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Numerical modeling of inertial particles in under-expanded jets[1]

YUAN YAO, University of Michigan, Ann Arbor, JASON RABINOVITCH, Jet Propulsion Laboratory, JESSE CAPECELATRO, University of Michigan, Ann Arbor — Inertial particle dynamics in flows that exhibit strong gas-phase compressibility and turbulence is crucial to many practical engineering applications. Such examples include coal dust explosions, shock wave lithotripsy, combustion/detonation, etc. Compared to their low-speed counterpart, particle-laden compressible flows like the examples listed here typically introduce new length- and time-scales and additional physics that further complicate modeling efforts. In this presentation, we perform three-dimensional Eulerian-Lagrangian simulations of particle-laden under-expanded jets to study the dynamics of inertial particles in compressible flows. The gas-phase equations are solved using a high-order, energy stable finite difference discretization. A combined ghost-point / direct-forcing immersed boundary method is employed to model the nozzle geometry. The focus of the present work is to assess the ability of existing drag models to capture particle dynamics through a series of compression and expansion waves (Mach diamonds). Particle trajectories and velocity distribution together with DMD modes are compared between different drag models and experiments. Two-way coupling effects on the structure of the Mach diamonds are also reported.

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