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Book Review

Transonic Vortical Gas Flows

E. G. Shifrin and O. M. Belotserkovskii, J. Wiley, NY, 1994, 359 pp., $125.00.

The aim of this book is to provide an extensive discussion of the qualitative properties of inviscid compressible flows of aerodynamic interest from a fairly rigorous mathematical point of view. The properties are then those of the Euler equations. The flows discussed are mainly those in nozzles and over airfoils and bodies of revolution. Despite the title, the bulk of the book is devoted to irrotational (potential) flow; extensions or non-extensions of certain results to flows with distributed vorticity are pointed out. Preliminary discussions of the numerical treatment of certain problems appear but no results, except for the shock shape and pressure distribution on a blunt body with a detached shock in supersonic flow. Transonic flow, in the context of the book, is any flow that contains a sonic surface, although completely subsonic flow is also discussed.

The book is organized into eleven chapters. Chapter 1 discusses general properties of the equations. The treatment relies on Bers' development of quasi-analytic functions. Integrals of motion and the hodograph representation are discussed. For flows with vorticity a corresponding (pressure, flow angle) plane used. Chapter 2 explores self-similar solutions near the center line of a transonic nozzle flow. Chapters 3 and 4 deal in detail with the theoretical and computational problems of flow through a nozzle. Chapter 5 treats subcritical flow over a profile and the inverse problem of airfoil theory is discussed. The far field is given both for potential and vortical flow. In chapter 6 supercritical airfoil theory is treated. The necessary occurrence of shocks and their probable structure is studied. The calculation of the lift by the Kutta-Joukowsky formula is demonstrated for the circulation at infinity, but not on the body due to the vortical wake of the shock waves. The correction term is identified and the wave drag formula is given. Chapter 7 discusses in detail the flow over a transonic corner point and presents an extension of Vaglio-Laurin's similarity solution. Chapter 8 gives a complete discussion of properties of the sonic line and regions of influence for bodies with detached shocks. Chapters 9, 10, and 11 study secondary shocks, an airfoil in a jet, and axisymmetric flows, respectively. The extension of the Nikolsky-Taganov theorem (for plane flow) of the monotonic dependence of flow angle on arc length along a sonic line is given.

This book has several virtues. It exposes in English many results from the Russian literature that are not well-known. It provides a theoretical basis for approximate analysis and for computation. It extends some of the ideas of quasi-analytic solution to flows with vorticity. Thus, the book is valuable for research workers doing both analytical and numerical computation.

There are also some defects. There are some omissions or vague statements. For example, it is proved that Prandtl-Meyer flow does not exist for flows with vorticity, but in fact for a special case a centered wave solution can be found. Also a criticism is given of a result of Lifshitz and Ryzhov for sonic singularities in nozzle flow and this criticism seems misplaced. The book lacks an index. This is somewhat made up for by a rather detailed table of contents. The translation is good except for some English language names that have been translated into Russian and back again into English such as Siers (Sears), Ladford (Ludford), etc. Some of the figures are missing notation or do not agree with notation in text.

Julian D. Cole
Rensselaer Polytechnic Institute