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Stellar electron-capture rates on nuclei based on Skyrme functional

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Weak interaction processes play a pivotal role in the life of a star, especially during the late stages of the evolution of massive stars (see e.g. [1,2]). In particular, during the supernova core-collapse, electron capture on free protons and on exotic nuclei controls the neutronization phase, until the formation of an almost deleptonized central compact object, the neutron star. In this work [3], electron-capture cross sections and rates on nuclei for stellar conditions are calculated for nuclei found during the collapse phase (e.g. iron group nuclei and germanium isotopes), using a self-consistent microscopic approach. The single-nucleon basis and the occupation factors in the target nucleus are calculated in the finite-temperature Skyrme Hartree-Fock model, and the charge-exchange transitions are determined in the finite-temperature random-phase approximation (RPA) approach [4]. The scheme is self-consistent, i.e. both the Hartree-Fock and the RPA equations are based on the same Skyrme functional. Several Skyrme interactions are used in order to provide a theoretical uncertainty on the electron-capture rates for different astrophysical conditions. The results of the calculations show that, comparing electron-capture rates obtained either with different Skyrme sets or with different available models, differences up to one to two orders of magnitude can arise.

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