Forbidden Unique β Decays and Neutrino Mass

R. Dvornický[1,2], **F. Šimkovic**[1,2]

[1]Bogoliubov Laboratory of Theoretical Physics, JINR, 141980 Dubna, Moscow region, Russia

[2]Department of Nuclear Physics and Biophysics, Comenius University, Mlynská dolina F1, SK–842 15 Bratislava, Slovakia

The precise measurement of the electron spectrum in β decays provides a direct determination of the values of neutrino masses. The relative number of events occurring in a narrow interval of energy ΔT near the endpoint is proportional to $(\Delta T/Q)^3$. Therefore isotopes with low Q-value are favorable.

The isotope $^{187}\mathrm{Re}$ has the lowest ground state to ground state Q value $\sim 2.47\ \mathrm{keV}$ [1, 2]. The energy distribution of emitted electrons in the first unique forbidden β-decay of ^{187}Re is presented. It is found that the p-wave emission of electron dominates over the s-wave. Our investigation shows that the Kurie function near the endpoint is within a good accuracy linear in the limit of massless neutrinos like the Kurie function of the allowed transitions.

The spin-parity change between the ground state of $^{138}La(5^+)$ and the first nuclear excited state of $^{138}Ce(2_1^+)$ is $\Delta J^\pi = 3^+$. Hence, the β decay of ^{138}La to the first excited state of ^{138}Ce is classified as the second unique forbidden. An improved calculation of the theoretical spectral shape of the emitted electrons associated with the second unique forbidden β decay of ^{138}La is presented. The calculation includes the effects of finite nuclear size and screening on the Dirac radial wave functions.

References

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