contrast) and a brief treatment of Zernike's phase-contrast method. In completing the discussion and analysis of the image of extended objects, the authors have included a brief but clear exposition of the principles of partial coherence and have examined the role it plays in microscopic observation of objects falling under this category. The analysis is then carried over to cases where aberration effects can no longer be neglected. In particular, they have examined the image-formation properties of instruments with small aberrations and the image contrast for individual or combined aberrations. The results of the theory are applied to special cases which are of practical importance. Among these, the question of the resolution of the image, the tolerance which can be allowed when aberrations are present, such as spherical aberration and coma, and the filtering properties of optical systems are discussed in detail. Finally, the appendices cover the derivation of the laws of geometrical optics from wave optics, coherence and spectral width, and the effect of partial-coherence illumination on the image of objects of low contrast. There are numerous references to the original literature, a detailed table of contents, and an alphabetical index.

Among the few errors and misprints detected by the reviewer, one seems to merit attention here: the authors erroneously attribute the method of stationary phase to Lord Rayleigh (p. 127), whereas the germ of it goes back to Stokes (1856). While the method's correct formulation was the work of Lord Kelvin (1887) and is universally known as Kelvin's principle of stationary phase, the rigorous foundation of the method was established only recently (1934-36) by van der Corput.

The book deserves the serious attention of everyone interested in this field of optics. Those directly connected with the design of optical instruments will find

John von Neumann

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JOHN VON NEUMANN, born in Budapest in 1903, was one of the most brilliant mathematicians of his time. He died in 1957 while serving as one of the five commissioners of the United States Atomic Energy Commission—the first foreign-born citizen to hold this high post. From 1933 until his death, he was Professor of Mathematics at the Institute for Advanced Study, Princeton, New Jersey. In 1940 he began to work intensively as a member of many U. S. governmental committees and as a consultant to numerous governmental and industrial laboratories. In 1956 he won the Fermi Prize and the Freedom Medal, the highest civilian award given by the U. S. These six volumes of the collected mathematical works of John von Neumann contain a reprinting of his published papers, some hitherto unpublished work, governmental reports recently released and reviews, written by various experts, of his unpublished work.

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valuable material on modern methods of analysis of images formed by optical instruments.

Dr. Boivin's book covers a narrower field than the preceding one. Here the main purpose is to give a detailed analysis of the image formation properties of rotational symmetric optical systems and to derive explicit expressions of the distribution of light in the image space for typical geometrical forms of the exit-pupil. Moreover, the mathematical calculations of the image amplitude function are carried far beyond those usually given in the literature, and in this respect is the most comprehensive treatise which so far has appeared in print. In addition to an excellent review of the general principles of diffraction theory and a complete mathematical treatment of diffraction theory of aberrations for rotational symmetric systems, the book contains a number of new and useful mathematical relations and original work by the author.

There are three main divisions, of which the first is a broad review of diffraction, especially the classical principles based on Huygens-Fresnel-Kirchhoff theory and the geometrical theory of aberrations for rotational systems as a preparation for the main text. The second part is devoted primarily to the derivation of general formulas representing the image amplitude function in the presence of all orders of spherical aberrations and amplitude variation over the exit pupil. The author has given a critical and useful survey of previous investigations, especially of the Dutch school (Zernike and his students). This reviewer does not agree with some of the criticisms and objections which the author has raised with respect to the limitations of the Zernike-Nijboer theory. However, the procedure given by Boivin for the evaluation of the integrals representing the image function has certain advantages over previous methods. The author's method of integration by parts using either the amplitude or phase function as total derivative (we shall call these procedures amplitude and phase integration, respectively) is valid for symmetrical functions only, i.e., spherical aberration and symmetrical variation of the amplitude (amplitude modulation) over the exit pupil, and for small and very moderate values of the aberration coefficients. The third part, devoted principally to the problem of diffraction by concentric annular apertures, contains in part Boivin's own investigations on this problem. Because of its important applications, especially in the design of modern telescopes, the author has given a detailed mathematical analysis of the problem and has applied the theory to the zone plate which is associated with the names of Sorret, Rayleigh, and Wood. Numerical tables of values of the coefficients entering in the formulas for the calculation of the image function and graphs of these functions for different values of the parameters (aberration coefficients, etc.) have been included in the text. Finally, a rather complete list of original publications is given at the end of each part of the text.

In view of the exhaustive treatment of this interesting branch of optics, this treatise is a valuable contri-

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bution to diffraction theory of aberrations. It should be on the shelf of everyone working in this field, and it will be especially useful to designers of modern optical instruments.

Elementary Introduction to Nuclear Reactor Physics. By S. E. Liverhant. 447 pp. John Wiley & Sons, Inc., New York, 1960. \$9.75. *Reviewed by Jacques Romain, General Dynamics.*

PROFESSOR Liverhant thinks that between a mathematically rigorous treatment of nuclear physics, accessible only to trained specialists, and a shallow qualitative exposition of no practical use there can be a middle level suitable for both advanced undergraduate students in physics and for engineering students. I feel he has fully succeeded in writing such a book, which may also be helpful as intermediate reading before tackling more advanced textbooks. It may be of interest as well to scientists in neighboring fields who wish to gain a neat knowledge of the physics involved without having to go through all of the mathematics. A very carefully prepared index, and an index of tables, allow the book to be used as a glossary of the nuclear vocabulary and an elementary reference book.

The book begins with three review chapters in which the author broadly explains the fundamental features of those aspects of nuclear physics which have a bearing on the physics of reactors. He proceeds to study, in a fair amount of detail, neutron reactions, fission and chain reactions, and the working conditions of a reactor. An elementary outlook on the nonsteady reactor, on nuclear radiations and their detection and measurement, and a general outline of health physics are included. The author is expert in acquainting his reader painlessly with unfamiliar concepts. He shows the calculations when they are simple enough, and quotes the main equations when the mathematics becomes too involved. (The mathematical knowledge required does not exceed general calculus and elementary differential equations.) Numerous diagrams are a considerable help in understanding. A fairly extensive bibliography is provided.

The stress is definitely on applications. The text is sprinkled with worked-out examples that either illustrate what has just been said or help to introduce the next topic. The choice of examples and problems covers a very wide range of practical applications.

Théorie des Ondes dans les Plasmas. By J. F. Denisse and J. L. Delcroix. 167 pp. Dunod, Paris, 1961. 16 NF. *Reviewed by L. C. Levitt, Boeing Scientific Research Laboratories.*

BOTH the aims and scope of this pocket-sized monograph are modest. It is devoted to a very detailed discussion of small-amplitude plane waves in plasmas. The treatment is entirely in terms of the so-called moment, or transfer, equations. Within the framework