APR21-2021-000706

Abstract for an Invited Paper
for the APR21 Meeting of
the American Physical Society

Neutron stars and the properties of matter under extreme conditions[1]

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Neutron stars were first posited in the early thirties, and discovered as pulsars in the late sixties; however we are only recently beginning to understand the matter they contain. I will describe, semi-historically, the ongoing development of a consistent picture of the liquid interiors of neutron stars, driven by observational as well as theoretical advances. These include observations of now three heavy neutron stars of ~ 2.0 solar masses and higher; simultaneous inferences of masses and radii of neutron stars via the NICER telescope, as well as earlier in low mass X-ray binaries; and past and future observations of binary neutron star mergers, through gravitational waves as well as across the electromagnetic spectrum. Theoretically an understanding is emerging in QCD of how nuclear matter can turn into deconfined quark matter in the interior, and be capable of supporting heavy neutron stars. With this as a basis I will discuss modern quark-hadron crossover equations of state, and comparison of their predictions with current observations.

[1]Research supported over the years by the National Science Foundation Grants from GP 4937 through to PHY1714042.