Preface

The book is a result of the Advanced School Computational Acoustics, which took place at the International Centre for Mechanical Sciences (CISM), Udine, Italy, in May 2016.

The aim of this book is to present state-of-the-art overview of numerical schemes efficiently solving the acoustic conservation equations, the acoustic wave equation, and its Fourier-transformed Helmholtz equation. Thereby, the different equations model both vibrational and flow-induced sound generation and its propagation.

Chapter "Fundamental Equations of Acoustics" sets the scene by providing the mathematical/physical modeling of acoustic fields. Thereby, the equations of acoustics are based on the general equations of fluid dynamics: conservation of mass, momentum, energy, and closed by the appropriate constitutive equations defining the thermodynamic state. The use of a perturbation ansatz, which decomposes the physical quantities such as density, pressure, and velocity into mean, incompressible fluctuating and compressible fluctuating ones, allows to derive linearized acoustic conservation equations and its state equation. Thereby, we derive acoustic wave equations for both homogeneous and inhomogeneous media.

Chapter "Non-conforming Finite Elements for Flexible Discretization with Applications to Aeroacoustics" focuses toward non-conforming finite elements for flexible discretization. Therewith, we allow for each subdomain an optimal grid. The two proposed methods—Mortar and Nitsche-type mortaring—fulfill the physical conditions along the non-conforming interfaces. We exploit this capability and apply it to real engineering applications in aeroacoustic. The results demonstrate the superiority of the nonconforming finite elements over standard finite elements concerning preprocessing, mesh generation flexibility, accuracy, and computational time.

Chapter "Boundary Element Method for Time–Harmonic Acoustic Problems" presents the solution of time–harmonic acoustic problems by the boundary element method (BEM). Specifically, the Helmholtz equation with admittance boundary conditions is solved in three-dimensional space. The chapter starts with a derivation of the Kirchhoff–Helmholtz integral equation from a residual formulation of the

Helmholtz equation. The discretization process with introduction of basis and test functions is described and shown for the collocation and the Galerkin method. Throughout the chapter, numerous different examples are presented, both simple one-dimensional examples having analytical solutions, which may be used for implementation verification, and rather industrial applications such as sedan cabin compartments, diesel engine radiation, and tire noise problems demonstrating the applicability.

Chapter "Direct Aeroacoustic Simulations Based on High Order Discontinuous Galerkin Schemes" focuses on direct aeroacoustic simulations based on high-order discontinuous Galerkin schemes. The framework presented is based on a particular version of the Discontinuous Galerkin method, in which a nodal as well as discretely orthogonal basis is used for computational efficiency. This discretization choice allows arbitrary order in space while also supporting unstructured meshes. After discussing the details of the framework, examples of direct noise computation are presented, with a special focus on the numerical simulation of acoustic feedback in a complex automotive application.

Numerical schemes lead to a system of algebraic equations, which needs efficient solvers. Therefore, Chapter "Direct and Iterative Solvers" presents a compact introduction to direct and iterative solvers for systems of algebraic equations typically arising from the finite element discretization of partial differential equations. Beside classical iterative solvers, we also consider advanced preconditioning and solving techniques like additive and multiplicative Schwarz methods, generalizing Jacobis and Gauss-Seidel's ideas to more general subspace correction methods. In particular, we consider multilevel diagonal scaling and multigrid methods.

We have pleasure in thanking our colleagues, Gary Cohen, Dan Givoli, Ulrich Langer, Steffen Marburg, Claus-Dieter Munz, and Martin Neumüller for presenting their lectures, and the students for attending the course and contributing to discussions. Furthermore, we particularly thank the Rectors and officers at CISM for their enthusiasm, assistance, and hospitality. Finally, we want to thank Springer for their kind assistance, and especially Sooryadeepth Jayakrishnan and his team for their great job in doing the layout.

Vienna, Austria Manfred Kaltenbacher

Springer
http://www.springer.com/978-3-319-59037-0

Computational Acoustics
Kaltenbacher, M. (Ed.)

2018, VII, 251 p. 122 illus., 89 illus. in color., Hardcover
ISBN: 978-3-319-59037-0