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Ab Initio Simulations of Electroweak Decay Spectra in astrophysical scenarios: the role of the electronic structure

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We present two recently developed ab initio methods for the calculation of beta decay spectra of light to heavy nuclei in astrophysical contexts.
The first method uses a variational approach with trial wave functions expanded in multidimensional Gaussian basis sets to accurately account for the electron-electron correlation in order to calculate bound and scattering states of few-body systems. We apply this approach to compute the photodetachment cross section and resonances of the positronium ion (Ps^-) and the electron capture of ^{7}Be, considering its ionisation state and excitation level to determine the configuration-dependent EC decay rate.
Furthermore, we discuss a theoretical approach based on the numerical solution of the electroweak Hamiltonian using a mean-field Dirac-Hartree-Fock method. This method is applied to calculate the beta decay of ^{134,135}Cs, crucial production channels for Ba isotopes in asymptotic giant branch (AGB) stars. By including multiple nuclear and electronic excited states (ES) above $\simeq$ 10 keV for both the parent and daughter nuclei, we find that the half-lives for $T > 10^8$ K for ^{134}Cs increase by more than a factor of 3 compared to previous works based on systematics. These new rates enable nucleosynthesis models to better explain the isotopic composition of Ba in presolar SiC grains and the Sun. We also demonstrate the applicability of our method to calculate beta decay in astrophysical scenarios with ^{176}Lu, ^{63}Ni, ^{87}Rb, ^{93}Zr and ^{79}Se.

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