

incompatible with the higher tone of the formal discussions. For example, some figures showing fits of crude, phenomenological, coordinate-space optical potentials to data and pages of Glauber-theory results—some even at energies near 100 MeV—do not include the more fundamental results available. In addition, some captions for figures of experimental versus theoretical results are inadequate for a text.

R. H. LANDAU
Oregon State University

The Brightest Stars

C. de Jager
458 pp. Reidel, Dordrecht, 1980. \$60.00

As techniques for astronomical observation have proliferated, it is a rare person who will tackle the problem of melding together the empirical information and the theoretical gropings that originate in such a wide variety of sources. C. de Jager is a former secretary-general of the International Astronomical Union and has been one of the prime movers of Dutch studies of stellar atmospheres. His book, a welcome addition to Reidel's series, *Geophysics and Astrophysics Monographs*, bears the stamp of classical Dutch astronomy: a conservative blend of empiricism and theoretical analysis.

During the late 19th and early 20th centuries, stellar spectra were ar-

ranged into a continuous one-dimensional classification. Annie J. Cannon classified about one-quarter million stars for the *Henry Draper Catalogue*, and, following the lead of a colleague, Antonia C. Maury, she occasionally noted peculiarities of the spectra, such as absorption lines that were unusually sharp or unusually fuzzy. Ejnar Hertzsprung showed that the sharpness of the lines was associated with high intrinsic brightness, and Walter S. Adams and Arnold Kohlschutter, were able to make this relation explicit by adding a second dimension to the empirical system of spectral classification.

Quantitative theoretical work began in the early 1920s with the development of a theory for thermal ionization. The first monograph on the interpretation of stellar spectra was Cecilia Payne's *Stellar Atmospheres*, which appeared in 1925. Payne showed that the most striking features of the spectral sequence could be correlated with temperature; the effects of density and of chemical composition could be ignored.

However, the second book on the topic, Payne's *The Star of High Luminosity* (1930), told a different story. Among the brightest stars, the secondary effects could not be ignored. Remark on that book in an autobiographical memoir written late in life, Payne-Gaposchkin said she found that "the superficial simplicity of [her] first

treatment had become blurred . . . the physical picture was becoming confused and the confusion has increased from that day to this."

Indeed it has. As de Jager says in his foreword, there is no group of stars that shows a more pronounced diversity than the stars of high luminosity. "Can one visualize a larger difference than between a luminous, young and extremely hot . . . star and a cool, evolved pulsating star of the Mira type, or an S-type supergiant, or . . . the compact nucleus of a planetary nebula?" This diversity, including not only differences of temperature and density but often variations of chemical composition, results from individual histories. Uniformity is now seen to be an oversimplification.

Despite all of this, de Jager makes a valiant reach for unification: "I have . . . tried to stress the mutual relationships . . . In addition I have tried to show how similar phenomena occur in stars of greatly differing types." Radiation pressure, mass-exchange between components of binary systems, outward flow, convection that can generate hydromagnetic waves, accretion flow that can produce gas hot enough to generate x radiation, pulsation, dust formation, maser action—they are all here, if only briefly.

This book is not easy to read. It is dense with information, and many of the data remain undigested and enigmatic. Of the 1831 references, some 45% was published in the three years prior to the completion of this book. Unfortunately, the titles of the papers are not included, and the book has no index, although cross-references are frequent in the text.

Research workers and graduate students will find a balanced introduction to a variety of phenomena, and a challenge for physical interpretation. It seems to me that the next step is to forget the details and to set about developing a unified theory of dynamical atmospheres.

CHARLES A. WHITNEY
Center for Astrophysics
Cambridge, Mass.

An Introduction to Atmospheric Physics (Second Edition)

R. G. Fleagle, J. A. Businger
446 pp. Academic, New York, 1980. \$29.50

This is the second edition of a well-received book, first published in 1963. Both authors have outstanding reputations. Under the leadership of Robert G. Fleagle, the Department of Atmospheric Sciences at the University of Washington developed from relative obscurity to its current eminent posi-



The Sun in soft x rays by Skylab. *The Brightest Stars* discusses active magnetic regions of the Sun's corona, which are seen here. (Courtesy, *American Science and Engineering*.)

tion; Joost A. Businger is well-known for his work on micrometeorology and air-sea interaction.

Traditionally, atmospheric physics is stratified in several ways: Meteorology is separated from aeronomy (the study of the upper atmosphere) by an imaginary surface at about 50 km. The authors have, wisely, decided not to cover aeronomy, because the physical disciplines required are different from those in the lower atmosphere.

