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BOOK REVIEW

Hydrodynamics and Nonlinear Instabilities. Edited by C. GODRÈCHE & P. MANNEVILLE. Cambridge University Press, 1998. 681 pp. ISBN 0521 45503 0. £85.

This book is a collection of five lectures and is based on a summer-school course that was held in 1991 in France. It provides a review of current research in the areas of specific interest of the contributors, rather than a comprehensive and traditional textbook that covers every introductory aspect. (All chapters have been updated since 1991 to include more recent research.) The result is a book that would not be particularly suitable for novices in fluid mechanics but that nevertheless excellently fulfils the stated aim to 'provide a thought-provoking overview ... suitable for graduate students and researchers'. The book is aimed at students and researchers not only of fluid mechanics, but also of statistical physics, condensed matter physics and applied mathematics. There is a strong mathematical bias, but the authors consistently relate the mathematics to the physical phenomena under consideration in an informal and intuitive way, resulting in a style that is very readable. Unfortunately, the price (£85) is likely to seem excessive to those at whom the book is aimed. Therefore, it is most likely to be a group or library, rather than an individual, purchase.

After a short preface and overview, the five chapters of this book are as follows: 1, An introduction to hydrodynamics; 2, Hydrodynamic instabilities in open flows; 3, Asymptotic techniques in nonlinear problems: some illustrative examples; 4, Pattern forming instabilities; 5, An introduction to the instabilities of flames, shocks and detonations. This is a long book: chapters 2 and 5 are each approximately twice the length of chapters 3 and 4 (themselves about 100 pages long). While each chapter (particularly 2 and 5) is almost a book in its own right, this collection provides the reader with the opportunity to learn about related areas of research. In general, the authors provide good references to papers that provide more detail.

My assessment is, of course, coloured by my own research interests (instabilities of boundary-layer flows) and therefore mainly concerns the earlier chapters. I liked the way that viscosity and Reynolds number are introduced in chapter 1, § 1.2. In fact chapter 1 has many nice explanations of familiar concepts, and includes order-of-magnitude estimates of various phenomena to good effect. I also appreciated the explanation of Rayleigh's criterion and Fjørtoft's criterion in § 4 of chapter 2, and the particularly clear explanation of viscous instability in § 7 of chapter 2. These are topics that appear in numerous other books, but this very fact makes it easier to make comparisons of style. This book also has, to its credit, many topics that are not so easy to find elsewhere. Chapter 2 very significantly updates chapter 4 of Drazin & Reid's *Hydrodynamic Stability*, which makes only brief mention of spatial, as opposed to temporal, instability of open flows. Chapter 3 starts with a fairly standard introduction to singular perturbation theory, nevertheless § 1.2 on the coating-flow problem is a pleasing example of the use of matched-asymptotic expansions. Section 4 of chapter 3 is a particularly clear presentation of the viscous-fingering problem. Chapter 4 significantly adds to current textbooks by extending the discussion of pattern-forming instabilities to include sections on secondary (Eckhaus, zigzag and drift) instabilities. The topics in chapter 5 (flames, shocks and detonations in initially premixed homogeneous reactants) were largely new to me, but bearing in mind that the book is intended to be an introductory text for those unfamiliar with the subject matter, I found it informative and pitched at the right level. The instability phenomena discussed in this chapter, which are illustrated with some nice photographic reproductions of experimental results, are intriguing. I cannot, however, say whether this chapter covers ground contained in other textbooks in a novel way.

My overall impression of the book is positive. However, I do have some small criticisms. The statement in the overview starting on page 8 that 'spatial amplification [of linear instability waves] occurs whenever $k'' \neq 0$' is incorrect; the sign of k'' (the imaginary part of the perturbation wavenumber) indicating spatial amplification depends on whether the wave in question propagates upstream or downstream of the point where the disturbance is introduced. Admittedly, this is only a passing confusion because the following sentence points to the section in chapter 2 where these ideas are discussed correctly and in detail. Although perhaps obvious, the meanings of B and μ on page 42 should be given for those not familiar with MHD flows. Some of the figures in chapter 1 could be improved, e.g. figure 2.5 does not really show the boundary-layer profile and the caption on figure 2.6 is unclear. On page 90 of chapter 2, it was surprising to find no reference to the work of Benjamin and Mullin on Taylor–Couette flow, and figure 3.1 (of chapter 2) is unclear: it takes a while to differentiate the axes from the rays and therefore to realize that it is a three-dimensional plot. The discussion of transient-growth mechanisms on page 144 is brief: perhaps more references to recent research in this area could have been given. It was a little disappointing to find no discussion of triple and higher-order decks and related developments; I think that there is a need for a clear introduction to these ideas. Another surprising omission was any reference to Hinch's *Perturbation Methods* in chapter 3. In general, and perhaps understandably given the remit of the book, the authors stop short of discussing genuine turbulence.

The generally consistent style and presentation (albeit with a more interactive style in chapters 3, 4 and 5, which have occasional exercises for the reader) suggests that the manuscript has been carefully prepared. However, I would have preferred the typeface of the figure labels to match that in the text; while this does not cause confusion, it spoils the appearence and makes the figures look 'amateur'. Since many figures also lack scales on the graph axes they end up looking like qualitative sketches rather than true representations of results. Another minor irritation is that rather confusingly section, equation and figure numbering are repeated in each new chapter without any differentiation.

In conclusion, the advances made recently in stability theory and nonlinear phenomenon have given this area of research a significant role in fluid dynamics, and therefore many readers of *JFM* will find this book useful and motivating. Aspects of the book could provide the basis for a graduate course, although time constraints would limit the amount that could be covered and the lack of questions means that the book does not provide a ready-made course for a lecturer.

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