On the shock-wave problem for multi-temperature (inert or reactive) gas mixtures

Authors: M. Bisi (Parma), G. Martalò (Bordeaux), G. Spiga (Parma)

Abstract:
A multi-temperature approach to gas mixtures is natural in several physical problems, and it has been widely dealt with in the Extended Thermodynamics literature. We show a consistent derivation of multi-temperature fluid-dynamics from kinetic theory, achieved assuming collision processes occurring at two different scales: the fast ones account for resonance, namely mechanical encounters between particles of the same species, while all the remaining (mechanical or chemical) interactions constitute the slow process. We test the hydrodynamic equations corresponding to this scaling on the classical steady shock wave problem in one space dimension. In a multi-temperature and single-velocity description at Euler level, shock profiles for a reacting mixture are analyzed and possible relevant bifurcations versus Mach number are discussed. If single species velocities are included in the set of hydrodynamic variables, the investigation becomes much more complicated, and even the simple inert binary mixture presents interesting phenomena like sub-shocks of different kinds and weak solutions with more than one discontinuity: our analytical results and some numerical simulations are presented, for hydrodynamic equations at Euler or Grad accuracy.