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REVIEWS

Stability of Parallel Flows. By R. BETCHOV and W. O. CRIMINALE. Academic Press, 1967. 330 pp. £6.40.

The text by Betchov and Criminale follows earlier books by Lin and Chandrasekhar, and extended articles by Stuart, Shen and Reid, on various aspects of the theory of hydrodynamic stability. In view of its title, it is natural to compare *Stability of Parallel Flows* with Lin's monograph, which is mainly devoted to that topic, and Reid's article, which is wholly devoted to it. Lin's book is now perhaps somewhat dated in view of the considerable advances and extensions of the last twenty years, while Reid's article, for all its elegance and clarity, is mainly concerned with mathematical questions. It may be felt, therefore, that there is a need for a new book which deals with the theory, calculation and applications of hydrodynamic stability of parallel flows. Does the book by Betchov and Criminale fulfill this need satisfactorily? I believe that it does not.

The main virtue of this book is that it emphasizes the important role that a digital computer can play in the solution of the eigenvalue problems of the Rayleigh and Orr–Sommerfeld equations, and in the direct numerical solution of the non-linear Navier–Stokes equations. Moreover, many examples are given, usually graphically, although I fear that they are on too small a scale to be useful to those who want actual numbers.

Set against the advantage of this approach, however, are a number of disadvantages. First, there is the authors' ambivalent attitude about the readership, which apparently is thought to include "the uninitiated", for whom the book is a "text" and the "more knowledgable researcher", for whom it is a "monograph"; as a result one is taken from very elementary mathematics, exemplified by an overlong explanation of the use of a complex function to represent a real function when the equation is linear, through too many mathematical and physical subtleties of the Orr–Sommerfeld and associated non-linear problems. Inevitably they have not succeeded in satisfying the requirements of readers at either of these extremes. Second, although the authors claim (p. 9) that "oscillations of boundary layers are analyzed with maximum clarity in Chapter II" I find that a number of their approximations in Chapter II are for me not helpful and certainly not clear. There are better analytical accounts elsewhere, in Reid's article, for example. Third, in a number of the later, and more advanced, chapters of the book the authors seem merely to describe recent research work very uncritically and with little judgement. This is especially true of the chapter labelled "Non-linear effects" (a topic which I happen to know well) but is also, I believe, true of the accounts of compressibility, stratified flows and magnetohydrodynamics, amongst others.

My attitude to this book, therefore, is that it is not a clear basic text from which one could really learn and understand the topic of *Stability of Parallel Flows*; nor is it a scholarly monograph with critical accounts of advanced topics. On the other hand, used with discretion and/or guidance, it could be

a useful reference work on a number of questions and for this reason I am glad to have it on my bookshelf.

J. T. STUART

Non-equilibrium Thermodynamics: Variational Techniques and Stability. Edited by R. J. DONNELLY, R. HERMAN and I. PRIGOGINE. University ofChicago Press, 1966. 313 pp. £3.60.

Non-equilibrium thermodynamics is a conference report devoted not to thermodynamics as such but to convection and related topics. The organizers of the conference had the idea of bringing together "specialists in both non-equilibrium thermodynamics and hydrodynamic stability". To judge from the papers and discussions the two groups had only moderate influence on each other! The articles of most interest to readers of the *Journal of Fluid Mechanics* are likely to be those devoted to hydrodynamic stability, and among them is one, that of P. H. Roberts, which applies Prigogine's ideas on non-equilibrium thermodynamics to the non-linear problem of Bénard (buoyancy driven) convection. To the approximation to which Roberts' work goes, at least, one can deduce that the Prigogine's variational theory is inexact for convection and of less rigour and value than perturbation schemes. Moreover, in a discussion, Finlayson and Scriven argue that Prigogine's variational principle is but a variation on Galerkin's method.

However, for my taste, the outstanding article in this volume is L. A. Segel's survey of non-linear hydrodynamic stability. With its clarity and elegance of exposition, it forms an admirable model and one which is truly a pleasure to read.

J. T. STUART

Ähnlichkeitstheorie in der physikalisch-technischen Forschung. By J. PAWLOWSKI. Springer-Verlag, 1971. 172 pp. DM 49.

