

Neutron stars and quark stars: two coexisting families of compact stars and pulsars?

Jürgen Schaffner-Bielich

Institut für Theoretische Physik/Astrophysik, J. W. Goethe Universität, Frankfurt am Main

ABSTRACT: The mass-radius relation of compact stars is studied in various nuclear field theoretical models. Parameter sets can be constrained to properties of nuclei. However, at large enough densities, new exotic particles appear in the interior, in particular strange baryons, hyperons. Their appearance can be constrained by hypernuclear data. At even further densities, a phase transition to quark matter can be present in the core of neutron stars. If the transition is first order, as suggested by our present understanding of QCD at high densities, one can show that there exists a new solution to the Tolman-Oppenheimer-Volkov equation. This new solution is stable and constitutes the so-called third family of compact stars, besides normal neutron stars and white dwarfs. Hence, there can coexist two different kinds of pulsars, one associated with ordinary neutron stars, the other one with compact stars with a quark core: quark stars.

We contrast recent neutron star measurements with the notion of having two kinds of pulsars. We will discuss constraints from recently measured astrophysical observations as radiation radii, pulsar mass measurements, QPO's etc. Implications for other astrophysical systems for the existence of quark matter in compact stars is outlined, like signals in gamma-ray bursts, gravitational wave emission from collapsing neutron stars to quark stars and proto-neutron star formation in supernovae.