Coriolis revisited

THE THEORY OF ROTATING FLUIDS: CAMBRIDGE MONOGRAPHS ON MECHANICS AND APPLIED MATHEMATICS. By H. P. Greenspan. 327 pp. Cambridge University Press, New York, 1968. $15.00

by DAVID R. RODENHUIS and WALTER M. ELSASSER

The dynamics of rotating fluids is not only a classical subject but also a topic of considerable current interest. The motivation for its study lies in the need for understanding the dynamics of geophysical and astrophysical phenomena in which the effects of overall rotation are often quite large and sometimes all important. This is true in the atmosphere and oceans, in the magnetosphere, in interstellar gas and in spiral galaxies, to name some examples.

The author thinks sufficiently in physical terms so that physicists will feel at home with his presentation. Greenspan, in his work at MIT, has contributed substantially to this field of fluid dynamics. It is particularly pleasing to note his equal interest in theory and in laboratory experimental work.

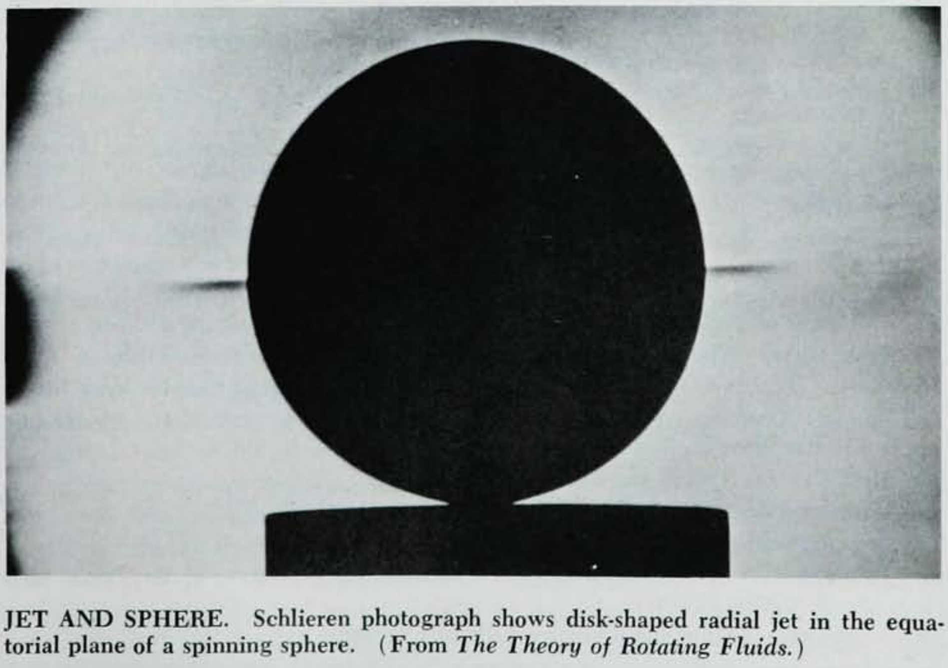
The subject of rotating fluids—indeed, fluid mechanics itself—is unfortunately all too foreign to many physicists. R. J. Emrich, H. A. Snyder and G. E. Uhlenbeck (writing in *Am. J. Phys.* **36**, 886, 1968) indicate that over half of the current PhD's in physics have never heard of the Navier–Stokes equations (the standard equations of motion of a viscous fluid). From the view of the physicist, then, this monograph may provide some stimulating insight into the world of fluid mechanics and particularly, into the effects of rotation upon fluid motions with their fundamental application to terrestrial and cosmic physics.

Although this book is not an introductory text, the reader may, after a modest amount of preparation in the fundamentals of fluid flow (for example, *An Introduction to Fluid Dynamics* by G. K. Batchelor, Cambridge University Press, 1967), find himself using Greenspan's monograph as a valuable guide to understanding some of the principles of geophysical or astrophysical motions.

After a brief introductory chapter, the book is arranged into three main parts: general theory of rotating fluids, oceanic applications and hydrodynamic stability. Two-thirds of the book is devoted to the general theory of rotating fluids, which is treated in three chapters according to linear and nonlinear theories, and the contained and unbounded nature of the fluid system. Topics of discussion include the Ekman boundary layer and the spin-up problem, inertial waves, and motion on, in and between spheres, cylinders and flat plates. The last two chapters of the book on oceanic circulation and stability are in no sense comprehensive; they deal with some very limited portions of these subjects: steady circulations, Rossby waves, existence and stability of boundary layers.

