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Bayesian Inference of High-density Nuclear Symmetry Energy from Radii of Canonical Neutron Stars

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Using the representative $R_{1.4}$ data in the literature, we infer the
high-density nuclear symmetry energy $E_{\rm sym}(\rho)$ and the associated nucleon specific energy $E_0(\rho)$ in symmetric nuclear matter (SNM) within a Bayesian statistical approach using an explicitly isospin-dependent parametric Equation of State (EOS) for nucleonic matter under several general conditions required for all NS models. The most important new physics we learned from this study are:
(1) The available astrophysical data can already improve significantly our knowledge about the $E_0(\rho)$ and $E_{\rm sym}(\rho)$ in the density range of $\rho_0 - 2.5\rho_0$ compared to what we currently know about them based mostly on terrestrial nuclear experiments and predictions of nuclear many-body theories.
In particular, the symmetry energy at twice the saturation density of nuclear matter is determined to be $E_{\rm sym}(2\rho_0)$ =39.2$^{+12.1}_{-8.2}$ MeV at 68\% confidence level approximately independent of the EOS parameterizations used. However, at higher densities, the 68\% confidence boundaries for both the $E_0(\rho)$ and $E_{\rm sym}(\rho)$ diverge depending strongly on the EOS parameterizations used and several other uncertainties.(2) The radius data and other general conditions, such as the observed NS maximum mass and causality condition introduce strong correlations for the high-order parameters used in parameterizing the $E_0(\rho)$ and $E_{\rm sym}(\rho)$.(3) The value of the observed maximum NS mass and whether it is used as a sharp cut-off for the minimum maximum mass or through a Gaussian distribution in the Bayesian analyses affect significantly the lower boundaries of $E_0(\rho)$ and $E_{\rm sym}(\rho)$ only at densities higher than about $2.5\rho_0$.

Abstract Type

Poster

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