Asymmetric Neutrino Reaction from Magnetized Proto-Neutron Stars in fully Relativisitc Framework including Hyperons

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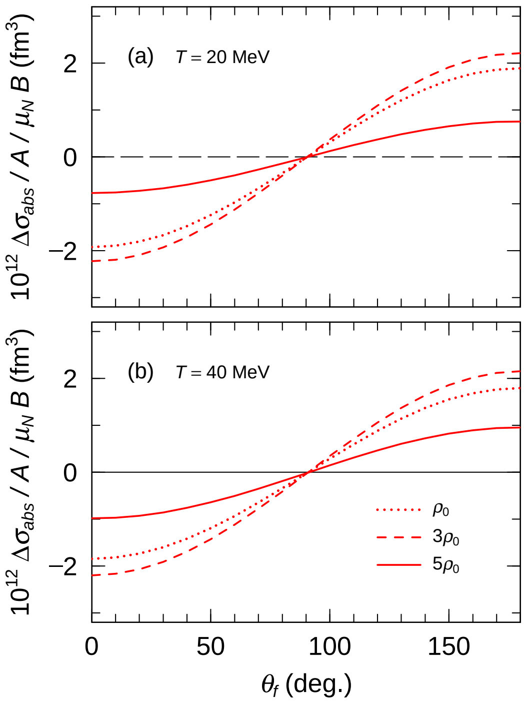
A new type of neutron star, called magnetar, which is associated with a super strong magnetic field has been discovered. It is therefore requisite to improve models of hot and dense hadronic matter which is presumed to manifest in the neutron star under strong magnetic field [2]. Neutrino emission as well as GW is the unique observable that provides signals of the change of internal structure of the neutron star [3]. In this paper we show, for the first time, our calculated scattering and absorptive neutrino cross sections in the hot and dense hadronic matter with hyperons under strong magnetic field [1].



Here we assume that there is uniform magnetic field along z-direction as $B = B\hat{z}$. Even adtronomically strong magnetic filed is still weaker than the strong interaction order: $\sqrt{eB} \ll \mu_a$, where μ_a is the chemical potential of the particle a. We therefore treat the magnetic field in the perturbative way, ignore the contribution from the conventional current, and thus consider only the spin-interaction. In this approximation the cross-section is given as

$$\sigma = \sigma_0 + \Delta\sigma \tag{1}$$

where σ_0 is independent of B, and $\Delta\sigma$ is proportional to B.

Figure shows $\Delta\sigma$ of the neutrino absorption part ($\nu_e \to e^-$) as a function of the incident neutrino angle θ_i, where the initial neutrino energy is taken to be the chemical potential. We found that the absorption cross-section is minimum at $\theta_i = 0°$ and maximum at $\theta_i = 180°$, leading to a vedry intersting phenomena that in the strong poloidal magnetic field, the neutrinos are strongly absorpted in the antarctic areas of the proto neutron stars. This result implies that the strong magnetic field could influence the pulser-kick and the cooling process of proto neutron stars. Furthermore, it is also expected to affect the spin-down of the proto neutron star under the toroidal magnetic field.

[1] T. Maruyama et al., in preparation.

[2] S. Reddy, M. Prakash and J.M. Lattimer, Phys. ReV. **D58**, 013009 (1998).

[3] P. Arras and D. Lai, Phys. Rev. **D 60** (1999) 043001.