

computers. In short, a lot of stuff. Once I got tuned in to the range of discourse, I made a mental list of the fashionable topics of the past decade or two and waited to see when each would get its few paragraphs. I was rarely disappointed.

Things are sketched out in a chain of one-to-four-page subsections with catchy titles: "Cement: A Hard Problem," "Savoring Simplicity," "The Religion of Mathematics," "Theories of Not Very Much," "The Curse of Turing," "RISC Assessment," "Digital Darwin," "Origin of Origins Studies," "The Naked Gene," "Unnatural Selection," "Cerebral Cartography."

If I seem to be making lists rather than reviewing a book, it is because this is, in some sense, a book of lists. Information is dished out on all length scales: chapters, subsections, paragraphs, sentences, subordinate clauses. Everything is at about the level and accuracy of the articles in the Tuesday "Science Times" section of the *New York Times*. On those topics about which I knew something, it was obvious that the reader was not being told enough to come to terms with the subject in any active way; on subjects I knew little about, I felt tantalized by the tidbits of hard information I was offered.

There is, however, a saving grace. The book has 67 pages of notes and a ten-page bibliography, for those wishing to learn more, and perhaps it is best to view *Frontiers of Complexity* as a guidebook to these references. You don't expect the *Guide Michelin* to convey more than the vaguest hint of the actual experience of wandering through the Louvre, and if Coveney and Highfield pique readers' curiosity enough to lure them further into the library they offer, perhaps they have done all one can reasonably ask.

But if you regard the notes as a commentary on the text rather than the other way around, then—and this is no fault of the authors—you will be in for a hard time. There must be about three notes per page, and about half of them expand interestingly on the text. In the age of computerized typesetting it is hard to understand the decision to put all such notes at the end of the book, but to do it without putting the page numbers of the relevant text at the top of each page of notes is an unkindness to the reader. And to omit even the number of the relevant chapter is inexcusable.

The authors are to be praised for providing a serviceable and skillfully constructed ten-page glossary—essential in a work of such broad scope.

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Space, Time and Quanta: An Introduction to Contemporary Physics

Robert Mills
Freeman, New York, 1994.
482 pp. \$21.95 pb
ISBN 0-7167-2436-7

How can we enhance our students' interest in introductory physics? Robert Mills, who is perhaps best known to physicists as a codeveloper of the Yang-Mills gauge theory of fundamental interactions, argues persuasively that an early exposure to contemporary physics is the answer. His *Space, Time and Quanta* is based on notes he used for a "pre-physics" course at Williams College and an honors introductory physics course at Ohio State University. He suggests that this book might also be used as supplementary reading in a course for nonmajors or as a text for either an interdisciplinary course or an advanced-placement high school course.

The book is divided into two parts. Part I, on space and time, covers motion and dynamics, including special and general relativity. Part II, on quantum physics, covers wave mechanics and some of its applications. (Part III—particles and fields—was not included in the published book in order to keep the length and cost within reasonable limits, but it can be ordered directly from the author for \$15.00; this part was not reviewed.)

Mills's story line is more or less linear, which makes it difficult in some places to extract short passages as supplementary readings. The book's length is due in part to the inclusion of a great deal of classical physics (Newton's laws, momentum conservation, wave motion), which is not only redundant, given the book's intended role as a source of supplementary material, but is also at variance with the notation found in the standard texts—using underlining to denote vectors, for example. Calculus is used throughout, which could prove daunting to students who lack adequate preparation in mathematics.

Nonetheless, there are some gems buried here, particularly the author's treatment of the second law of thermodynamics (including the calculation of the effect of civilization on the entropy of the universe) and his discussion of the role of the observer in quantum mechanics. I found these chapters stimulating, thought-provoking and well worth the price of admission. The glossary of nearly 50 pages is carefully done and is a real asset for a book at this level.

Space, Time and Quanta lacks evidence of a careful editorial hand. There are many typographical errors, including subscripts and superscripts out of place, the interchanging of italic and roman characters, and spelling errors. There are too few illustrations for an introductory text (and no photographs at all), and insufficient care has been taken with the illustrations: Three names are misspelled in figure 10.2.1; figure 11.5.1 has an unexplained double scale on the righthand side; figure 15.3.1 shows a very curious reflection of light from glass, and its caption may lead the reader to believe that it illustrates the behavior of a single photon. Some of the historical references are also misleading: The Bohr picture of the atom did not get a "boost" in 1914 from the Franck-Hertz experiment (that interpretation came much later), and far from being "not very well understood" in 1909, alpha particles had already been identified by Rutherford as ionized helium atoms.

The debate over the place of contemporary physics in the introductory course rages on among physics educators. The lack of such material in the standard texts motivates books such as *Space, Time and Quanta*, but their place in the curriculum is not well established and their impact not well studied. I suspect that, either as a prelude or an accompaniment to the standard melody line, this material would enrich and excite students, but its success may be especially dependent on the local context and the care of the instructor in selecting material appropriate to the audience.

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Thin-Film Deposition: Principles and Practice

Donald L. Smith
McGraw-Hill, New York, 1995.
616 pp. \$65.00 hc
ISBN 0-07-058502-4

Donald L. Smith brings a revitalizing rigor to his *Thin-Film Deposition: Principles and Practice* that is a commendable advance over previous monographs on the subject and sets a new standard for texts in this fast-moving, empirically driven field. Open the text to almost any page and one is likely to be confronted (perhaps horrified) by a tangle of equations supplementing the warm and fuzzy qualitative descriptions with which practitioners have become so comfortable. Symptomatic of this departure are the nine pages of symbols and abbrevia-

tions preceding the first chapter.

