J. Fluid Mech. (1998), *vol.* 367, *pp.* 378–381. Printed in the United Kingdom

BOOK REVIEWS

A Modern Introduction to the Mathematical Theory of Water Waves. By R. S. Johnson. Cambridge University Press, 1997. xiv + 445 pp. Hardback ISBN 0 521 59172 4 £55.00; paperback 0 521 59832 X £19.95.

Two good reasons for studying water waves are (i) that roughly two thirds of the Earth's surface is covered by water waves, and (ii) that water waves present sufficiently challenging problems that much of the development of the mathematical theory of wave motion over the past 200 years has been pioneered on their theory. The latter reason is to the fore in this book, which is presented as either an advanced undergraduate or a beginning graduate text on water waves which enables 'the main principles of modern applied mathematics to be seen in a context that has practical overtones and is mathematically exciting'. It is perhaps the most appealing fact of applied mathematics that techniques and solutions derived for one problem can often be used with little or no extra work on completely different problems. Water waves do give a stimulating range of such mathematics, with the added advantage that very often their behaviour may be seen by direct personal observation.

The first chapter introduces Euler's equations of motion for an inviscid fluid and the corresponding boundary conditions, so no previous knowledge of fluids is required, but familiarity with vector calculus is desirable, though the ideas of asymptotic expansions are presented. Further, this chapter should not be skipped by the knowledgeable because scalings are introduced here with a notation that is used through much of the book without further comment.

Chapter 2, on classical problems in water waves, covers most of the topics that can be found in older texts, including linear theory, waves on variable depth, ray theory, ship waves. Stokes waves, shallow water theory, dam break, hydraulic jumps and bores, and the solitary wave and other topics. This is not as rushed as it may seem since there are 139 pages.

The two remaining major chapters are on weakly nonlinear waves: with weak dispersion leading to the Korteweg–de Vries (KdV) equation, and slow modulations of dispersive waves leading to the cubic nonlinear Schrödinger equation. Of course, both these chapters include solitons; in both cases *n*-soliton solutions are derived with a truncated account of the inverse scattering method, and with Hirota's method. In the shallow water, weakly dispersive, chapter further relevant equations derived include a cylindrical KdV equation, an 'integrable' Boussinesq equation which can describe waves travelling in opposite directions, the Kadomtsev–Petviashvili equation for waves travelling in almost the same direction, and equations for unidirectional waves on a flow that varies with depth.

For deeper water, along with the nonlinear Schrödinger equation are the Davey–Stewartson equations for waves on moderate water depth where the associated wave-induced current needs to be included. This is specialized to a long-wave version to include some more soliton results.

Each chapter has an extensive list of examples, often indicating further interesting results with references to original papers, and answers in an appendix. In an epilogue viscous effects are studied.

The book lives up to title: there is a good range of topics that are not found in older books and it is useful to have such account. As indicated above, some of these topics are also relevant to other wave motions. I can see this book being appreciated by the mathematically inclined, and by those seeking a handy reference on these modern topics. However, as the author is at pains to make clear, many physical effects have been omitted. In addition there are quite a number of places where anyone interested in applications should be wary, as the author's enthusiasm for the equations drifts away from reality.

The Davey–Stewartson equations for long waves have soliton solutions, but the equations' derivation follows the same approach as for Stokes waves, and as Stokes himself was aware, the Stokes wave solution fails for long waves; so this limit of the Davey–Stewartson equations is only of mathematical interest. Similarly, the discussion of viscous effects on sinusoidal waves uses a Reynolds number which does not include any measure of the amplitude of the wave motion. It is thus rather difficult to interpret the results presented, especially for deep water since the Reynolds number depends on depth. Other faults are mostly oversights, in particular two solutions of the nonlinear Schrödinger equation, in a form first given in Peregrine (1983), are said 'not to represent a travelling wave', when they are given in a frame of reference which is already moving with the linear group velocity. However, overall it is a book that I am pleased to have, and with the above caveats I recommend it as a book that matches its title.

REFERENCE

PEREGRINE, D. H. 1983 Water waves, nonlinear Schrödinger equations and their solutions. *J. Austral. Math. Soc.* B **25**, 16–43.

D. H. PEREGRINE

SHORT NOTICES

Alternative Mathematical Theory of Non-equilibrium Phenomena. By D. STRAUB. Academic Press, 1997. 377 pp. ISBN 0-12-673015-6. $69.95.

