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Supersonic Jet Mixing with Vibrational Non-Equilibrium[1]
HEATH H. REISING, UTSAV KC, PHILIP L. VARGHESE, NOEL T. CLEMENS, University of Texas at Austin — A new study has been initiated to study the effect of vibrational non-equilibrium on turbulent mixing and combustion. This work is relevant to high-speed, high-temperature environments, such as scramjet combustors, where shocks and mixing can lead to high degrees of vibrational non-equilibrium. In this experimental study, a new facility has been developed that consists of a perfectly-expanded axisymmetric Mach 1.5 turbulent air jet issuing into an electrically heated co-flow of air for precise control of the temperature and thus vibrationally-active population. This hot flow can be brought into non-equilibrium when the co-flow fluid is rapidly mixed with the colder supersonic jet fluid. Effects of the non-equilibrium can be isolated by replacing the nitrogen in the flow with argon. The degree of non-equilibrium in the jet shear layers is quantified by using high-spectral resolution time-averaged spontaneous Raman scattering centered on the Stokes-shifted Q branch line of N_2 at 607 nm. In this first phase of the study, the effect of non-equilibrium on the mixing field will be investigated, but future work will focus on H_2-air combustion. Planar Rayleigh thermometry is utilized to investigate the effects of vibrational non-equilibrium on the turbulent structures and thermal dissipation field.

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