Book Reviews

A Problem in Dynamics

The Theory of Rotating Fluids. H. P. GREENSPAN. Cambridge University Press, New York, 1968. xii + 328 pp., illus. $15. Cambridge Monographs on Mechanics and Applied Mathematics.

The paradoxical way in which gyroscopes react to external influences is well known: the spinning mass of metal tends to twist not about the line of action of any newly applied torque but about a perpendicular axis; precessions result, which are of great importance for vehicular attitude control. The reactions of rotating fluids (liquids or gases) to external influences are even more tortuous and paradoxical. However, the intensive study to which they have been subjected in the past two decades did not have primarily technological motives: rotating fluids are still rather too unpredictable for use in engineering components, except in such relatively simple operations as centrifugal separation.

The motives, rather, have been mainly geophysical. The earth's great fluid masses—the liquid core, the ocean, and the atmosphere—are strongly influenced, in the way they react to the forces (of largely thermal origin) tending to move them, by the fact that they are in large-scale rotary motion with the angular velocity of the earth. Their motions relative to that large-scale rotation constitute the atmospheric weather and the ocean circulation, with their importance for the ecology of all kinds of living things, and the core eddies, with their geomagnetic importance. Scientists, motivated by these geophysical considerations, have increasingly sought clues to the basic dynamics of rotating masses of fluid by studying theoretically their motion under a great variety of external influences and comparing the results of those studies with laboratory experiments wherever possible.

The body of science so built up, laying emphasis on comparing theory and experiment for such movements of rotating masses of homogeneous liquid as can be realized in the laboratory, but referring often to specific geophysical phenomena that may be in part illuminated by individual studies of this kind, is excellently described in this well-written book. On the even more complicated subject of rotating stratified fluids, the book includes only a small amount of material, but enough to make the reader quite clearly aware of the possibility that particular phenomena may be grossly altered by stratification and of the need for careful scrutiny of this aspect in geophysical applications.

The central phenomena described, each from several points of view, are Ekman layers, Taylor columns, spin-up, inertial waves, Rossby waves, forced motions (and decaying disturbances) within a uniformly rotating container, and motion within a precessing container. Most of these important but complex and to some extent "unexpected" phenomena are first introduced in chapter 1 through simple experiments and elementary theoretical ideas. Their nature in certain limiting cases that possess considerable practical significance, while allowing simplification of theory through linearization, is described in the very long second chapter. The understanding so achieved is then used as a framework for explaining the meaning of various harder pieces of theory, valid in other (essentially nonlinear) cases, in chapter 3. Excitation of inertial waves (and of their limiting case, the Taylor columns) is the main theme of chapter 4. To balance the concentration on essentially laminar flow in most of the book, chapter 6 gives a good account of criteria for instability, including instability of Taylor vortices, Ekman layers, and vertical shear layers, as well as "baroclinic instability."

Discussions, in chapter 5 and elsewhere, concerning extensions of the book's central ideas into the enormous field of oceanography are for reasons of space somewhat slender. Stratification introduces more complexities even than those that are mentioned: it profoundly alters inertial waves; on a rotating spherical earth, it especially permits extra "baroclinic" modes, and does not bring about the "loss of effective stretching of vortex lines" that (in the context of flow in a cylinder) is noted on page 127. Again, "inertial boundary layers" are, possibly, of uncertain application to the depth-averaged equations for a real ocean, because the depth-averaged inertial terms are approximated in the theory in such a manner that their inaccuracy is both large and variable in form (depending on current distribution in depth).

The main section of the book, chapters 2 and 3 on contained rotating fluids, has many outstanding features, which include the making of several important distinctions. With the convention that the axis of rotation is vertical, containers whose curves of constant "height" (from top to bottom) are a set of closed contours behave in one way: "geostrophic" motions outside the Ekman boundary layers tend to be excited with flow around those curves. When, however, those curves are not closed but terminate on a vertical boundary, it is waves of generalized Rossby type that are excited in forced motions or disturbance decay. A quite different degenerate case is that of a container of uniform height, which would permit any geostrophic motion. Then it is the mass balance of flow in and out of Ekman layers that forces the geostrophic motion to be irrotational, and a further crucial distinction then depends on whether the fluid region is or is not simply connected. In these degenerate cases vertical shear layers are often present. The clear account of this complex topic is one more excellent feature of this permanently important book.

M. JAMES LIGHTHILL
Imperial College of Science and Technology, London

Atmospheric Event

Lightning. MARTIN A. UMAN. McGraw-Hill, New York, 1969. xvi + 272 pp., illus. $13.50. McGraw-Hill Advanced Physics Monograph Series.

The subject matter covered by the title *Lightning* is so vast it is inconceivable that any single volume could do it justice. The phenomenon of lightning is of such impressive drama and power that it has an important

place in mythology, religion, history, art, and letters. Even if the author chooses to confine himself to the scientific aspects of lightning alone, as Uman has done, he must choose from a formidable mountain of observations, data, theories, and speculations. Some readers may be disappointed to find that this book scarcely mentions unusual lightning phenomena, such as those associated with volcanoes, tornadoes, and nuclear explosions, that it has nothing to say about the role of lightning in anthropology, ecology, biology, atmospheric chemistry, and cloud physics, and that it does not deal with such topics as whistlers, spherics, lightning control, or the effects of lightning on animals, buildings, and airplanes.

