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Atomic electron shell excitations in neutrinoless double β decay

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The excitation of electron shell of a daughter atom in a neutrinoless double β decay causes change in shape of the total energy peak of β particles at the end of the energy spectrum. This fact has important implications for modelling the energy spectrum of β particles, which is sensitive to the mass and Majorana nature of the neutrino. We report the overlap amplitudes between the parent atom and the daughter ion for eleven atoms whose two-neutrino double β decay has been observed experimentally. For these atoms, the mean excitation energy and its variance were calculated using several methods. We performed Dirac-Hartree-Fock computations based on the GRASP software package. The results were compared with calculations performed within the non-relativistic Roothaan-Hartree-Fock model, as well as with estimates obtained using the Thomas-Fermi and Thomas-Fermi-Dirac-Weizsäcker models. In about a quarter of the cases, when the electron shell structure is inherited from the parent atom, a transition to the ground state or the lowest-energy excited state occurs. De-excitation of the daughter ion in the latter scenario is accompanied by the emission of photons in the ultraviolet range, which can serve as an auxiliary signature of double-β decay.

The results are reported in

[1] M.I. Krivoruchenko, K.S. Tyrin, and F.F. Karpeshin, JETP Lett. 117, 884 (2023).

[2] M.I. Krivoruchenko, K.S. Tyrin, and F.F. Karpeshin, JETP Lett. 118, 470 (2023).

[3] K. S. Tyrin, M. I. Krivoruchenko, arXiv:2408.00068 (2024).

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