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Sound–Flow Interactions

Springer

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Preface

The Cargèse Summer School "Sound–flow interactions" was held in the Institut d'Etudes Scientifiques de Cargèse in Corsica, France from 19th June to 1st July, 2000.

The understanding of sound and flow interactions has made some remarkable progress since the pioneering works of the Russian and British schools, in the 1950s. In addition, the growing availability during the past 10 years of sophisticated computer/electronics/materials techniques allows for the development of a growing number of applications as well as the possibility of addressing new fundamental problems. The coupling between acoustic waves and flow motion is basically nonlinear, so that the sound propagation and generation is modified by the flow and the flow can also be modified by the sound. As a result, this problem is investigated in many different scientific communities, such as applied mathematics, acoustics and fluid mechanics, among others. In our opinion, the time had come to try to gather the researchers in the different communities together in a tutorial environemnt. So, this school brought together worldwide specialists in order to present various aspects of sound–flow interactions, and share expertise and methodologies so as to promote cross-fertilisation.

The basic knowledge in the area is introduced by A. Hirschberg and C. Schram. He presents the aeroacoustics of internal flow in a very lively way with a lot of illustration devices. He introduces aeroacoustic analogies and applications like musical instruments, the Rijke tube, speech production *etc.* M.S. Howe introduces the theory of vortex sound in a very didactic way. From Lighthill's acoustic analogy, he shows how vorticity and entropy fluctuations can be seen as sources of sound. Then, using the compact Green's functions, he shows how to compute the vortex sound. As an example of the method presented, he applies this theory to pressure transients generated by high-speed trains. F. Lund gives the basic equations of sound–flow interactions. Then he introduces very clearly the scattering of sound because of vorticity and gives the most recent results on ultrasound propagation through a disordered flow. V. Ostashev presents geometrical acoustics in moving media and the important practical problem of sound propagation in turbulence (atmosphere, ocean). A. Fabrikant examines the plasma–hydrodynamics analogies including the resonant wave-flow interaction in shear flows, waves of negative

energy and over-reflection and acoustic oscillators in fluid flows. P. J. Morrison describes the dynamics of the continuous spectrum which occurs in shear flow. The results are interpreted in the context of infinite dimensional Hamiltonian systems theory. G. Chagelishvili presents new linear mechanisms of acoustic wave generation in smooth shear flows using a non-modal study. N. Peake presents fluid–structure interactions in the presence of mean flows, including the problems of instability and causality. Finally, W. Lauterborn presents nonlinear acoustics with applications to sonoluminescence and to acoustic chaos.

In this Cargèse Summer School, 54 students from 12 nations, and 11 lecturers from 7 nations participated.

Aknowledgements. The Summer School and this publication would not have been possible without:

- financial support from the European Union, the Centre National de la Recherche Scientifique, the Ministère des Affaires Etrangères, the Ministère de l'Education Nationale, de la Recherche et de la Technologie and the Groupement de Recherche "Turbulence";
- the guidance of Elisabeth Dubois–Violette, director of the Institut d'Etudes Scientifiques de Cargèse;
- the help of Chantal Ariano, Nathalie Bedjai, Brigitte Cassegrain, Pierre-Eric Grossi and the whole team in preparing and hosting of this school.

Finally, we wish to thank the lecturers for giving so much time in preparing the lectures and writing them up, as well as making themselves available for discussions during the school.

Le Mans, Paris, Lyon
September 2001

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Some of the lecturers of the Cargèse School, from left to right: M.S. Howe, A. Hirschberg, P. Morrison, W. Lauterborn, V. Ostashev, A. Fabrikant, N. Peake, T. Colonius *(Photo C. Schram)*

Some of the participants of the Cargèse School *(Photo C. Schram)*

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