from geometry as Schutz would wish. The topology of a space restricts the geometric structures it may support, as illustrated by the fact, known to Carl Frederich Gauss, that the sphere S^2 cannot as a whole be given a flat Riemannian metric. Schutz generally avoids global topological and geometric considerations (like compactness and completeness), and his use of topological terms (such as *Hausdorff* and *foliation*) is imprecise and even incorrect.

As an introduction to geometric methods, this book is valuable in describing the objects of interest and the machinery which physicists use to work with them. Accordingly, it should help to make research articles in theoretical physics accessible to the reader. The book provides less insight into topology and global geometry, and those who would consider them are advised to look elsewhere.

Extragalactic Astronomy

J. Sersic

245 pp. Reidel (US dist. Kluwer, Boston), 1982. $49.50

Extragalactic astronomy is a youthfully exuberant field of research. Over the past twenty years there has been rapid growth in the quantity and quality of observational data. New data along with equally exciting theoretical developments have frequently brought extragalactic astronomy from the pages of technical journals to newspaper columns. Significant changes in the field now occur on a timescale of a year or even less.

The dynamism of the field makes it extremely difficult to write the much-needed texts. *Extragalactic Astronomy* by José Luis Sérsic fails to meet the challenge to provide a clear, logically developed treatment of some of the fundamental models, observations and problems.

The publisher, the translator, and the editor as well as the author share responsibility for the weaknesses of the book. There is no excuse for the hundreds of misprints in a 250-page book. They appear in the text, in equations and even in running page titles. One figure caption rather charmingly credits "Halo Observatories" (more commonly known as Hale). The translation is often so awkward that sentences are incomprehensible even to those who work in the field. These flaws alone are sufficient to make the book a poor choice for the intended audience of students and working astronomers and physicists.

Sérsic covers selected topics with some emphasis on areas to which he has contributed. In principle, this strategy has merit. However, the overall logical structure of the field should be made clear in a book intended as a text. The physical arguments in this monograph are neither well-developed nor well-motivated. Descriptions of the links between the data and the models are inadequate. The data quoted are often more than ten years old and have frequently been supplanted in the literature by more extensive, higher-quality data. Sérsic overlooks these more recent data and the analyses that accompanied them. For example, the discussion of binary galaxies cites the well-known early (1962) work of Thornton Page but ignores Edwin Turner's equally widely recognized 1976 study; the results of Turner's study depart substantially from those of Page. On the theoretical side, the section on the formation of galaxies and clusters of galaxies contains no mention of the "pancake" picture suggested by Yakov Zel'dovich and Rashid Sunyaev. A student of the field should have at least a passing acquaintance with this very frequently referenced model.

The one strength of this book is the beautiful set of photographs of galaxies and systems of galaxies. These plates are reminiscent of Sérsic's *Atlas de Galaxias Australes*, the *Hubble Atlas* of the Southern Hemisphere.

There is still no single book from which one can learn the elements of extragalactic astronomy. P. James E. Peebles' book, *Physical Cosmology*, though more than ten years old, remains a classic in the field. Dimitri Mihalas and James Binney's *Galactic Astronomy* contains excellent discussions of the structure, kinematics, and stellar and gaseous content of galaxies. These books, unlike *Extragalactic Astronomy*, are accessible to students and to physicists without prior training in astronomical jargon.

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The galaxy NGC 5128 shows a complex optical structure that suggests recurrent activity has taken place in it. (Copyright by AURA, this photo appears in *Extragalactic Astronomy*.)

Mathematical Theory of Entropy

N. F. G. Martin, J. W. England

257 pp. Addison-Wesley, Reading, Mass., 1981. $29.50

Mathematical Theory of Entropy is carefully—even lovingly—written, but few physicists will find it easy reading. The authors presuppose a familiarity with measure theory at a mathematician's first-year graduate level, appropriate, of course, for a volume in the series *Encyclopedia of Mathematics and its Applications*. Nonetheless, most physicists, even after working their way through chapter one, "Topics from Probability Theory," which provides a minimal background, will find the book tough sledding.

The heart of the book is chapter two. There the authors define the entropy function, generalize it to conditional probabilities, and establish some properties. The introduction to this chapter, a heuristic discussion of information and uncertainty, is verbally muddy. The trouble is that, knowing what the answer is to be, the authors don't pose the question carefully. Thereafter, however, the chapter goes well. A section on the entropy of dynamical systems is particularly nicely done.

Fully half the book is devoted to sophisticated applications of entropy. A chapter on information theory, well introduced, concerns the noisy-channel coding theorem. Ergodic theory comes next, with an emphasis on Bernoulli systems. The fifth chapter is devoted to an aspect of topological dynamics: the (topological) entropy of a mapping, as a measure of how much the iterated mapping mixes the original sets. And the last chapter, on statistical mechanics, focuses on the rigorous treatment of an infinite system, specifically, a classical lattice system, for which the canonical distribution is appropriate.

