28 February 2025 ·

Qeios

Peer Review

Review of: "General Features of the Stellar Matter Equation of State From Microscopic Theory, New Maximum-Mass Constraints, and Causality"

Martin Veselský[1]

1. Czech Technical University of Prague, Czech Republic

The manuscript “General Features of the Stellar Matter Equation of State From Microscopic Theory, New Maximum-Mass Constraints, and Causality” by Francesca Sammarruca and Tomiwa Ajagbonna presents investigations of the equation of state of hadronic matter in neutron stars. The equation of state is represented by the model of chiral effective field theory at lower densities and by a polytrope at higher densities. Possible values of polytropic exponents are obtained after applying constraints on properties of neutron stars such as the maximum mass and radius at the canonical mass. The obtained EoS are then applied to the description of neutron star cooling.

The description of the chiral EFT method does not go into much detail, so I don’t have any comments on that. I am wondering about the choice of transition density at 0.277 fmˆ-3, which is less than twice the nuclear saturation density. Is it due to limitations of the model, not allowing it to describe higher densities? In any case, I assume that the given model can also describe symmetric nuclear matter, and in that case, further constraints could be applied based, e.g., on the systematics of Danielewicz et al. (Danielewicz, Lacey, Lynch, Science 298, 1592 (2002)), obtained using nuclear reaction data. Such results could further elucidate the conclusion presented in the present work that the first polytropic exponent is larger than the second one at higher densities.

Concerning the cooling of the neutron stars, the presentation of results in Figures 6-8 is not easy to decipher, but if I understand correctly the color code applied to both symbols and lines, the model description predicts faster cooling for the heaviest neutron stars than the observed data show. It is possibly a standard behavior, but it would be worth a short comment. Could it be that, e.g., non-

 doi.org/10.32388/MEHQYV

nucleonic degrees of freedom might allow a higher proton fraction and thus a faster onset of DU cooling than in the purely nucleonic scenario?

In conclusion, I think that the manuscript can be published after providing comments on the questions given above.

Declarations

Potential competing interests: No potential competing interests to declare.

doi.org/10.32388/MEHQYV