Mini-Symposium:
Advanced Numerical Methods for Aeroacoustics Problems

IACM 22nd Computational Fluids Conference
CFC 2023

Wolfgang Schröder, Matthias Meinke

Institute of Aerodynamics and Chair of Fluid Mechanics, RWTH Aachen University, Wüllnerstr. 5a, 52062 Aachen, Germany

JARA Center for Simulation and Data Science, RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, Germany

E-Mail: office@aia.rwth-aachen.de

Wind turbines, fans and aircraft, i.e., system components with extensive sound generation, are often used in the direct vicinity of humans due to their applications in energy conversion, air-conditioning, transportation etc. Since noise pollution is a threat to humans' health and well-being, there is a growing societal demand for the mitigation of environmental noise. Therefore, it is necessary to predict and understand the mechanisms of noise generation such that optimization strategies for noise reduction can be defined.

Since Sir James Lighthill's seminal work in the 50s of the last century, there is a direct link between fluid mechanics and acoustics, this field is called aeroacoustics. It has extensively evolved in the last years in areas such as jet noise, airframe noise, rotor noise, community noise, engine-core noise, combustion noise etc. However, it still requires further development of advanced theoretical, numerical, and experimental approaches. This includes not only highly accurate measurements and simulations of the acoustic field but also an efficient postprocessing and analysis of the experimental and numerical data to improve the understanding of the essential noise sources of a turbulent flow field. It is especially true for hybrid computational fluid dynamics/computational aeroacoustics approaches in which the flow field is numerically resolved to determine the acoustic sources, which in a next step are used to predict the acoustic near and far field. From a numerical point of view there is lots of open questions in this hybrid context that deal, e.g., with conservative and non-conservative formulations of the conservation equations, the treatment of embedded boundaries, spatial and temporal interpolation of noise source terms, linear and non-linear formulations for the acoustic field equations, acoustic model development based on data driven approaches like proper orthogonal decomposition, dynamic or empirical mode decomposition. The same applies to highly resolved measurements of the flow and acoustic field, e.g., by particle-image velocimetry and microphone arrays, where the three-dimensional and time-dependent data are to be processed to determine the acoustic sources. The development of general procedures, which are directly applicable to wall-bounded and free shear layers, low subsonic or transonic flows with local shocks, reacting flows etc., is extremely challenging. Machine learning approaches have recently shown promising potential and are currently being developed.

In brief, the mini-symposium on *Advanced Numerical Methods for Aeroacoustics Problems* will bring together scientists who deal with the latest developments in numerical and experimental techniques and advanced processing of huge data sets to determine and analyze acoustic sources. This is the essential knowledge to develop passive and active noise reduction methods.