Nevertheless, the writing is literate and well organized, with good motivations and an easy flow of thought into which the symbolic expressions are smoothly integrated. A liberal sprinkling of carefully conceived figures supplements the text. Particularly helpful is the list of 15 or more exercises appended to each chapter, with which the serious student can check and reinforce his or her comprehension. In sum, it seems evident that this textbook evolved from course notes that, in the spirit of the 1990s, were continually improved, over several incarnations, to their present highly developed state. This very precision of development aims Smith's treatise squarely at the level of an introductory graduate course, although the work will also serve as an excellent reference and study volume for the knowledgeable practitioner.

The text is organized into ten chapters and five appendices. After a short introductory chapter, the next two chapters review the underlying subjects of gas kinetics and vacuum technology in preparation for the subsequent treatments of evaporation, deposition and epitaxy, wherein thermal evaporation is regarded as the classical mode of vaporization for thin-film deposition. Alternative modes of vaporization by chemistry (volatile compounds), energetic beams (electron, ion and laser) and glow-discharge sputtering are then considered, where the all-important subject of energetic deposition is embedded in the latter two chapters. The final chapter considers thin-film analysis and properties while each chapter contains its own list of references and recommended readings, and the book concludes with an 18-page index that will serve the reader well.

Notwithstanding the breadth of his approach, Smith also includes such recent developments as laser ablation, modification of depositing films by low-energy ion bombardment and control of macroparticles from cathode arc and laser ablation vapor sources. The author's allusion to the nuances of his subject, such as the variation and measurement of residual stress during thin-film deposition, is impressive; although one wonders if this level of detail might be confusing to a student entering the field, it is eminently useful to those who may use this book as a reference.

In a monograph this ambitious, it is perhaps inevitable that some misconceptions and errors should go undetected, as in figure 9.11, where the indicated nonuniform magnetic field configuration would concentrate plasma erosion of the cylindrical sputtering

target at its midpoint, contrary to the efficient utilization (uniform erosion) of the sputtering target referred to in the text. In fact, practical cylindrical magnetron development hinges on the imposition of both exterior and interior magnetic coils carefully configured and aligned so that the imposed field is highly uniform and parallel to the axis of the target, thereby effecting a uniform plasma discharge and uniform target erosion. The reader should bear in mind the possibility of such occasional inaccuracies.

Regarding the overall organization of this book, my principal comment is that the essential and current subject of energetic deposition, which is fundamental to the understanding of thin films, could have been usefully consolidated and elaborated as a separate chapter. Nevertheless, this attractively presented monograph is an admirable effort and an important addition to the literature on thin-film deposition. It should stand the test of time and deserves to be issued in subsequent corrected and updated editions. Buy it!

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Physical Processes in Astrophysics. *Lecture Notes in Physics 458.* Proc. Mtg., Paris, France, Sep. 1993. I. W. Roxburgh, J.-L. Masnou, eds. Springer-Verlag, New York, 1995. 249 pp. \$73.00 hc ISBN 3-540-60259-3

The Physics and Chemistry of Interstellar Molecular Clouds. *Lecture Notes in Physics 459.* Proc. Symp., Zermatt, Switzerland, Sep. 1993. G. Winnewisser, G. C. Pelz, eds. Springer-Verlag, New York, 1995. 393 pp. \$92.00 hc ISBN 3-540-60482-0

QSO Absorption Lines. *ESO Astrophysics Symposia.* Proc. Wksp., Garching, Germany, Nov. 1994. G. Meylan, ed. Springer-Verlag, New York, 1995. 471 pp. \$39.00 hc ISBN 3-540-60152-X

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Theory of Electron-Atom Collisions: Part 1: Potential Scattering. *Physics of Atoms and Molecules.* P. G. Burke, C. J. Joachain. Plenum, New York, 1995. 255 pp. \$69.50 hc ISBN 0-306-44546-8

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Chaos—The Interplay Between Stochastic and Deterministic Behaviour. *Lecture Notes in Physics 457.* Proc. Sch., Karpacz, Poland, Feb. 1995. P. Garbaczewski, M. Wolf, A. Weron, eds. Springer-Verlag, New York, 1995. 571 pp. \$133.00 hc ISBN 3-540-60188-0

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Annual Review of Physical Chemistry, Vol. 46. H. L. Strauss, G. T. Babcock, S. R. Leone, eds. Annual Reviews, Palo Alto, Calif., 1995. 771 pp. \$51.00 hc ISBN 0-8243-1046-2

Computers and Computational Physics

How We Learn; How We Remember: Toward an Understanding of Brain and Neural Systems. Selected Papers of Leon N. Cooper. *World Scientific Series in 20th Century Physics 10.* L. N. Cooper, ed. World Scientific, River Edge, N.J., 1995. 393 pp. \$53.00 pb (\$99.00 hc) ISBN 981-02-1815-X (981-02-1814-1 hc)

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Computer Simulation Studies in Condensed-Matter Physics VIII: Recent Developments. *Springer Proceedings in*