of events occurring in deep space, e.g., birth and death of stars in galactic systems, interaction between galaxies. Here, again, the Doppler shift of the hydrogen line is a powerful tool, especially when compared with the shift of the optical spectra. In their conclusion, the authors state that it is not easy to disentangle the most important contributions of radio astronomy to the understanding of the universe. Their book, however, can be highly recommended as a guide to the discoveries disclosed by radio astronomy.

Yankee Scientist—William David Coolidge. By John Anderson Miller. 216 pp. Mohawk Development Service, Schenectady, N.Y., 1963. $3.95.
Reviewed by R. B. Lindsay, Brown University.

The history of science is to a great extent the story of the men whose ideas and achievements have become a part of our scientific heritage. Hence scientific biographies assume an important role in education and in particular in the training of scientists. While no amount of reading about how great scientists tackled their problems can necessarily make a young person into a successful scientist, a good biography can provide valuable stimulus to the mind prepared to receive it.

William David Coolidge has had a long and eminent career as an industrial scientist, and it is highly appropriate that a biographical sketch of him should be made available. Mr. Miller has done a good job of providing this in the relatively short compass of 200 pages. At the same time he has added considerably to our understanding of the development of industrial research in applied science in the United States during the past sixty years.

The author traces in chatty style Coolidge's educational experience at the Massachusetts Institute of Technology, where he was a member of the class of 1896, and at the University of Leipzig, where he received his doctor's degree in 1899 with a thesis under Paul Drude on the dielectric constant of liquids. Back at the Institute in Cambridge he shifted to work in physical chemistry under Professor A. A. Noyes and stayed there until 1905, when Dr. Willis R. Whitney persuaded him to join the staff of the newly organized Research Laboratory of the General Electric Company in Schenectady. He remained in this activity for thirty-nine years, during the last twelve of which he served as director of the Laboratory.

Mr. Miller describes in relatively simple fashion Coolidge's researches on the production of ductile tungsten, his achievements in the production of high power x-ray tubes, and his First World War work in underwater sound. Ample attention is also paid to Coolidge's important contributions to better public understanding of the role of industrial research in the nation's economy.

This is by no means a profound and searching study, but it does provide an engaging picture of the trials, problems, and success of a distinguished scientist. It should be read with interest by all physicists.

Thermal Physics. By Philip M. Morse. 455 pp. Benjamin, New York, 1964. $10.50.
Reviewed by Bruce W. Shore, Harvard College Observatory.

As the title suggests, this book covers the disciplines of physics in which thermal properties are important—the subjects often treated separately as thermodynamics, kinetic theory, and statistical mechanics. It is intended for textbook use in a one-semester senior-graduate course that provides the necessary foundation for strictly graduate-level study in physics and engineering. Thus this text presents thermodynamics as an important tool for the physicist, rather than as an end of its own. The reader is constantly reminded of the many ways he will be building upon this subject in graduate study.

Many physicists are already familiar with the earlier "preliminary edition" of this work, published as a paperback (at $4.50) in 1961. The present hardbound "revised edition" is an expansion from 276 to 455 pages, bringing in important new examples and clarifying several sketchy points of the earlier edition. The number of problems was roughly doubled, to a new total of 123.

The text is divided into three main sections: Thermodynamics (ten chapters), Kinetic Theory (five chapters), and Statistical Mechanics (twelve chapters). Each chapter fits into a clearly defined plan, progressing from macroscopic properties of matter to a microscopic atomic description. Yet the author does not hesitate to inject atomic-scale examples frequently, using models that receive full discussion only later on, to show how macroscopic properties relate to atomic properties. A list of chapter titles does not do justice to the exposition, though it does indicate the approach. Very briefly, the thermodynamics section begins with basic notions—heat, temperature, and pressure—progresses to state variables and the first and second laws of thermodynamics, proceeds to entropy, followed by the thermodynamic potentials. The kinetic theory section starts from notions of probability and distribution functions, proceeds to phase space, transport phenomena, and fluctuations. (The previously brief phase-space chapter was expanded considerably in the new edition, and now gives a vivid picture of how points move in phase space.) The statistical mechanics section takes the information theory approach. It develops the various ensembles—microcanonical, canonical, and grand canonical—and proceeds to the quantum statistics of Bose-Einstein and Fermi-Dirac particles, stopping just short of the Boltzmann H-Theorem and cluster expansions.

