Adaptive high-resolution methods for simulating shock-induced hydrogen-air combustion

Ralf Deiterding
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)
Institut für Aerodynamik und Strömungstechnik
Bunsenstr. 10, 37073 Göttingen
ralf.deiterding@dlr.de

The presentation discusses the construction and application of high-resolution finite volume methods for the reactive Euler and Navier-Stokes equations for simulating the ignition and propagation of detonation phenomena in gaseous mixtures involving hydrogen as a fuel. In order to cope with the challenge of accurately resolving shock waves and combustion fronts, a block-based dynamic adaptation method with temporal and spatial refinement is employed. The incorporation of second-order shock-capturing as well as higher-order finite-difference-type schemes into the adaptive algorithm is explained.

Discussed simulation results include detonation structure computations of Chapman-Jouguet detonations under transient conditions in hydrogen-oxygen mixtures in two and three space dimensions and detonation-type combustion phenomena in hydrogen-air mixtures induced by the bow shock of a supersonic spherical projectile. All computations have been carried out in parallel on distributed memory machines and CPU times and parallel performance will also be partially reported.