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Numerical issues in the simulation of variable-density flows[1] LEE SHUNN, FRANK HAM, PARVIZ MOIN, Stanford University — The interaction of variable-density flow-solvers and tabulated state-relationships is explored in the context of combustion and mixing problems. Numerical issues arising from the inconsistent evaluation of density in hydrodynamic simulations are highlighted and discussed. Particular attention is given to the strong coupling that occurs between density, velocity, and pressure in low-Mach number, incompressible flow-solvers. The implications for turbulence and combustion models resulting from numerical complications surrounding this coupling are briefly outlined. An adaptive method that utilizes optimized quadrature-rules over tetrahedral volumes to reliably enforce the equation-of-state in variable-density simulations is developed. The new method is shown to mitigate many of the undesirable artifacts previously observed. A summary of the costs and benefits associated with the adaptive method is given. The method is applied to the large-eddy simulation of a three-dimensional buoyant helium plume, and the simulation results are compared with experimental data and previous computations.

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Lee Shunn
Stanford University, Mechanical Engineering

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