That the book is written by two mathematicians is noticeable in more ways than one. A physicist will be surprised to read (on page 227) that "entropy = 'pressure' − energy" is "the usual relationship between pressure, energy, and entropy in statistical thermodynamics." On page 229 an aside informs us that a liter of air contains "on the order of 10^{27} particles," generous by a factor of 10^4. Only a few misprints came to light, however, and the book is tastefully designed.

Altogether, we have here a book written with care and with thought for the reader. The topics are valuable ones, especially in this day of chaotic dynamics. To anyone with the mathematical preparation, I warmly recommend Martin and England's little volume.

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Atoms in Astrophysics

P. G. Burke, W. B. Eissner, D. G. Hummer, I. C. Percival
356 pp. Plenum, New York, 1983. $49.50

Understanding gaseous nebulae has, from the beginning, depended upon understanding the atomic physics that is going on in them. At the end of the last century, James E. Keeler measured precisely the wavelengths of the two strong green nebular emission lines. Since then astronomers and physicists have realized that, except for the hydrogen and helium lines, the strong nebular emission features could not be identified with any lines emitted in known sources under ordinary laboratory conditions. Ira S. Bowen solved the puzzle of the nebular lines in the 1930s, when he showed that they arise in "forbidden" transitions among low-lying levels of ions of abundant elements—O^{++} in particular for the green lines—that are too weak to be detected except at the extremely low densities in huge masses of nebular gas. Early theorists, including Herman Zanstra, George H. Shortley, Donald H. Menzel, G. C. Cillie, Leo Goldberg, Bengt Strömgren and Lawrence H. Aller, achieved qualitative and semiquantitative understanding of several phenomena: photoionization by ultraviolet photons from the hot stars invariably immersed in optically observed gaseous nebulae; recombination and the complicated cascade processes in which photons from many series—Lyman, Balmer, Paschen, Brackett, and so forth—are emitted, converted and destroyed; and collisional excitation and radiative decay. Because of the low densities in gaseous nebulae, two-body collision processes are the main excitation mechanisms for almost all their radiation. Quantitative interpretation of the physical nature of nebulae from the observational data requires accurate knowledge of the rates of these processes.

Since the early 1950s the world leader in research on the atomic physics of nebulae has been Michael J. Seaton. He and the group working with him at University College, London, have calculated, with increasing precision, excitation cross sections, recombination coefficients and photoionization cross sectons and predicted spectra of nebular gas under many different assumed physical conditions. These quantum-mechanical calculations provide the basis of our understanding of H II regions, planetary nebulae, nova and supernova shells, and—to the extent that we do understand them—active galactic nuclei, quasars and QSOs.

This book, dedicated to Seaton and presented to him on his 60th birthday, summarizes and reviews this tremendous body of work. Ten chapters, all written by Seaton's collaborators, colleagues and associates, give an excellent account of the genesis, development and present status of quantum mechanics in astrophysics. Except for the chapter by David R. Bates on the very similar atomic physics of auroras and the chapter by David R. Flower on the applications to planetary nebulae, the book concentrates on the quantum mechanics itself.

Two especially good chapters are those on long-range interactions, by Gillian Peach, and on quantum-defect theory, by David L. Moores and Hannelore E. Saraph. Although quantum mechanics is, in principle, a "known" subject, extensive theoretical development was necessary to apply it to these complicated atomic problems. Both chapters give clear, logical developments of their subjects, explaining the reasons behind the concepts and methods that they describe. Two other chapters, one by Philip A. Burke and Werner Eissner, the other by Harry Nussbaumer and Peter G. Storey, together make up an excellent summary of the theoretical ideas and the practical applications of the quantum-mechanical treatment of collisional excitation of complex ions and atoms by slow electrons.

This book is, in the main, well written. It is excellently produced, in an attractive, readable format. It will be indispensable to anyone who is seriously interested in research on atomic processes in astrophysics.

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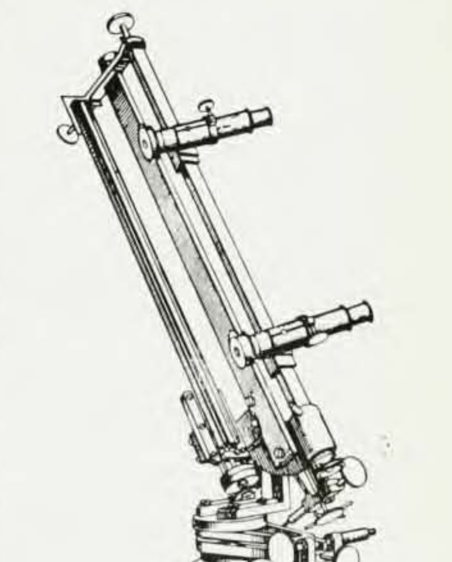
Ferdinand Braun: A Life of the Nobel Prizewinner and Inventor of the Cathode-Ray Oscilloscope

F. Kurylo, C. Susskind
289 pp. MIT Press, Cambridge, Mass., 1981. $29.95

Ferdinand Braun, the German physicist and Nobel laureate, enjoyed a prolific career during an energetic and fruitful era in the development of



Braun's comparator for measurement of very small distances originally appeared in *Annalen der Physik und Chemie*; it is reproduced in *Ferdinand Braun*, reviewed here.