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Delineating the properties of neutron star matter in cold, dense QCD

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The properties of dense QCD matter are delineated through the construction of equations of state which should be consistent with QCD calculations in the low and high density limits, nuclear laboratory experiments, and the neutron star observations. These constraints, together with the causality condition of the sound velocity, are used to develop the picture of hadron-quark continuity in which hadronic matter continuously transforms into quark matter (modulo small 1st order phase transitions). The resultant unified equation of state at zero temperature and beta-equilibrium, which we call Quark-Hadron-Crossover (QHC18 and QHC19), is consistent with the measured properties of neutron stars and in addition gives us microscopic insights into the properties of dense QCD matter. In particular to $10n_0$ the gluons can remain as non-perturbative as in vacuum and the strangeness can be as abundant as up- and down-quarks at the core of two-solar mass neutron stars. Within our modeling the maximum mass is found less than 2.35 times solar mass and the baryon density at the core ranges in $5-8n_0$.

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