Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Explosive, Spatially Distributed, Time Resolved Thermal Energy Deposition into a Finite Gas Volume DAVID R. KASSOY, University of Colorado — Add thermal energy quickly to a finite volume of gas. Kaboom!! How much? How fast? An asymptotics-based analysis of the Navier-Stokes equations is used to study the response of a finite gas volume (length scale R') to spatially distributed, time resolved energy deposition per unit mass (characterized by q_R') on a specific time scale (t_H') short compared to the initial acoustic time of the volume (t_A'=R'/a_0'), where a_0'=$\sqrt{\gamma}$R'T_0 is the initial acoustic speed) such that t_H'/ t_A'=ε <<1. The initial state is described by (T_0',p_0',ρ_0'), and speed zero. The energy deposition is related to the initial internal energy by q_R'= $[a_0']^2/\alpha$ where $\alpha \leq 1$, compatible with a characteristic temperature rise in the heated spot ΔT'/T_0'=O(1/α). Ephemeral inertial confinement prevails when $\varepsilon^2 << \alpha <<1$, characterized by pressure rising with temperature because the density change and internal Mach number are both very small. Alternatively, when the energy addition reaches a critically large amount, $\alpha = \varepsilon^2$, the heat addition process is fully compressible and the internal Mach number reaches sonic values. One can apply these scaling concepts to explain the spontaneous appearance of hot spots observed in detonation initiation processes and the associated gasdynamic wave generation

David R. Kassoy
University of Colorado

Date submitted: 27 Jul 2009 Electronic form version 1.4