Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Nuclear matter Equation of State and Brown-Rho scaling

By

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Nuclear matter equation of state (EoS) is a longstanding problem in both nuclear physics and astrophysics. A primary focus of our research has been the derivation of a reliable EoS microscopically, staring from the basic nucleon-nucleon (NN) interactions. The use of two-nucleon interactions alone is unable to obtain the empirical nuclear matter saturation properties (E/A=-16 MeV and n_0=0.16 fm^{-3}). We have studied the medium effects from the Brown-Rho (BR) scaling and three-nucleon forces, and found that their inclusion is essential in satisfactorily reproducing the nuclear-matter saturation properties. Our calculated EoS in the high density ($~5n_0$) region is consistent with the heavy-ion collision experiment data.

With our EoS for pure neutron matter, we have studied the dilute fermionic system at the unitary limit (scattering length approaching infinity), where the ratio of ground-state energy over that of the non-interaction system is believed to be a universal constant. We have calculated this ratio for the cold neutron matter and obtained a constant ratio close to 0.44, which is considered one of the best estimations.

Neutron stars are a unique nature laboratory for testing the nuclear matter EoS, especially in the high density region. We have applied our EoS to the Tolman-Oppenheimer-Volkoff equations and calculated the neutron star's mass, radius and moment of inertia. It is found that our EoS could support a neutron star with mass up to $~1.8M_{sun}$, which is close to the newly observed two-solar mass neutron star.

The nuclear symmetry energy is a topic of much current interest in nuclear physics. We have studied its density dependence and found the symmetry energy increases monotonically. Our results are compared with experimental data.

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