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Hybrid Nuclear Matter EOS with Color Superconducting Quark Phase: Bayesian Constraints from Observations

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We perform a Bayesian analysis of the equation of state (EOS) constraints using recent observational data, including pulsar masses, radii, and tidal deformabilities. Our focus is on a class of hybrid neutron star EOS that incorporates color superconducting quark matter, based on a recently developed nonlocal chiral quark model. The nuclear matter phase is described using a relativistic density functional approach within the DD2 class, while the phase transition between nuclear and quark matter is described using a Maxwell construction.

Our analysis identifies a region within the two-dimensional parameter space, defined by the vector meson coupling and scalar diquark coupling, where the observational constraints are met with the highest probability (90% of the maximum). We present the overlap of this region with those where other properties are fulfilled:

1. A strong phase transition that produces a third family of compact stars.
2. A maximum mass of the hybrid neutron star that exceeds that of the purely nucleonic star.
3. An onset mass for quark deconfinement below one solar mass.

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