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REVIEWS

Sound Propagation in Stratified Fluids. By C. H. WILCOX. Springer, 1984. 198 pp. DM56.00 (soft cover).

In his introduction the author of this monograph says that his intended audience includes (*a*) applied physicists and engineers concerned with sound in stratified fluids, and (*b*) mathematicians interested in spectral analysis for partial differential operators. He has probably succeeded admirably for the group (*b*), but most readers in group (*a*) will find the monograph largely unintelligible. Indeed the author acknowledges that these two groups are disparate and that, in honesty, there is no common domain of discourse. He has attempted to give, at the beginning of each chapter, a summary that presents the basic physical concepts. These summaries will help the physicist who is prepared to learn the mathematical terminology. They invoke such ideas as wave solutions, for a guiding layer, that have incident, reflected and transmitted plane waves satisfying Snell's law.

The propagation of sound waves in guiding systems was studied by Lord Rayleigh in 1878. One of the pioneering papers for sound in stratified systems was by Pekeris in 1948. The subject has been covered in many textbooks, particularly Brekhovskikh, 1960. These and many other works use conventional mathematics of the kind that most physicists and engineers can understand. It is doubtful whether the writers would have accepted the author's contention that their methods are non-rigorous and have other faults.

This book deals with sound waves in the simplest kind of plane-stratified system in which gravity is ignored. The equations are linearized, so that only waves of small amplitude are studied. The medium is isotropic and non-dispersive. It is assumed that the square of the velocity of sound is real, positive and bounded, with a positive lower bound. The effect of shear and bulk viscosities is ignored, but in the first few pages, surprisingly, the effect of thermal conductivity is included. The author says that it is negligible if the acoustic disturbances are rapid enough, and it is finally neglected from page 4 onwards. In fact, it becomes important for sufficiently rapid disturbances with a frequency exceeding about 10^8–10^9 Hz in air or water, and can be neglected only if the disturbances are much *less* rapid than this. Viscous damping has a smaller transition frequency and there is therefore a stronger case for its inclusion, but it is neglected from the outset.

These simplifications are admirable for the physicist who wants to acquire an understanding of the basic physical principles unencumbered by complications. But this published work on guided waves has gone very far beyond this. The theory of sound waves in the atmosphere has been extended to include gravity, winds, curvature of the strata, and the Coriolis force that makes the medium anisotropic. For electromagnetic waves the subject has advanced even further because the stratified magnetoplasmas of the ionosphere and magnetosphere are highly anisotropic and dispersive, and the square of the effective wave velocity is not bounded, nor restricted to positive or to real values. The published papers on these topics use conventional mathematics. Probably the techniques of functional analysis have not yet advanced far enough to deal with them.

It will by now be clear that the present reviewer is a physicist. He has successfully used the older conventional type of mathematics for guided waves, in both teaching

and research, including computing. It is, of course, essential that theoretical physicists should be educated in the meaning and importance of mathematical rigour. This must introduce them to such mathematical concepts as Hilbert space, Lebesgue measure and so on, as used in this book. But it emphatically does not mean that they must then expect to use these concepts for solving all their problems.

This book seems to be a mathematical exercise designed to show the power and importance of the mathematical methods, and written by a mathematician who is expert in functional analysis. But it gives no numerical values and no discussion of orders of magnitude. The descriptions of the physical meaning of the results are brief, and there are no diagrams. Regretfully it cannot be recommended for the many physicists and engineers interested in guided waves; a small number of mathematical specialists may find it of interest.

KENNETH BUDDEN

SHORTER NOTICES

Theories of Fluids with Microstructure. By V. K. STOKES. Springer, 1984. 209 pp. DM 88.00.

Readers of this *Journal* might reasonably suppose that a book with this title is about the mechanical and physical properties of a fluid which contains some dispersed small-scale discrete entities, such as a solution of macromolecules, or a suspension of clay platelets, or an emulsion, or blood, or a dusty gas, but they would be wrong. It seems that the word 'microstructure' has been adopted by a group of theorists to designate fluid media with two unusual properties, one being a non-zero angular momentum density and the other a non-zero moment per unit area exerted across a surface element. This book provides an introduction to the kinematical and dynamical relations needed for the description of the motion of fluids with 'microstructure', and very complicated they are. The author does not say why it is worthwhile to study such hypothetical fluids, nor does he give data about real fluids exhibiting his assumed properties. The book will thus be of interest primarily to those who regard the greater generality of fluids with 'microstructure' as adequate justification for studying them.

Remote Sensing of Shelf Sea Hydrodynamics. Edited by J. C. J. NIHOUL. Elsevier, 1984. 354 pp. $69.25.

