BORN & WOLF *(continued from page 77)*

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.

ALLEN *(continued from page 77)*

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,

1981, 1989) to *Weird Water and Fuzzy Logic* (Prometheus, 1996). Washington University physics professor Michael W. Friedlander gave us a new survey of cranks, crooks, and charlatans in *At the Fringes of Science* (Westview, 1996). Carl Sagan summarized his career-long concerns about pseudoscience and superstition in his lively 1996 book *The Demon-Haunted World* (Random House). There have also been some single-subject books on topics like cold fusion and polywater, and some multiauthor anthologies.

But in *Voodoo Science*, Robert Park has brought us a book that has a freshness and originality—and an importance and potential for influence—perhaps not seen since Gardner's first. Its focus is on recent episodes of fringe science that capture the imagination not just of the public but of Washington policymakers and the major news organizations. And he shows why scientists would do well to pay attention, why they should even devote some time to helping people in high places distinguish good from bogus science. Because over and over again, Park's examples show the inability of people—high and low—to make that distinction.

Park is perfectly situated for the task: He is professor of physics and former head of the physics and astronomy department at the University of Maryland, and he has become widely known through the acerbic, weekly "What's New" electronic newsletter he produces as director of the Washington office of the American Physical Society. From there he keeps watch on, among other things, the latest examples of people (some of them scientists) who—if they aren't just dead wrong and credulous—use and misuse science, or twist or exaggerate scientific findings to gain public funding or advance their own causes.

Park coined "voodoo science" as an umbrella term: It encompasses "pathological science" (Irving Langmuir's term [PHYSICS TODAY, October 1989, pages 36–48]), "in which scientists manage to fool themselves"; "junk science," in which people craft arguments and tortured theories "deliberately intended to befuddle jurists or lawmakers with little or no scientific background"; "pseudoscience," whose practitioners adopt the language and symbols of science when "there is no evidence at all"; and "fraudulent science," in which what may have begun as honest error evolves through "almost imperceptible steps from self-delusion to fraud."

Most of Park's cases are from the past dozen years. It's all here: Joseph Newman's "energy machine" and Dennis Lee's "free-energy" devices (its advocates downplay the term "perpetual motion machine"); "Vitamin O" (water packaged in vials and sold as "stabilized oxygen molecules" to increase energy and stamina and prevent disease); the Pons and Fleischmann cold fusion proposition; "magnet therapy" (or, as *ABC World News Tonight* in 1997 called it, "biomagnetic therapy"), now a multimillion dollar business; homeopathy's infinite dilutions and Jacque Benveniste's "remembering water" claims; the Podkletnov gravity shield (which NASA spent four years and more than $1 million attempting to validate); Deepak Chopra's "quantum healing" confusions; and the *l'avion renifleur*, or "sniffer plane," a secret device that was said to be spectacularly successful at detecting oil fields (the French government got so embroiled in this scheme it invested $200 million in it). When the device proved to be a hoax, the government covered it up, and when the cover-up was later revealed, quashed any plans of Valéry Giscard d'Estaing to again seek the presidency of France.

Two chapters on the exaggerated claims and fears of health effects of electromagnetic fields (promoted heavily by Paul Brodeur in his books and *New Yorker* articles), and the millions of dollars that have been spent to conduct a series of increasingly definitive studies to put those claims finally to rest, are sobering. Park also explores the case of the x-ray laser and the space station as examples of exaggerated claims on behalf of political and technological agendas.

All these cases bear an important lesson: It is dangerous to consider pathological science, junk science, pseudoscience, and fraudulent science so silly as to be unworthy of serious scientists' attention. Time after time Park shows federal agencies, congressional representatives, judges, and juries getting embroiled in voodoo science—without, of course, realizing at the time that is what it is. Policymakers' time and attention are diverted, taxpayers dollars are wasted, and the public's perception of science gets all out of whack. The public is the loser.

Park is an effective guide through this morass. He repeatedly draws on physical principles to explain clearly where a claim is wrong or impossible. He understands the politics and the dynamics of belief. He calls or visits proponents to see what makes them tick. He treats them with some compassion. He has participated directly in some of the investigations of "voodoo" propositions. He has served on evaluative scientific panels and attended sometimes bizarre public hearings. All this gives *Voodoo Science* first-person credibility and vividness. And Park is not only a clear-thinking scientist, he's a good storyteller. The book is a great read.

Park finds vexing the reluctance of scientists to confront voodoo science. Scientists are human and, Park emphasizes, they have no more intellect or virtue than anyone else. Time and time again, individual scientists have gotten caught up in self-delusion or worse. As Park says, "The scientific method transcends the flaws of individual scientists. Science is the only way we have of separating truth from ideology, or fraud, or mere foolishness." But it won't happen, Park maintains, unless scientists are willing to come forward and make it happen.

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Supersymmetry: Squarks, Photinos, and the Unveiling of the Ultimate Laws of Nature

Gordon Kane
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On page 116 of *Supersymmetry*, Gordon Kane classifies physicists according to their views on the form that Higgs physics (the physics of electroweak symmetry breaking) will take: He lists fundamentalists, who "believe there exists a fundamental particle, the Higgs boson, as in the simplest form of the theory"; atheists, who "believe there is no fundamental particle at all, but some as-yet unknown form of the interactions at higher energies will somehow play the role of Higgs physics"; and agnostics, "who are uncertain." I am one of Kane's atheists: I prefer the dynamical approach of John Bardeen, Leon Cooper, and John Schrieffer to what we call the Higgs mechanism over the elementary scalar approach of Lev Landau and Vitaly L. Ginzburg.

There are many things I do like about Kane's book, and some I don't.

First, what I like: *Supersymmetry* is clearly written. When Kane explains