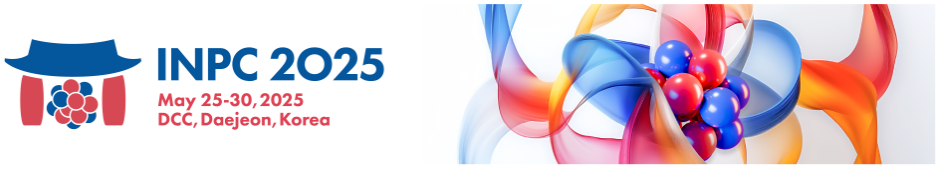

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Fine-Features of Nuclear Equation of State from Bayesian Analyses of Future Neutron Star Radius Measurements to 0.1 km Accuracy

Friday, 30 May 2025 11:00 (15 minutes)

To more precisely constrain the Equation of State (EOS) of supradense neutron-rich nuclear matter, future high-precision X-ray and gravitational wave observatories are proposed to measure the radii of neutron stars (NSs) with an accuracy better than about 0.1 km. However, it remains unclear what particular aspects (other than the stiffness generally spoken of in the literature) of the EOS and to what precision they will be better constrained. In this talk, we report results of a recent study [1] within a Bayesian framework using a meta-model EOS [2,3] for NSs. In particular, we infer the posterior probability distribution functions (PDFs) of incompressibility K_0 and skewness J_0 of symmetric nuclear matter (SNM) as well as the slope L, curvature $K_{\rm sym}$, and skewness $J_{\rm sym}$ characterizing the density dependence of nuclear symmetry energy $E_{\rm sym}(\rho)$, respectively, from mocked NS radii from future measurements with accuracy ΔR ranging from about 1.0 km to 0.1 km. We found that (1) the ΔR has little effect on inferring the stiffness of SNM at suprasaturation densities, (2) smaller ΔR reveals more accurately not only the PDFs but also pairwise correlations among parameters characterizing high-density $E_{\rm sym}(\rho)$, (3) a double-peak feature of the PDF($K_{\rm sym}$) corresponding to the strong $K_{\rm sym}-J_{\rm sym}$ and $K_{\rm sym}-L$ anti-correlations is revealed when ΔR is less than about 0.2 km, and the locations of the two peaks are sensitive to the maximum value of $J_{\rm sym}$ reflecting the stiffness of $E_{\rm sym}(\rho)$ above about 3 times the saturation density ρ_0 of SNM, (4) the high-precision radius measurement for canonical NSs is more useful than that for massive ones for constraining the EOS of nucleonic matter around $(2-3)\rho_0$.

References

[1] Bao-An Li et al., Phys. Rev. D 110 (2024) 10, 103040
[2] Nai-Bo Zhang and Bao-An Li, Astrophys. J. 921 (2021) 2, 111
[3] Wen-Jie Xie and Bao-An Li, Astrophys. J. 899 (2020) 1

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