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Improvements in analyzing Lorentz symmetry violation in double-beta decay

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Possible deviations from Lorentz invariance in the framework of the Standard Model Extension are more and more studied at present, including the neutrino sector. Observable effects due to the so-called countershaded operator cannot be investigated by measurements of neutrino oscillations and time of flight, but can be in double-beta decay (DBD) experiments, for example by a detailed analysis of the summed electron spectra emitted in the two-neutrino double-beta decay. A precise measurement of these spectra corroborated with accurate theoretical predictions allows constraint of the coefficient (ä)3of which control the Lorentz violation (LV) effects due to the time-like component of this operator.
In this work we present a more rigorous method to predict theoretical summed electron spectra in two-neutrino double beta decay within the LV formalism. This is based on a precise calculation of phase space factors (G) and their deviations due to LV effects (dG). In our method the Fermi functions are built from "exact"electron wave functions obtained as solutions of a Dirac equation in a Coulomb-type potential given by a realistic distribution of the protons in the daughter nucleus and with inclusion of finite nuclear size and screening effects. In addition, in the expressions of the phase space factors kinetic factors related to the electrons and neutrinos energies are taken into account, while in previous analyzes they were omitted.
Our study is done for four experimentally interesting nuclei, namely 48Ca, 82Se, 100Mo and 136Xe. We found that the differences between the G and dG values calculated with our method and with previous methods raise with the atomic number Z and amount up to 30% for the 136Xe. Our results can be of interest for the current investigations of LV effects in DBD experiments and can lead to relevant improvements of the actual constraints on the (ä)3of coefficient.
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