Dimensional analysis can be of great help in solving complicated problems, as it usually allows a reduction of the number of independent variables. Therefore in most textbooks on heat transfer, chemical engineering or fluid mechanics a chapter is devoted to this topic. Having read one of these chapters a student should be able to determine a set of the dimensionless variables if he can find or guess the physical quantities of importance in the problem. However, in many cases there remain a few questions and a feeling that the subject is close to being an art.

The present book treats dimensional analysis in more detail. In the first chapter, a strict formalism is developed and the Π-theorem is derived. Applications to physical and technical problems are shown next. A useful method for finding a complete set of dimensionless variables from the dimensional matrix is given. It is, of course, equivalent to finding solutions to a set of homogeneous, linear, algebraic equations. The consequences of choosing different systems of fundamental units (length, time, etc.) and transformations to different sets of dimensionless variables are also investigated.

The concepts of similitude and modelling are treated in chapter 4. Little comment is needed if all relevant dimensionless variables are equal. In an example a case is considered for which this condition is not fully satisfied and the consequences are shown. The rest of the book is devoted to problems arising mainly in chemical engineering and concerned with variable fluid properties, non-Newtonian behaviour and mixing, heat transfer and transport in extruders. The section about extruders also contains experimental results of interest.

The book treats the subject in great detail. The formalism developed cannot, of course, replace intuition and the insight into the physical problem which is necessary to treat such problems with success. This is brought out in the chapters treating applications. However, it might have been demonstrated with more emphasis that in problems of fluid mechanics where the governing differential equations are known but are too difficult to be solved, a complete set of dimensionless variables (including their physical interpretation) can be obtained directly from the equations. If a deep insight into the methods of dimensional analysis is needed the present book will be of great help, but for students completely unfamiliar with the subject consultation of the respective chapter in a good textbook is recommended as a first step.

H. THOMANN

SHORTER NOTICES

Principles of Hydro-Elasticity. By FUMIKI KITO. Published by the Memorial Committee for Retirement of Dr F. Kito, 1970. 129 pp. $5.00.

This book has been compiled by Dr Kito by combining a number of his technical reports written during the period 1949–69 and adding some introductory chapters on relevant mathematical methods. The later chapters describe the effect of surrounding liquid on various kinds of elastic vibration of solid bodies or boundaries. The nature of the treatment is more fundamental than technical.

An Introduction to Tensor Calculus. By JACQUES L. MERCIER. Wolters-Noordhoff Publishing, 1971. 152 pp. $6.45.

This little book starts off with a discussion of contravariant and covariant transformation laws and goes on to develop general tensor analysis. The book makes minimal contact with fluid mechanics, and it barely justifies the claim of the preface that the "efficiency of tensor calculus is shown by deriving the general equations of classical and continuum mechanics and particularizing them to the cases of elasticity and fluid mechanics". Traditional methods using simple vectors and Cartesian tensors would seem to be both more efficient and more closely related to the physical content.

Hydraulic and Pneumatic Power for Production, 3rd edition. By H. L. STEWART. Industrial Press Inc. 1970. 476 pp. $14.00.

The first edition of this textbook came out in 1955, and the second in 1963. This third edition "thoroughly updates all subject matter previously covered and adds

two entirely new chapters on pneumatic logic and fluidics". The discussion is technical, but unmathematical, and the text is amply illustrated with figures and photographs.

Equations of Mathematical Physics. By V. S. VLADIMIROV, edited by A. JEFFREY, translated by A. LITTLEWOOD. Marcel Dekker Inc. 1971. 418 pp. $19.75 or £9.40.

This is a translation of a book originally published in Russian in 1967. The author approaches the partial differential equations of mathematical physics from the point of view of distribution theory. The treatment is concise and clear, and the book deserves serious consideration as an alternative to other available texts for advanced courses on partial differential equations. The price however may be prohibitive.

Proceedings of Symposium on Turbulence Measurements in Liquids. Edited by G. K. PATTERSON and J. L. ZAKIN. Continuing Education Series, Department of Chemical Engineering, University of Missouri-Rolla, 1971. 155 pp. $8.00.

The Symposium consisted of three invited lectures and 22 contributed papers on techniques for measuring statistical properties of turbulence in liquids, notably the hot-film anemometer and the laser doppler velocimeter. The *Proceedings* will be of value to experimentalists in this area. The scientific quality is high (which is more than can be said for the quality of the print and the paper binding) and the contents provide an interesting and authoritative picture of an important field that has developed rapidly during the last ten years.