Abstract Submitted
for the APR10 Meeting of
The American Physical Society

New Equation of State for Supernova Simulations GANG SHEN, CHUCK HOROWITZ, Indiana University Bloomington — In this work, we calculate the equation of state (EoS) of nuclear matter for a wide range of temperatures, densities, and proton fractions for use in supernova and neutron star merger simulations. We employ a full relativistic mean field (RMF) calculation for matter at intermediate density and high density, and the Virial expansion of a nonideal gas for matter at low density. This is an improvement over the Lattimer-Swesty equation of state, that uses a simple liquid drop model, and the H. Shen and Toki equation of state, that uses the Thomas Fermi and variational approximations. We use the RMF parameter set NL3, and approximate the unit cell for non-uniform nuclear matter as a spherical Wigner-Seitz cell, wherein the mean fields of nucleons are solved fully self-consistently. The Virial gas consists of neutrons, protons, alpha particles, and 8980 species of nuclei with masses from FRDM mass tables. As the density decreases, the mean field results match smoothly to the Virial gas. At very low density, the Virial expansion reduces to nuclear statistical equilibrium. We tabulate the resulting EoS at over 100,000 grid points in the temperature range $T = 0 \sim 80$ MeV, the density range $n_B = 10^{-8} \sim 1.6$ fm^{-3}, and the proton fraction range $Y_P = 0 \sim 0.56$. This table will soon be available for supernova and neutron star merger simulations.

Gang Shen
Indiana University Bloomington

Date submitted: 25 Oct 2009 Electronic form version 1.4