DNP12-2012-020214

Abstract for an Invited Paper
for the DNP12 Meeting of
the American Physical Society

Dissertation Award in Nuclear Physics: Nuclear Equation of State in Astrophysics: Effect of Nuclear Symmetry Energy

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The equation of state for neutron rich matter plays a central role in many areas of nuclear astrophysics. One of key unknowns is the nuclear symmetry energy and its density dependence, which defines how different the neutron rich matter is from symmetric nuclear matter. I will discuss in detail a framework to generate a set of complete nuclear equations of state at finite temperature with distinct nuclear symmetry energy for the study of core collapse supernova and binary neutron star mergers. I will illustrate that, iso-vector interactions which give rise to the nuclear symmetry energy alter the kinematics of charged current reactions for electron neutrino and anti-neutrino in proto-neutron star. The electron fraction in the neutrino driven wind can thus be influenced by the nuclear symmetry energy. I will also describe a connection between the nuclear symmetry energy and the convection in proto-neutron star: it may have observable signature in the supernova neutrino signal, which can be measured in large water detectors such as SuperK.