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Book Review

Turbulent Shear Layers in Supersonic Flow

Alexander J. Smits and Jean-Paul Dussauge, American Institute of Physics, Woodbury, NY, 1996, 357 pp., $80.00

This book's 357 pages is divided into 10 chapters with 137 figures. The range of flow conditions considered is set in the Preface as $1.5 \leq M \leq 5.0$. Flows over rough surfaces and the effects of injection or suction are not covered. Finally, the important topics of stability and transition are excluded.

Chapter 1 is an introduction, but it is not written for the uninitiated in this specific field. Many specialized concepts, notations, and terms are used without definition or explanation. Section 1.7 on measurement techniques seems out of place in this chapter, and the reader has to be quite familiar with the background to grasp the points being made here.

The equations of motion (for laminar flows) are presented in Chapter 2. The important results are simply stated; there are no derivations. This chapter also contains a discussion of compressible Couette flow and vorticity.

The third chapter concerns equations for turbulent flow. The first section presents a brief discussion of averaging, including Reynolds averaging and mass-weighted, or Favre, averaging. In the rest of the book, however, the distinction between the two is not always made clear, and the notation problems aggravate this difficulty. Early in Chapter 3, the notation $(\,)''$ is proposed for Reynolds averages and $(\,)'$ for Favre averages. In Sec. 3.2.5, it is then suggested that a single prime be used for both, with an overbar denoting Reynolds averages and a tilda denoting Favre averages. At best, this is confusing to the reader. Specifically, which turbulence data in the later chapters are Reynolds averaged and which, if any, are Favre averaged? What kinds of averages do the hot wire and laser Doppler velocimetry results discussed in Sec. 1.7 measure and why? Here the equations are again simply stated without derivation or explanation. For example, the physical meaning of the terms in the turbulent kinetic energy (TKE) equation is not given. Also, the equations for the dissipation and Reynolds stress are not presented even though k–ε models and the Reynolds stress equation are mentioned later in the text. The thin-shear-layer equations are developed using order-of-magnitude arguments.

Chapter 4 covers fundamental concepts including Kovasznay's modes, velocity divergence in shear flows, and velocity induced by a vortex field; it has an extended discussion of rapid distortion concepts and Mach numbers for turbulence and very brief discussions of direct numerical simulations and modeling issues. Indeed, the latter section is the only place in the book where the very important matter of turbulence modeling is discussed, and the coverage here is cursory, with terms such as mixing length, eddy viscosity, and k–ε model being used without introduction or explanation.

Morkovin's hypothesis is the subject of Chapter 5. The material in this short chapter is clear and well organized.

Chapter 6 covers mixing layers in some detail. The treatment is quite thorough and clear, although it is curious that the well-known spreading parameter σ and some of the classical analyses and results are not mentioned.

Chapter 7 discusses boundary-layer mean-flow behavior in considerable depth. Boundary-layer turbulence behavior is covered in Chapter 8, again in considerable depth. The only small objection might be to the omission of a TKE balance across the boundary layer. These two chapters can be viewed as forming the real core material of the book because they (along with the last two chapters discussed next) concern the subject areas where these two well-respected authors have made substantial personal contributions. The coverage is very selective, emphasizing their own work and that of associates, but it is comprehensive. The authors' valuable insights into these complex topics come to the fore here, and much useful information is presented and discussed.

The material in Chapters 7 and 8 is generalized in Chapter 9, "Perturbed Boundary Layers," and Chapter 10, "Shock Boundary-Layer Interactions." Again, these are areas where the authors are acknowledged experts, so their discussions are particularly useful.

There are some flaws in the presentation of this book. The most serious is the lack of a Nomenclature. As pointed out earlier, many symbols are introduced and used without any definition or explanation. There is also confusion with symbol usage. The problems with notation for turbulence quantities were mentioned earlier. In other places, both k and q^2 are used for TKE, and both θ and δ_2 are used for momentum thickness. The second problem concerns the discussion of concepts, devices, models, and specific terms without introduction. This will make it hard for all readers except those already familiar with the subject area to gain the full benefits available from this book. Additional sketches and more complete definitions throughout would have made a great difference. Finally, the Preface states a hope that this book will "...give the reader a general introduction to the field, whether they be students or practicing engineers..." The lack of homework problems or worked examples coupled with the difficulties just cited will surely make it largely inaccessible to students.

This book will, however, find a place in the "must read" section of the bookcase of every knowledgable researcher interested in or working in this field. I suspect that the pages of my copy will be well worn.

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