J. Fluid Mech. (2001), vol. 429, pp. 410–412. Printed in the United Kingdom

BOOK REVIEWS

An Introduction to Turbulent Flow. By J. Mathieu & J. Scott. Cambridge University Press, 2000. 374 pp. ISBN 0521 570662. £60 (hardback); ISBN 0521 775388. £24.95 (paperback).

It takes a shrewd fluid dynamicist to avoid the subject of turbulence for long. It lies at the core of so much of what we observe, from the eruption of solar flares to reversals in the Earth's magnetic field or the vagrancies of the weather. Yet the budding enthusiast keen to get to grips with this diverse, complex subject rapidly discovers something rather extraordinary: there are very few introductory texts on turbulence. There are simple, heuristic descriptions of turbulence in most undergraduate books on fluid mechanics, and many excellent, if daunting monographs. However, with the notable exception of Tennekes & Lumley's classic text, there is virtually nothing in between. As an attempt to bridge this gap, *An Introduction to Turbulent Flow* by Mathieu & Scott is a welcome addition to the existing literature.

The strength of the book lies in the authors' determination to keep the discussion at a truly introductory level, and not give way to a natural inclination to address their peers by including a dissection of the latest advances in the subject. Of course, this will not be to everyone's taste, particularly those hardened researchers who might point out that (with the exception of Chapter 8) much of the text could have been written some decades ago. However, it could be argued that there already exists a multitude of monographs and conference proceedings which have documented the various incremental advances in the subject as they unfolded. So the seasoned researcher is rather well served by the current literature, whereas the poor novice has a vast mountain to climb, yet there is very little in the existing texts to aid his or her progress.

The book is nicely set out, making use of a variety of beautiful photographs which bring the subject to life. It is a tribute to both the authors and the CUP editor that a subject as forbidding as turbulence can be made to look so enticing. Chapter 1 provides a brief overview, touching on such topics as the transition to turbulence, the hallmarks of turbulence and the practical consequences of turbulent flow. By necessity this chapter jumps around somewhat, and indeed at times one has the sensation of having embarked on a random walk; but the introductory section on the transition to turbulence is particularly well written.

Chapter 2 provides an introduction to those aspects of statistics which are most relevant to turbulence. Again the exposition is careful and well suited to those new to the subject. The discussion of the all-important central limit theorem, which is so often treated inadequately in turbulence books, is extensive and thoughtful. Next, in Chapter 3, we touch on dynamical issues. Here the wide range of length and time scales encountered in turbulence is discussed. Richardson's energy cascade, Kolmorgorov's microscales, and the two-thirds law are all introduced. Unfortunately, the origins of Kolmorgorov's two-thirds law and the rationale for the conventional estimate of the Kolmorgorov microscales are held back from the reader. It would seem that we have to wait until we have mastered the Fourier transform and reached Chapter 7 before the mysteries of Kolmorgorov's theories can be revealed. This is, perhaps, a misjudgement. It is true that it has become traditional to describe Kolmorgorov's theories in the context of Fourier space, but this is somewhat arbitrary. They were originally developed in real space. Still, this is, perhaps, a matter of taste and the authors' approach is no different to many others.

Chapters 4 and 5 provide a traditional description of turbulent shear flows. In Chapter 4 we are introduced to the ideas of Reynolds stresses, eddy viscosity, the exchange of energy between the mean flow and the turbulence, and so on. This is all very classical stuff, but well described. The careful discussion of the non-local nature of pressure is particularly pleasing. Chapter 5 builds on these simple ideas, providing a detailed discussion of the structure of jets, wakes and boundary layers.

We start to encroach on the material of traditional monographs in Chapters 6 and 7 where the spectral description of turbulence is developed. These are, perhaps, the least satisfactory parts of an otherwise sound book. It seems unnecessary, for example, to obscure Kolmorgorov's brilliant yet simple ideas by placing the Fourier transform between the reader and physical reality. Still, perhaps it is churlish to lay the blame for this at the feet of the authors as they simply follow a conventional line of attack.

The book closes with a brief discussion of the numerical simulation of turbulent flows. This is very welcome, though the chapter is, perhaps, a little brief. Moreover, the inclusion of one-point closure modelling here is, perhaps, a little out of place. Such models might have been summarized more naturally in Chapter 4 since they are, by and large, eddy viscosity models. But this is a minor quibble.

Despite the reservations listed above, this reviewer is enthusiastic about Mathieu & Scott's *Introduction to Turbulent Flow*. It is a welcome attempt to bridge that vast chasm which exists between the heuristic, undergraduate accounts of turbulence and the many forbidding monographs on the subject. I wish it every success.

P. A. Davidson

High Speed Flow. By C. J. Chapman. Cambridge University Press, 2000. 258 pp. ISBN 0521 661692 £52.50 (hardback); ISBN 0521 666473 £19.95 (paperback).

This book is intended for 'undergraduates, postgraduates and research workers in fluid dynamics', according to the cover. The text starts with the real basics (conservation of mass and momentum), then goes on to consider some of the fundamentals of thermodynamics, followed by a chapter on shock-less flows.

There are two chapters on shocks (and associated one-dimensional flows), and then three chapters on two-dimensional flows follow, including one on Prandtl-Meyer expansions, one on flows past aerofoils, and another devoted to the theory of characteristics. Towards the end of the book there are two rather more advanced chapters, the first a lengthy and detailed one on shock reflections, the second on the hodograph method. Each chapter ends with a good number of student exercises, many of which are very challenging. The emphasis throughout the book, predictably for an introductory text, is on inviscid flows.

Overall, the treatment is rather more mathematical in style than some other texts (for example Liepmann & Roshko's erstwhile *Elements of Gas-dynamics*, Wiley), and as a consequence Chapman's book is more likely to appeal to mathematicians rather than engineers, thus filling a small niche at the bookstore. On the other hand, courses on high-speed flows, for mathematics undergraduates particularly, are much less fashionable nowadays, compared with some decades ago.

My major criticism of the text is its disregard for numerical methods. High-speed flows are inherently nonlinear, rich in physics and are incredibly challenging to the theoretician and experimentalist alike. The calculation of flows of this type has been a major success for computational fluid dynamics. Numerical techniques are an essential tool for researchers in this field (and the primary tool in the industrial environment) and their omission in this book is a significant shortcoming.

The early chapters follow a standard treatment of their respective topics. There are myriad permutations of shock conditions (the cover boasts 'the most extensive set of formulae on oblique shock waves ever assembled'). The chapter on the hodograph method does a good job of explaining a difficult technique (although, in line with the remarks above regarding computational techniques, this method is now of rather more academic than practical interest).

The book concludes with a list of papers published on high-speed flows in *JFM* from 1990 to 1998. The usefulness of this is somewhat limited these days, given some of the excellent search facilities (including that of *JFM per se*) now available on the Web. This list serves little purpose, by its very nature will be surely soon out of date, and anyway there are other fluid mechanics journals, apparently!

P. W. Duck