Abstract

A solid propellant combustion model describing an asymptotically thin kinetic reaction zone separating a region of unburnt solid reagent and gaseous products is briefly reintroduced. The model equations consist of a system of nonlinear partial differential equations in each region linked by jump conditions at the interface. This system admits a basic solution where a planar reaction zone progresses into the reagent with a fixed velocity and temperature profile which is found to be linearly unstable to small perturbations in certain physical parameter regimes. While the linear stability results are valid for small perturbation amplitudes and times, nonlinear effects eventually become dominant. Furthermore, the linear results do not allow for modal interaction. We utilize multiple time scale expansions to describe the evolution of a perturbation consisting of a pair of weakly unstable modes. Our analysis results pair of coupled nonlinear ODE's of Stuart-Landau type which determine their amplitude and phase. The analytical results are then compared with a direct numerical simulation of the model equations and are found to agree over much of the parameter space.