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BOOK REVIEW

ACOUSTICS OF FLUID–STRUCTURE INTERACTIONS

M.S. Howe

Cambridge University Press 1998

This book provides an inter-disciplinary overview of the physics of flow-structure interactions. The text does an excellent job of drawing together the details of the three relevant fields, namely, fluid mechanics, acoustics and elasticity.

The viewpoint is that of a physicist, rather than a mathematician or engineer, in the sense that the emphasis is on the development of the governing equations, rather than on rigorous proofs, or on detailed applications. Within this framework, the book strikes a nice balance between mathematics and phenomenology. The material is very concentrated and the pace is intense throughout, but explanations are lucid and the material is exquisitely organized.

One small quibble: the subject area is misrepresented in the title. The words "fluid–structure interaction" have frequently been used to refer to structural acoustics (in the absence of flow). A more appropriate title would be *Acoustics of Flow-Structure Interactions.*

The book consists of six chapters, of which the first provides a prodigious overview of the basic equations of all the three relevant fields. In 100 pages, the governing differential equations are developed, the typical boundary conditions described, and common solution techniques addressed. While too concise to serve as an introduction to the material presented, it provides a concentrated review to the educated reader, and simultaneously serves nicely both as a definition of notation, and as a reference for the later chapters.

The remaining chapters are organized by increasing boundary complexity.

The second chapter covers sound generation in unbounded flows, that is, the influence of boundaries on the production of sound (as opposed to production of vorticity) is ignored. Section 1 develops Lighthill's acoustic analogy, and then discusses some solutions for simple geometries, including low Mach number turbulence, and sound radiation by a spinning vortex. The second section develops the Ffowcs Williams–Hawkings equation. Further sections discuss vorticity and entropy fluctuations as sources of sound, two-phase flows, absorption, and jet noise.

Chapter 3 addresses the sound generation in a fluid with rigid boundaries. It begins by discussing the influence of rigid boundaries in general terms. The second section addresses special cases that can be treated by the method of compact Green's functions. Vortex–airfoil interaction noise, boundary layer noise, and trailing edge noise are treated in the following three sections. Finally, the chapter discusses sound generation by moving surfaces.

In Chapter 4, the discussion proceeds to fluids with flexible boundaries. This chapter deals with the effects of elastic plates, including scattering of bending waves by discontinuities and edges, and the effects of inhomogeneous elastic walls. Several examples are developed in the final section, involving sound generated at an elastic edge.

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Chapter 5 proceeds to the difficult coupled problem, in which the flow is influenced by the acoustics. The first section deals with damping at a smooth wall. The second section considers attenuation of sound by vorticity production at edges. There is a section on interaction with perforated screens, one treating surface compliance, and another describing flow/acoustic interactions in tube banks, such as those occurring in industrial heat exchangers. The final section deals with nonlinear interactions.

Resonant and unstable systems are treated in the last chapter. A linear and a nonlinear theory of cavity resonances is developed. There is a discussion of edge tones and organ pipes. The last two sections deal with combustion instabilities, and thermoacoustic engines and heat pumps, respectively.

The book concludes with a very extensive list of references, including nearly 500 articles and books, which are referred to throughout the text.

The book is recommended as a reference for professionals or as a textbook for upper echelon graduate students. It also serves well as a bridge for experts lacking background in any one of the relevant fields.

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