source Cyg X-1. While theoretical models have been developed to explain the observed x-ray luminosities, spectral energy distributions, and spatial structure of these various cosmic x-ray sources, many puzzles still remain.

J. Leonard Culhane and Peter W. Sanford, two active investigators in observational x-ray astronomy, have written a general review of their field. Their book describes the history and achievements of this branch of modern astronomy from its beginnings to the present. It reviews the physics of the emission, absorption and detection of x rays and discusses all known classes of astrophysical x-ray sources. The book places particular emphasis on research carried out between 1971 and 1978. Only passing reference is made to the results obtained with the Einstein x-ray satellite, in operation from November 1978 to April 1981, results that have significantly advanced the field. For example, the direct high-resolution x-ray-imaging studies of such objects as supernova remnants and galaxy clusters carried out with the Einstein satellite supercede the occultation studies of extended x-ray structure discussed in detail in *X-ray Astronomy*. Unfortunately, a rapidly advancing field such as x-ray astronomy necessarily presents a moving target to those who write about it.

According to its dust jacket, this book is intended for both students and interested amateurs. I find that the level of the book is not entirely appropriate for either audience. For students, the book has the serious deficiency that it includes no citations to the scientific literature, although it does refer to specific studies by investigators' names and dates; it lists only a brief bibliography of eleven general references in x-ray and modern astronomy. The mathematical level of the book is elementary, certainly below that appropriate to an advanced undergraduate or graduate student in physics or astronomy. The comparatively few equations presented are plagued by a significant number of typographical errors.

For a lay audience, *X-ray Astronomy* does not consistently achieve a suitable scientific level. Although the authors make a clear attempt to provide the astrophysical background necessary for understanding the material presented, this effort is only partly successful. For example, while Planck's relation between photon energy and frequency is carefully explained, readers are assumed to be familar with the concept of an electron–hole pair in the depletion region of a reverse-biased junction diode. I suspect that the book provides more detail in the description of instrumentation and experimental technique than would interest a lay audience.

The main strength of Culhane and Sanford's book is its breadth: All aspects of the field are discussed. With the caveat that the book suffers from its attempt to address both technical and lay audiences, *X-ray Astronomy* provides a broad historical introduction that might be suitable for interested readers with some background in the physical sciences.

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The Theory of Atomic Structure and Spectra

R. D. Cowan
731 pp. U. of California P., Berkeley, 1981. $45.00

The theory of atomic structure benefited from two major advances—Racah algebra and computers—from its early success in the application of quantum mechanics illustrated by the classic treatise *The Theory of Atomic Spectra* by E. U. Condon and G. H. Shortley. Stimulated by these advances and by demands for accurate data from related fields, such as astrophysics and plasma physics, atomic structure theory has progressed in the past two decades to the point that it can provide both qualitative and quantitative guides to experimental spectroscopy. Robert Cowan is one of those who have contributed substantially to the progress by providing theoretical data to decipher complex spectra. His rich practical experience and wide scope of expertise are well documented by his numerous papers. This book is, in a way, a summary of his lifelong contribution to atomic spectroscopy.

The book, which covers all the traditional subjects of atomic structure theory, is focused mainly on the practice of analyzing complex spectra. In contrast to other books on atomic structure, such as those by J. C. Slater, by I. I. Sobel'man, and by E. U. Condon and H. Odabasi, Cowan's cites many examples of transition metals, rare earths and even actinides. He presents topics with intuitive approaches that are easy to follow. For instance, because he does not emphasize mathematical rigor at the expense of clarity, the discussions on Racah algebra are compact but easy to understand. He develops the formulae for the Coulomb integrals and spin–orbit interaction several times, each at a more advanced level—an instructive practice for students though others might find it repetitive. He also covers many subjects difficult to find in other textbooks on atomic structure: resonances in photoionization, quantum defect theory, atomic spectra in plasma, spectra of highly ionized atoms, electron scattering. However, most of these discussions are treated to varying depths. Some readers may require additional reading to obtain a deeper understanding.

For a graduate student who wants a balanced overview of theoretical methods for atomic structure, the book may present a distorted picture because the theoretical methods described in it are largely limited to those practiced by the author: the Slater approximation and its variants to the Hartree–Fock method. Cowan omits or barely mentions topics in both relativistic and nonrelativistic theories of atomic structure, in which there has been substantial progress in the last decade. An inexperienced reader is likely to get the mistaken impression that atomic structure theory is used mainly to provide estimates of such parameters as ζ_{nl}, F^k and G^k to do least-square fits to complex spectra. For instance, there are more powerful and more physically significant methods (for example, C. Froese-Fischer's *The Hartree–Fock Method for Atoms*) to deal with correlation effects than the particular type of configuration interaction method Cowan discusses. Also, while he includes spin–orbit interaction in most of his discussions, he ignores or only parenthetically mentions all other relativistic effects of comparable significance.

To students who are looking for physical principles that govern atomic structure, the book will be a somewhat misleading guide for a survey of currently used methods as well as for inspiration for future theoretical improvements. The book will, however, benefit those who need practical knowledge in spectral analysis using traditional methods such as the least-square fits of complex spectra.

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Field Theory: A Modern Primer

P. Ramond
396 pp. Benjamin/Cummings, Reading, Mass., 1981. $26.95 cloth, $14.50 paper

This is an enthusiastic and informal introduction to modern field theory, sometimes a bit too breathless for my taste, but generally valuable. It is a book that suffers from what it does not do or say but is redeemed by what it does.

To touch upon the drawbacks first: How can anyone write a book on quantum field theory without once in the text mentioning Julian Schwinger? Many of his functional techniques are here, woven into the arguments, but credit goes to P. A. M. Dirac and Richard Feynman all the way. And this