As pointed out already, an understanding of the material requires a certain knowledge of fluid mechanics and boundary-layer theory. The formulation of the governing equations needs only a knowledge of vector calculus, but the solution of the simultaneous, nonlinear partial differential equations may involve similarity solutions and integral-transform methods. These methods are not elucidated in the text; rather, the reader is referred to the original papers. This fits the purpose of the author, which was to collect a body of substantially new, fundamental and provocative material on rotating fluids "for the support and promotion of research." The reader will find himself frequently returning to the references which are extensive and up-to-date. Furthermore, the frequent reference to simple laboratory experiments, which are complemented by a good selection of plates in the text, should arouse interest in some readers at the least. The book is limited for the most part to incompressible flow of a rotating homogeneous fluid, yet this simple medium still admits interesting and even startling effects, such as Taylor columns, inertial wave propagation, and secondary circulation coupling the (Ekman) boundary layer with the interior flow. Furthermore, the author often takes pains to provide physical explanations and insights and has made a special effort at the beginning of each section to clarify the aim of the material considered and to relate it to adjacent chapters. For these reasons a novice may find even a brief contact with the book stimulating.

So far as we know this is the first monograph completely devoted to the



JET AND SPHERE. Schlieren photograph shows disk-shaped radial jet in the equatorial plane of a spinning sphere. (From *The Theory of Rotating Fluids.*)

dynamics of rotating fluids. Because the book is issued by Cambridge University Press, it is in the best of company and deserves this place.

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Superconductivity for everyman

AN INTRODUCTION TO THE THEORY OF SUPERCONDUCTIVITY. By Charles G. Kuper. 301 pp. Clarendon Press, Oxford, 1968. $9.60

by JOEL A. SNOW

Two types of monograph are needed to summarize and unify the present state of an advanced scientific field. Inward-looking monographs are expert's books, intended for the small corps of professional specialists whose research is actively extending the frontiers. As the body of knowledge expands and specialities grow within specialities, the inward-looking books must necessarily become evermore esoteric, and the potential audience perforce remains limited. Outward-looking monographs are nonexpert's books, intended for the broad range of scientists and students whose major interest is in related fields, who have an interest in applications, or who are drawn to the subject out of curiosity. Such books must eschew elegance in deference to clarity and avoid jargon in favor of language that is understandable to a heterogeneous audience. Charles Kuper's book on superconductivity theory falls into the latter class. It is designed for, and deserves the attention of, the many engineers, chemists, experimentalists, and nonspecialist theorists who wish to use or appreciate the theory without mastering it.

In recent years superconductivity has moved from the status of a laboratory curiosity and perplexing theoretical puzzle to the threshold of major technological importance. Superconducting switching circuits, high-field magnets and superconducting linear accelerators all either exist or are under development, and the prospect of the associated development of large-scale cryogenic techniques hints at such applications as high-power long-distance transmission of electricity. Thus many people have a need to learn the essentials of the underlying theory, and Kuper has undertaken a task that is well worth the effort. The theory took its great leap forward 12 years ago, with the development of the BCS (John Bardeen, Leon Cooper, Robert Schrieffer) theory and, contrary to the occasional situation in which a new, comprehensive theory is so overwhelming that it stifles further development, the original BCS paper led quickly to further applications, elaborations and refinements. The experimental and theoretical literature have both grown very rapidly, and most of the remaining experimental disagreements and conceptual perplexities have now been resolved.

Though the original BCS paper may properly one day be known as a masterpiece of scientific exposition, it was originally thought to be quite obscure, and the subsequent theoretical literature has tended to be relatively opaque to nonspecialists. Much of this difficulty arises because the full apparatus of the quantum many-body formalism is generally required.

The present comprehensive version of the theory, due to G. M. Eliashberg, L. P. Gor'kov, Yoichiro Nambu, Philip W. Anderson and others, uses the formalism of many-body Green's functions, an elegant technique with its own lore and language, and an unfortunate proliferation of notations. Kuper approaches this high plateau assuming only that the reader knows some classical physics and elementary quantum mechanics.

The chosen approach is historical and phenomenological, with more than half of the book devoted to material that is dismissed in the first chapter of Schrieffer's well known advanced monograph. Basic experimental results are sketched in where appropriate, with particular attention given to various models that describe the observed thermodynamic and electromagnetic properties. Though most of the arguments are familiar, they are put forward clearly and with painstaking detail. A very few forward references, for example, using the BCS density of states while discussing two fluid models with an energy gap, make it possible to present many of the most useful relationships and much of the intuitive content of the subject without any direct reliance on quantum me-

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