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Boundary Layer Effects on Ignition in a Shock-Tube System

KEVIN GROGAN, MATTHIAS IHME, Stanford University — Direct numerical simulations (DNS) of an argon-diluted hydrogen/oxygen mixture are performed to study the weak and strong ignition regimes in a shock-tube system. An adaptive mesh-refinement (AMR) algorithm is used to resolve physically relevant features such as the viscous boundary layer, the shock bifurcation region, and the ignition kernels. The simulations employ a second-order accurate, nonlinear, hyperbolic equation solver that is modified to include a finite-rate kinetic mechanism, and detailed mass, thermal, and viscous diffusion transport properties. Detailed two- and three-dimensional simulations are performed to investigate effects of viscous heating, shock bifurcation, and thermo-viscous boundary layer on the ignition behavior. The locations of the ignition kernels for various post-reflected-shock conditions are studied as well as the ignition sensitivity due to the choice of thermal boundary conditions. These detailed simulations are analyzed, and correlations between observed weak and strong ignitions are compared to the ignition criterion that was proposed by Meyer and Oppenheim.

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