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Dependence of the bulk viscosity of neutron star matter on the nuclear symmetry energy

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We investigate the weak-interaction-driven bulk-viscous transport properties of npe matter in the neutrino transparent regime. This work complements our recent study that shows that the dynamics of neutron star mergers away from beta equilibrium can be precisely described by an Israel-Stewart formulation with far-from-equilibrium bulk and relaxation time transport coefficients, which are strongly affected by the nuclear symmetry energy [1]. In this work, we designed a simple parametric model for the equation of state and the bulk viscosity that satisfies all the thermodynamics (causality and stability) and observational constraints from LIGO/VIRGO and NICER. This parametric model explicitly depends on the nuclear symmetry energy parameters and is ideal for studying their effects on equilibrium and out-of-equilibrium properties. With this new model, we systematically show how the transport coefficients vary with the nuclear symmetry energy. We also discuss how the nuclear symmetry energy affects gravitational-wave observables, such as the dissipative tidal deformability [2] present in the inspiral phase of neutron star mergers.

[1] Y. Yang, M. Hippert, E. Speranza, and J. Noronha, "Far-from-equilibrium bulk-viscous transport coefficients in neutron star mergers", Phys. Rev. C 109, 015805 (2024).

[2] J. L. Ripley, A. Hegade K. R., R. S. Chandramouli, and N. Yunes,"First constraint on the dissipative tidal deformability of neutron stars," Nat. Astron. 8, 1277 (2024)

Category

Theory

Collaboration (if applicable)

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