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REVIEW

Principles of Non-Newtonian Fluid Mechanics. By G. ASTARITA and G. MARRUCCI. McGraw-Hill, 1974. 289 pp. £6.45.

A number of new books on non-Newtonian fluid mechanics are currently being prepared for publication. This book is the first to emerge. It is now about ten years since the publication of the influential books by Lodge (*Elastic Liquids*, Academic Press, 1964) and Truesdell & Noll (*The Nonlinear Field Theories of Mechanics*, Springer, 1965) and it is therefore interesting to discover what style of book would appear. On the dustjacket it is stated that the book is an exposition of "the results of the modern non-linear theory of continuous media in terms appropriate to the engineering scientist, and the authors suggest pragmatic approaches to the solution of typical problems".

Chapter 1 is mainly concerned with vectors and tensors using an abstract but informal approach. Covariance and contravariance, the usual paraphernalia of tensors and Christoffel symbols are also introduced in this chapter. Since the latter rarely appear in pragmatic approaches to fluid mechanics I began to be a little apprehensive and also curious to see what use was made of these items in the text. On pp. 113–114 we are told how to compute $\nabla\mathbf{V}$ in spherical polar co-ordinates, using a general tensor formulation, but apart from this we mercifully escape the use of general tensor component representations. On p. 22, where the divergence operator is discussed, I found the following discomfiting statement: "It has to be stressed that $\nabla.\mathbf{a}$, in spite of the notation, cannot be interpreted as a scalar product, and $\nabla\mathbf{a}$ cannot be considered as a dyad". I think I am in good company when I refuse to treat this statement seriously. I am not suggesting that most of the mathematical statements in the book outrage one like the quotation above, because much of the exposition is excellent. I believe that the approach used in this book is a mathematical overkill since much of the apparatus presented is not used; at least one contemporary book on the mechanics of continuous media (e.g. *Cours de Mécanique des Milieux Continus*, vol. 1, by P. Germain, Masson, 1973) succeeds in covering its ground with more accessible tools. Much of the rest of the presentation is an attempt, often very skilful, to present the basic elements of modern continuum mechanics. In chapter 2 the authors deal with objectivity and use the purely viscous Reiner–Rivlin theory as an example. Chapter 3 presents a good treatment of various kinematic matters, repeating the classifications of flow fields given previously by Truesdell & Noll. Chapter 4 discusses the concept of a simple fluid, functionals and fading memory, plus some thermodynamics. Chapter 5 discusses rheometrical flow systems. While there is a great deal of formality in the definitions, the treatment of specific flows is perfunctory, and in most cases only the results are given. Not even the important cone and plate flow is treated fully. Extensional flows are given the full symmetry treatment, and a short discussion of linear viscoelasticity follows. One of the few obvious blunders occurs on p. 193, where equation (5-4.91) and the discussion stemming

from it are incorrect; the normal stress pattern is not that given there. Curiously, the pattern for a special case given on p. 203 is correct. It is good to see the discussion of the *KBKZ* constitutive relation in chapter 6 and some valid criticism of other models, yet I wish that more concrete illustrations of some of these points were presented. Chapter 7 is a surprise. It deals, in a simple way, with dimensional analysis, superposed flows, flow around submerged objects, boundary layers, turbulent flows in dilute polymer solutions, waves and stability. Most of this material does not use the heavy mathematical artillery developed in earlier chapters. This chapter contains many interesting ideas, some of which are controversial.

In summary, the authors have, with exceptions in chapter 7, followed the Truesdell & Noll line of development and ignored Lodge's more physical approach; in particular scarcely any experimental data and no molecular theories are included. Admittedly satisfactory data are hard to find, but I do feel that one should not omit data to the extent done here. There are other good and poor features of the book, but, in the main, it may be summed up as another précis of Truesdell & Noll. Consequently, it can scarcely be expected to open up new vistas in fluid mechanics. An exposition in the style begun in chapter 7 might, on the other hand, have given us a useful account of the authors' own experiences.

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