Equation of state for neutron stars: Hyperon mixing in SU(3) flavor symmetry

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Using several relativistic mean-field models (such as GM1, GM3, NL3, TM1, FSUGold and IU-FSU) as well as the quark-meson coupling (QMC) and chiral quark-meson coupling (CQMC) models, we calculate the properties of neutron stars within relativistic Hartree approximation. In determining the couplings of the isoscalar, vector mesons to the octet baryons, we examine the extension of SU(6) spin-flavor symmetry based on quark model to SU(3) flavor symmetry. Furthermore, we consider the strange (\(\sigma^*\) and \(\phi\)) mesons, and study how they affect the equation of state for neutron stars. As a result, we find that the equation of state in SU(3) symmetry can sustain a neutron star with mass of \((1.8 \sim 2.1)M_\odot\) even if hyperons exist inside the core of a neutron star. In Figure 1, we present the mass-radius relations in the QMC, CQMC, GM1 and TM1 models, and these models in SU(3) symmetry can explain the mass of PSR J1614-2230 [1]. Therefore, the extension from SU(6) to SU(3) symmetry and the strange vector (especially \(\phi\)) meson play important roles in supporting a massive neutron star. In addition, the variation of baryon structure in matter using the QMC and CQMC models is also significant to describe a heavy neutron star.

![Figure 1: Mass-radius relations in the QMC, CQMC, GM1 and TM1 models (left: QMC and CQMC, right: GM1 and TM1). In each model, we calculate three cases: (1) only the non-strange mesons (\(\sigma, \omega\) and \(\rho\)) are included in SU(6) symmetry; (2) all the mesons including the \(\sigma^*\) and \(\phi\) are considered in SU(6) symmetry; (3) all the mesons are included in SU(3) symmetry. The shaded area shows the mass of PSR J1614-2230, \(1.97 \pm 0.04M_\odot\) [1].](image)