BOOKS

Revision of a Pair of Classics: Born and Wolf's, and Allen's

Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light

Max Born and Emil Wolf
Cambridge U.P., New York, 1999 [1959]. 7th edition. 952 pp. $59.95 hc ISBN 0-521-64222-1

Reviewed by Eugene Hecht

Writing a book review of "Born and Wolf" is like writing a review of *The Odyssey*. It cannot be approached without a certain awe and the foreknowledge that whatever you say is essentially irrelevant. Indeed, for anyone who hasn't the time to read the rest of this essay, let me summarize: *Principles of Optics* is a great book, the seventh edition is a fine one, and if you work in the field you probably ought to own it.

The book dates back to the early 1950s, when Max Born, who had written *Optik* 17 years earlier, began to cast about for people who might coauthor a new, updated version. As fate would have it, the job ultimately fell to Emil Wolf, now Wilson Professor of Optical Physics at the University of Rochester and a scholar of considerable renown, but then only an eager young man in his late twenties. The plan was to modernize *Optik*, but Wolf went well beyond that. Although a careful reader can still see Born's inspired hand, most easily in the figures, Wolf's was, and continues to become, a very different book from Born's. Among other things, it's now 350 pages longer.

When *Principles of Optics* came out in 1959, it was still the "dark ages," just before the laser and the great photonic renaissance. Remarkably, the book dealt presciently with such issues as coherence theory and holography—holography, no doubt, because the man who recommended Wolf to Born eight years earlier was Dennis Gabor, the 1971 Nobel laureate and discoverer of holography.

Principles of Optics is a great, rigorous, ponderous, unwavering mathematical tract that deals with a wealth of topics in classical optics. It's not really a textbook in any modern sense of the word (despite the fact that Born's *Optik* called itself "ein Lehrbuch"), although it is often used as one in graduate schools. For many students the analyses are a little overwhelming, but that's a part of the formal style of the book: This is a tour de force, never meant for easy reading. If it must be characterized, *Principles of Optics* is a conceptual reference book, a collection of superb monographs. In the 1960s, "Born and Wolf," as it came to be known, was where one went to learn about subtleties like the Ewald–Oseen extinction theorem or the Wiener–Khintchine theorem. During the next four decades, and six editions, the book became an indispensable classic.

Cambridge University Press acquired the work in the late 1990s. After reprinting the sixth edition in 1997, Cam-

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EUGENE HECHT, *of Adelphi University, is the author of the textbook* Optics *published by Addison Wesley (1998).*

Allen's Astrophysical Quantities

Edited by Arthur N. Cox
AIP Press (Springer-Verlag), New York, 2000 [1976]. 4th edition. 719 pp. $99.00 hc ISBN 0-387-98746-0

Reviewed by Catherine A. Pilachowski

On the desks of many astronomers are well-worn copies of a modest green volume: *Astrophysical Quantities* by Clabon Walter Allen (1904–1987), last published by Athlone Press in 1976 as a corrected reissue of the 1973 third edition. Because many of today's astronomers (as well as many of today's fields of astronomy) were far from mature—if even alive—when the last edition came out, the new fourth edition, published by Springer-Verlag and the AIP Press, is most welcome. *Astrophysical Quantities*—first published in 1955—has been a dependable and indispensable reference on astronomy for decades, and the new edition promises to become just as vital a part of every astronomer's library.

The new edition, *Allen's Astrophysical Quantities*, edited by Arthur Cox, more than doubles the size and content of the previous edition, with new chapters on radio, infrared, ultraviolet, x-ray, gamma-ray, and neutrino astronomy, plus other modern topics, and a far more detailed treatment of all astrophysical subjects, from Earth to cosmology. Of particular note is the increased coverage of extragalactic astronomy, which has come to prominence since the third edition was written.

Breaking from Allen's tradition of sole authorship, Cox assembled nearly 100 astronomers to prepare the 27 chapters in the new edition. Even in the 1970s, it was apparent that a fourth edition could not be produced singlehandedly; the explosion of astronomical knowledge in the past quarter century only exacerbated the difficulty.

The fourth edition is immensely useful, providing detailed information on astronomical topics from basic diagnostic features in the Sun's spectrum to the locations and error boxes of gamma-ray bursts. Much of the information from the third edition is preserved, updated, and extended, and much additional new information has been added.

The coverage of the individual chapters varies in completeness, as one might expect when the chapters are written by different authors. In many chapters, the material from the third edition has been completely revised and reorganized to reflect modern paradigms for the subject. The chapter on the Sun, for example, incorporates new perspectives gained from decades of multiwavelength space observations, from helioseismology, and from modern theoretical understanding of the physics of the Sun. In other chapters, for example, "Atoms and Molecules," basic data have been updated and modernized, but not

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CATHERINE A. PILACHOWSKI *is an astronomer and stellar spectroscopist on the staff of the National Optical Astronomy Observatory in Tucson, Arizona. She studies the compositions of stars in the Milky Way.*

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bridge decided to do a substantial revision in the seventh: The entire text would be reset in a larger, clearer typeface and the mathematical nomenclature would be modernized. That most welcome revision was a titanic undertaking. Still, except for a few minor gaffes (for example, figure 8.31 on p. 466, equation 5 on p. 658, and the equation reference on p. 696) and typographical inconsistencies (for example, pp. 67, 82, 433, and 485), they did a remarkably good job. The error in equation 74 on page 69 was introduced into the sixth edition while something else in the fifth was being corrected; it got carried over to the seventh, so it doesn't really count.

