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The equation of state of dense QCD and the stability of massive neutron stars PHILIP POWELL, Lawrence Livermore National Laboratory, GORDON BAYM, University of Illinois at Urbana-Champaign, TORU KOJO, Central China Normal University, YIFAN SONG, University of Illinois at Urbana-Champaign — The properties of extreme quantum chromodynamic (QCD) matter have historically been largely a matter of speculation, with predictions heavily dependent on model assumptions or asymptotic approximations. However, recent neutron star mass and radius measurements, heavy-ion collision experiments, and lattice QCD simulations are providing the first significant empirical insights into the QCD phase diagram and present an opportunity to constrain effective models of extreme QCD matter. We investigate a hybrid nuclear-quark model that incorporates the well-established properties of hadronic matter at densities < 2 times nuclear density (n_0) with a symmetry-based interacting quark model expected to be valid for densities above $\sim (4-6)n_0$. By obtaining empirical constraints on model parameters, we demonstrate the possibility of a smooth crossover between low temperature hadronic and quark matter at $\sim (2-3)n_0$, characterized by a gradual onset of the quark degrees of freedom with increasing density. Such a crossover is consistent with the stability of neutron stars of mass 2 solar masses. Finally, we obtain significant constraints on the structure of the QCD phase diagram, including the location of possible critical points and dense superfluid quark matter.

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