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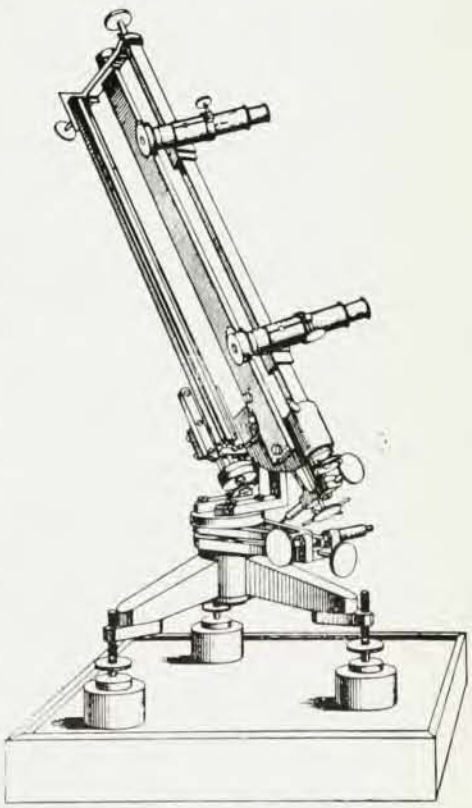
Ferdinand Braun: A Life of the Nobel Prizewinner and Inventor of the Cathode-Ray Oscilloscope

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.