All of this is, of course, expecting far too much. If the author had chosen a more restrictive title that better described his book, for example, "Physics of the Lightning Flash," there would be little to criticize. He has done a solid and useful piece of work to provide a clear, authoritative, and up-to-date exposition of many of the physical phenomena associated with lightning. Until now this material has not been available in a single text.

One of the particularly useful portions of this book is the introductory chapter, which provides a condensed version of the detailed discussions that follow. The first table, which gives minimum, maximum, and representative values that have been measured for more than a dozen important variables associated with the lightning flash, is a valuable compilation. The six chapters that follow, treating in detail such subjects as lightning photography and spectroscopy, electrical measurements, thunder, and the theory of discharge processes, will be useful for the advanced student and the scientist working in this field.

Two appendices provide an introduction to the very puzzling literature of bead and ball lightning, which, as Uman notes, is voluminous enough to fill a book of its own. Two other appendices bring lightning research up to date with a discussion of recent developments and project it into the future with suggestions for further studies. The value of the book is enhanced by comprehensive lists of references and detailed author and subject indexes.

BERNARD VONNEGUT
Atmospheric Sciences Research Center, State University of New York, Albany

A Technique

Chemical Applications of Mössbauer Spectroscopy. V. I. GOLDANSKII and R. H. HERBER, Eds. Academic Press, New York, 1968. xiv + 701 pp., illus. $29.

The phenomenon of recoilless emission and absorption of nuclear gamma radiation, reported by R. L. Mössbauer in 1958, has now taken its place alongside other nuclear phenomena such as nuclear magnetic resonance as an important and unique method for investigation in several branches of physics and allied fields. Thus, as an addition to the excellent account by G. K. Wertheim (*Mössbauer Effect: Principles and Applications*, Academic Press, 1964) there has been a need for a comprehensive treatment of the subject at the research level. The proceedings of several conferences and the now-yearly reports of the Mössbauer symposia (*Mössbauer Effect Methodology*, vols. 1–4, I. J. Gruverman, Ed., Plenum, 1965–1968) have partially filled this need. The present volume, edited by V. I. Goldanskii and R. H. Herber, should go a long way toward providing a satisfactory one-volume reference work. The title of the book is too restrictive; it could, justifiably, have been called "Applications of Mössbauer Spectroscopy."

In a field that has developed as explosively as has Mössbauer research, it is probably inevitable that a useful book would consist of a series of articles contributed by a large number of workers. The editors have sought to overcome the resulting lack of continuity and uniformity by means of numerous and detailed footnotes. These notes also often serve as addenda to bring the text up to date.

The book covers the important applications of the Mössbauer effect to nuclear, solid state, and atomic physics and to pertinent problems in biophysics. Chemical applications are indeed stressed, after suitable introductions, in the treatment of the Mössbauer effect in ^{57}Fe, ^{119}Sn, xenon and iodine, the rare earths, and the heavy elements. Some special effects are described and an excellent treatment of spin relaxation phenomena in solids is included. The only serious drawback to the use of the book as a general reference work on the Mössbauer effect is the omission of applications to relativity and resonant time effects and to mineralogy and geophysics, where Mössbauer spectroscopy is increasingly used. Topics such as the implantation of Mössbauer nuclei in various environments are too recent to have been included.

In summary it should be stressed that the book does provide the first comprehensive treatment of the applications of Mössbauer spectroscopy to chemical problems. The impressive amount of research reported in this area supports the early prediction that this may be where the Mössbauer effect will make its greatest contributions in the long run.

This reviewer has already had occasion to consult the book in the course of research and found it very helpful. The hackneyed phrase of the reviewer seems especially appropriate: no serious research worker in this field should be without access to this book.

S. S. HANNA
Department of Physics, Stanford University, Stanford, California

Crystallography

Molecular Crystals. Their Transforms and Diffuse Scattering. JOSÉ LUIS and MARISA AMORÓS. Wiley, New York, 1968. xxiv + 479 pp., illus. $22.50. Wiley Monographs in Crystallography.

This is the second book in a series, Wiley Monographs in Crystallography, edited by Martin J. Buerger, the first of which was *Polymorphism and Polytypism in Crystals* by A. R. Verma and P. Krishna.

The book is essentially divided into two parts. The first three chapters deal with the theory of scattering of x-rays by atoms and molecules, by an ideal periodic structure, and by a real crystal. The remaining three treat applications to the diffuse scattering of molecular crystals, diffuse scattering by thermal waves, and temperature dependence of diffuse scattering. In the theoretical treatment an important place is taken by the Q-function (self-image of the electron density) and by the difference Fourier transform (the difference of the molecular Fourier transforms at temperature $T = 0$ and temperature T). There is also a great deal of emphasis on optical analogs, particularly Fraunhofer patterns obtained by representing atoms by disks of varying size and recording the diffraction pattern of the assembly. The text is supplemented by a large number of excellent illustrations.

The chief merit of the book is that it is practically the first one available