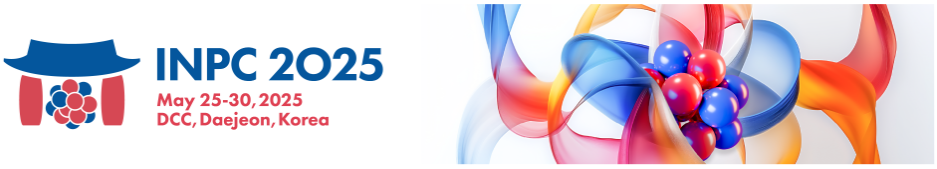

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Constraining of Nuclear Matter Equation of States with Rotating Neutron Stars

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In terrestrial experiments one may extract information about the nuclear equation of state (EoS) near saturation density. Developments of astronomical observation technology have enabled the study of the EoS at higher densities, which are difficult to replicate experimentally, through information derived from astronomical phenomena of neutron star. These observational findings not only allow for the validation of parameter sets in existing nuclear models within high-density regimes but also provide valuable data for refining parameters during the model-fitting process.

An example of parameter fitting is incorporating neutron star mass-radius curves. However, most EoS studies involving neutron stars utilize the Tolman-Oppenheimer-Volkoff (TOV) equation, which assumes a spherically-symmetric hydrostatic equilibrium state. Needless to say, neutron stars rotate, and this rotation can deform their equilibrium shape, potentially altering the mass-radius relationship. Among the numerical methods developed to model rotating celestial objects, the Komatsu-Eriguchi-Hachisu (KEH) method, proposed in 1989 [1], is considered the most stable and reliable.

In this study, we have newly developed a computational code of the KEH method and applied it to describe rapidly rotating neutron stars with nuclear EOSs based on Skyrme and Gogny interactions. We have found that M-R relation changes substantially when angular frequency exceeds about 500 Hz. Namely, for a given central density, both mass and radius are increased by the rotational effect. Specifically, the shape of a neutron star with 1.4 solar mass is deformed in oblate shape with a ratio of longer and shorter axes roughly 0.93 to 0.83 for angular frequency 600 Hz to 800 Hz in case of SLy230a EoS. It underlines the importance of considering rotational effects on the M-R relations in assessing EoS against observational data. In this talk, we will discuss possible implications of our findings for astrophysical modeling of neutron stars.

[1] H. Komagtsu, Y. Eriguchi, I. Hachisu, Mothly Notice. Sup. **237**, 355-379(1989)

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