NEUTRINO PROCESSES WITH HOT NUCLEI IN SUPERNOVAE

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The significant role played by processes with neutrinos in core-collapse supernovae is well known [1]. At densities of $\rho > 10^{11}\, g\, cm^{-3}$ neutrino interactions with matter become important, leading to neutrino trapping and thermalization. Moreover, neutrino energy deposition behind the stalled shock may play a crucial role in successful explosion.

We study thermal effects on the cross sections and rates for neutrino-nucleus reactions occurring under supernova conditions. The approach we use is based on the thermal quasiparticle random phase approximation combined with the Skyrme energy density functional method (Skyrme-TQRPA). The approach enables self-consistent studies of neutrino reactions with hot nuclei in a thermodynamically consistent way, i.e., without assuming the Brink hypothesis and without violation the detailed balance principle. For the sample nuclei, ^{56}Fe and ^{82}Ge, the Skyrme-TQRPA is applied to analyze thermal effects on the strength function of charge-neutral and charge-exchange Gamow-Teller transitions which dominate neutrino-nucleus reactions at $E_\nu \leq 20\, MeV$. For the relevant supernova temperatures we calculate cross sections for neutrino inelastic scattering and absorption. The results are compared to those obtained from large-scale shell-model calculations [2,3] and possible reasons for the observed discrepancy are discussed . We also apply the method to examine the process of neutrino-antineutrino pair emission by hot nuclei.

REFERENCES

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