

# Aeroacoustics: Flow Induced Sound

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## Abstract

Aeroacoustic is a quite young scientific discipline, which focuses on flow induced sound. In general, solving the full set of compressible flow dynamics equations results in both, the flow structures and the radiated sound. However, for practical applications this approach is not feasible, and we have to investigate in the physics of the sound generation mechanism. The course will provide an overview about different modelling approaches, and will discuss some applications in technical and medical science. The following topics will be discussed:

### (1) From fluid dynamics to acoustics.

- a) Conservation equation of fluid dynamics
- b) Acoustic conservation equations and the wave equation
- c) Interaction between flow and acoustics

### (2) Aeroacoustics (part I)

- a) Lighthill's inhomogeneous wave equation
- b) Solution of the wave equation using Green's function

### (3) Aeroacoustics (part II)

- a) Curle's analogy
- b) Helmholtz decomposition
- c) Acoustic perturbation equations

### (4) Applications

- a) Cylinder in cross flow
- b) Axial fan
- c) Human phonation

## Suggested reading:

- [1] M. Kaltenbacher (ed.): *Computational Acoustics*, Springer International Publishing, 2018, ISBN: 978-3-319-59038-7
- [2] M. S. Howe: *Theory of Vortex Sound*, Cambridge Texts in Applied Mathematics, 2003
- [3] M. Kaltenbacher: *Numerical Simulation of Mechatronic Sensors and Actuators: Finite Elements for Computational Multiphysics*, Springer-Verlag, Heidelberg, 2015, ISBN: 978-3-642-40169-5
- [4] M. Kaltenbacher, A. Hüppe, A. Reppenhagen, F. Zenger, S. Becker: *Computational Aeroacoustics for Rotating Systems with Application to an Axial Fan*, AIAA Journal, 5, 2017
- [5] S. Zörner, P. Sidlof, A. Hüppe, M. Kaltenbacher: *Flow and Acoustic Effects in the Larynx for Varying Geometries*. Acta Acustica united with Acustica, 102, 2016