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Acoustic impedance characterization via numerical resolution of the inverse Helmholtz problem CARLO SCALO, DANISH PATEL, PRATEEK GUPTA, Purdue University — Impedance boundary conditions (IBCs) regulate the relative phasing and amplitudes of pressure and velocity fluctuations and, therefore, the acoustic energy flux. We present a numerical method to determine the acoustic impedance at the surface of an arbitrarily shaped cavity as seen by a generically oriented incident external harmonic planar wave. The proposed method (conceptually) inverts the usual eigenvalue-solving procedure underlying Helmholtz solvers: the impedance at one or multiple (but not all) boundaries is an output of the calculation and is obtained via implicit reconstruction the linear acoustic waveform at the frequency of the incident wave. The linearized governing equations are discretized via a mixed finite-difference/finite-volume approach and are closed with a generalized equation of state. Results are validated against quasi one-dimensional cases derived via direct application of Rott's linear thermoacoustic theory and by comparison against fully compressible Navier-Stokes simulations. This work is motivated by the need to develop a comprehensive suite of predictive tools capable of performing high-fidelity simulations of compressible boundary layers over assigned IBCs, accurately representing the acoustic response of arbitrarily shaped porous cavities.

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