

# **Stony Brook University The Graduate School**

## **Doctoral Defense Announcement**

### **Abstract**

**Breaking Temperature Equilibrium for Mixed Cell Hydrodynamics**

**By**

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Eulerian numerical schemes work well for smooth single-component hydrodynamical flow modeling. For multicomponent flows in compressible regimes, the emergence of large gradients in flow variables and the presence of material contacts degrade the quality of traditional Eulerian finite difference methods. Although higher order Godunov methods adequately capture shocks, artificial diffusion at contacts leads to poorly resolved interfaces. Many techniques, such as adaptive mesh refinement, interface preservers and explicit interface treatments, have been proposed to address these problems.

We study two Eulerian codes that adopt different techniques to overcome the difficulties of modeling multicomponent compressible hydrodynamics. RAGE, a code developed for the U.S. Department of Energy's Advanced Simulations and Computing program, implements adaptive mesh refinement (AMR) to improve resolution of shocks and contacts. FronTier, a code developed at Stony Brook, resolves contacts and prevents numerical diffusion by tracking material interfaces and maintaining the jump in states across interfaces. The use of mixed cells distinguishes RAGE from FronTier. In RAGE, interfaces exist implicitly in mixed cells, where the code assumes pressure, temperature and velocity equilibrium among the multiple material components present, while FronTier maintains an explicit interface across material contacts. Although the equilibrium assumption of RAGE provides desirable mathematical properties and a relatively simple numerical implementation, the model depends on a microphysical assumption of that may not be valid for some shock interactions.

By studying and comparing test problem results from FronTier and RAGE, we investigate how the mixed cell equilibrium assumption influences flow hydrodynamics. In particular we consider several one and two--dimensional test problems. For the one--dimensional test problems and a two--dimensional test problem with similar materials, the two codes produce qualitatively similar results. However, in two dimensional Richtmyer--Meshkov instabilities with strong shocks and high contrast materials, we find that the pressure--temperature--velocity equilibrium assumption leads to large scale differences in the interface structure and relevant thermodynamic variables.

**Date:** September 21, 2007

**Program:** Applied Math and Statistics

**Time:** 10:00 am

**Dissertation Advisor:** John Grove

**Place:** (Building, Room No.)