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Direct Numerical Simulation of Three Dimensional Honeycomb Liner with Circular Apertures[1] Q. ZHANG, D.J. BODONY, UIUC — Acoustic liners are effective methods to decrease aircraft engine noise. Early designs and understanding of them were mostly made through theoretical analysis and experiments. More recently, numerical simulations of the detailed fluid mechanics of liners have been used to provide A better understanding of the liner working mechanisms but are typically limited to 2-D geometries. In this work, a 3-D model of a NASA Langley honeycomb liner with circular holes is studied by direct numerical simulation using a high-fidelity compressible Navier-Stokes code with overlapping mesh capability. The simulations are first validated by predicting the liner impedance as a function of frequency (1–3kHz) for normally incident sound waves at 130 dB amplitude and comparing to Langley experimental data. The flow through the circular opening, or aperture, was examined and found to be primarily laminar with the vorticity attached to the aperture walls. The effect the sound amplitude was then investigated, up to 160 dB. Around an amplitude of 140 dB the attached aperture wall vorticity begins to separate with an oscillatory, axisymmetric, laminar jet, dominated by vortex rings, appearing at 150 dB. At 160 dB the oscillatory jet becomes turbulent. Connections between the liner impedance and the jet structure are made, as are detailed phase-averaged statistics. The jet production process was also examined in detail.

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