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Towards a better description of neutrino opacity in hot and dense matter

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An accurate description of neutrino interaction in hot and dense nuclear matter is important to dynamics of core-collapse supernova (CCSN) explosion and nucleosynthesis in CCSN as well as neutron star mergers (NSMs). In this work, improvements regarding neutrino opacity calculations in different aspects are studied. Firstly, higher order weak interaction terms like weak magnetism and pseudo-scalar coupling are included with full form factor dependence. Secondly, nucleon energy shifts in low-density nuclear matter have been obtained by using virial expansion and the Brueckner-Hartree-Fock (BHF) approach based on chiral EFT interactions, which can lead to a relatively accurate charged current neutrino opacity in the neutrino sphere in CCSNe. Thirdly, nucleon-nucleon bremsstrahlung processes, which are believed to be important at relatively high density region for neutrino transport, have been revisited using in-medium T-matrix formalism. RPA effects can be further taken into account on top of the above improvements.

Primary author: GUO, Gang (GSI, Germany)

Presenter: GUO, Gang (GSI, Germany)

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