β-delayed γ-ray spectroscopy of ^{168}Dy

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and EURICA 2014 collaboration

Atomic nuclei tend to be deformed when moving away from shell closures, giving rise to rotational motion. In well-deformed nuclei, characteristic rotational bands can be built on intrinsic states, including not only the ground state, but also any kinds of vibrational states and other quasiparticle configurations. These intrinsic excitations play an important role in stabilizing the nuclear shape. Recent spectroscopic studies on ^{170}Dy[1)] and ^{172}Dy[2)] using the EUROBALL-RIKEN Cluster Array (EURICA) setup[3)] revealed that the γ-vibrational levels emerge at unusually low excitation energy compared to the adjacent even-even nuclei. This result indicates an enhancement of the γ-vibrational mode in this doubly mid-shell region, leading presumably to an excursion from axial symmetry.

This report presents a preliminary result of γ-ray spectroscopy of ^{168}Dy following the β decay from ^{168}Tb. The same decay channel has been studied before in Ref. [4], where only three γ rays at 75, 173, and 227 keV were assigned for the excited states in ^{168}Dy. The former two γ rays have been confirmed as the $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$ transitions in the ground-state rotational band, respectively, by means of multi-nucleon transfer reactions[5)]. In the present work, we explore the level structure of ^{168}Dy with higher statistics than Ref. [4] with a particular focus on the non-yrast states being characteristic of γ- and octupole-vibrational modes.

The decay spectroscopy experiment for neutron-rich Dy isotopes has been performed at RIBF at the RIKEN Nishina Center. The nuclei of interest were produced by the in-flight fission of a ^{238}U primary beam at 345 MeV/u incident on a Be target with an average intensity of 12 pnA. About 1.2×10^4 ^{168}Tb^{65+} ions were transported through the BigRIPS-ZeroDegree spectrometers and finally implanted into the WAS3ABi[6)] active stopper system comprised of two double-sided silicon-strip detectors (DSSSD). Each DSSSD has a thickness of 1 mm and an active area of 60×40 mm^2 with 1 mm pitch. The DSSSDs recorded events of heavy-ion implantation and subsequent decay electrons (both β rays and internal conversion electrons). Gamma rays were detected by EURICA with a full energy-peak efficiency of about 10 % for 1 MeV γ rays. Figure 1 shows the β-delayed γ-ray spectrum measured within 20 s after the implantation of ^{168}Tb. In addition to the transitions reported previously,[4,5)] several new γ rays are clearly visible at 216, 322, 915 and 1131 keV. A fit of the electron time distribution measured in coincidence with these γ rays yields a half life of 10.4(5) s (see Fig. 2), which is consistent with the value obtained independently from the analysis of β-decay half lives[7)]. The detailed level scheme of ^{168}Dy including these new transitions is still under consideration.

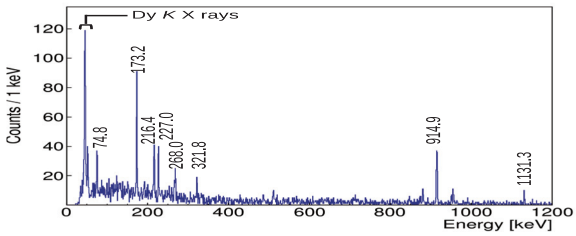

Fig. 1. Gamma-ray spectrum following implantation of ^{168}Tb within 20 s.

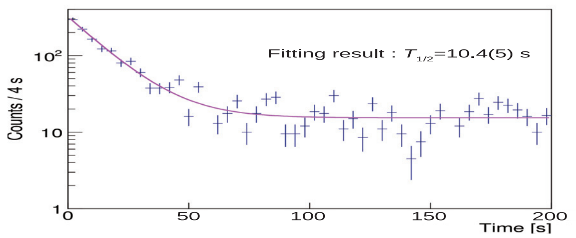

Fig. 2. Electron time distribution after implantation of ^{168}Tb measured with a sum of gates on the γ-ray peaks labeled in Fig. 1 except for the 75-keV line and X rays. An exponential function with a constant background was used for fitting.

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