

REVIEWS

Numerical Simulation of Plasmas. By Y. N. DRESTROVSKII and D. P. KOSTOMAROV.
Springer, 1986. 304 pp. DM 169.

Tokamaks. By J. WESSON. Oxford University Press, 1987. 309 pp. £50.

The first of these two books, a translation of a Russian work published in 1962, deals with the modelling of the magnetoplasmas in toroidal fusion machines, especially those known as tokamaks. In their preface the authors speculate about the future of tokamaks: 'The first power plants of this type are expected to function by the turn of this century', a somewhat optimistic view if the state of accepted tokamak theory is used as the yardstick of progress. (The standard theory fails by two or more orders of magnitude to predict correctly the avalanche of energy and plasma from tokamaks, a failure that is usually attributed to the action of turbulence.)

There are five chapters: (1) Controlled fusion and numerical simulation, (2) Simulation of kinetic processes involving Coulomb interaction, (3) Simulation of MHD processes, (4) Transport models and (5) Hybrid models.

Chapter 1 contains a brief survey of basic fusion physics, followed by an account of the trapping of particles in tokamak fields. In chapter 2 standard kinetic theory is developed, and the Coulomb collision operator explained in detail. Relaxation times are calculated for a range of situations, including the injection of fast ions. The concept of current drive using various types of wave is described. Numerical methods are introduced. This is a useful, well-presented account. Chapter 3 gives the standard MHD equations with their reduced forms for tokamak fields and for high and low beta plasmas. Equilibrium problems are given detailed attention, together with their numerical solutions. The standard treatment of stability in ideal MHD is presented. The influence of finite conductivity, giving the reconnection of magnetic surfaces, and the growth of magnetic islands is also included.

In chapter 4 the authors face the difficult task of explaining the transport of mass and energy from tokamaks. Following an uncritical survey of the standard (neo-classical) theory of transport, there is a list of the empirical formulae that have been adopted for the electron and ion thermal diffusivities. This signals the substantial failure of fusion plasma theoreticians to understand what is going on in toroidally confined plasmas. The final chapter deals with models of plasma heating and confinement that combine distinct physical processes, also blighted by the ever-present empirical adjustments. This book has nearly 400 references. It should appeal to tokamak theoreticians, especially those who adhere to the view that plasma turbulence causes mass and energy transport rather than the other way around.

The Oxford text by Wesson, with contributions from some other plasma physicists, is presented rather in the style of a handbook, giving brief surveys of the physical principles and basic equations frequently required in fusion plasma research. It provides a broad coverage of the experimental, technological and theoretical aspects of tokamaks, giving the reader guidance to the literature should he wish to pursue the details. That progress in tokamak research has been largely empirical because of the shortcomings of theory – at least for mass and energy transport – is admitted in the preface, and to some extent amplified in the text. However, one feels that much more should have been written on this central failure, now extending over nearly three decades.

Following an introduction to fusion and the tokamak concept for plasma

confinement, the text gives a brief survey of the main equations of plasma physics. The defect of the modular method of presentation becomes apparent. There is an uneven coverage of material, in an order not always helpful to the reader. For example the fluid equations *follow* kinetic theory as if they are merely consequences of the conservation of particle number instead of being distinct conservation laws. The next chapter gives a good account of equilibrium, finishing with a section on current drive. Confinement is then discussed, with too much attention given to the failed neo-classical theory and not enough to the wealth of experimental observations and to the attempts to explain them using turbulence fluctuations to enhance transport. The chapters on heating and MHD stability are useful and clearly written. Chapter 7 on instabilities is mainly an account of the observations, with some theory on magnetic islands and the tearing mode instability offered in explanation. But it is admitted that the understanding of the phenomena involved is 'incomplete and uncertain'. Chapter 8 is a brief description of microinstabilities.

The last three chapters deal with plasma-surface interactions, diagnostics and tokamak devices considered as experimental machines. Impurities coming into the plasma from the surfaces of the containment vessel radiate energy and so reduce the efficacy of plasma heating. This continues to present a serious problem for fusion machines. Some of chapter 9's sub-headings are: desorption, wall cleaning, sputtering, arcing, limiters, diverters and tritium inventory. The chapter on diagnostics deals with electromagnetic, laser, cyclotron, X-ray and neutral particle techniques. The final chapter gives the salient observations obtained in 15 leading tokamaks. (No less than 45 of these complicated and expensive experimental devices have now been built.)

With such a wide range of engineering, physical and mathematical material to cover, Dr Wesson had a daunting task. He has produced a readable account of a fascinating quest, whose future is now increasingly uncertain.

L. C. Woods

Civil Engineering Practice. Vol. 2: Hydraulics/Mechanics. Edited by P. N. CHEREMISINOFF, N. P. CHEREMISINOFF and S. L. CHENG. Technomic, 1988. 780 pp. S.Fr. 330.

The publishers describe *Civil Engineering Practice* as a 5-volume encyclopaedia but, if volume 2 is anything to go by, it is not an encyclopaedia in the usual sense. Although it contains a wide range of articles by many different authors there is no attempt to cover all relevant topics in the chosen fields. Also, although most of the articles are clearly intended primarily for practising civil engineers some are essentially research publications with little practical relevance.

