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Neutrino(Antineutrino) Cross Sections in some Nuclear Targets at Supernova Neutrino Energies

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"Supernova explosion is a phenomena which occurs in the late phase of stellar evolution. In this explosion, most of the gravitational energy released in a core collapse is carried by the neutrinos. Such neutrino bursts carry about ≈ 2.5 x 1053 ergs of energy in a very short period of time [1]. It is considered that these neutrinos provide valuable information about the proto-neutron star core, its equation of state, core collapse and supernova explosion mechanism. This information will lead to a better understanding of supernova physics. With the observation of supernova neutrinos from SN1987A in Kamiokande, IMB and BAKSAN [2, 3] the feasibility of detecting such events in future is given serious consideration. Many detectors developed for neutrino oscillation experiments are also sensitive to the detection of supernova neutrinos. These detectors are either taking data or are in various stages of development. The interaction of neutrinos with dense neutron rich matter in the core results in the difference in the spectral distribution for the various neutrino families. With the development of fast computers, modeling for the supernova neutrino flux has tremendously improved. There are various groups presently working on the simulations, for example the groups of Duan et al. [4], Kneller et al. [5] and Totani et al. [6].

We shall present a new calculation of the inclusive reactions for supernova neutrinos in 40Ar, 56Fe and 208Pb for neutrino(antineutrino) induced charged current and neutral current processes. These calculations are done using local Fermi gas model [7] which takes into account Pauli blocking, Fermi motion effects and the Q-value of the reaction. The renormalization of weak transition strengths in the nuclear medium is also taken into consideration. The effect of Coulomb distortion of the outgoing lepton produced in charged reactions is taken into account by using Modified Effective Momentum Approximation(MEMA) [7] as well as Fermi function [7]. We find that these two methods of taking Coulomb interaction into account results in a large difference in the cross section at low energies. Furthermore, we have also studied the effect of nucleon correlations on the total scattering cross section which is used in predicting the supernova event rates. Effect of nucleon correlation has different nature for neutrinos and antineutrinos. Using the flux given by the groups of Duan et al. [4], Kneller et al. [5] and Totani et al. [6], we have calculated the supernova event rates and studied the dependence of event rates on supernova neutrino/antineutrino flux. We find that large variations in the supernova neutrino/antineutrino flux results in a significant difference in the event rates.

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