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Nambu–Jona-Lasinio description of hadronic matter from a Bayesian approach

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A microscopic nuclear matter formalism with explicit chiral symmetry based on the Nambu Jona-Lasinio model is considered to describe nuclear matter. To reproduce nuclear matter properties adequately at the saturation density, four-point and eight-point interactions are introduced. Within a Bayesian inference approach, the parameters of the model are determined by imposing nuclear matter, both experimental and from ab-initio calculations, and neutron star observational constraints. Nuclear matter properties are well reproduced with an effective mass of 0.75 to 0.8 nucleon mass at the saturation density. At 90% confidence level, the radius of a 1.4 $M_\odot$ star varies between 11.48 km and 13.20 km, masses as large as 2.2 $M_\odot$ are predicted and the radius of a 2 $M_\odot$ star is above 10.5 km. High-density perturbative QCD (pQCD) results exclude equations of state that predict larger maximum masses and radii. The speed of sound increases monotonically with density and reaches values as large as $\sqrt{0.7}c$–$\sqrt{0.8}c$ in the center of massive stars. Several properties such as the polytropic index or the renormalized trace anomaly, that have been proposed to identify the deconfined phase transition, are analyzed. Interestingly, the radius of the obtained posterior that also meets pQCD constraints aligns closely with the mass-radius measurement of the recent PSR J0437-4715, which contrasts with other relativistic mean field model results.

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