This volume on Hydraulics and Mechanics is divided into six sections. Section one is concerned with 'Hydraulics/Open Channel Flow'. It includes articles on dam-break floods, internal flows in hydraulic jumps, submerged logarithmic weirs, measuring flumes, chute entrances and laminar flow in channels. Section two deals with flow in pipes. There are articles on head losses at junctions, water hammer, design of horizontal pipelines and hydraulic transport of solids. The important problem of sediment transport is covered, partially, in section three. As well as a review of the standard results for bed forms, bed load, saltation and suspended load, there are articles on side-slope transport, friction factors, scour at bridge piers, meanders and stilling basins. This section also includes an article on river ice.

The last three sections deal with Mechanics/Solid Mechanics, Fluid Mechanics and

Solid-Fluid interactions. Readers of *JFM* might expect a lot from a section with the grand title 'Fluid Mechanics' but, in fact, it contains only two articles: one on turbulent surface jets and the other on Stokes and Rayleigh layers near permeable boundaries. Similarly, 'Solid-Fluid Interactions' includes only three articles. One is a brief review of standard results in this area and the other two deal with liquid containers and slope stability.

The overall impression given by this volume is that it has many of the advantages and disadvantages of a set of conference proceedings. It may appeal to a similar market.

J. F. A. SLEATH

The following volumes of conference proceedings have also been received:

- Measurement Techniques in Power Engineering.** Edited by N. H. AFGAN. Hemisphere Publishing, 1985. 356 pp.
- Measurement Techniques in Heat and Mass Transfer.** Edited by R. I. SOLOUKHIN and N. H. AFGAN. Hemisphere Publishing, 1985. 569 pp.
- Heat and Mass Transfer in Fixed and Fluidized Beds.** Edited by W. P. M. VAN SWAALJ and N. H. AFGAN. Hemisphere Publishing, 1986. 732 pp.
- Measuring Techniques in Hydraulic Research.** Edited by A. C. E. WESSELS. Balkema, 1986. 275 pp. £31.50.
- Rarefied Gas Dynamics, Volumes 1 & 2.** Edited by O. M. BELOTSEKOVSKII, M. N. KOGAN, S. S. KUTATELADZE and A. K. REBROV. Plenum, 1985. 1423 pp.
- Thermodynamics and Fluid Mechanics of Turbomachinery, Volumes I & II.** Edited by A. S. ÜÇER, P. STOW and CH. HIRSCH. Martinus Nijhoff, 1985. 1096 pp.
- Optical Methods in Dynamics of Fluids and Solids.** Edited by M. PÍCHAL. Springer-Verlag, 1985. 385 pp.
- International Workshop on Applied Differential Equations.** Edited by XIAO SHUTIE and PU FUQUAN. World Scientific, 1986. 446 pp. £53.70.
- Advances in Turbulence.** Edited by G. COMTE-BELLOT and J. MATHIEU. Springer-Verlag, 1987. 586 pp.
- Turbulence Management and Relaminarisation.** Edited by H. W. LIEPMANN and R. NARASIMHA. Springer-Verlag, 1988. 524 pp. DM 148.
- Fluid Power Transmission and Control.** Edited by SHENG JINGCHAO AND ZHU SHANAN. International Academic Publishers, 1989. 886 pp.
- Physicochemical Hydrodynamics: Interfacial Phenomena.** Edited by M. G. VELARDE. Plenum, 1988. 1111 pp. US\$165.
- Computational Modelling and Experimental Methods in Hydraulics.** Edited by Č. MAKSIMOVIĆ and M. RADOJKOVIĆ. Elsevier, 1989. 526 pp. £63.
- Mathematics in Oil Production.** Edited by S. F. EDWARDS and P. R. KING. Clarendon Press, 1988. 373 pp. £35.
- Liquid Metal Magnetohydrodynamics.** Edited by J. LIELPETERIS and R. MOREAU. Kluwer, 1989. 479 pp. US\$109, £71.
- Instabilities and Nonequilibrium Structures II.** Edited by E. TIRAPEGUI and D. VILALROEL. Kluwer, 1989. 314 pp. US\$97, £63.
- Current State of Technology in Hydraulic Machinery.** Edited by A. P. BOLDY and DUAN CHANG GUO. Gower, 1989. 330 pp. £45.

- Material Instabilities in Continuum Mechanics and Related Mathematical Problems.** Edited by J. M. BALL. Clarendon Press, 1988, 542 pp.
- Three-Dimensional Turbulent Boundary Layers – Calculations and Experiments.** Edited by B. VAN DEN BERG, D. A. HUMPHREYS, E. KRAUSE and J. P. F. LINDHOUT. Vieweg, 1988. 163 pp. £22.65.
- Proceedings of the Seventh GAMM-Conference on Numerical Methods in Fluid Mechanics.** Edited by M. DEVILLE. Vieweg, 1988. 458 pp.
- Panel Methods in Fluid Mechanics with Emphasis on Aerodynamics.** Edited by J. BALLMAN, R. EPPLER and W. HACKBUSCH. Vieweg, 1988. 262 pp. £22.65.
- Numerical Simulation of the Transonic DFVLR-F5 Wing Experiment.** Edited by W. KORDULLA. Vieweg, 1988. 305 pp. £38.25.