SPIE Reports

BOOK REVIEWS • SHORT COURSES • MEETINGS • SPIE SCENE • ADVERTISERS

Book Reviews

Paul R. Yoder, Jr., Book Reviews Editor

Send books for review to the Managing Editor, Optical Engineering, P.O. Box 10, Bellingham, WA 98227-0010. Since there is not space to review all books received, the Book Reviews Editor will use his discretion in selecting those of most interest to the readership of this journal.

Advances in Optical and Electron Microscopy, Volume 10

R. Barer and V. E. Cosslett, eds., xi + 346 pp., illus., index, references. ISBN 0-12-029910-0. Academic Press, 24/28 Oval Road, London NW1 7DX, England (1987) $89 hardbound.

Reviewed by Brian J. Thompson, University of Rochester, Rochester, NY 14627.

This particular book is the tenth volume in the series *Advances in Optical and Electron Microscopy*—a series that was founded in 1966. Volume 10 is a milestone volume for several reasons: first, it is the tenth volume, and second, it contains an article on "Fifty years of instrumental development of the electron microscope." But, finally, the most important reason is that it is the last volume to be published under the joint editorship of founding editors R. Barer and V. E. Cosslett. They have passed the responsibility to C. J. R. Sheppard of Oxford University and T. Mulvey of the University of Aston. I will take this opportunity on behalf of all readers to thank the founding editors for providing us with 10 first-rate volumes.

The current volume is particularly fine and contains four major survey articles. The first of these is written, appropriately enough, by one of the newly appointed editors, Dr. Sheppard, on the subject of "Scanning optical microscopy" (pp. 1–98)—a subject to which Sheppard has made many significant contributions. After a short introduction the author starts with a very useful discussion of the advantages of scanning, which leads into a section on confocal microscopy that is tutorial but yet accurate and up to date. A detailed comparison is then provided between point-source and point-detector microscopes, including differential phase contrast and spectroscopic microscopy. The final topics include the use of laser sources, heterodyne microscopy, and nonlinear microscopy. The article is well illustrated and well referenced. I am sure that my colleague G. Sommargren will forgive his name's being misspelled "Sommergren" in the text (p. 83) and "Sommergen" in the list of references (p. 97). An honorable mention in this review will ease the pain!

"Holographic Microscopy" (pp. 100–209) is the subject covered by M. Pluta in the second article. It starts with a review of some of the basic concepts of holographic microscopy. Two major chapters of the work then describe systems without objective lenses (i.e., no lenses after the object, although there may be lenses before the object to produce converging, diverging, or collimated beams), and those with objective lenses (modified conventional microscopes are included in this category). In-line and off-axis systems are discussed for both sets of systems. A separate chapter is devoted to the problem of coherent noise and its control by means of spatial or temporal redundancy. Holographic interference microscopy is discussed in Chap. VI, which includes a description of the observation of phase objects. While applications are described throughout the article, there is a final chapter that discusses applications in biomedicine and materials science and the analysis of three-dimensional distributions of particles (a topic dear to this reviewer's heart). This article, like the former, has excellent illustrations and a good set of references.

Retiring editor V. E. Cosslett contributes the third article, which is a description of "Fifty years of instrumental development of the electron microscope" (pp. 215–267). As the author points out, "the electron microscope is 50 years old, more or less." The "more or less" phrase is the difference between "conception" and "realization." I am confident that the reader will find this a very readable and informative piece of writing.

The final offering is a chapter entitled "Photoelectron imaging: photoelectron microscopy and related techniques," by O. Griffith and G. F. Rempfer. This again turns out to be an appropriate topic, since 1987 (and this volume was published in 1987) "is the one hundredth anniversary of the observation by Hertz that u.v. radiation impinging on the negatively charged electrodes of a spark gap triggered an electric discharge." Both the theory and the applications of the photoelectron microscope are discussed, with particular emphasis on those applications in the physical and biological sciences. The remainder of the paper describes progress in related methods, including scanning x-ray photoelectric microscopy in a SEM and electrostatic point projection microscopy.

