THERMAL EFFECTS ON NEUTRAL-CURRENT INELASTIC NEUTRINO SCATTERING CROSS SECTION[1]

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Neutral-current inelastic neutrino scattering on nuclei plays an important role in the evolution of the core collapse of a massive star towards a supernova explosion [1]. This process together with inelastic neutrino-electron scattering rapidly leads to an equilibrium between neutrinos and matter, helping to maintain a larger lepton fraction inside the core and, hence, to attain a stronger shock wave responsible for the supernova explosion. The problem is complicated by the fact that during the collapse neutrino-induced reactions occur at finite temperature for which the thermal population of nuclear excited states is expected to be important. Transitions from these states to low-lying final states can contribute to the enhancement of neutrino-nucleus cross sections (see, e.g., [2]).

We study thermal effects on inelastic neutral-current neutrino scattering on even-even nuclei in the iron region. It is assumed that allowed GT_0 transitions in the neutral channel dominate the inelastic cross section. To obtain the GT_0 strength distribution at finite temperature we employ the quasiparticle random phase approximation extended to finite temperature with the formalism of the thermo field dynamics [3]. It is found that a temperature growth increases the fraction of low- and negative-energy transitions in the GT_0 strength distribution (Fig. 1). The latter corresponds to transitions from thermally excited nuclear states to low-lying states. It is shown that at moderate neutrino energy $E_\nu < 10$ MeV the inelastic scattering cross section essentially depends on temperature (Fig. 2).

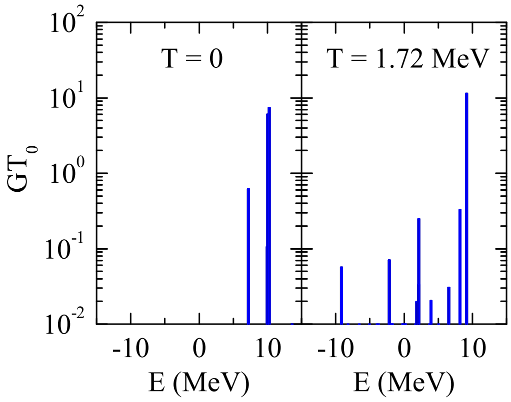

Fig. 1. Distribution of the GT_0 strength in cold and hot ^{54}Fe.

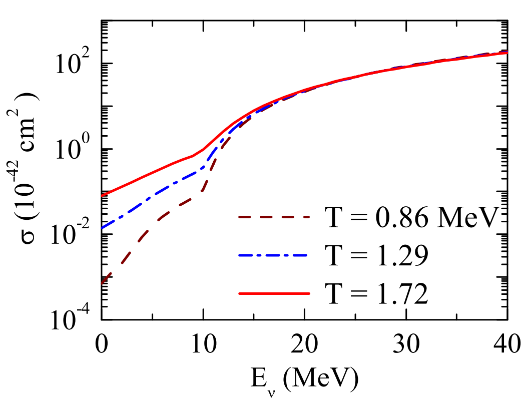

Fig. 2. Cross section of neutrino inelastic scattering on ^{54}Fe at different T.

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