J. Fluid Mech. (2002), *vol.* 471, *pp.* 409–410.
Printed in the United Kingdom

BOOK REVIEW

Asymptotic Modelling of Fluid Flow Phenomena. By R. KH. ZEYTOUNIAN. Kluwer, 2002. 545 pp. ISBN 1 4020 0432 X. £110 or $161.
J. Fluid Mech. (2002), *vol.* 471. DOI: 10.1017/S0022112002002070

This book claims to be the '... first book devoted to asymptotic modelling of fluid flow phenomena...'. A first thought might be that Van Dyke's book, *Perturbation Methods in Fluid Mechanics* (Academic Press, 1964), published almost forty years earlier enjoys that status. So apart from a factor of two and a half in length what is the difference? The answer is a difference in philosophy. At a time when computational fluid dynamics was in its infancy Van Dyke was at pains to demonstrate that perturbation, or asymptotic, techniques could be used to advantage to simplify problems to the extent that they were amenable to analytical treatment; the fluid dynamical literature abounds with testimony to the success of this approach. The present author's approach differs in the sense that whilst computational fluid dynamics is now a mature discipline: '*For some time the growth in capabilities of numerical simulation will be dependent on, or related to, the development of asymptotic modelling*' with a definition of asymptotic modelling as '*The art of modelling assisted by the spirit of asymptotic techniques*' (author's italics). The author is, then, intent upon deriving model equations from the governing Navier–Stokes equations, and not upon their solution, although an exception is made for the classical low-Reynolds-number flow past a sphere.

Apart from a brief introductory chapter the book is divided into three parts. Part I, 'Setting the Scene', does just that and is the shortest. Apart from introducing the Navier–Stokes equations there is a chapter on asymptotic methods, namely the methods of matched expansions, multiple scales and averaging. The final chapter is on 'useful limiting forms' of the equations, which includes the usual suspects, namely the Euler equations, Prandtl's boundary-layer equations and the low-Reynolds-number Stokes/Oseen equations. Part II is the longest, devoted to the 'Main Asymptotic Models' in five chapters. The first discusses low Mach number flows whilst the second, and longest, is devoted to inviscid flow models. These include water waves, both linear and nonlinear, in which the Boussinesq, KdV equations, and others feature; modelling of turbomachinery flows; transonic and hypersonic model equations; and a final section on modelling of rolled-up vortex sheets. The next chapter is a natural progression to high-Reynolds-number boundary-layer models including the effects of weak compressibility. The last section gives an account of the Taylor shock layer, oddly since the very next chapter is devoted to models of nonlinear acoustics beginning with a section on Burger's equation. The final chapter of this part is on low-Reynolds-number asymptotics for both steady and unsteady flows, with compressibility effects included. Hydrodynamic lubrication theory also features. Part III involves 'Three Specific Asymptotic Models'. The first of these concerns thermal convection and interfacial phenomena, in particular the Rayleigh–Bénard–Marangoni problem and the Bénard–Marangoni problem for a freely falling vertical film. The second chapter is a skirmish with geophysical fluid dynamics where the author's goal is a 'return of Meteorology to the family of Fluid Dynamics' to be achieved from the derivation of 'a set of consistent rational asymptotic models for various atmospheric phenomena, which are useful in Meteorology'. The final chapter is devoted to the triple-deck model for high-Reynolds-number flows and flow separation, indeed a triumph of asymptotic modelling in the later part of the 20th century, reflecting Prandtl's triumph at its beginning.

Cited references, of which there are many, are organised chapter by chapter, which may not be the most helpful presentation, nor are they presented consistently in the sense that many do not include the title of the paper in question. It is also unfortunate that the references for Chapter 1 are not recorded. But more serious, for a book of this scope and length, is the lack of an Index. This is a substantial book, at a correspondingly substantial price, and although it contains a wide range of material it seems unlikely that it will become the first port of call for those seeking model equations in a particular branch of fluid mechanics.

N. Riley