Beta-decay half-lives of ^{78}Kr fragments from Cu to Ge

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The most commonly observed decay process for proton-rich nuclei is β^+ decay. Further away from stability, the Q value of this process increases and the proton separation energy decreases, allowing β-delayed proton (βp) emission. The half-lives and proton branching ratios of nuclei near the proton drip line, especially around $Z = 30 - 40$, are of particular interest for astrophysical rp-process (rapid-proton capture) calculations in X-ray bursts on the surface of accreting neutron stars. The beta and beta-delayed proton decays compete with the rapid-proton capture process.

Nuclei in this mass region were produced and identified with unprecedented statistics at RIBF in 2015 within the RIBF4R1 experiment.[1] The fragments were produced by fragmentation of a ^{78}Kr beam (350 MeV/A and 150 pnA) on a Be target. After the selection and identification by the BigRIPS fragment separator, the nuclei were implanted in the silicon detectors of the WAS3ABi setup[2] surrounded by the EURICA γ-detector array.[3]

The position and time correlations between the implantation and subsequent decay events provide the time distribution used to determine the half-lives of the nuclei of interest. The fit function is composed of the contribution of the parent nucleus, the daughter nuclei for the different decay branches (β and βp decays) and a constant background. The background component of the function is extracted from a fit of negative times between implantation and decay.

More accurate half-lives and proton branching ratios were obtained from the analysis of the experiment. The values for the βp emitters ^{57}Zn, ^{61}Ge, ^{65}Se, ^{68}Kr and ^{69}Kr were previously reported in Ref. 4). Furthermore, new half-life values of the β emitters ^{55}Cu, ^{56}Cu, ^{60}Ga, ^{65}As and ^{63}Ge were determined. Their fit and time distributions are shown in Fig. 1. Half-life values with a better precision than literature were obtained, providing new inputs to future rp-process calculations.

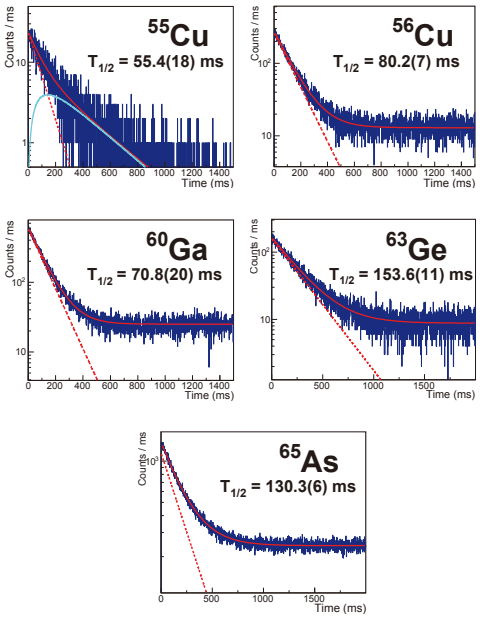

Fig. 1. Time distributions of ^{55}Cu, ^{56}Cu, ^{60}Ga, ^{65}As and ^{63}Ge with their respective β-decay half-lives determined in this work. The dotted red lines are the contributions of the isotopes of interest, whereas the full red lines represent the sums of the decay of interest and a constant background. In the case of ^{55}Cu, the additional light blue line is the contribution of the daughter decay (^{55}Ni), also included in sum line.

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