Beta decay study of ^{156,157}Pr nuclei

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Neutron-rich rare-earth nuclei with $A \sim 160$ situated between the $Z = 50$–82 and $N = 82$–126 closed shells exhibit collective nuclear structures characterized by quadrupole, octupole, and hexadecapole deformations. These deformations are important since they affect the energies of the excited states of nuclei. It is thus important to experimentally study this region of the nuclear chart to enhance our understanding of these deformations. This can also contribute to providing insights into understanding the broad peak observed at $A \sim 160$ in the r-process element abundance distribution. β-decay spectroscopy helps one to understand the low-lying level structure of the ground-state rotational bands and non-yrast levels of daughter nuclei. It also provides complementary information about the ground-state nuclear structure of the parent nuclei.

In our region of interest, the energy levels of ^{156}Nd have been demonstrated via spontaneous fission[1–3] while nothing is known about the energy levels of ^{157}Nd. This report presents preliminary results on these isotopes using the β-γ spectroscopy of ^{156}Pr and ^{157}Pr. This study will enhance our understanding of their low-lying states and further elucidate the ground-state spin-parity of ^{156,157}Pr and ^{157}Nd, which have been studied via systematics only.

In-flight fission of 345 MeV/nucleon ^{238}U ions at RIBF, RIKEN was carried out to produce rare-earth neutron-rich isotopes. The isotopes were identified using the BigRIPS separator. An active stopper, WAS3ABi, was used for ion- and β-detection, while an array of Ge detectors, EURICA, was used for γ-ray detection.

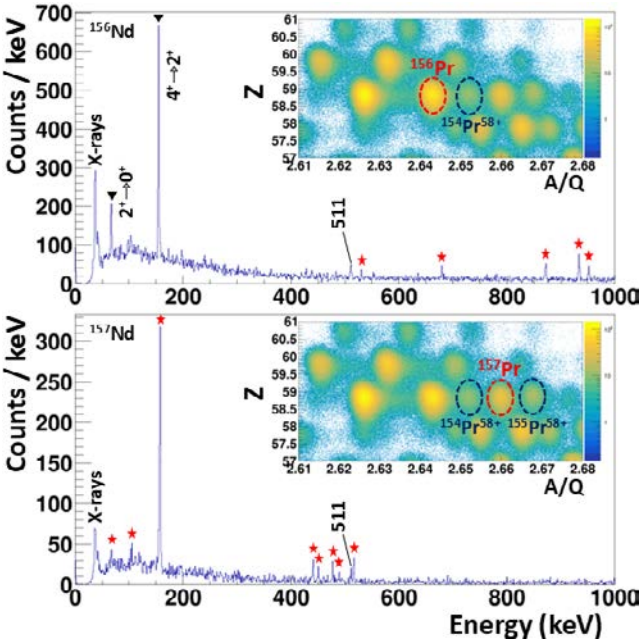

Fig. 1. Energy spectra of the β-delayed γ-rays in ^{156}Nd and ^{157}Nd. The 511-keV peak from annihilation is also observed. Insets: PID showing fully stripped ^{156,157}Pr and hydrogen-like ^{154,155}Pr^{58+} implanted nuclei.

Figure 1 presents the γ-ray energy spectra of ^{156,157}Nd isotopes and particle identification (PID) plots in the insets. For the γ-ray energy spectra following ^{156}Pr and ^{157}Pr beta decay, β-decay events up to 2 s and 1 s, respectively, after implantation, were plotted based on approximately four times their reported half-lives.[4] Preliminary novel γ-peaks (marked as star), along with known ones (marked as triangle), are shown. Possible background from the decay of hydrogen-like ^{154}Pr^{58+} and ^{155}Pr^{58+} in the γ-ray energy spectrum is negligible. Further analysis is ongoing.

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