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REVIEWS

Mechanics of Continua and Wave Dynamics, 2nd edn. By L. M. BREKHOVSKIKH and V. GONCHAROV. Springer, 1994. 342 pp. Dm 78.

This book is based on lectures given by the authors to students in physics and geophysics and presents a very personal and original view of the mechanics of continuous media by focusing from the outset on linear wave phenomena in both solids and fluids.

The first part covers the theory of elastic, for the most part isotropic, solids with a stress–strain relationship given by Hooke's law. After a brief introduction, longitudinal, torsional and bending waves of beams and rods are treated at an elementary level, and the concept of a dispersion relation and of group velocity is introduced in its simplest form. Then, the general linear relationship between stress and strain is developed in tensor notation, together with a good discussion of boundary conditions at material interfaces. This leads to a lucid presentation of longitudinal and transverse waves of different polarization in homogeneous isotropic media, followed by a discussion of surface Rayleigh waves and Love waves in a layered medium. The first part ends with a discussion of waves in thick and thin plates. The second part, taking up two thirds of the book, is devoted to waves in fluids and starts with four sections of basic introduction. Being necessarily short and selective, it is doubtful whether they are adequate to acquire a sufficient background in fluid mechanics. For the principal topic of the book, linear waves without dissipative effects, the introduction to viscous flows seems unnecessary and the section on classical statistical theory of turbulence appears disconnected from the rest of the book. The following sections on wave phenomena, however, provide again excellent and elegant introductions to geophysically relevant surface waves, internal waves and waves in rotating fluids, to elementary acoustics and to waves in magnetohydrodynamics. The closing section, finally, provides a (necessarily) limited discussion of nonlinear wave phenomena, developed with a generic model equation.

The presentation of this wide variety of topics is on an admirably uniform elementary level for readers with a solid background in undergraduate level mathematics and is supplemented by a very useful collection of problems well integrated with the text. The reader not experienced in any area of wave dynamics, however, must be warned that the bibliography is on the economical side and that the limitations of the theoretical developments are generally not well advertised. No mention is made of the fact that only waves without an energy source are treated explicitly, i.e. that hydrodynamic instabilities are not considered: equation (12.53), for instance, is the compressible Rayleigh equation, but its unstable solutions are left out of the following discussion of acoustic wave transmission across a vortex sheet. Another example is the brief discussion of wave propagation in inhomogeneous media (Section 12.2.4) where the breakdown of the geometric acoustics approximation for the wave amplitude at foci and on caustics receives only a cryptic remark. If these limitations are kept in mind, the book should, owing to its enormous breadth and level, provide very stimulating and relatively easy reading for scientists and advanced students who wish to broaden their horizons.

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Ray Methods for Nonlinear Waves in Fluids and Plasmas. By A. M. Anile, J. K. Hunter, P. Pantano and G. Rousso. Longman, 1993. 243 pp. £39. ISBN 0 582 02343 2.

The book begins with a terse statement of the basic equations of compressible flow, of thermodynamics, of magneto-fluid dynamics and of plasma dynamics (with erratic inconsistencies in the use of upper and lower suffices for Cartesian tensors), then continues (with numerous spelling mistakes, as throughout the book) with a chapter on introductory concepts in wave theory. These comprise kinematic wave theory, and the briefest introduction to characteristics, with some odd looseness ('a shock is a generalised solution which is a piecewise smooth function with a finite number of discontinuity lines in the (x–t) plane...'), continuing with asymptotic expansions and the use of the perturbation–reduction method to derive the Burgers and KdV equations, and the nonlinear Schrödinger equation for modulated waves. As throughout, the notation here is highly compact, which is undoubtedly a blessing for general theory but gives little 'feel' in particular cases. Chapter 3 contains group velocity ideas for linear anisotropic waves and multiple scale methods for inhomogeneous media. Chapter 4 has ray methods for nonlinear hyperbolic waves, and somewhat of an understatement (p. 64) that 'it [the ray method] has been applied successfully to several problems in fluid mechanics (Boillat 1965, Chin *et al.* 1986, Eckhoff 1981)'! Here we also find a version of the famous Fubini solution for periodic simple waves, but with absolutely no interpretation or discussion in physical terms (e.g. in terms of harmonic generation, energy cascade). The only application given is to one-dimensional acoustic propagation in a density-stratified atmosphere.

