Equations of State for Mixed Stars

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Landau predicted the possible existence of a neutron star after the neutrons were discovered by Chadwick in 1932. In 1934, it was suggested that neutron stars were formed after a supernova explosion, which happens when the core of a very massive star undergoes gravitational collapse. The first supernova explosion was registered in 1054 by the Chinese. The Crab Nebula in the Taurus constellation is the remnant of this explosion. Recently, a supernova explosion was observed in the Magellanic Cloud 170,000 light years from the Earth. Once the gravitational collapse of a massive star with mass of the order or larger than 8 solar masses takes place, a protoneutron star can be formed. Several different stages may happen during the evolution process. The protoneutron stars are known as evolutionary endpoints and they slowly cool down to form a neutron star, which is a stable and cold compact star. The structure of compact stars is characterized by its mass and radius, which in turn are obtained from appropriate equations of state (EOS) at densities about one order of magnitude higher than those observed in ordinary nuclei. At these densities, relativistic effects are certainly important. In this work we investigate the properties of mixed stars formed by matter described by appropriate equations of state. The equations of state are built from a hadronic, a mixed and a quark phase. We have used the non-linear Walecka model for the hadron matter and the MIT Bag and the Nambu-Jona-Lasinio models for the quark phase. The calculations were performed for $T = 0$ and for finite temperatures in order to describe neutron and protoneutron stars. The star properties are discussed.