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Dynamics of the LTD Transition

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The laminar flame to turbulent flame to detonation transition in a chemically reactive medium is a highly transient, complex, and dynamic process in which there are continuous qualitative and quantitative changes in the state of the gas. The transition begins with an initially small flame or spark that evolves into a turbulent flame, producing compression and shock waves. The shocks, in turn, may couple with the flame to form unsteady, propagating shock-flame complexes that may transition to a detonation. The complete process is illustrated here with videos made from numerical solutions of the multidimensional, unsteady, chemically reacting, Navier-Stokes equations. The discussion focuses on selected features of the flow, including: formation of a turbulent flame and the nature of the turbulence, shock-wave transitions from single to double Mach reflection, creation of hot spots as the origins of detonations, and comparisons between simulations and experimental data. (This work is done in collaboration with Vadim N. Gamezo, Takanobu Ogawa, David A. Kessler, and Alexei Poludnenko, and is sponsored by ONR, NIOSH, NASA, and NEDO.)