The new computer type is much easier to read, even though the setting of mathematical expressions often lacks compositional elegance. Ironically, the publisher seems to have scanned the photos from a previous edition, degrading the images in the process and rendering most of them terribly muddy.

As for revisions of content, there is a substantial amount of new, and for the most part interesting, material. Section 4.11 is a fascinating account of the mathematical basis of the so-called CAT scan, using Fourier methods and the Radon transform. The Rayleigh–Sommerfeld diffraction integrals are insightfully discussed in section 8.11, where they are compared with the earlier, alternative, Kirchhoff theory. Section 10.5 treats interference of broadband light and explores the resulting spectral shifts—a surprising phenomenon discovered by Wolf. Chapter 13 is a new treatment of scattering from inhomogeneous media. And there are several new appendices. All of these additions increase the utility of the book and showcase the remarkable range of Wolf's research, even if they contribute to a somewhat idiosyncratic table of contents.

When reviewing such a fine book, one can only quibble with minutia. For example, the historical discussion of Maxwell's work on electromagnetic waves (1864–73) came long after the measurements of Kohlrausch and Weber (1856). The account on page xxx, which implies that Kohlrausch and Weber were active participants in establishing the speed of such waves, is misleading. A better presentation is given on page 12. In a different vein, it would have been nice if, during this relatively robust revision, the author had put aside the antique Gaussian units and struck a blow for the *Système International*. Interestingly, the rays in figure 4.35, which look weird, are not, and the rays in figure 8.6b, which look right, are not.

My rather worn copy of the fifth edition has a clearly erroneous equation 44 on page 386, which was only partially corrected in the sixth edition. That slightly faulty revision was then carried over to the seventh edition (equation 44 on p. 429). The problem is that E is defined on page 428 as "the total energy incident on the aperture" and it should be the total energy incident per unit time. That would give the intensity the proper units of energy per unit area per unit time. The same issue arises on page 437, in equation 5 on page 439, and again on page 440. To be precise, equation 16 on page 442 doesn't actually give the radii of the dark rings; these quantities, which are proportional to the radii, are unitless.

In a new footnote on page 522, the word "wavefront" is afforded its modern spelling, although throughout the book it is written as "wave-front." There's no mention of holographic diffraction gratings in the otherwise complete discussion of gratings. The term "sinc function" appears for the first time in the new chapter 13 (p. 704), long after the modern reader would have expected to find it. Out of the almost 1200 reference citations, only about 9% are for publications appearing after the 1960s. These and other little quirks are worth mentioning, because they underscore the fascinating dichotomy that is evident in *Principles of Optics*: a book that is both dated and timeless.

In summary then, *Principles of Optics* is a great book, the seventh edition is a fine one, and, as I said, if you work in the field you probably ought to own it.

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fundamentally changed since the third edition.

New chapters reflect the growth of astronomy in the intervening decades. The chapter on theoretical stellar evolution, for example, provides detailed tables of information on stellar models with supporting observational data, as well as written descriptions of the state of the field, plots of critical data, and formalisms and key equations used in the models. Tabular material is updated in a handful of chapters, but the treatment of the subject has barely changed since the third edition, even though the fields covered have evolved substantially since then.

The writing of the individual chapters began in the early 1990s, and continued through 1999. Authors were asked to update their contributions through the end of 1997, but this was not successful in all cases. Thus, many of the most exciting discoveries from the end of the 1990s are not included in the book: planets around other stars, identification and properties of very low-mass or substellar objects like L and T dwarfs, optical counterparts to gamma-ray bursts, and the cosmological implications of discoveries of distant supernovae, for example. Other subjects, such as star formation or deep galaxy surveys, are barely touched, although these fields have been quite active for some years.

The new edition may also have the effect of moving physics and astronomy closer together, because meter-kilogram-second units are adopted in many places in preference to the centimeter-gram-second units traditionally used in astronomy. Readers should also note that a few errors inevitably occurred as the units were translated. The solar constant, for example, is correctly given in cgs units but not in MKS units.

Overall, *Allen's Astrophysical Quantities* is an impressive collection of astrophysical data and knowledge that will serve well astronomers, astrophysicists, and physicists working in astrophysics. One can only hope that it will not be another 30 years before this essential reference is revised again. For this fourth edition, Cox has my heartfelt thanks for undertaking—and completing—a Herculean labor.

Voodoo Science: The Road from Foolishness to Fraud

Robert L. Park
Oxford U. P., New York, 2000.
230 pp. $25.00 hc
ISBN 0-19-513515-6

There have been science books that challenged fringe science before. Martin Gardner wrote the classic book about pseudoscientists nearly half a century ago. His *Fads and Fallacies in the Name of Science* (1952, in print as a Dover paperback) still crackles today with clarity and wry observations about the foibles of those who adapt the language of science, but not its methods, in propounding the often preposterous. Gardner has since produced his own sequels, from *Science: Good, Bad, and Bogus* (Prometheus,