THE IV[TH] WORLD CONGRESS OF NONLINEAR ANALYSTS.
WORKSHOP ON COUPLED PROBLEMS, PROCESSES, AND PHENOMENA:
MODELING, CONTROL, AND ANALYSIS.
FL, USA, JUNE 30 - JULY 7, 2004

Multiphysics Coupling Methods for Supernova Simulations

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Abstract

Supernovae are thought to be the major contributors to the chemical enrichment of interstellar matter with heavy elements. Energy injection by supernovae into the interstellar medium, triggered star formation, and feedback in galaxy formation are regarded as key to our understanding of the formation and evolution of galaxies. The central issue we are concerned here is the physics of fluid mixing which determine the total energy release during supernova explosion.

Simulations of fluid mixing in supernova are extremely difficult since mixing is multiscale and involves multiphysics including hydrodynamics, radiation process, and turbulent combustion. For multiphysics coupling, we adopt two approaches. We directly add the combustion code to our front tracking hydrodynamic package. Our combustion code is based on a tracked sharp flame numerical model. For the radiation transfer, we use inter-package coupling by connecting the output from a radhydro package to the input of the front tracking code. Here a high order interpolation algorithm is needed to transfer states from the radiation output to the hydro input since different grid systems are used in these two packages. The radiation heat rate will be mapped to an energy source for the front tracking code in its time-space grid.