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REVIEWS

Body Tensor Fields in Continuum Mechanics. By A. S. LODGE. Academic Press, 1974. 319 pp. $29.50

The greatest elegance and simplicity in mathematical physics is often achieved by choosing variables every one of which is strictly relevant to the problem in hand, and disregarding over-elaborate mathematical structures in which only certain combinations of the defined symbols are of any physical significance. So it was natural, about a quarter of a century ago, that the invariant forms of rheological equations of state were analysed rather neatly by making use of tensor fields measured by their components in co-ordinate systems convected with a deforming body. Once it was realized that rheological properties of a material element must be independent of its translatory and rotational motion in space, then any kinematic quantities referring to systems of reference outside the body were irrelevant and best avoided.

Professor Lodge puts the early development of mathematical rheology along these lines in perspective in a historical note; but he leaves no doubt that in his view the early workers, who followed a "common convention" of identifying a tensor by the set of its components in a specified reference system (instead of, as he prefers, a single bold-faced letter), did not really understand what a tensor was! His book shows how the relevant tensor algebra and calculus should (in his view) be developed, with some of the purely mathematical niceties added. Two kinds of Euclidean geometric manifolds are taken to be quite distinct – body manifolds defined in a deformable continuous body (with convected co-ordinate systems) and space manifolds (with rigid co-ordinate systems) – so that body tensors, space tensors, and Cartesian tensors come to be regarded as three distinct entities; although transformations from one to another need to be introduced later. A matrix notation is used for sets of tensor components, but has to be abandoned when tensors of higher than second order are considered. "The extension to higher rank tensors is fairly obvious" is something of an oversimplification in this context. A decided disadvantage of the dyadic and matrix notation is that an inadmissable proposed rheological equation of state is not always detectable at a glance.

Probably the most important achievement of the general analysis of rheological behaviour through the medium of a convected co-ordinate system was the unambiguous definition of a physical constant (tensor) of a (small piece of) material: a tensor independent of all kinematic and dynamic variables, of temperature and of time which in any convected co-ordinate system has constant coefficients. Professor Lodge is content to define instead the category of "material constants" which are in general temperature-dependent body tensors; and he includes, for example, the metric tensor of a reference configuration within this category. In the application of thermodynamics to a perfectly elastic (anisotropic) solid, there is a reference to "material constant body tensors ... evaluated for con-

venience at some arbitrary but definite temperature", but no explanation that these are not necessarily a complete set of true physical constants for the material. One effect of the extension of the concept of a 'constant' is to obscure somewhat the distinction between inherent isotropy and anisotropy of a material. It will also leave the discerning reader in some doubt as to what happens when temperature changes cannot be ignored, and in what sense "it is a striaghtforward matter to derive" the general form of equations of state of a perfectly elastic anisotropic solid in terms of partial derivatives of a specific free-energy function.

Summarized in the book are some useful features of the geometry of deformation, such as formulae for angles between co-ordinate curves, distances between neighbouring co-ordinate surfaces, metrics especially useful for torsional flow, cone-and-plate rheometry, helical flow, motion in an orthogonal rheometer, and shear-free flows. In contrast some of the fundamental, and difficult, points in tensor calculus are left as problems for the reader. Solutions to problems, a full bibliography, subject and author indices, and other appendices on mathematical points are valuable features.

J. G. OLDROYD

SHORTER NOTICES

Proceedings of the 4th International Conference on Numerical Methods in Fluid Dynamics. Edited by R. D. RICHTMYER. Springer, 1975. 457 pp. DM 37.

The fourth conference in this quadrennial series was held at the University of Colorado in June 1974 and was attended by several hundred chemical and mechanical engineers and applied mathematicians. The proceedings are published as Volume 35 of Springer's *Lecture Notes in Physics* series. They begin with two invited reviews by H. B. Keller and H. Kreiss: the first on modelling boundary-layer flows and the second on initial/boundary-value problems for hyperbolic partial differential equations. These are followed by some sixty short contributed articles on numerical modelling of a wide variety of flows.

Turbulence in Liquids. Edited by G. K. PATTERSON and J. L. ZAKIN. Department of Chemical Engineering, University of Missouri, 1975. 414 pp. $16.

This is the Proceedings of the Third Symposium on Turbulence in Liquids (September 1973); it contains four invited lectures and 24 contributed papers, some with discussions. The majority of the papers dealt with instrumentation problems, conditional sampling or measurements which could have been – and in one case were! – made in air, but there are four papers on non-Newtonian fluids, three on two-phase flow and two on stratified flows. A panel discussion on "Promising directions for liquid turbulence research" is intrinsically interesting but contains practically no reference to the special problems of liquid flows.

Turbulent Mixing in Nonreactive and Reactive Flows. Edited by S. N. B. MURTHY. Plenum, 1975, 464 pp.

This book is the Proceedings of a Project Squid Workshop held in May 1974. An 85-page introductory review by the editor sets the scene in a way that will be particularly helpful to non-specialists. There follow 22 papers, grouped into theoretical and experimental treatments and generally of high standard. Edited transcripts of verbal discussions follow most of the papers and there is a general discussion, chaired by H. W. Liepmann, at the end. The result is a welcome record of a lively meeting, and the editor has organized it into a useful 'state-of-the-art' review.

Modelling of Marine Systems. Edited by J. C. J. NIHOUL. Elsevier, 1975. Dfl. 70.00.

The result of a 1973 conference on marine 'modelling', the intention of this volume is to bring together several papers on physical, chemical and biological aspects of the ocean. A model as used here evidently differs from a theory in having a more practical intent. The papers range from a purely verbal description of the problems of making numerical models of the hydrodynamical equations, through specific scale analyses of particular problems (e.g. tides) to discussions of the coupled properties of biological and hydrodynamical systems. One of these latter papers displays many so-called energy circuit diagrams of bizarre complexity. For fluid dynamicists or physical oceanographers the book would serve as an introduction to the state of the art of making mathematical descriptions of population growth and other biological phenomena in the sea.

Finite-Amplitude Wave Effects in Fluids. Proceedings of the 1973 Symposium, Copenhagen. Edited by L. BJØRNØ. I.P.C. Science and Technology Press Ltd, 1974. 287 pp.

This book is a nicely printed collection of the individual papers presented at the symposium. The individual styles have not been distorted by the editing, which is confined solely to recording some of the discussions that followed the papers and the addition of a preface. The book does not therefore contain any simple guide from which an outsider can rapidly acquire a feeling for the current status of the subject. But it provides a splendid guide to the expert, because the papers are, in the main, up-to-date reports from an international gathering of many of the subject's foremost practitioners. At the conference, more time was devoted to theoretical than to experimental papers and many different aspects of the subject were considered: nonlinear effects in the vicinity of small sources; extremely effective procedures describing the propagation of finite amplitude viscous waves; resonance-tube phenomena; boundary-layer effects; cavitation; atmospheric waves; scattering of sound by sound; interaction of sound with bubbles and aerosols; and many important facets of the parametric array. Many of the subjects seem to have come to fruition at this fifth international meeting on nonlinear waves, so that these proceedings are likely to have more permanent value than those of most scientific gatherings. The book is essential reading for today's serious student of the subject and some parts of it might eventually evolve into basic reference material.