PHYSICS AND ASTRONOMY

SEMINAR

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“Variable Density Mixing and Turbulence”

Abstract

Variable density mixing is important in geophysical flows, combustion, type Ia supernova explosions and many other applications. However, modeling and simulating strongly non-Boussinesq flows is difficult, and experimental measurements are needed to understand some of the important physics of variable-density turbulent mixing. I will present Vertical Shock Tube experiments studying initial condition dependence of shock-driven variable-density mixing (Richtmyer-Meshkov instability). I will then present experiments performed at the Turbulent Mixing Tunnel of a heavy jet (density ratio, s=4.2) compared to a single-fluid jet (s=1.2) in coflow at jet Reynolds numbers of about 20,000. Quantitative planar laser-induced fluorescence and particle image velocimetry are performed simultaneously at multiple downstream positions within the momentum regions of both jets, with 10,000 realizations at each location. We compare Reynolds- and Favre-averaged Reynolds stresses that reveal the spatial extent of variable-density effects in the jet. These large data sets allow us to calculate turbulent kinetic energy budgets, and we find that there is negative turbulent kinetic energy production in the heavy jet. We demonstrate, through experimental measurements, that this is caused by reduced gradient stretching in the axial direction and increased turbulent mass fluxes. We also find a scaling for the budget mechanisms in the non-Boussinesq regime that uses the effective density and the velocity half-