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Constraining the nuclear equation of state from terrestrial experiments and neutron star observations using relativistic mean-field models

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The accurate measurement of the neutron skin thickness of ^{208}Pb by the PREX collaboration, using parity-violating electron scattering, has revealed a significant discrepancy between the experimental result and theoretical predictions. To explain the PREX-2 data, a large slope parameter of the nuclear symmetry energy, L , is required. However, a smaller value of L is favored to account for the compact neutron star radii indicated by the precise measurements from NICER mission. In particular, a NICER view of the fourth pulsar, PSR J1231-1411, provides the stringent constraint on a neutron star radius. To address this tension between terrestrial experiments and astrophysical observations, we construct nuclear equations of state using recently developed effective interactions within the relativistic mean-field (RMF) model, incorporating isoscalar- and isovector-meson mixing (Astrophys. J. 929 (2022) 82; Phys. Lett. B 843 (2023) 138013; arXiv:2411.13210). We investigate the effects of scalar-isovector meson and its mixing on asymmetric nuclear matter, finite nuclei, and neutron star matter, with particular focus on the density dependence of the nuclear symmetry energy. Our findings reveal that the nuclear symmetry energy softens around twice the nuclear saturation density due to scalar-meson mixing. This feature allows for a simultaneous explanation of the PREX-2 data and astrophysical observations from NICER and GW170817. Additionally, we discuss the result of the neutron skin thickness of ^{48}Ca from the CREX experiment.

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