In summary, this is a fine volume and an excellent addition to the series.

Optics of Charged Particles

Hermann Wollnik, ix + 293 pp., illus., index, references, appendixes. ISBN 0-12-762130-X. Academic Press, Inc., 6277 Sea Harbor Drive, Orlando, FL 32821 (1987) $50.00 hardbound.

Reviewed by A. J. H. Boerboom, Albrecht Dürerstraat 25, 1077 LT Amsterdam, Netherlands.

Several books on ion optics have been published. Most of them start with the derivation of the equations of motion of the ions in electric and magnetic fields. The next chapters more resemble a textbook than an appropriate introduction to direct application of ion optics. Wollnik's book takes a clearly different approach. Simple and plain descriptions and clear drawings enable the reader in an easy way to understand ion optics and to appreciate its possibilities. Moreover, several subjects are discussed that have been ignored in previous books.

The first chapter is an introduction. The Gaussian approximation is treated by analogy with light optics. Ion trajectories are treated by means of transfer matrices. The latter simple method embodies great possibilities. It is amply discussed and the meanings of the several matrix elements are explained.

In the second chapter, the obligatory equations of motion are derived. However complicated these general derivations, for most applications the final expressions suffice and can be applied without studying the theory.

The next chapter provides a good review of the ample literature on quadrupole lenses and quadrupole mutiplets. Here, the advantages of matrix methods when designing complicated assemblies of quadrupole lenses become clear.

In the fourth chapter, the author discusses the magnetic and electric sector fields. In my opinion, a general summary is missing. In other books, Matsuda et al. and Boerboom have shown that in all z- (or ϕ-) independent electric as well as magnetic fields the ion trajectories may be exactly represented by a general expression, such as

$$x = \sum a_{mn} \cos[m(\alpha z + \phi) + n(\beta z + \theta)] ,$$

$$y = \sum b_{mn} \cos[m(\alpha z + \phi) + n(\beta z + \theta)] ,$$

with ϕ and θ being independent of m and n. This enables one to derive general focusing properties and aberration characteristics in a simple way. However, there is a good review of uniform, inhomogeneous, and wedge-shaped magnetic fields and of cylindrical or toroidal electric fields, including oblique and curved entrance and exit boundaries.

In the foregoing chapters, the individual ion trajectories were discussed. Next, the general properties of ion beams are treated. Several other books on ion optics fail to discuss the simultaneous behavior of ion beams although this theory is indispensable when designing an ion optical instrument.

The method is explained for such simple cases as field free space and the ion lens. Then the general case is treated by means of matrix calculus. This treatise includes the behavior of beam envelopes, also in the presence of space charge. Here, the Pierce field, which produces a parallel ion beam also in cases where a space charge is present, could have been mentioned.

Special attention is given to ion beams in periodic fields. Also, fringe fields of sector magnets (both uniform and inhomogeneous) and electric and quadrupole fields are discussed, and practical expressions are given for their influence on the ion trajectories.

The mathematical systematics of aberrations of second and higher order are given. Here, a geometric elucidation of the influence of aberrations on imaging would have been useful. Some possibilities to correct for these aberrations are mentioned in the last chapter. The important relations between the several aberration coefficients (symplecticity conditions), however, are presented.

The book concludes with a review of the fundamentals of instrument design. Special attention is given to the "quality factor" of an instrument.

Although at some places small additions could be made and field calculations could have been treated, Wollnik's book is a valuable contribution to the existing literature on ion optics of charged particles. The question is, however, in what respect is this book of importance for people interested in light optics? It is well known that both ion optics and light optics originate from the same root (Fermat's principle) and thus are fundamentally similar. However, in practice, very soon divergences appear.