This book is unique in that it avoids the second stratification, into dynamic meteorology (thermodynamics and hydrodynamics) and physical meteorology (optics, acoustics, radiation and cloud physics). As a result, the book manages to present, in a clear and concise manner, all the fundamental physics of the lower atmosphere. It is more complete than the first edition, in which atmospheric hydrodynamics was omitted.

The volume contains chapters on gravitational effects, properties of atmospheric gases, properties and behavior of cloud particles, atmospheric motions, radiation, transfer processes and atmospheric signal phenomena and concludes with some rather elementary sections on mathematical and basic physical topics. Each chapter is followed by several pages of problems and answers to the problem; they range from simple to quite difficult.

Although the book was originally intended to be a text, due to the conventional division of meteorology into dynamic and physical in university curricula, this is probably not its most important purpose. Instead, it is an outstanding work from which physicists, chemists, mathematicians and engineers can gain an understanding of the basic properties of atmospheric processes. It is also useful for students who have had courses in dynamic meteorology and seek an introduction to other branches of atmospheric physics.

The authors generally did an excellent job of covering many subjects clearly. I was particularly impressed by the new chapter on signal phenomena (leading to a useful summary of techniques of remote sensing, both from the ground and from satellites).

Of course, every reviewer will miss some material that seems more important than some that is included. In particular, at the beginning of the chapter on atmospheric motions, the authors quote L. F. Richardson on the possibility of weather forecasting on the basis of physical equations. However, they barely mention the extensive field of numerical modeling of the atmosphere, which has led to improved forecasting and to better understanding of atmospheric phenomena on all scales. While stratospheric pollution

is treated, another large subject, air-pollution modeling of the lower atmosphere, is not mentioned.

In spite of these omissions, I believe that the authors have produced an excellent volume, which I especially recommend to physicists.

HANS A. PANOFSKY
Pennsylvania State University

The Early Years: The Niels Bohr Institute 1921-1930

Peter Robertson

175 pp. Akademisk Forlag, Copenhagen, 1979. \$12.00

Universitetets Institut for Teoretisk Fysik of the University of Copenhagen, more commonly known over the early years as the Bohr Institute and officially renamed in 1965 as the Niels Bohr Institute, has been considered by physicists as the most important center for the early research on the quantum theory of atomic structure. Its subsequent history has amply established its world-famous status. Students of the history of physics will therefore welcome this volume by a member of the Department of History and Philosophy of Science in the University of Melbourne, Victoria, Australia.

The period covered in the book, namely, from the founding of the Institute in 1921 to the end of the decade, has long been felt by many to have been the most exciting time in its history. It was early in this period that Bohr's fundamental grasp of the quantum theory interpretation of the periodic system of the elements was fully recognized and the element hafnium (named for the City of Copenhagen) was identified. The middle of the decade saw the invention of quantum mechanics and its promise of the successful evaluation of atomic energy levels for which the orbital interpretation of Bohr's original fundamental hypothesis could give only rough indications. All the leading figures in the rapidly unfolding drama of atomic physics were visitors at the Institute during those early years, and much vital research was performed there under the enormously stimulating influence of the Director. The whole story of what went on there is one of the most fascinating in the history of physics, and the author of the present volume has done ample justice to it within the space limitations to which he was subjected.

Bohr's outstanding ability as a shrewd promoter and administrator is well brought out in connection with the construction and equipping of the original Institute building, which after many vicissitudes was officially opened on 8 March 1921. It was a compact affair, with research laboratories in the

basement, a library and lecture room on the ground floor and living quarters for the director and his family on the second floor. The building was not added to until 1925, when considerable support was provided by the Rockefeller Foundation in the United States.

The book successfully portrays the high points of the achievements of the Institute during its first decade. These include the vital experimental spectroscopic and chemical work of Dirk Coster and George Hevesy, the development of matrix mechanics by Werner Heisenberg, with the formulation of the indeterminacy principle and its generalization by Bohr into the concept of complementarity. Not overlooked is the famous controversy with Erwin Schrödinger over the interpretation of wave mechanics and the initial development of the Copenhagen probabilistic interpretation of the significance of the atomic wave function. The book closes with a graphic account of the Bohr-Einstein controversy on the problem of determinism versus indeterminism in atomic physics.

Some 50 illustrations, mainly photographs of persons connected with the Institute, add to the interest of the volume. There is also a nearly complete list of visitors to the Institute and workers there during its first decade.

This book should be on the shelves of all physicists who are interested in the early development of the quantum theory of atomic structure.

R. BRUCE LINDSAY
Brown University



Bohr (left) with James Franck and George de Hevesy (right) at the Institute in 1934.

Photoacoustics and Photoacoustic Spectroscopy

A. Rosencwaig

321 pp. Wiley, New York, 1980. \$35.00

It is appropriate that on the hundredth anniversary of the discovery of the