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Rarefied Gas Dynamics: From basic concepts to actual calculations by Carlo Cercignani (Cambridge texts in applied mathematics, Cambridge University Press, 2000, 320 pp.) £ 18.95; US$ 29.95 paperback
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Carlo Cercignani is the author or co-author of several popular reference textbooks about the Boltzmann equation. One may ask, what is the use of yet another textbook on the subject? The answer is: pedagogy and complementarity. Up to recently, most of the reference books on the Boltzmann equation were either highly specialized treatises or patchworks of very fundamental and more practical aspects. Recently, the impressive development of the most theoretical aspects of the mathematics associated with the Boltzmann equation led Cercignani, Illner and Pulvirenti to write a monograph exclusively dedicated to these questions and intended for a broad audience. This new book by Cercignani is in some sense the companion of the latter monograph; also intended for a broad audience, it considers only practical aspects of the use of the Boltzmann equation in fluid mechanics problems, be it modelling, (approximate) analytical resolution, numerical simulations, and applicability of the results. And it does not aim at a detailed and technical analysis, but rather in conveying an accurate and rather complete survey. We should add that this book is certainly by far the best available in its category, be it for the clarity of exposition or for the vast amount of literature which is browsed.

Some of the main features in this book are:

- the care for modelling assumptions;
- the importance given to simplified, exactly solvable models (either because the geometry is highly simplified, because the Boltzmann equation is changed for a model equation like BGK, or because only local equilibria are considered);
- no rigorous mathematical justifications for most assertions – this would have necessitated a considerable theoretical apparatus, and anyway is in large part an open problem;
- systematic confrontation of the results to experiments and numerical simulations. Very often does the author recall the history of the experiments which are described. Since the book covers several decades of research, it is striking to see how the huge progress in computational capacity has enabled numerical simulations to be in many cases simpler, more reliable and more flexible, than experiments. However, the author also reminds us that the lack of experimental data is still a problem in several areas of the field;
- comparison between the Boltzmann and Navier–Stokes descriptions of a rarefied flow: in particular, when does one expect both to coincide and when the former cannot be dispended with: typically, at high Knudsen number (even though the Boltzmann equation is sometimes relevant in regimes with very small Knudsen number, as the author recalls), or for the description of boundary layers (Knudsen layer, or Sone sublayer, due to curvature). A few spectacular cases of disagreement are described (Knudsen minimum effect in Poiseuille flow, Maxwell's thermal creep effect), where Navier–Stokes would lead to wrong results!
- many anecdotes which illustrate the history of the subject. It is a pleasure to read about the instructive controversies or famous mistakes (sometimes by some of the big names in the subject, as demonstrates the story of the H-theorem for mixtures by Boltzmann);
- each chapter is essentially self-contained (to achieve this, the author did not hesitate to copycut a few paragraphs) and complemented with its own, large bibliography.

The plan of the book is as follows. First, a very concise and well-written introductory chapter provides the non-specialist with all he/she has to know about the Boltzmann equation to read the book. Then the author considers problems in a slab: Couette and Poiseuille flows, looking for explicitly solvable situations, and discussing the change of behavior in terms of the Knudsen number. Next, all kinds of waves (sound, shocks, ...) are discussed. Then he turns to a more general and systematic treatment of perturbative methods and linearization. In the end of the book, mixtures, polyatomic gases, and evaporation/condensation phenomena are discussed. There is also a specific chapter for practical aspects of the Direct Simulation Monte Carlo method – but numerical results are discussed throughout the whole book. The author has put a lot of emphasis on several important points which he knows particularly well: for instance gas-surface interaction (on many occasions he demonstrates that the simplest reflection boundary conditions are quite unrealistic), modelling of mixtures, boundary layers.

Now for the missing topics: as acknowledged by the author, the most 'famous' absent in the book is the kinetic theory of plasma physics. Nothing is said either about kinetic descriptions of quantum phenomena (but this area is still in construction). Thus the discussion is confined to 'classical' mechanics in the strong sense.

Who should consult this book with profit? Everybody interested in modelling or simulations of rarefied flows (researchers, engineers, experimentalists, ...). In addition to acquainting them with the basic notions for a number of situations, this book will orientate them very efficiently through a vast literature. The book is very well-suited for students in fluid mechanics (e.g. in aeronautics, but not necessarily, since it requires no prior knowledge about kinetic theory). Specialists of Navier–Stokes may be interested in the discussion of non-applicability of their favorite equation. Finally, specialists of theoretical questions in kinetic theory may be curious about the practical use and applicability of the Boltzmann equation.

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An Engineering Approach to the Calculation of Aerodynamic Flows by Tuncer Cebeci with the aeronautical industry, mainly McDonnel Douglas (Springer-Verlag, Heidelberg, Germany, 1999, 396 pp.) DM 159; öS 1161; sFr 144; FF 599; £ 61; US$ 96 hardcover ISBN 3-540-66181-6

For some of the techniques a listing of a Fortran computer program is also given.

In the first part, the complete set of calculation methods for airfoils in incompressible flows is well outlined, including the effect of separation bubbles. This part is well documented with computer programs and is a very useful basis for any student or young engineer approaching the problem of airfoils from the numerical point of view.

Going to more complex problems, such as transonic flows and three-dimensional bodies, the formulation of the problem is not always as complete as in the first parts of the book, but it is, in any case, a very good guide to the problems.

Very interesting is the last part, covering some applications: it is not a complete overview of the application of computer programs to the solution of aeronautical fluid dynamics, but a set of cases that seems to have been encountered in a real professional career, and therefore are a summary of working experience more than an academic essay.