Relativistic EOS of supernova matter with strangeness

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The equation of state (EOS) plays an important role in high density phenomena such as high energy heavy-ion collisions, neutron stars, and supernova explosions. Until now, the two sets of EOS (Lattimer-Swesty EOS \cite{1} and Shen EOS \cite{2}) have been widely used and applied to numerical simulations of core-collapse supernovae. The constituents in these EOSs are neutrons, protons, alpha-particles and nuclei, restricting the framework within the non-strange baryons. In order to clarify the long-time evolution of core collapse to proto-neutron star cooling and the formation of black hole, and neutron star mergers that may involve higher density/temperature, it would be necessary to include other particle degrees of freedom. Especially, hyperons (baryons containing strange quarks) are commonly believed to appear in neutron star core and to modify the neutron star profile.

In this paper, we present relativistic EOSs with hyperons under the current understanding of interaction \cite{3}. Starting from the SU(3) relativistic mean field theory \cite{4}, we modify the scalar meson-baryon couplings to fit recently suggested depth of $\Sigma$ and $\Xi$ potentials in nuclear matter \cite{3}. Hyperon fraction can be large at high density ($\rho_B > 3\rho_0$) or at high temperature ($T > 40$ MeV). While these extreme conditions may not be reached in prompt explosions, hyperons may play important roles in black hole formation processes as well as in neutron stars.

In the presentation, we discuss how we can determine hyperon potentials in nuclear matter, and we also discuss the role of thermal pions in supernova matter.

References