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Critical ignition in rapidly expanding self-similar flows[1] MATEI I. RADULESCU, BRIAN MCN. MAXWELL, University of Ottawa — The generic problem of ignition of a particle undergoing an expansion given by a power law rate of decay behind a decaying shock is addressed in the present study. It is demonstrated, using a one-step Arrhenius irreversible reaction, that a sufficiently strong expansion wave can quench the reaction. The critical conditions for extinction are obtained in closed form in terms of the time scale for the expansion process and the thermo-chemical properties of the gas, yielding a critical Damkohler number, i.e. the ratio of the expansion time scale to the homogeneous ignition time scale, given by $(\gamma\text{-}1)E_a/RT\text{-}1/n$, where n is the power law exponent of the self-similar expansion $\rho \sim t^{-n}$. The critical ignition criteria, which is valid in the asymptotic limit $n(\gamma\text{-}1)(E_a/RT)=O(1)$, was found in excellent agreement with numerical results. The applicability of the results obtained are discussed for ignition in rapidly expanding flows which occur behind decaying shock waves, as encountered in problems of detonation initiation by a Taylor-Sedov blast wave, and reacting jet start-up, and for reactions in steady hypersonic flows around projectiles.

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