6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

SPLIT BOUNDARY CONDITIONS FOR COMPUTATIONAL AERO-ACOUSTICS OF ISENTROPIC FLOWS

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Keywords: *Isentropic flow, Computational Aeroacoustics, Finite Elements, Weak imposition of boundary conditions*

The high computational cost of solving numerically the fully compressible Navier-Stokes equations, together with the poor performance of most numerical formulations for compressible flow in the low Mach number regime, has led to the necessity for more affordable numerical models for Computational Aeroacoustics. For low Mach number subsonic flows with neither shocks nor thermal coupling, both flow dynamics and wave propagation can be considered isentropic. Therefore, a joint isentropic formulation for flow and aeroacoustics can be devised which avoids the need for segregating flow and acoustic scales. Under these assumptions density and pressure fluctuations are directly proportional, and a two field velocity-pressure compressible formulation can be derived as an extension of an incompressible solver. Moreover, the linear system of equations which arises from the proposed isentropic formulation is better conditioned than the homologous incompressible one due to the presence of a pressure time derivative. Similarly to other compressible formulations the prescription of boundary conditions will have to deal with the backscattering of acoustic waves. In this sense, a separated imposition of boundary conditions for flow and acoustic scales which allows the evacuation of waves through Dirichlet boundaries without using any tailored damping model will be presented. This imposition is made weakly, either through a Nitsche's method or through the method that we call linked Lagrange multiplier. It does not require that the boundary coincides with element boundaries, and it is therefore well suited to be used with unfitted meshes.