Isomer spectroscopy of neutron-rich Nd isotopes

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Prolate-deformed nuclei are found to appear in the neutron-rich part of the nuclear landscape around $Z = 60$ and beyond $N = 90$, after the systematic studies of excited states. In strongly deformed nuclei, quantum number K is known to be a good quantum number. Since transitions with large changes in K are suppressed, many nuclei in this region have isomeric states. In addition to the quadrupole deformation, appearances of higher-order deformations such as octupole and hexadecupole deformations have been predicted[1)]; however, they are not yet understood well. Isomer spectroscopy is a useful method to gain information on such structures of these nuclei.

Neutron-rich $_{60}$Nd isotopes have been investigated by means of isomeric γ-ray spectroscopy. Such isotopes were produced by the in-flight fission of ^{238}U at RI Beam Factory in RIKEN Nishina Center, and were selected and identified by using the BigRIPS separator. The identification of the nuclei was performed on the basis of the ΔE-TOF-$B\rho$ method, which allows an event-by-event determination of their atomic number and the mass-to-charge ratio, where ΔE, TOF, and $B\rho$ denote energy loss, time of flight, and magnetic rigidity, respectively. The identified particles were implanted into passive and active stoppers. A passive stopper made of Cu was used for the measurement at a high count rate, while the WAS3ABi[2)] active stopper consisting of five double-sided silicon strip detectors was used for the β-γ spectroscopy. Delayed γ rays were detected by the germanium cluster detector array EURICA[3)]. Gamma rays previously known from the 5^- K-isomeric state of ^{156}Nd[4)] were observed, and new K-isomeric states of heavier isotopes were discovered.

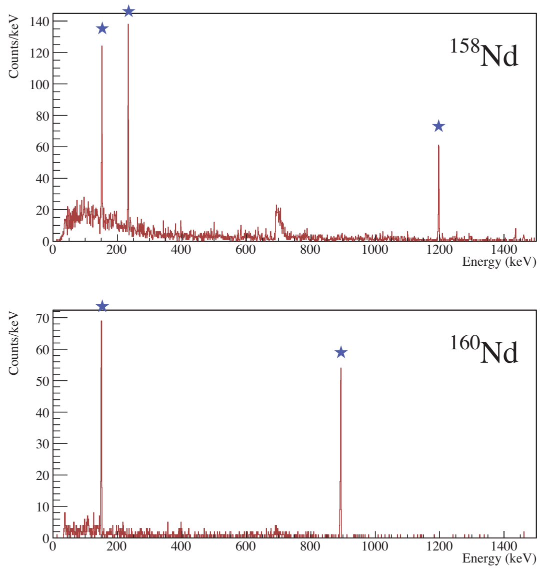

Fig. 1. Gamma-ray energy spectra for $^{158}_{60}$Nd$_{98}$ and $^{160}_{60}$Nd$_{100}$. Marked peaks are the γ rays identified newly. The spread peak at ~ 700 keV comes from (n,n$'$) reaction with Ge.

Figure 1 shows the γ-ray energy spectra of ^{158}Nd and ^{160}Nd using both the passive and active stopper data. We have observed three strong peaks at 151.6, 233.4, and 1198.2 keV for ^{158}Nd, and two strong peaks at 150.2 and 893.0 keV for ^{160}Nd. In both ^{158}Nd and ^{160}Nd, the half-lives of γ rays were preliminarily obtained as 0.339(20) μs and 1.63(21) μs, respectively. From the systematics of Nd isotopes, the energy of the first 2^+ states will be around 70 keV. However, such low-energy γ transition is highly converted, and accordingly, the 70-keV peaks could not be observed. Further analysis to make spin-parity assignments based on the decay pattern and coincidence relations is now in progress.

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