The index of refraction n in light optics (which is, in fact, a ratio of velocities) corresponds to the square root of final over initial energies, which is also a ratio of velocities. Now, n varies from 1 to about 2, whereas an ion can start with 0.01 eV but can be accelerated to, for example, 1 MeV, so the square root varies by a factor of 10^4. Also, in light optics, the index of refraction changes abruptly at the surface of a lens and the lens can be concave or convex, so the magnitude of n along an axis of symmetry is not the only important factor. In ion optics, the potential V is determined by Laplace's equation, and its value along an axis of rotational symmetry is continuous and determines the complete potential distribution. Moreover, an analogue of the effect of space charge does not exist in light optics.

Yet, with these differences in mind, a comparison of light and ion optics can be very instructive, and Wollnik's book is certainly a valuable tool for this purpose.

Optics—Light for a New Age

Jeff Hecht. Part of Charles Scribner's Sons Books for Young Readers. 170 pp., illus., index. ISBN 0-684-18879-1. Macmillan Publishing Co., 866 Third Ave., New York, NY 10022 (1987) $14.95 hardbound.

Reviewed by Paul R. Yoder, Jr., Taunton Technologies, Inc., 631 Main Street, Monroe, CT 06468.

This short monograph bears little resemblance to those books normally reviewed in this column since it is intended for the young reader. The author touches superficially on a wide variety of topics—"simple optics and how they work," "making pictures: cameras and television," and "ray guns and reality: light at war"—to mention just a few. In this reviewer's opinion, the only merit this work offers to the readers of *Optical Engineering* is to give our children an early taste of the breadth of the field of optics. If their curiosity is whetted, we would be well advised to help them search for other literary sources for more details.

Books Received

Applications of Multiquantum Wells, Selective Doping, and Superlattices, edited by Raymond Dingle, Gain Electronics Corp. Semiconductors and Semimetals, Vol. 24, R. K. Willardson and Albert C. Beer, series editors. xi + 511 pp., illus., index, references. ISBN 0-12-752124-0. Academic Press, Inc., 1250 Sixth Ave., San Diego, CA 92101 (1987) $75 hardbound. Covers basic phenomena, materials, and optical and electrical properties of various structures; electronic devices and circuits based on quantum well, superlattice, and single, selectively doped heterostructure interface structures; and generation and detection of light using single or multiquantum well structures.

Fluid Mechanics Source Book, Sybil P. Parker, editor in chief. Part of McGraw-Hill's new Science Reference Series, taken from material previously published in the *McGraw-Hill Encyclopedia of Science and Technology,* 6th edition (1987). 274 pp., illus., index, list of contributors, bibliographies with some entries. ISBN 0-07-045502-3. McGraw-Hill Book Co., 11 W. 19th St., New York, NY 10011 (1988) $45 hardbound. Examines fluid statics, fluid dynamics, and both nonviscous and viscous flow and explains such subjects as waves and disturbances, similitude, the physics of fluids, and the measurement and display of properties.

Optics Source Book, Sybil P. Parker, editor in chief. Part of McGraw-Hill's new Science Reference Series, taken from material previously published in the *McGraw-Hill Encyclopedia of Science and Technology,* 6th edition (1987). 399 pp., illus., index, list of contributors, bibliographies with some entries. ISBN 0-07-045506-6. McGraw-Hill Book Co., 11 W. 19th St., New York, NY 10011 (1988) $45 hardbound. Covers such aspects as geometrical optics, optical imaging systems, the physical nature of light, wave optics, the interaction of light with matter and with energy fields, the technology and applications of lasers, light detection and processing, the measurement of light, and human perception of light.

Physical Chemistry Source Book, Sybil P. Parker, editor in chief. Part of McGraw-Hill's new Science Reference Series, taken from material previously published in the *McGraw-Hill Encyclopedia of Science and Technology,* 6th edition (1987). 406 pp., illus., index, list of contributors, bibliographies with some entries. ISBN 0-07-045504-X. McGraw-Hill Book Co., 11 W. 19th St., New York, NY 10011 (1988) $45 hardbound. Includes chemical thermodynamics, chemical reactions, surface chemistry, transport processes, the structure and properties of matter, electrochemistry, electroanalytical chemistry, cells and batteries, and optical phenomena.