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A Bayesian approach to revisit the dense matter equations of state in light of the compact object HESS J1731-347

The recent observation of the compact object HESS J1731-347, with a mass of $0.77\ ^{+0.20}_{-0.17}\ \mathrm{M}_{\odot}$ and radius $10.4^{+0.86}_{-0.78}$ km, make it one of the most intriguing objects if it truly is a neutron star. In this paper, we explore the dense matter equation of state (EoS) in the context of this object being a neutron star. We consider three EoS categories—neutron stars, strange stars, and hybrid stars—and apply Bayesian model selection to evaluate them. Our results indicate that for hadronic models, a stiffer EoS at intermediate densities is favored. Consequently, the Brueckner-Hartree-Fock approximation and models using Effective-interactions diverge from recent astrophysical data when HESS J1731-347 is included. For strange stars, EoSs with three-flavor quark matter prefer smaller bag parameters. When examining hybrid EoS models with a first-order phase transition, we find a tendency for early phase transitions. Overall, when comparing preferred EoS across these categories, hybrid EoSs best align with current astrophysical constraints.

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