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REVIEWS

Turbulence Strömungen. Eine Einführung in die Theorie und ihre Anwendung. By Julius C. Rotta. Teubner, 1972. 267 pp. DM 68.

It is noted in the preface to Rotta's book that, although almost all real flows are turbulent and turbulence is enormously important for many practical problems, there are very few books on turbulence which can be used as a textbook and, in particular, no such books at all in the German language. I can say in this regard that there are no such books in Russian either; apparently, in the whole world literature, except for the book by Rotta, only the recent book by H. Tennekes & J. L. Lumley (*A First Course in Turbulence*, MIT Press, 1972), which is quite different from Rotta's book, can be considered as an introductory textbook on turbulence.

It is clear that in a book the size of Rotta's it is impossible even to mention all aspects of the mechanics of turbulence. A ruthless selection of the material to be included is absolutely necessary, and it is inevitable that this selection should be partially subjective and should vary from one author to another. In the case of Rotta's book the reader is warned in the preface that such questions as transition to turbulence, turbulent heat and mass transfer, compressibility effects and sound emission will only be mentioned briefly and practically important turbulent flows of non-Newtonian fluids and of plasmas will not be mentioned at all. In my view it is a pity that the study of turbulent heat transfer and the behaviour of scalar fields in turbulent flows are excluded from consideration since these questions are of great importance for many engineering applications (and almost all geophysical applications too) and are often considerably simpler than the study of vector velocity fields. (It is noteworthy that the study of turbulent transfer of heat and of turbulent dispersion of contaminants plays a considerable role in the book by Tennekes & Lumley.) Nevertheless I understand that it is the right of an author to select the contents of his textbook, and I don't think that the selection made by Rotta is unsatisfactory. More questionable to me is the arrangement of the material included in the book.

The book begins with the introductory chapter "General foundations". After a brief description of the characteristic features of turbulent flows, the basic notions of probability theory (i.e. the theory of random variables and random functions) are considered here. However it seems to me that the exposition is more general and slightly more complicated than in fact is necessary. For example, the author introduces the notions of a characteristic function and cumulants in the main body of the book (and not in small type) whereas these notions are used only in a small remark on p. 258; and in his Fourier analysis of random functions he makes unnecessary mathematical difficulties for himself and for readers, since he does not limit himself to stationary random processes and homogeneous random fields but tries to include more general random functions which are unnecessary in such a book. The dynamical equations are also formulated in chapter 1 in a quite general form and the equations for incompressible fluids are considered as a special case, although more than 99 % of the book deals with incompressible fluids. These remarks would be unimportant in the case of a scientific monograph but for a textbook they have some importance.

The second chapter, "Homogeneous turbulence", is the most complicated in the book and also the furthest removed from direct engineering applications. Such an order can be easily justified by logic (by reference to the fact that in principle homogeneous turbulence is the simplest case) but I think it is not suitable for any inexperienced reader. I think also that the most important applications of the notion of isotropy of the small-scale structure of quite general turbulent flows at high enough Reynolds numbers deserve more attention. (Incidentally, the author gives only rather old experimental data of Grant, Stewart & Moilliet confirming the Kolmogorov theory; the data are good but there are many newer results and the estimation of the Kolmogorov constant published by Grant *et al.* is slightly out of date now. And a short remark on pp. 100–101 on the turbulent structure within the dissipation range and on energy dissipation fluctuations is even more out of date.) On the other hand the study of the asymptotic behaviour of the spectra of isotropic turbulence as $k \to 0$ which has no real physical meaning and of various self-preservation hypotheses for isotropic turbulence does not deserve the space, in an elementary textbook, that it is given in the present book.