This book is not intended as a treatise (it covers fewer specific applications than Landau and Lifshitz's *Statistical Physics*, for example), but it includes many interesting applications and illustrative examples. The new hardbound edition includes several important additions: it introduces entropy parameters and nonequilibrium thermodynamics as part of the discussion of the thermodynamic potentials, and it includes a much lengthier discussion of BE and FD statistics, a section on interparticle forces, and an excellent discussion of the properties of liquid helium. Among the other numerous examples which also appear in the preliminary edition, I might mention the

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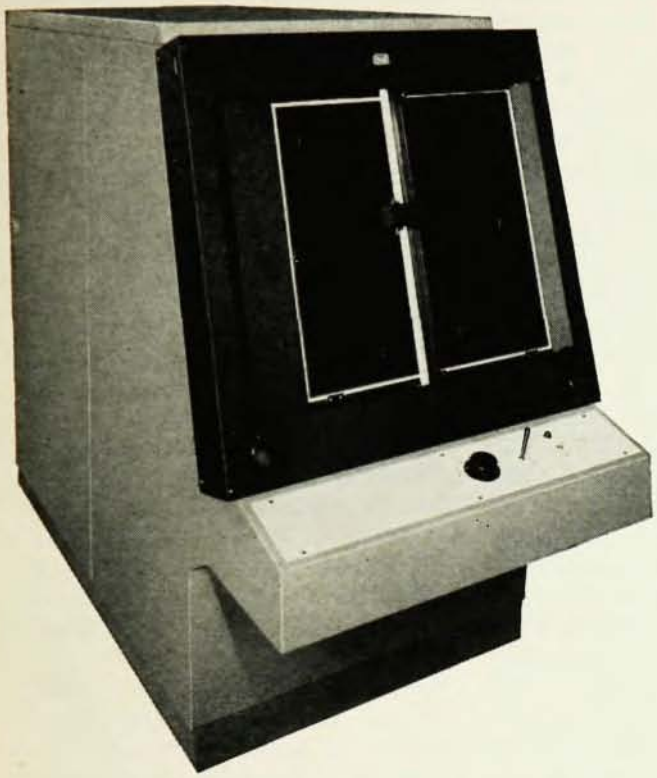

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paramagnetic gas, the Debye crystal, electrons in metals, black-body radiation, and diatomic molecules.

One of the most striking—and satisfying—aspects of this text is the emphasis Professor Morse places upon various types of work other than PV work. At the outset he notes the contribution made to a change in internal energy by magnetic and electric forces, by tensions, and by chemical changes. He drives this home repeatedly with examples, such as the paramagnetic gas.

The author constantly emphasizes motivation: what is the physical meaning of the Legendre transform? why introduce enthalpy, free energy, and the other potentials? Always some physical example, pertinent (though not always familiar) to physicists, precedes the introduction of a new concept. (The Gibbs function first appears quite naturally in a discussion of the superfluid properties of liquid helium.) This makes the arguments remarkably easy to follow. The author took care to write clearly and physically, yet precisely. His style is informal and casual, yet not lax; the result is an excellent text for learning basic thermal physics.

Laminar Boundary Layers. L. Rosenhead, ed., 687 pp. Clarendon Press, Oxford, 1963. Cloth, $14.50.
Reviewed by Lawrence Talbot, University of California, Berkeley.

