new addition to the quasar literature. The focus of this book is arguably the correct one; to paraphrase Cecelia Payne-Gaposchkin's comment on Galactic novae, we know little about quasars except the facts. Weedman adopts a unique approach in beginning with a discussion of observational techniques and detector technology. The peculiar characteristics of quasars justify and perhaps necessitate this: Quasars are intrinsically luminous at all observed wavelengths and can be surveyed by a plethora of techniques (recall that their emission of radiation at radio wavelengths was what drew attention to these stellar-appearing sources). On account of their great distances, however, quasar research is faint-object astronomy, and much of the development of modern astronomical detector technology has been driven by the need for better quasar data.

Weedman outlines the fundamental observational cosmology needed to make sense of quasar surveys and, in the most valuable section of the book, discusses determination of the quasar luminosity function and quasar evolution.

Missing from the book, but alluded to in the preface, is a sense of the rich history, excitement and controversy that characterized the early days of quasar research. (Ironically, the best historical perspective is provided by Weedman himself in a 1976 article in the *Quarterly Journal of the Royal Astronomical Society*.) The sections on the astrophysics of quasars are also rather thin, though clearly this is not the main thrust of the book; in a graduate course on quasars, this book could be supplemented with Donald E. Osterbrock's updated classic *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei* (University Science Books, Mill Valley, Calif., 1988) and other readings. Also, I was disturbed by the fact that Weedman's book does not contain a single figure illustrating a quasar spectrum, either in the well-studied optical region or across the entire observable electromagnetic spectrum. I found only a few statements with which I took issue, but inspection of the literature revealed that my prejudices were based on results published after the book went to press in late 1985.

Weedman has been at the forefront of studies of the distribution and luminosity function of quasars and related objects for 20 years. His book grew out of introductory graduate-level classes he has taught at several universities. The intended audience is obviously beginning graduate students in astronomy, because a certain amount of fundamental astronomical knowledge is presupposed, though no background in quasars *per se* is necessary. The text is written in the enjoyable, conversational style that characterizes much of Weedman's writing.

Not since the inspiring—but now obsolete—*Quasi-Stellar Objects* by Geoffrey and Margaret Burbidge (Freeman, San Francisco, 1966) has there been a suitable monograph to introduce graduate students to quasar research. Weedman has helped to fill a long-standing need in this regard.

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Atomic Collisions and Spectra

U. Fano and A. R. P. Rau
Academic, San Diego, Calif., 1986. 409 pp.
$82.50 hc ISBN 0-12-248460-6;
$29.95 pb ISBN 0-12-248461-4

The experimental techniques of atomic physics have made considerable advances in the last 20 years and by now have produced an enormous amount of new data and greater understanding both of spectroscopy and collisions. In spectroscopy the breakthrough has come from the implementation of synchrotron and laser light sources, which opened up new areas of photon energy, intensity and spectral resolution. In collision physics the advance has come from the development of increasingly sophisticated detection techniques involving multiple-coincident detection of collision products with high-energy resolution.

There have been concomitant improvements in the theoretical treatment of the interaction of electrons, nuclei and photons, but very few books have appeared documenting these newer theoretical approaches at an advanced level. Traditionally spectroscopy and collisions have been treated separately, as exemplified by two venerable textbooks, *Theory of Atomic Spectra* (Cambridge U. P., New York, 1935) by Edward Condon and George Shortley and *Theory of Atomic Collisions* by N. F. Mott and H. S. W. Massey (Oxford U. P., New York, 1987 [third edition]). However, when photon energies exceed the lowest threshold for two-particle breakup (ionization or dissociation), it is clear that there is an intimate connection between photon absorption, leading to fragmentation, and collisions.

This book by Ugo Fano and Ravi

Rau is perhaps the first to be written with the unification of the theoretical treatment of spectroscopy, collisions and fragmentation as one of its express aims. There is a need for such a book to replace the two standard, but dated, texts mentioned above. One could hardly expect this to be achieved in a single volume of some 400 pages. Nevertheless this is an extremely good book and at the same time a very personal one. It contains principally the modern theory of atomic processes as developed over the last 25 years by Fano and his students at the University of Chicago. The references are generally very selective, as the authors admit, and alternative approaches not in sympathy with the authors' style are simply omitted. This allows Fano and Rau to develop a consistent and coherent method of treatment in a self-contained text.

Fano's great service to atomic theory has not been the introduction of new theoretical methods *per se*, although this he has done abundantly, but rather the application of various mathematical tools to give physical insight into the theory, and above all to make it accessible to experimenters. The recurring theme of his efforts has been the manipulation of atomic theory into a form in which observable quantities are cast in terms of a few key parameters. The establishment of precise values for these parameters is then a matter to be expedited by either calculation or experiment, as the case may be. The importance of this coordination of theory and experiment to the rapid advancement of a field of research is clear. This book demonstrates the power of Fano's approach, nowhere better exemplified than in his early theory and parametrization of the profile of atomic resonances.

