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Experimental adventures in variable-density mixing

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Variable-density flows present challenges for experimental measurements and turbulence modeling. I will review the experiments that we have been performing at Los Alamos over the past decade to better understand the effects of initial conditions on subsonic and shock-driven variable-density flows in a wide range of flow conditions, including density ratios of 4:1 and Atwood numbers of 0.6. Shock tube experiments allow us to explore the effects of Mach number and initial conditions on unsteady variable-density mixing, and wind tunnel experiments using jets allow us to make detailed measurements that are still difficult in shock tubes. Explosively-driven experiments put us into regimes of high Mach number (Mach 9) and Atwood numbers close to one in gases, but they present new measurement challenges. Diagnostic developments are allowing us to measure Favre-averaged turbulence quantities for the first time in flows in shock tubes, providing important new information on turbulence modification due to density gradients and fluctuations. The success of experiments and model improvements depends on strong collaborations among modeling, experiment, and simulation, and I will talk about my positive collaboration experiences, with challenges and advice for future generations of researchers.