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Nuclear beta decay studies for neutrino physics and dark matter search

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We investigate the atomic exchange effect between the bound electrons of the final atom and those emitted in the allowed β decay of the parent nucleus. Electron wave functions are computed using the self-consistent Dirac–Hartree–Fock–Slater method, with orthogonality between continuum and bound states of the final atom enforced by modifying the last iteration of the self-consistent procedure. Our results suggest that these exchange effects can resolve discrepancies between theoretical predictions and experimental measurements in the low-energy region of the β spectrum. The significance of various atomic corrections is further examined in the context of one of the most promising candidates for determining the neutrino mass scale: the unique first forbidden β transition of ^{187}Re. Additionally, the developed β decay model is used to compute electron spectra for nuclei that represent unavoidable background sources in dark matter search experiments.

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