cal misdirection to test the attentiveness of people like me.

Pais's history flows smoothly onward from beginning to end as he sets his course "by adopting the style of an epic . . . , hoping to serve the reader in deciding whether, and if at all in what way, this will provide a mirror for her or his own reflections." He succeeds; throughout, the reader is captivated by his thorough analyses of historical events, and by his beautiful style of writing, familiar light touch and charming turns of phrase: The electron–proton model of the nucleus was as sensible as a "house built of bricks, or . . . a necklace made of pearls," and it must be "bourne in mind that antimatter is as much matter as matter is matter." Equally engaging are his perceptive comments on Max Planck, Ernest Rutherford, Niels Bohr, Paul A. M. Dirac, Pauli, J. Robert Oppenheimer and many other physicists whose work he has studied and whose lives often intersected with his own. When all is said and done, however, the greatest strength of this book is that in it Pais has brought the same high standards of intellectual inquiry to the history of physics that he has brought to physics itself. In so doing, he has bridged the disciplines and achieved distinction in both. I am tempted to say that this book is the work of a modern natural philosopher.

Electronic Properties of Surfaces

Edited by M. Prutton
195 pp. Adam Hilger, Bristol, 1984. $17.00

The extremely rapid growth of the study of solid surfaces that has taken place over the past ten years has resulted in significant advances in a variety of spectroscopic techniques and their application. The parallel development of computational schemes based on effective one-electron models of solids and solid surfaces has helped stimulate the advances by providing a meaningful framework for analyzing experimental results and refining our understanding of the underlying phenomena. A subset of the activity in this field is represented by electron-emission spectroscopic techniques (photoelectron emission and Auger-electron spectroscopy) and the closely related enterprise in which ground-state electronic properties are numerically calculated. The book reviewed here is a reprint volume consisting of three review articles covering these topics that originally appeared in *Reports on Progress in Physics* in 1980–81. Some additional material and references have been added to the individual reviews to bring the volume up to date.

The first section, by J. E. Inglesfield, covers the theory of electronic states at surfaces. A tutorial section on electronic states at surfaces, which includes a description of several methods for calculating surface electronic structure, introduces the terminology of the field. This is followed by a number of examples in which the technique is applied to investigate surface states, the work-function and surface potentials, and surface crystallography, including relaxation and reconstruction. The choice of examples is balanced in the sense that both semiconductor and metal surfaces are considered, and there are abundant references to computational results, which should be useful to many readers. The treatment in this section will probably be more useful to experimental physicists and general readers than to band theorists.

The second section, by R. H. Williams, G. P. Srivastava and I. T. McGovern, covers photoelectron spectroscopy of solids and their surfaces. Here again the content and style reflect the general emphasis of review papers in *Reports on Progress in Physics*: The article is written to expose developments in the field in a manner comprehensible and useful to a broad range of scientists. The paper discusses basic elements of theoretical models of the photoemission process, including photoionization, conservation laws, symmetry rules, multiple scattering and reference levels, with adequate references to original work. The portion of the review that covers experimental considerations—including sample requirements, sources and energy analyzers—is quite sketchy and could have been more informative without significantly increasing the length by citing some of the existing literature that covers the topics in more detail. The addendum to this section describes some advances in the field since 1980, but fails to use the opportunity to cite recent work in epitaxial layers and other useful reviews, such as *Polarized Electrons in Surface Physics* by Roland Feder (World Scientific, Singapore, 1985) and the excellent review on angle-resolved photoemission by E. Ward Plummer and Wolfgang Eberhardt (*Adv. Chem. Phys.* **49**, 533, 1982).

The third section, by P. Weightman, covers x-ray-excited Auger- and photoelectron spectroscopy. It covers historical background and instrumentation in a brief introduction by referring to reviews. The remainder of the article is a rather nice review of both experimental and theoretical developments in atomic, molecular and solid-state physics. This particular review cites a large number of references and should be of interest to both the general reader and the expert.