The substance and flavour of this unusual book are conveyed by the following extract from the beginning of the author's preface: "This text is intended to give rise to a new theoretical approach suitable for many studies on complex phenomena of general physical interest. Founded on the mathematical formulation of J. W. Gibbs' thermodynamics and substantially extended by G. Falk, a continuum theory will be presented here that may be applied to mechanics, thermodynamics, fluid dynamics, and electrodynamics.... Based on the Gibbs–Falkian thermodynamics mentioned above, a set of partial differential equations is derived and available for a field description of a great variety of dissipative processes in fluids."

Coherent Flow Structures in Open Channels. Edited by P. J. ASHWORTH, S. J. BENNETT, J. L. BEST & S. J. MCLELLAND. Wiley, 1996. 733 pp. ISBN 0-471-95723-2. £65.

Conference proceedings seem to be getting bigger, and the day when two volumes will be the norm is approaching. This book arose from a three-day international conference at the University of Leeds in April 1995, and there were 33 presentations which surveyed the state of the art. One can only marvel at the sophistication of the current ideas about coherent flow structures. Almost all the presentations are intended for specialists, and it would have been helpful if some of them could have made easier reading.

Chaos and Determinism. By A. FAVRE, H. GUITTON, J. GUITTON, A. LICHNEROWICZ & E. WOLFF. Johns Hopkins Press, 1995. 177 pp. ISBN 0-8018-4911-x. £37.

The native language of the authors of this book is French, and the book was initially written and published in French (see *J. Fluid Mech.* vol. 206, 1989, p. 628). Encouraged by the success of the book, the authors have now translated and published it in English. Members of the French Academy have made scientific and philosophical analyses of phenomena familiar in their own fields, with turbulence in fluid mechanics as the chief model. Some readers may have an uncomfortable feeling that it is pretentious talk with little of the common sense that characterizes work on turbulence. But hasty judgements would be unwise. The sense is elusive, and readers are advised to absorb the text slowly, especially as a change of language is involved.

Boiling Heat Transfer and Two-Phase flow. By L. S. TONG & Y. S. TANG. Taylor & Francis, 1997. 542 pp. ISBN 1-56032-485-5. £56.95.

As befits a subject central to the safe operation of many nuclear reactors, following an interval of 32 years there is a dramatic difference between this book and the first edition (Tong 1965). The page count has more than doubled and scarcely ten pages are left untouched. However, the general structure of the book is little changed. There are descriptive accounts of the multitude of phenomena that occur when liquids boil and when gas–liquid mixtures flow through pipes and other structures. These are followed up with numerous results, briefly stating formulae or showing diagrams that summarize experimental observations, with the aim of providing designers with a guide for both steady and unsteady flow conditions. The new preface no longer includes an objective: 'To provide research workers with a concise handbook that summarises literature surveys in this field'. However, researchers, as well as the students and designers who are mentioned, may still appreciate this more substantial guide to a voluminous literature.

REFERENCE

TONG, L. S. 1965 *Boiling Heat Transfer and Two-Phase Flow*. Wiley, xiii + 242 pp.

Nonlinear Mathematics and its Applications. Edited by P. J. ASTON. Cambridge University Press, 1996. 256 pp. ISBN 0-521-57696-8. £15.95.

This collection of papers arose from an EPSRC Spring School in Applied Nonlinear Mathematics held at the University of Surrey in 1995. The volume as a whole is attractively produced and well-edited, and the articles cover a wide variety of topics, ranging from the chaotic motion of driven oscillators to nonlinear elasticity and fracture, wave instability, and the growth of solid tumours. The three papers of most interest to fluid dynamicists will perhaps be (*a*) J. C. Gibbon's article on the Navier–Stokes equations, where he contrasts some general results in the 2d and 3d cases, (*b*) T. Mullin & J. J. Kobine's 'Organized Chaos in Fluid Dynamics', which applies ideas from dynamical systems theory to Taylor–Couette flow (but ends with a discussion of how helpful – or unhelpful – such ideas might be more generally in fluid mechanics) and (*c*) F. T. Smith's concise survey of instability and transition theory in boundary layers.

Annual Review of Fluid Mechanics, vol. 30. Edited by J. L. LUMLEY, M. VAN DYKE & H. READ. Annual Reviews Inc., 1998. 750 pp. ISBN 0-8243-0730-5. $60.

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