Study of the superallowed $0^+ \rightarrow 0^+$ β decay of ^{70}Br†

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One of the core concepts of the Electroweak Standard Model (ESM) is the unitarity of the Cabibbo-Kobayashi-Maskawa (CKM) matrix which describes the mixing between the three families of quarks. Increasingly high-precision measurements of the CKM matrix elements are required to set the limits on any possible physics beyond the ESM. The largest matrix element, the up-down term V_{ud}, can be extracted from high-precision measurements of half-lives, masses, and branching ratios of superallowed β transitions between $J^\pi = 0^+$, $T = 1$ analog states starting in $N = Z$ nuclei.[1)] In this report we provide the most precise half-life measurement for the $T = 1$ ($J^\pi = 0^+$) ground state of the heavy self-conjugate nucleus ^{70}Br and the first estimate of the total branching fraction decaying through the first 2^+ state in the daughter nucleus, ^{70}Se.

The ^{70}Br nuclei were produced in the fragmentation of a ^{78}Kr primary beam at 345 MeV/nucleon and 38 pnA colliding with a 5-mm thick Be target. After separation and selection in the BigRIPS separator, the nuclei were implanted in the WAS3ABi active stopper, surrounded by the EURICA γ-ray spectrometer.[2)]

Standard delayed-coincidence techniques were applied to study the β decay of ^{70}Br, including an exhaustive evaluation of the factors that could influence the half-life measurement.[3)] As an example, Fig. 1 shows the half-life of the $T = 1$ ($J^\pi = 0^+$) ground state as a function of the fitting range (a) and the β threshold (b). The average half-life deduced is shown as a thick continuous line and the total error as dotted-dashed lines. The isomeric ratio of the $T = 0$ ($J^\pi = 9^+$) state is also shown for each lifetime fit and, in thick dashed line, the overall deduced value. The resulting half-lives for the $T = 0$ ($J^\pi = 9^+$) isomer and the $T = 1$ ($J^\pi = 0^+$) ground state, $t_{1/2} = 2157^{+53}_{-49}$ ms and $t_{1/2} = 78.42 \pm 0.51$ ms, respectively, are the most precise values reported hitherto in the literature.

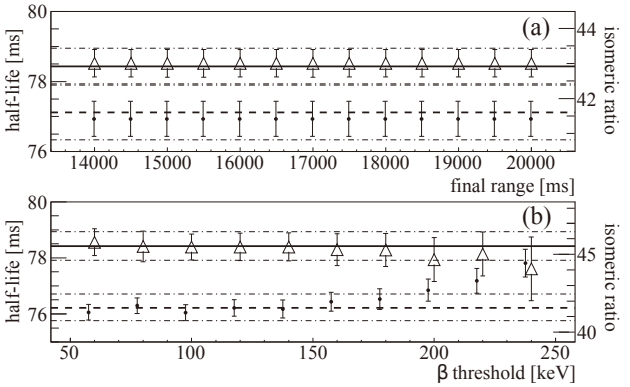

Fig. 1. Measured half-lives for the $T = 1$ ($J^\pi = 0^+$) ground state (empty triangles) and isomeric ratios for the $T = 0$ ($J^\pi = 9^+$) isomer (full dots) in ^{70}Br as a function of the fitting range (a) and the β threshold (b).

The branching ratio of the superallowed $0^+ \rightarrow 0^+$ transition, $R = 97.94 \pm 1.75\%$, was estimated from the measured γ imbalance of the 2^+_1 level in ^{70}Se, as described in Ref. 3). This has allowed for a first estimate of the $\mathcal{F}t$ value associated with this decay, calling for a new mass measurement of ^{70}Br in order to confirm the Conserved Vector Current hypothesis.[1)]

The analyses of the ^{70,71}Kr β and ^{71}Kr isomer decays are in progress.

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