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The Quark-Hadron Phase Transition in Neutron Stars and Protoneutron Stars JACOB B. ROARK, Department of Physics, Kent State University — Neutron stars have masses between 1.4 and 3 $M_{\odot}$, all packed into a sphere just 12 to 13 km across (roughly the size of Manhattan). Consequently, neutron stars exhibit some the of highest material densities in the universe, averaging around 7×10^{17} kg/m^3, over three times the density of an atomic nucleus. Under such astronomical pressures, some very interesting, novel states of matter can be achieved, such as quark matter, in which nucleons effectively dissolve and quark deconfinement occurs. In this project, the quark-hadron phase transition was studied for three different scenarios: neutron stars, neutron stars with mixed phases, and protoneutron stars (in which lepton fraction must be conserved). A quantum hadrodynnamic effective model based on the spontaneous breaking of chiral symmetry was employed to achieve this data, along with a mean field approximation. In each case, the point at which phase transitions no longer occur (the critical point) was found, characterized by temperature and baryon chemical potential. For neutron stars, the critical point was found to occur at T=168.82 MeV and μ_B=230.05 MeV; for neutron stars with mixed phases, T=168.86 MeV and μ_B=226.50 MeV; and for protoneutron stars, T=168.82 MeV and μ_B=247.25 MeV.

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