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Pre-supernova (anti)neutrino emission via weak processes with hot nuclei

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(Anti)neutrino luminosities and spectra arising from neutral- and charged-current weak reactions with a hot nucleus ^{56}Fe are computed for pre-supernova conditions and compared with the contribution of thermal processes [1,2]. It is found that thermodynamically consistent consideration of thermal effects within the thermal quasiparticle random phase approximation produces a higher luminosity and a harder spectrum of electron neutrinos, compared to the standard technique based on the large-scale shell model weak-interaction rates. It is shown that in the context of electron antineutrino generation, the neutrino-antineutrino pair emission via nuclear de-excitation (ND) is at least as important as the electron-positron pair annihilation process. We also show that flavor oscillations enhance the high-energy contribution of the ND process to the electron antineutrino flux. This could potentially be important for pre-supernova antineutrino registration by the Earth's detectors.

1. A.A. Dzhioev, A.V.Yudin, N.V. Dunina-Barkovskaya, and A.I. Vdovin, Particles 6 (2023) 682-692
2. A.A. Dzhioev, A.V.Yudin, N.V. Dunina-Barkovskaya, and A.I. Vdovin, Monthly Notices of the Royal Astronomical Society 527 (2024) 7701-7712

Section

Neutrino physics and nuclear astrophysics

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