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Sound generation by entropy perturbations passing through sudden flow expansions[1] DONG YANG, JUAN GUZMN-IIGO, AIMEE MORGANS, Imperial College London — Entropy perturbations generate sound when accelerated/decelerated by a non-uniform flow. Current analytical models provide a good prediction of this entropy noise when the flow cross-sectional area changes are gradual, as is the case for nozzle flows. However, they typically rely on quasi-1D and isentropic assumptions, and their predictions differ significantly from experimental measurements when sudden area increases are involved. This work uses a theoretical approach to quantitatively identify the main mechanisms responsible for the mismatch. A new form of the acoustic analogy is derived in which the entropy-related source terms are rigorously identified for the first time. The theory includes three-dimensional and non-isentropic effects. The approach is applied to the flow through a sudden area expansion, for which the large-scale flow separation creates a recirculation zone. The derived acoustic analogy is simplified for low Mach numbers and frequencies, and solved using a Green's function method. The results provide the first quantitative evidence that the presence and spatial extent of the recirculation zone, rather than the flow non-isentropicity, is the dominant factor causing deviation from predictions from quasi-1D, isentropic theory.

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