The meat of the book is in parts B and C. This sequence of chapters presents the theory of photon absorption and electron scattering in the low-energy region (a few eV to a few tens of eV) and applies it to a wide variety of atomic and molecular targets. In this low-energy region, the principal dynamics is governed by the formation of a collision complex restricted to a finite volume. Interactions (by energy or linear and angular momentum exchanges) in that volume decide the overall fate of the system. The precise details of the occupation of finely resolved final states is of secondary importance and is decided by delicate forces at large distances. In parts B and C the authors assemble the necessary mathematical methods of scattering theory

to implement such a pictorial view, principally the Jost matrix, R matrix and multichannel quantum-defect methods. They show how other approaches, for example, close-coupling methods, are incorporated in this formalism. The subject matter of part C, multichannel phenomena, is very complex but its understanding is facilitated by the treatment in part B of exclusively single-channel phenomena. This preliminary section is written very clearly and simply and gives the book great pedagogical value. Nevertheless, extraction of the maximum gain from the material often requires algebraic effort on the part of the reader. This is a book to be used; it is not a book for a casual reader. These two sections of the book are a major contribution to the field.

Part A is entitled "Perturbation Theory" but is restricted to a discussion of single-photon absorption and fast collisions with structureless charged projectiles. The treatment is limited to the first Born approximation. The authors adopt the point of view that the theory is only well understood in the low- and high-energy regimes. However, some attempts to cast higher-order perturbation methods for collisions within the language of parts B and C might have been useful.

The last section, part D, is devoted largely to the fundamental problem of electron correlation, the motion of two highly excited electrons around a positive core. The theoretical description of such states proceeds by a representation in terms of hyperspherical coordinates. A full and illuminating account of the successes of this powerful method is given. The subject is presented clearly, and again the authors emphasize the physical insight into the dynamics of these resonances afforded by the hyperspherical picture. However, no account of the large body of work on earlier or alternative treatments of doubly excited states is given. A reader not conversant with the field may obtain a somewhat unbalanced view of the situation. Nevertheless this is a fine account of the progress made through application of hyperspherical methods. The study of multiparticle excitations, their resonance formation and pathways of fragmentation is largely unexplored territory in atomic and molecular physics and will be an important direction for research effort in the years to come.

In summary, this book is a major addition to the atomic physics library. The central sections contain the elements of the modern, unified approach to electron–atom collisions and atomic spectra and point the way to general application in the theory of more complex atomic and molecular collision processes. This book should be in the toolbox of every graduate student in atomic physics, both theorist and experimenter.

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Dynamics of Josephson Junctions and Circuits

Konstantin K. Likharev
Gordon and Breach, New York, 1986. 614 pp. $170.00 hc
ISBN 2-88124-042-9

The Josephson effect in superconductors has, since its discovery in the 1960s, been the focus of great interest both because of its implications for fundamental questions in physics and because of its potential applications in certain areas of electronics, where it promised significant increases in device speed and sensitivity. By far the largest research effort using the Josephson effect has been an attempt to develop Josephson junctions as high-speed (picosecond) switches for digital applications. The emphasis is now shifting to analog applications, and in fact the most important successes of the Josephson effect have been in analog devices, namely the voltage standard and SQUID magnetometers and millimeter and submillimeter mixers (SIS detectors), where quantum-limited sensitivity is being approached.

Konstantin Likharev's latest book, *Dynamics of Josephson Junctions and Circuits*, should be of great interest to researchers working on Josephson effect devices, particularly those interested in analog applications. Likharev is at present head of the Laboratory for Cryoelectronics at Moscow State University. He has for years been one of the leading theorists working on the Josephson effect, during which time he has had a prodigious output and developed an encyclopedic knowledge of the field.

This book is very much focused around Likharev's own research interests, namely the microwave and noise properties of Josephson junctions. Indeed the bulk of the book is devoted to quantum interference and microwave properties, including the effects of noise, which are important for understanding the sensitivity limits of devices. This is just the current area of growing device research interest (leaving aside the new high-temperature superconductors).

A great strength of this book is its focus on mathematical techniques for obtaining analytical results using various models of the Josephson junction. It is surely the most complete compendium of such results available. This approach is nicely supplemented by graphs from computer simulations and results from other workers where appropriate. While all of the results presented show the strong imprint of Likharev's style, the book nonetheless serves as an excellent guide to other work in the field, with references to papers by about 1500 authors. The detail and focus make the book much better suited as a reference for workers in the field than as an introductory text, for which purpose a book such as *Principles of Superconductive Devices and Circuits* by Theodore Van Duzer and Charles Turner (Elsevier, New York, 1981) would serve better.

Dynamics of Josephson Junctions and Circuits fills a gap in the literature and presents much information not available in other books. It is an essential reference for researchers.

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Intellectual Mastery of Nature: Theoretical Physics from Ohm to Einstein

Christa Jungnickel and Russell McCormmach
U. of Chicago P., Chicago, 1986. 350 + 435 pp.

Vol. 1: The Torch of Mathematics, 1800–1870
$55.00 hc ISBN 0-226-41581-3

Vol. 2: The Now Mighty Theoretical Physics, 1870–1925
$65.00 hc ISBN 0-226-41584-8

At the beginning of the 19th century physics had little place in the curriculum and research of German-language universities. Natural science was part of the philosophical faculty and existed mainly to serve the needs of medical students. Professors of physics usually had to buy their own instrument collections, and the experimental and theoretical lectures were distinguished by whether the instructor used equipment or only a blackboard. As is well known, the profound changes in physical theory that took place early in the current century were in large measure the