Abstract Submitted
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Shock wave unsteadiness in an over-expanded nozzle BRITTON OLSON, SANJIVA LELE, Stanford University — A suite of Large-Eddy Simulations has recently elucidated the unsteadiness of a shock wave in an over-expanded planar nozzle. The simulations model the nozzle used by Johnson and Papamoschou (*P*hys. Fluids **22**, 2010), who found that the exhaust jet was destabilized by the shock wave oscillations. Shock wave unsteadiness has been observed in several experiments with similar nozzle geometries. The mechanism which drives the instability is a feedback loop between the nozzle exit and the shock wave. The shock boundary layer interaction causes flow separation and reversal, which then causes an obstruction at the exit of the nozzle. The obstruction is seen as a change in the effective exit area, which in turn causes the shock to readjust its position. When the shock moves, the nature of the shock induced separation changes and the cycle repeats, never becoming stationary. Parametric variation of the nozzle geometry and pressure ratio demonstrate that the instability has a dependence on the Mach number and Reynolds number. A reduced order model (ROM) which is based on the proposed mechanism and the LES data is developed. Preliminary results indicate that the ROM predicts the frequency of the instability to within 10% when compared to the LES data.

Britton Olson
Stanford University

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