The combination of these three review articles does not in itself represent

anything more than the sum of the component parts (as might a book); however, the availability of three well-written and complementary reviews conveniently bound in a single volume makes for a useful general reference covering electronic properties of surfaces.

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Theory of Neutron Scattering from Condensed Matter, Volumes 1 and 2

Stephen W. Lovesey
344 pp. Clarendon, Oxford, 1984. $59.00 each

Neutron scattering is a unique and powerful experimental tool for investigating condensed-matter systems. One can study routinely, via the neutron–nucleus interaction, the structural characteristics of liquids and solids from the submicron range to the atomic scale, while the neutron–electron magnetic-dipole interaction permits the determination of magnetic structures. The versatility of the technique allows one to investigate interesting scientific problems not only in condensed-matter physics but also in chemistry, metallurgy, biology and fundamental physics. The beauty and power of neutrons as a probe of microscopic physics, however, are best revealed when one is interested in the time-dependent collective behavior of systems. Neutron scattering is the only experimental method available to study the nature of excitations such as magnons, phonons, rotons and excitons, and to investigate diffusion and tunneling in the full range of crystal momenta and energies. Neutron scattering provides fundamental information about the properties of condensed-matter systems that cannot be obtained with any other experimental technique.

The classic reference book presenting the traditional topics of condensed-matter physics of interest to neutron scatterers has been Walter Marshall and Stephen Lovesey's *Theory of Thermal Neutron Scattering* (Oxford U.P., New York, 1971). That text covers the basic theoretical concepts needed for the interpretation of experimental neutron-scattering data. Lovesey, who is a theoretical physicist at the Rutherford–Appleton Laboratory in England, has updated the original text to produce *Theory of Neutron Scattering from Condensed Matter*. He has split the original text into two volumes, the first of which covers nuclear scattering, while the second is devoted to magnetic scattering. The references and examples have been updated, and there are some new examples (particularly in Volume 1). However, the new book, for the most part, is identical to the original work. In this regard it would be more appropriate to refer to it as a second edition of Marshall and Lovesey. It is only a little longer than the original text (681 pages versus 608).

One of the important advantages of neutrons is that they are a weakly interacting probe, so that the physical properties of the sample are generally not distorted by the scattering process (in contrast to electron scattering, for example) and hence the interpretation of experimental data often reduces to a proper description of the collective behavior of the system. As a result, the book spends much of its time describing the basic concepts of condensed-matter physics, such as magnons and phonons; these are often good discussions in their own right. As advertised in the title, there is essentially no discussion of experimental techniques, and consequently the text is not helpful for the experimenter, who is interested in taking data. For diffraction experiments George Bacon's *Neutron Diffraction* (Oxford U.P., New York, 1975) should be consulted, while for inelastic scattering no experimental textbook is available.

One of the deficiencies of the present pair of volumes is that they provide no coverage of new subjects that have become prominent since the writing of the first edition. For example, there is no discussion of liquid crystals, spin glasses, low-dimensional systems, charge-density waves or the physics that can be revealed with newer experimental techniques such as backscattering, spin-echo spectrometry and small-angle scattering, or with pulsed neutrons. Nevertheless the two volumes constitute the best neutron-scattering book available for condensed-matter physicists.

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Numerical Methods in Fluid Dynamics

Edited by F. Brezzi
333 pp. Springer-Verlag, New York, 1985. $20.50

Numerical Methods in Fluid Dynamics contains the texts of four lectures given at the third 1983 session of the Centro Internationale Matematico Estivo, held at Como, Italy, in July 1983. These "state of the art" lectures are general discussions of the major numerical methods in computational fluid mechanics: finite-difference, finite-element, spectral and particle methods (the last category includes, among other techniques, the particle-in-cell method, the random-vortex method and particle methods in plasma physics). The contributors are among the lead-