Chapter 3 is devoted to the general study of shear-flow turbulence and chapter 4 to particular types of shear flow (pipe and channel flows, free turbulent flows and boundary-layer flows). These two chapters are the most important in the book, and my feeling is that they are also the best. Chapter 3 begins with a consideration of the Reynolds equation and the budget equations for the second moments of the velocity fluctuations in turbulent shear flow. Then the author shows some examples of correlation function measurements and after this devotes approximately ten pages to rather compressed but quite clear exposition of the main features of wall turbulence. The next section of chapter 3 is devoted to free boundaries of turbulent flows with a special emphasis on the intermittency phenomenon. The end of the chapter is devoted to semi-empirical approaches; after the classical hypotheses by Boussinesq, Prandtl, von Kármán and Taylor some modern semi-empirical theories are also considered briefly. In chapter 4 attention is given primarily to similarity and dimensional considerations and self-preservation of the flows. (Here the author gives the well-known derivations by Izakson and Millikan of the logarithmic laws for the velocity profile and skin friction in pipes and channels without reference to either author.) However the empirical data and semi-empirical methods of turbulent flow computations are given adequate space in chapter 4. Boundary-layer flows are considered in more detail than all other types of shear flows; the author justifies this by the special importance of boundary layers, but it is natural to think that his considerable contribution to the development of boundary-layer theory has also played a role in his decision.

The fifth and last chapter is called "Further problems". It occupies eight pages and contains quite short remarks on turbulent heat and mass transfer, sound generation by turbulence, compressibility effects, analytical theories of turbulence, and the general statistical approach of E. Hopf.

My review of the book contains several critical remarks; nevertheless, I think that the positive features of the book outweigh its deficiencies. My feeling is that the textbook by Tennekes & Lumley is more interesting for students of physics and geophysics, but the book by Rotta is more 'classical' and formal and probably more suitable for future engineers, who need the methods of computation above all else. In any case it is a reasonable textbook in a very important part of fluid mechanics in which the number of the available textbooks (in any language) is clearly insufficient from all points of view.

A. M. YAGLOM

SHORTER NOTICES

Kuroshio: Physical Aspects of the Japan Current. Edited by H. STOMMEL and K. YOSHIDA. University of Washington Press, 1972. 517 pp. $40.00.

Students of ocean currents wishing to learn about the Kuroshio and its environment have been somewhat disabled by the abundance and variety of uncondensed materials in libraries and data centres. This treatise, a collection of articles (in English) by Japanese and American oceanographers which summarize and review the pertinent observations, succeeds in removing that disability. By intent, the treatment is descriptive rather than theoretical, and it is exhaustively detailed; it has produced a much needed source for up-to-date physical-oceanographic information on the western North Pacific.

Matched Asymptotic Expansions and Singular Perturbations. By W. ECKHAUS. North-Holland, 1973. 145 pp. $8.95.

The language of this monograph is more mathematical then that of the well-known books by Van Dyke and by Cole: a long sequence of increasingly elaborate definitions is introduced to classify the maladies, and to delineate the difficulties, of singular-perturbation problems. However, these definitions are not essential to the constructions that follow, and are not used to prove theorems justifying the formal approximations, so that readers may be inclined to take them lightly. The emphasis is on linear problems, but the examples also show nonlinear ones misbehaving themselves. There is a useful account of work by the author and his colleagues on the boundary layers of linear elliptic equations of the second order that reduce to first order away from the boundary of the domain.

Fluid Dynamic Measurement in the Industrial and Medical Environment. Proceedings of the DISA Conference, Volume 1. Conference Papers. Edited by D. J. COCKRELL. Leicester University Press, 1972. 343 pp. £5.00.

Fluid Dynamic Measurement in the Industrial and Medical Environment. Proceedings of the DISA Conference, Volume 2. Discussion. Edited by D. J. COCKRELL. Leicester University Press, 1972. 88 pp. £1.00.

The papers presented at this international conference yield information on a wide range of fluid dynamic measurement techniques. While some workers discussed the development of completely new gadgets, most contributions considered the (sometimes unsuccessful) modification of old devices for use in awkward and novel circumstances, from large industrial gas burners to diseased human arteries. In view of the sponsor, it is not surprising that most authors treated aspects of hot-wire or hot-film anemometry, but there were also papers on ultrasonic and laser-Doppler anemometers, on temperature, pressure and shear-stress measurements, and on estimations of void fraction in two-phase flow. As at most conferences, some papers were not worth the writing, some are hard to read, and some are burdened with obscure, complicated diagrams. Nevertheless, a fluid dynamicist in search of experimental ideas will find in these volumes a useful compendium of modern techniques.