Asymmetric Neutrino Emission from Magnetized Proto-Neutron Stars: Effects of Absorption Cross-Sections in Iso-Entropical Conditions [1]

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In our previous works [2], we calculated neutrino scattering and absorption cross sections on hot and dense magnetized proto-neutron-star (PNS) matter including hyperons under a strong magnetic field in a relativistic mean field (RMF) theory. The calculation results showed that the magnetic contribution increases the neutrino momentum emitted along the direction parallel to the magnetic field and decrease it along the opposite direction.

These works have been done in the isothermal model, which is not realistic because the temperature decrease as the radial position becomes farther from the center of the PNS. In addition, the mean-field used in the previous works cannot allow neutron stars mass of 2 $M_\odot$.

To get more realistic results, we introduce the new parameter-sets of RMF and calculate the neutrino cross-sections in the isoentropic conditions. Fig. 1 shows total energies per baryon, temperature profiles, and number fractions for constituent particles in an isoentropic system with entropy per baryon $S/A = 1$.

In Fig. 2, we show the magnetic part of the absorption cross-section as a function of the initial neutrino angle in the matter with $S/A = 1$ and $B = 10^{18}$ G.

At $\rho_B = \rho_0$, the magnetic field suppresses the absorption cross-sections in a direction parallel to the magnetic field by about 8.3 % for an entropy per baryon of $S/A = 1$. The suppression of σ_A for $S/A = 1$ at $\rho_B = \rho_0$ turns out to be much larger than in an isothermal model with $T = 20$ MeV, because the temperature at this density in the isoentropic model is only about $T = 7$ MeV. At lower temperature the magnetic contribution becomes larger. However, at higher densities and temperatures the suppression is comparable in the two models.

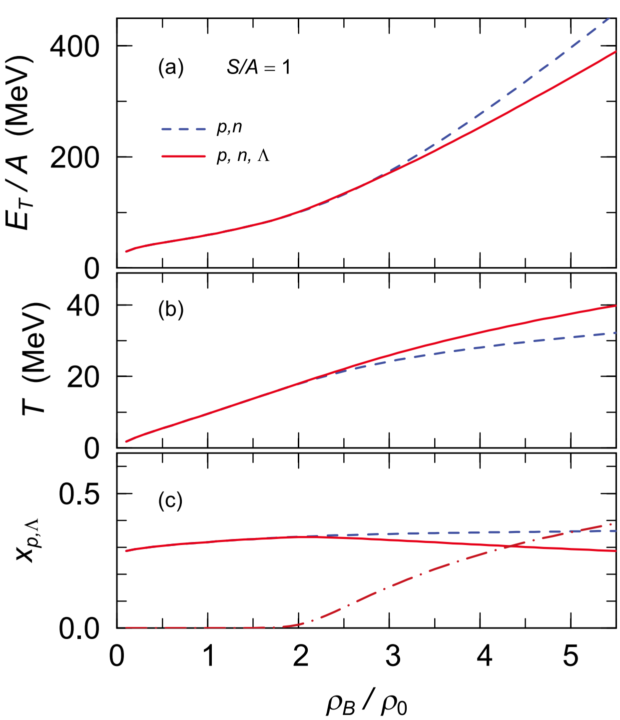

Figure 1: Density dependence of the total energy per baryon E_T/A (a), Temperature T (b) and proton fractions x_p of neutron-star matter at a lepton fraction $Y_L = 0.4$ and for entropy per baryon $S/A = 1$. Solid and dashed lines represent results with and without Λ particles, In the lower panel (c) a dot-dashed line indicates the x_Λ fraction.

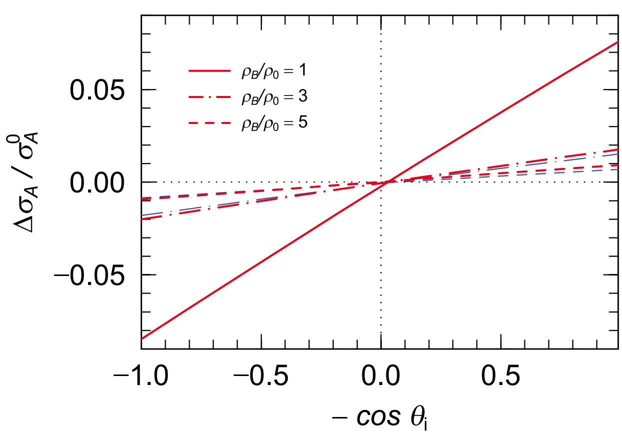

Figure 2: Ratio of the magnetic part of the absorption cross-section $\Delta\sigma_A$ to the cross-section without a magnetic-field σ_A^0. The thick and thin lines indicate the results for matter with and without Λs, respectively. The strength of the magnetic field is $B = 10^{18}$ G, and neutrino incident energies are taken to be equal to the neutrino chemical potentials.

References

[1] Maruyama, T., et al.: 2014, *Phys. Rev. D*, **90**, 067302.
[2] Maruyama, T., et al.: 2012, *Phys.Rev. D*, **86**, 123003.