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Electron capture rates on neutron-rich nuclei in core-collapse supernova

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The rates of electronic captures (EC) on nuclei largely determine the dynamics of the late-stage evolution and collapse of massive star which is a prelude
to the explosion of type II supernova.

To simulate this astrophysical phenomenon one needs a large-scale set of data on the EC probabilities. The data are needed for a large number of nuclides most of which are unstable and, possibly, have rather short lifetime. Besides, the EC's occur in a
stellar matter which affects their probabilities since it is extremely hot and dense. The most reliable and systematic calculations of ECs in stellar environment
have been performed for nuclei of sd and pf shells within the Large Scale Shell Model approach [1].
However, the approach has some restrictions, in particular, it cannot be applied to nuclei with mass number $A > 65$ and
to first-forbidden transitions involved high-lying spin-dipole nuclear resonances.

In [2], the thermodynamically consistent method which overcome the above shortcomings of the LSSM approach has been elaborated.
Essentially, the method is the quasiparticle RPA extended to finite temperatures (TQRPA) in the framework of the
thermo field dynamics [3]. The method allows to calculate temperature-dependent strength
functions of the process taking into account both the exo- and endo-energetic nuclear transitions.
In [4], the TQRPA has been combined with self-consistent microscopic Hamiltonian based on the Skyrme energy density functional.

Here, we compute the EC rates on even-even neutron-rich nuclides ^{78}Ni and $^{76-80}$Ge in hot and dense presupernova
matter. The contributions of allowed 0^+, 1^+ and first-forbidden 0^-, 1^-, 2^- transitions are considered.
Three different Skyrme parameterizations are used: SLy4, SGII, SkM*. In agreement with our earlier study [2] we observe that unblocking
effect for the Gamow-Teller transitions is quite sensitive to increasing temperature. For ^{78}Ni the EC cross sections were computed within
the Donnelly-Walecka multipole expansion method. It is found that not only thermally unblocked allowed 1^+ transitions but also thermally unblocked first-forbidden 1^- and 2^- transitions favour to EC.

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