The decision of the Fluid Motion Panel of Great Britain in the middle thirties to make available an up-to-date account of fluid dynamics resulted in the splendid two-volume *Modern Developments in Fluid Dynamics*, brilliantly edited by Sydney Goldstein. Later, in 1953, the effects of compressibility on fluid flow were considered in the two additional volumes, *High Speed Flow*, edited by Leslie Howarth. However, at the same time the Howarth volumes were being written, the British Aeronautical Research Council resolved that a new series of volumes on fluid dynamics, *Fluid Motion Memoirs*, should be prepared. The first in this new series, *Incompressible Aerodynamics*, edited by Bryan Thwaites, appeared in 1960. The present volume is the second in this new series, and a third volume on turbulence is in preparation.

By all standards, *Laminar Boundary Layers* is a worthy successor to the Goldstein volumes. The present volume covers essentially all the subject matter on laminar incompressible flow which first appeared in *Modern Developments*, plus many new topics. The title does not in fact convey all that is contained within, because although boundary-layer problems receive the greatest attention, most of the important properties and exact solutions of the Navier-Stokes equations are discussed as well, as are many wake and internal flows. The book consists of ten chapters, representing the contributions of twelve authorities. The uniform excellence and harmony of the exposition throughout must surely attest to the efforts of Editor Rosenhead. A remarkable quality of the exposition is that, without exception, every contribution shows clear evidence that the authors have made a conscientious effort to give their subjects a fresh look. The volume so abounds with novel ideas that even the most experienced fluid dynamicist cannot fail to be stimulated into rethinking about some old problems.

The first two chapters, authored by M. Lighthill, present the physical and aerodynamical background of the subject. After the relevant fluid properties and dimensionless parameters are exposed, a detailed and lengthy discussion is given of basic fluid-dynamic phenomena which are observed in all fluid flows, with special attention given to the role of vorticity and vorticity transport. This discussion must rank as a high point of the book.

Chapter 3, by G. Whitham, contains the derivations of the fundamental equations, similitude considerations, and a discussion of some exact solutions. Following this is C. K. Illingworth's chapter on flow at small Reynolds number. Here is presented much of the material on Stokes and Oseen flows which is more recent than *Modern Developments*, such as the method of inner and outer expansions, and the use of Stokes and Oseen variables.

Chapter 5, on two-dimensional boundary layers, by C. W. Jones and E. J. Watson, and Chapter 6, on approximate solutions, by G. E. Gadd, Jones, and Watson, contain a complete and very well integrated account of boundary-layer theory and the many solutions, exact and approximate, which have been obtained for the various boundary-layer problems. Workers in boundary-layer theory will undoubtedly find this material of great value.

Following are two lucid chapters by J. T. Stuart on unsteady boundary layers and hydrodynamic stability, and a well-written contribution by L. F. Crabtree, D. Küchemann, and L. Sowerby on three-dimensional boundary layers. The volume ends with an informative chapter on experimental methods by R. C. Pankhurst and N. Gregory. It is worthy of mention that in addition to the material on experimental techniques contained in the final chapter, one finds throughout the entire volume the conscientious blending of theory and experiment which is so essential to success in the study of fluid mechanics.

Supplementing the text is a reference list containing some 1150 entries arranged in author alphabetical order; each entry contains the complete title of the reference and the pages in the volume on which the referenced article is discussed. This reference list by itself is almost worth the price of the volume.

Inevitably, in a single volume which attempts to cover so vast a subject as viscous flow, some selection of material must be made. It was decided at the outset to restrict the coverage essentially to incompressible flows. This decision is understandable, though in this reviewer's opinion regrettable (see review which follows). Within the domain of incompressible theory, probably the most important topic which is not extensively treated in the present volume is the exact numerical solution of flow problems using modern high-speed computing equipment. Significant advances have been made in this area, some in fact too recent to have been included in this book. Perhaps this will be the subject of a future Memoir.

In this reviewer's opinion, *Laminar*