This book is based on contributions from the 15th annual International Liège Colloquium on Ocean Hydrodynamics which aims to cover recent problems and growth areas in physical oceanography. Remote sensing is thus a very fit topic for such a forum and the eighteen individual papers making up the volume cover many aspects of satellite, airborne, and ground-based systems for obtaining information about shelf sea hydrodynamics.

Satellite-borne systems figure strongly and include synthetic aperture radar, altimeters, infra-red, and colour sensors. The varied information about the sea surface available from these different sensors is discussed. Special interest is shown in how surface data can be used to draw conclusions about subsurface processes or features. One such example is that bottom topography is frequently visible in SAR images of the sea surface. Similar airborne and ground-located systems are also discussed.

Apart from presenting the types of data available by remote sensing the book also contains some detailed analysis to explain several of the phenomena so revealed.

Thus, for example, there are kinetic studies of vortex structures shed by currents, and the question of how subsurface features affect surface data is considered in some detail. The book will make useful and interesting reading for all oceanographers because of the wide range of effects treated and the fact that much of the data is very recent.

Random Walks in Biology. By H. C. BERG. Princeton University Press, 1983. 142 pp. £14.30.

This book is concerned with probability, diffusion and the movement of microorganisms. Through this little book, one of today's most creative biophysicists shares some of the contents of his bag of tricks. The treatment is elementary, yet it covers theory and application for a remarkable variety of complex topics. For example, simple random walks lead to various diffusion equations and their solutions. Viscous drag at low Reynolds number introduces sedimentation, field flow fractionation and the computation of diffusion coefficients. The discussion of bacterial locomotion includes the theory of flagellar propulsion and the effect of rotational diffusion. *Random Walks in Biology* can be highly recommended as a stimulating introduction or a lucid reminder.

The Science and Technology of Coal and Coal Utilization. Edited by B. R. COOPER and W. A. ELLINGSON. Plenum, 1984. 666 pp. $85.00.

This collection of twelve articles provides the newcomer with an introduction to the basic science of coal and also to some of its current or future uses. The 23 authors come from all over the U.S.A.; they cover a wide range of disciplines (geology, physics, chemistry, engineering, etc.) and indeed work for a great variety of employers (university, private industry large and small, as well as government research institutions). The titles of the articles give a flavour of the book's coverage. They are: The science and technology of coal and coal utilization, Coal characterization, Coal preparation and cleaning, Role of impurities, Gasification and indirect liquefaction, Direct liquefaction, Fluidized-bed combustion, Coal-fired open-cycle MHD plants, Fuel cell power plant systems, Catalysis and catalytic deactivation, Materials of construction, and finally Instrumentation and monitoring. The emphasis is on a description of coal and its properties with a view to those new processes which are now under evaluation. Interestingly, there is no chapter on acid rain or other atmospheric pollution derived from the burning of coal. This is thus a book for the new or old coal enthusiast, who can read about how it might be used in future power stations, whether they be based on MHD systems, fuel cells or fluidized beds. The approach is non-mathematical and the authors have succeeded in writing for the new graduate; the book includes a large bibliography.

Ocean Hydrodynamics of the Japan and East China Seas. Edited by T. ICHIYE. Elsevier, 1984. 423 pp. $71.25.

This book is the proceedings of the second Japan and East China Seas Study Program Workshop, held in Tsukuba University, Japan, in April 1983. The publishers and editor have worked hard to ensure its speedy publication, notably by the use of camera-ready copy. In some cases, noted by the editor, this has meant that referees'

comments have either not reached the author, or that there has been no time to make modifications based on those comments.

Some 38 papers were given at the workshop; 29 of these appear in the proceedings, divided roughly into ten main areas. These are: the hydrography of the area; coastal phenomena; analytical and numerical models; one paper on hydraulics; sea levels and tides; remote sensing; turbidity; and wave prediction. The two papers of most interest to fluid dynamicists are probably Guan's overview of the circulation, including the maintenance of the amazing vertical stratification (from 4 °C at 50 m depth to 28 °C at the surface), and Kawasahi and Sugimoto's experiments on flow over a sill with topography, and the varied regimes produced.

Nonlinear Partial Differential Equations in Applied Science: Proceedings of the U.S.–Japan Seminar. Edited by H. FUJITA, P. D. LAX and G. STRONG. North Holland, 1983. 457 pp. $60.00 (paperback).

The 26 papers in this volume were presented during a 5-day meeting in July 1982. The tremendous variety of nonlinear equations is revealed in the range of problems, about half of which have their origins in fluid mechanics, e.g. the Navier–Stokes equation, two-dimensional convection patterns, the nonlinear Schrödinger equation, combustion models. The emphasis throughout is upon rigorous mathematical results. This volume gives an indication of the many separate treatments which are currently being developed in the qualitative study of nonlinear problems.