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Inferring the Equation of State from Neutron Star Observables via Machine Learning

We have conducted an extensive study using a diverse set of equations of state (EoSs) to uncover strong relationships between neutron star (NS) observables and the underlying EoS parameters using symbolic regression method. These EoS models, derived from a mix of agnostic and physics-based approaches, considered neutron stars composed of nucleons, hyperons, and other exotic degrees of freedom in beta equilibrium. The maximum mass of a NS is found to be strongly correlated with the pressure and baryon density at an energy density of approximately 800 MeV.fm^{-3}. We have also demonstrated that the EoS can be expressed as a function of radius and tidal deformability within the NS mass range 1-2$M_{\odot}$. These insights offer a promising and efficient framework to decode the dense matter EoS directly from the accurate knowledge of NS observables.

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