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Structure in the speed of sound: from neutron stars to heavy-ion collisions

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Neutron star equations of state that can sustain heavy neutron stars over 2 Msun necessitate a large, rapid rise in the speed of sound. The family of equations of states, which assume electric neutrality along beta equilibrium and vanishing temperatures, with large bumps in the speed of sound have been suggested to be incompatible with the equation of state extracted from heavy-ion collisions. If it is true that heavy-ions exclude large bumps in the speed of sound up to values close to the causal limit, then this in turn excludes the possibility of ultra-massive neutron stars (i.e. up to 2.5 Msun).
In our studies, we convert equations of state with a bump in the speed of sound that are compatible with massive neutron stars to nearly symmetric nuclear matter using the nuclear symmetry energy expansion with 4 coefficients. With a range of different coefficients, we are able to obtain upper and lower bounds for converted symmetric nuclear matter with causality and stability constraints. We compare our converted equation of state with heavy-ion collision data by the hadronic transport method SMASH with the mean-field potential.

Category

Theory

Collaboration (if applicable)

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