

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 familiar 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.

HALDAN COHN
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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.

YONG-KI KIM
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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

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Authorized translation from the Russian edition by D. B. Pontecorvo

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sort of omission is not just a matter of history: There are places where the adoption of a different technique would produce results far more transparent—for example, the calculation of determinantal factors by the parametric method of Bruno Zumino and Charles M. Sommerfield is far clearer, while touching related aspects of gaussian functional integration, than the ζ -function method Ramond uses (the essence of which appeared in Schwinger's papers and lecture notes almost 30 years ago). Another annoying aspect of this neglect of the work of others is notational—for example, the use of the symbol Δ_F to represent the causal propagator Δ_C of E. C. G. Stückelberg and Schwinger—and can present a problem to younger readers who might lose a factor of $2i$ in transcribing the notation of this book to, for instance, the canonical QED work of Freeman Dyson (no reference to him, either). There are better ways to describe the physical content and calculation of the Lamb shift, even when one is restricted to a single page. And there is a distinction between a Feynman path integral (FPI) and functional integration, although by page 333 the use of "FPI" has mercifully given way to the phrase "generating functional." And so on.

However, these complaints and annoyances must not stand in the way of the really good material which Ramond presents, at just the right level, for his introductory course. The best sections are those dealing with supersymmetry, dimensional regularization, renormalization-group arguments, and various topics centering about Yang-Mills interactions. Many things are missing, but these really important modern topics are handled just right. In addition, there are small sets of very nice problems at the end of each chapter, a very useful part of any text at this level. The references appended to each section could be more extensive, but they are certainly adequate, and the serious student should have no difficulty in using this book as a jumping-off point for more detailed studies.

In summary, while I suspect the author has spent too much time at Caltech, he has nevertheless put together a book that can be used with profit by students everywhere. Buy it—but watch those factors of $2i$!

H. M. FRIED
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Electric Fields of the Brain: The Neurophysics of EEG

P. L. Nunez

484 pp. Oxford, New York, 1981. \$45.00

Electrical signals connect the billions of neurons in the human brain via a dense network of fibers of incompara-

ble complexity. The signals consist of changes in membrane potentials propagated by cable conduction along dendritic fibers and by a regenerative process along axons. These so-called *action potentials* mediate postsynaptic potentials on the dendritic membranes of other neurons across special junctions, the *synapses*. Not only does communication occur over these private lines, but also special chemicals that affect groups of neurons equipped with appropriate receptor sites are broadcast throughout the nervous system. How are we to monitor the performance of this incredibly complex system?

One of the main tools of the neurophysiologist has been the microelectrode. Developed in the 1940s, it allows the experimenter to select a particular neuron for study and obtain a precise record of its electrical activity. By comparison, the alternative of recording electrical changes by gross electrodes attached to the scalp—while having the virtue of being noninvasive—was at first crude and rather uninformative. Initially, only certain global features, the various EEG rhythms, could be made out in the squiggly lines of the recordings and assigned to particular states.

The increasing importance of the EEG has emerged from a better understanding of the relationship between scalp potentials and the various current sources in the brain, especially in the cerebral cortex. In another dramatic development on-line computer averaging of large numbers of EEG traces has brought out the so-called *event-related potentials* or *evoked potentials*. Unlike the unprocessed EEG, these waveforms are highly reproducible in detail and represent the course of activity in specific cortical and subcortical centers following a sensory stimulus.

Today the EEG is a widely used and valuable clinical tool whose diagnostic capabilities include "brain tumors, epileptic conditions, infectious diseases, mental retardation, head injury, drug overdose, and ultimately brain death."

In *Electric Fields of the Brain* Paul Nunez, a research neuroscientist at the University of California Medical School in San Diego, aims to bridge the "communications gaps between the many scientific fields related to EEG research." The book is written with the understanding that many clinicians who use EEG techniques routinely do not thoroughly comprehend the physical principles involved.

At the same time Nunez attributes the "paucity of good physics and engineering support for EEG studies" to "the reputation of EEG as a scientific backwater." While EEG research has long outgrown that early reputation, the scientific support is still inade-

quate. This volume therefore fills an urgent need. It brings together the encephalographer and the physicist and enlightens both. It belongs on the bookshelf of anyone working in the broad and burgeoning field of neuroscience. Reginald G. Bickford is fully justified when he predicts in a brief foreword that the book will become "a classic in the field," comparable to Robert Plonsey's 1968 *Bioelectrical Phenomena*.

The author's language is exceptionally clear throughout, even in the necessarily technical discussions. In eleven chapters Nunez takes the reader from a general description of the nature of cerebral current sources and an overview of electromagnetic theory to more detailed treatments of current sources in homogeneous and inhomogeneous media. Discussions follow on temporal and spatial properties in EEG, neural circuits and brain waves.

A practical discussion of EEG techniques, contributed by Ron D. Katznelson, covers electrode placement, multi-channel recording and the problem of locating current sources and sinks and includes a brief and elementary discussion on brain-generated magnetic fields and their detection by means of SQUID devices. In another chapter Katznelson attempts to relate details of cortical microstructure, in particular, the cortico-cortical connections and their intrinsic time delays to the dominant frequency components in the EEG.

There are eight appendices that cover such topics as quasistatic formulation of Maxwell's equations (with particular attention paid to the dielectric properties of tissue and membrane), the membrane diffusion equation, and specialized matters, including dipoles and dipole layers inside concentric spheres.

ERICH HARTH
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The Physics of Glaciers

W. S. B. Paterson

Second edition, 380 pp. Pergamon, New York, 1981. \$48.00 cloth, \$17.50 paper

The second edition of W. S. B. Paterson's book on *The Physics of Glaciers* will be welcomed by glaciologists and glacial geologists. Paterson's first edition (1969) became one of the most quoted sources for glaciological data, concepts, and ideas and enjoyed wide acclaim from his peers. As Paterson notes in the preface to the second edition, the 12 years that have passed since the publication of the first edition have seen major advances in glaciology. These new advances have been incorporated into existing chapters in many cases, and when the advances have been sufficiently extensive they