Chapter 5 deals with the propagation of weak discontinuities, for which an exact ray theory is formulated. The compatibility relations across a discontinuity are merely cited with no explanation, all of which must be quite opaque to the reader not already conversant with this material. Characteristic and intermediate shocks are also dealt with in a formal manner, and again would benefit from illustration in one specific context and application. This chapter is concisely summarized in the first paragraph of chapter 6: 'the rays are the bicharacteristic curves of the original quasilinear system...' – but nowhere in chapter 5 is this stated, nor are bicharacteristics even mentioned – just one example of a lack of care that frequently irritates the reader. Chapter 6 then covers 'shock dynamics' but through a rational asymptotic approach, a ray theory for weak shocks which decouples geometrical and nonlinear effects and yields an infinite hierarchy of equations for the shock strength and its normal derivatives as the shock propagates along a ray. The hierarchy can be telescoped into a single quasilinear hyperbolic equation for the shock strength, and this approach is therefore equivalent, not surprisingly, to Weakly Nonlinear Geometrical Optics.

Chapter 7 gives a ray approach to the dynamics of shocks of arbitrary strength. The theories of Whitham and Prasad are 'at best heuristic', whereas the approach presented here is rational – but limited to small times through expansion about the original wavefront. Some results overlap with those of Whitham's theory, but new results emerge for shock stability. All this small-t analysis makes it clear how penetrating was Whitham's insight in his formulation (albeit non-rational, as yet) of 'shock dynamics'.

Chapter 8 – on multi-dimensional nonlinear dispersive and dissipative equations – could benefit from the obvious physical explanations and interpretations. There is only the briefest description of perturbed solitons, their amplitude variation according to an energy law and the formation of a 'shelf' to satisfy mass and momentum conservation. It is somewhat strange that these physical arguments are used here in preference to the asymptotic-expansion ideas that dominate the rest of the book. I find the term Generalized Burgers equation for the notoriously intractable Zabolotskaya–Khokhlov equation (p. 115) inappropriate – not simply because the parallel would be to call the Kadomtsev–Petviashvili equation the Generalized KdV equation, but because the distinctive feature of ZK (and KP) is thereby de-emphasized, and completely escapes the authors' attention. Earlier, for example on p. 107, they had correctly identified the Generalized Burgers and KdV equations as equations in time and one space dimension with allowance for weak ray tube area variation. By contrast ZK and KP are the equations which replace those equations, respectively, when transverse variations, in one or two transverse coordinates, become so strong that the phenomena of diffraction enter. Why is there no discussion of this crucial difference? And why is nothing made, in interpretation, of the reduction of cylindrical KP to spherical or plane KdV? And why is there so little on experiments, which abound in multi-dimensional wave problems? There is a little on two- and three-dimensional plasma configurations, but often too brief to be informative, and sometimes (p. 117) just a list of authors.

Later chapters deal with dispersion and anisotropic waves, and with interactions between dispersive waves, and between hyperbolic waves. I find chapters 10 and 11 much more appealing than the first nine chapters. The treatments are succinct and elegant, and there is much in the way of interpretation and discussion, and reference to specific physical contexts that the reader can really get to grips with. These last two (lengthy) chapters in fact for me justify publication of the book and my reading of it. Perhaps a newcomer to the field – a beginning graduate student – could read enough of the earlier parts to get the general message (though he would be well advised to carry out all the calculations for a specific application, for example cubically nonlinear shear waves in a viscoelastic solid) and then proceed to the last two chapters, returning later to the intervening introductory material in which, for me, there is too much arid formalism and too little talk about what it all means.

I have admired much of the work of the authors in journal publications and in lectures, and believe it to be characterized by succinct and elegant presentation with good appreciation of the essential physical context. I regret to say that I was disappointed by much in this book; succinct it certainly is, but all too often lacking in motivation and interpretation.

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