equations in selected physical contexts that range from water and plasma waves for the Kortweg–de Vries and nonlinear Schrödinger equations to dislocation theory for the sine–Gordon equation. Chapter 8 introduces the important and unavoidable topic of Backlund transformations, the nonlinear counterpart of the superposition rule for solutions in linear systems. Finally, Chapter 9 covers soliton perturbation theory, which often serves as the connecting link between the exactly solvable theories and real physical systems. Each topic is lucidly presented by reference to a readily understandable specific physical example. This approach eases the way for the stepwise introduction of relevant mathematical formalisms. Supplementing the textual materials are a few relevant exercises offered at the end of most sections. Advanced undergraduates and entering graduate students of physics, applied sciences and mathematics alike will enjoy learning from this fine, self-contained primer. I have only one *caveat*: Watch out for over a dozen misprints that occur mostly in the formulae and their numbering!

Solitons: Mathematical Methods for Physicists is a well-written, compact monograph, a fine translation from the original German. It derives from a graduate-level theoretical physics course taught by its author, Gert Eilenberger, at the University of Cologne. While the book rightly assumes some familiarity with differential equations and function and operator theories, a conscientious reader, with pencil and paper in hand, will benefit most from this highly condensed treatment. Definitely more formal in content and set at a somewhat higher level than Lamb's book, this volume does succeed in giving a self-contained introduction to the mathematics of solitons in one space dimension.

After concisely stating the necessary physical motivations, the book focuses on the methods of inverse scattering. It treats the Kortweg–de Vries system first as a Lagrangian field theory with solitons and higher conservation laws, then as a detailed illustration of the inverse scattering transform, which is further developed with other soliton equations. A chapter is devoted to the sine–Gordon system, the canonical example of a nontrivial integrable relativistic field theory in two-dimensional space–time. There follows an introduction to the statistical mechanics of the sine–Gordon system, a topic of much current experimental import in condensed-matter physics. Finally, for good contrast, Eilenberger further illustrates the inverse scattering transform for a discrete system, the Toda lattice, an object of fascination for both mathematicians and physicists. He gives a selected list of annotated references that will facilitate further study. Eilenberger has done an excellent job of summarizing the essential aspects of current soliton theory and has succeeded in conveying the structural beauty and scope of the subject. Graduate students in physics willing to work diligently through the book will profit much from this solid introduction to a topical area of research. It would make an excellent text for a short concentrated course or a supplementary reading for a longer one.

Solitons and the Inverse Scattering Transform is written by Mark J. Ablowitz and Harvey Segur, among the foremost authorities in the field. They intend their book to be an up-to-date compendium and a comprehensive guide to the many theoretical and mathematical ideas about solitons developed over the last decade. The book focuses on the mathematical intricacies of the inverse scattering transform and, to a lesser extent, on related approaches to solving integrable equations. It begins with a concise, highly informative, historical introduction to solitons. It then presents in great detail the formalism of the inverse scattering transform, upon which the materials of subsequent chapters are built. Chapter 2 covers the transform in other settings: higher-order eigenvalue problems and scattering problems in higher dimensions, the Toda lattice, and finite-band solutions (specifically of the Kortweg–de Vries equation). Chapter 3 surveys methods other than the inverse-scattering transform, covering topics such as Backlund transformations, Hirota's method for N-soliton solutions, and Painlevé transcendents as well as soliton perturbation theory. Chapter 4 offers selected physical applications of the transform—discussed at varying lengths—to hydrodynamics, nonlinear optics, axisymmetric gravitation and quantum field theory. Each chapter closes with a rich fund of exercises, some of which are actually challenging research problems. Also a helpful "Appendix of the Fourier Transform" is provided. This impressive book—with its exhaustive bibliography of over 500 articles—will serve equally well as an advanced text and an authoritative reference guide to the mathematics of solitons. It is ideally suited for engineers, physicists and applied mathematicians who desire to acquire a broad but quite detailed view of this fascinating and explosive area of research.

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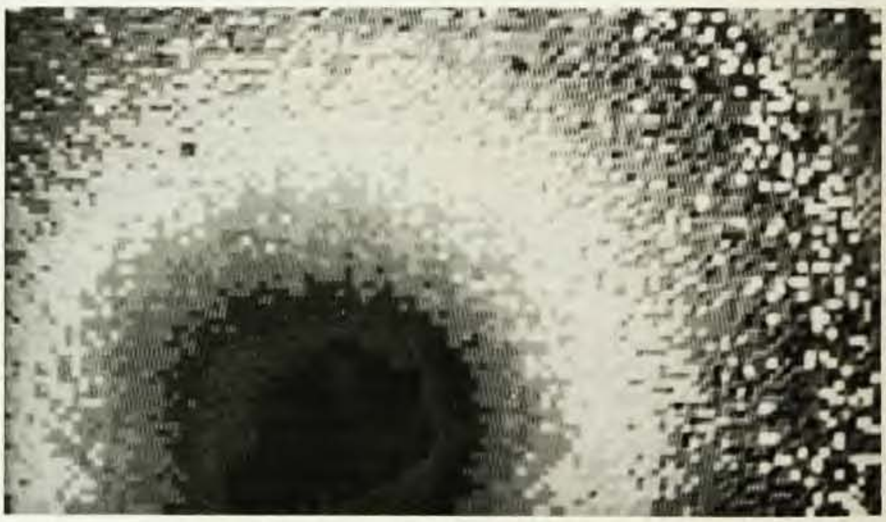
Chia-Hsiung Tze, a member of the physics department of Yale University, is interested in the mathematical theories of solitons.



The star Sirius in an x-ray image produced by the fine-error sensor of the International Ultraviolet Explorer satellite on 20 September 1978. (Photograph taken by Fred Espenak.)

X-ray Astronomy

J. L. Culhane, P. W. Stanford
Scribner's, New York, 1981. $25.00

The study of x-ray emissions by nonterrestrial sources has undergone dramatic advances since it began in the late 1940s with the positive detection of solar x-radiation. During the past three decades instrumentation has progressed from simple photographic detectors and Geiger counters briefly sent aloft on sounding rockets to a sophisticated focusing x-ray telescope equipped with two-dimensional imaging detectors aboard the HEAO-2 ("Einstein") satellite. A wide variety of astronomical objects are now known to produce x rays, including ordinary main-sequence stars, white dwarfs and neutron stars, active galaxies, clusters of galaxies, and quasars. X-ray astronomy has also provided the first tentative identification of a black hole in the x-ray 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