The hyperon puzzle in neutron stars

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Neutron star mass measurements provide an observational test bed for probing matter at supra-nuclear densities. Particularly, the measured masses, $M = 1.97 \pm 0.04\, M_{\odot}$ and $M = 2.01 \pm 0.04\, M_{\odot}$ of the neutron stars in PSR J1614-2230 and PSR J0348+0432 respectively have provoked a crisis for many of the current models for the equation of state (EOS) of dense matter. The case of the EOS for hyperonic matter, derived within microscopic many-body approaches based on two-body and three-body interactions among baryons, is emblematic. In fact, using these EOS models and solving the stellar structure equations in general relativity, one obtains maximum stellar masses well below the observational limit of 2 $M_{\odot}$.

Due to the large value of the central density of neutron stars and to the rapid increase of the neutron and proton chemical potentials with density (as a consequence of their fermionic nature), hyperons are expected to appear in the inner core of neutron stars above a baryon density of about 2 - 3 times the nuclear matter saturation density. Thus the presence of hyperons in neutron stars seems unavoidable, unless some physical mechanism prevents their formation.

This conflict between the predictions of stellar models based on microscopic EOS for hyperonic matter and the measured neutron star masses is known in the literature as “the hyperon puzzle in neutron stars”.

In this talk I will briefly illustrate the present status of microscopic calculations of hyperonic matter and their applications to neutron star physics. I will later discuss some possible solutions for the hyperon puzzle in neutron stars and I will also shortly introduce the other talks of this topical session of the 12th International Conference on Hypernuclear and Strange Particle Physics.