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High precision decay energy measurements of low Q-value beta decays with JYFLTRAP at IGISOL

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High-precision measurements of single $\beta^\pm$ decays or electron capture (EC) are the most model-independent methods to determine the absolute scale of the (anti)neutrino mass. Decay transitions with the lowest possible Q value are desirable. Currently, only three nuclei with low ground-state-to-ground-state (gs-to-gs) decay Q values are employed for direct neutrino-mass measurements [1-3]. Further explorations for low Q-value ground-state-to-excited-state (gs-to-es) β decay or EC transitions are crucial. In addition to the slightly positive Q values, the slightly negative Q values can also be of interest in seeking for a new type of transition process, like the virtual radiative “detour” transitions (RDT) [1]. A precise and accurate determination of the decay Q value is extremely important in the context of searches for the absolute (anti)neutrino mass scale or for RDT study, with potential implications for low-energy solar-neutrino detection.

Recently, multiple gs-to-gs low-Q-value beta-decay candidates ($^{72,76,77}\text{As}$, ^{75}Se , ^{75}Ge , $^{95-97}\text{Tc}$, ^{111}In , ^{131}I , ^{136}Cs , ^{155}Tb , and ^{159}Dy) have been measured with JYFLTRAP at the University of Jyväskylä [1-3]. The measured high-precision Q values, coupled with nuclear energy level data, are used to determine the energetic permissibility of these low Q-value gs-to-es beta decay candidates, and ascertain the absolute Q value. Subsequently, the suitability of these beta decays with low Q values for direct searches for neutrino mass or for RDT study can be inferred. In this report, the state-of-the-art Penning Trap experimental techniques to determine the gs-to-gs Q value to a relative uncertainty of $\sim 10^{-9}$, along with the Q-value measurement results of select cases for neutrino mass determination, RDT study, potential implications for low-energy solar-neutrino detection. will be discussed.

Reference:

- [1] Z. Ge, T. Eronen et al., Phys. Rev. C, 108:045502 (2023).
- [2] Z. Ge, T. Eronen et al., Phys. Rev. Lett., 127:272301(2021).
- [3] Z. Ge, T. Eronen et al., Phys. Lett. B, 832:137226 (2022).

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