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Book Reviews

High Speed Flow

C. J. Chapman, Cambridge University Press, New York, 2000, 257 pp., $29.95

This book does a good job of being what it purports to be: a small, inexpensive softcover introduction to compressible flow, purely from the perspective of applied mathematics. The experimental and computational aspects of the topic are not covered, making the book unsuitable as an elementary text for engineers. Even math majors are ill-served, in my opinion, if shown only the theoretical aspects of this visual, application-rich field. (The book is illustrated solely by simple line diagrams.)

Having said that, there are some surprising topics in Chapman's book that are seldom found even in the "flagship" texts on gas dynamics: the shock polar diagram, Crocco's equation, and unsteady Mach reflection. An entire chapter is devoted to the hodograph method—nowadays seldom taught, but the historical and bibliographic notes are nicely done. The author has drawn extensively from the *Journal of Fluid Mechanics*, giving the book a unique perspective, though one that is hardly in the mainstream of high-speed flow.

In fact, the lack of any attempt at practicality is rather glaring: oblique-shock theory is given without working charts, characteristics theory without a worked example, transonic airfoils and shock detachment without flow photographs. Key applications such as high-speed inlets and wind tunnels are ignored. Two-dimensional supersonic nozzle flows with exit-pressure mismatch are curiously covered in a chapter on steady one-dimensional flow.

Writing this review gives me the opportunity to comment on the plethora of introductory compressible-flow textbooks available—some 20 in all—9 of which are apparently now in print[1–9] and several of which are quite recent. Most of these are good texts, and some are classics, making one wonder what drives new entries in this field. Nevertheless, few of them have the depth to support an advanced course or second semester of gas dynamics at the graduate level, leaving an important need largely unfulfilled. Into this varied array of high-speed flow texts, Chapman's contribution takes its rightful place, though it is a minor one.

References

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Gary S. Settles
Pennsylvania State University

Rarefied Gas Dynamics

Carlo Cercignani, Cambridge University Press, New York, 2000, 306 pp., $29.95

The subtitle of this technically elegant, softcover book—*From Basic Concepts to Actual Calculation*—only hints at its remarkable content. The purpose of the book is "to provide a working understanding of the essentials of rarefied gas dynamics and to form the foundation and give the background for a study of the original literature," and this has been achieved in eight chapters, each of which has an extensive list of references to the original literature. The subjects of the chapters are an interesting mix of applied-mathematics-centered and physical-phenomena-centered perspectives (e.g., Chapter 5, Perturbation Methods in More than One Dimension; Chapter 8, Evaporation and Condensation Phenomena). Each chapter is accompanied by several problems meant

to illuminate or expand on points in the text. The author anticipates that the book could be used as a textbook for graduate classes in either engineering or applied mathematics. The reviewer believes that this purpose has indeed been achieved.

The book begins with an introduction to the Boltzmann and model equations, including the boundary conditions presented by gas surface interactions. Two chapters follow, both on solutions to selected gas slab phenomena. Chapter 4 deals with rarefied aspects of propagation phenomena and shock waves. The subsequent chapter discusses perturbation methods in more than one dimension. Important physical aspects of the role of polyatomic gases in rarefied gas dynamics, mixtures, chemistry, and radiation are discussed in Chapter 6. A complete chapter is devoted to numerical techniques for solving the Boltzmann equation. The final chapter is a discussion of evaporation and condensation phenomena.

Each of the chapters can be thought of as a review paper discussing the contribution of mathematical techniques to the understanding of selected rarefied gas dynamic physical phenomena. All are readable and quite enthralling, exhibiting the authors' exquisite insight. In fact, as a reviewer I had great difficulty in simply reviewing the book because I was enticed into reading much of it in great detail. Although limited in length, the topics chosen by the author to illustrate the applications of modern kinetic theory are excellent and are inclusive of many of the really interesting rarefied gas dynamic phenomena. I found the chapter on evaporation and condensation particularly instructive. There is extensive literature on evaporation and condensation that Prof. Cercignani distills to a readable and informative summary. Actually, the same comment can be applied to each of the chapters.

The organization of the book is such that a particular topic not explicitly chosen for discussion by the author may appear in several places. In one of my diversions from finishing this review, I was interested in thermal creep and generally thermal stress–induced flows. It turned out that important information on this particular subject appears in several chapters in the book. The index is excellent in directing the mining of this distributed information.

In summary, Carlo Cercignani has produced a unique book that may be a harbinger of the future. For those of us who would like to understand the insight available from the mathematics without going into all of the detail, this is a wonderful book. The price is right, and the book provides an immediate entrée into the important research literature in the topics that are covered. Students should find it extremely useful. I believe the book's role as a textbook may be particularly important because it will provide convenient, guided access to the extensive literature on the Boltzmann equation. As pointed out by the author, kinetic equations traceable to the Boltzmann equation are presently applied in many fields.

E. P. Muntz
University of Southern California

Errata

Elliptic Grid Generation

Reijo Lehtimäki
Helsinki University of Technology,
FIN-02015 HUT, Espoo, Finland

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EQUATION (2) should read as follows:

$$g^{kj}\frac{\partial^2 x^{\lambda}}{\partial \xi^k \partial \xi^j} = (K_1 + K_2)n^{\lambda} \qquad (2)$$