Beta-gamma spectroscopy of neutron-rich ^{150}Ba[†]

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Intruder orbitals due to the strong $l \cdot s$ coupling in atomic nuclei can cause higher-order interactions, for example, octupole-deformed shapes energetically favored in certain nuclei. Octupole correlations ($\lambda = 3$) are caused by the interactions between orbits with $\Delta j = \Delta l = 3$. Nuclei with Z or $N = 34$, 56, 88, and 134 possess such orbits at or close to the Fermi surface and are expected to have strong octupole correlations. Recently, static octupole deformation was reported in the $Z \sim 88$, $N \sim 134$ (Ra) region by Gaffney *et al.*[2)] and at $Z \sim 56$, $N \sim 88$ (Ba) by Bucher *et al.*[3)] However, the result that ^{148}Ba may have strong octupole correlation as ^{144}Ba does[4)] raised a question whether ^{150}Ba also possess strong octupole correlation.

Neutron-rich Ba ($Z = 56$) isotopes were produced at RIBF and measured by means of β-γ spectroscopy at the F11 focal plane of the ZeroDegree spectrometer. An active stopper, WAS3ABi,[5)] and HPGe array, EURICA,[6)] were used for β-ion correlation and γ-ray detection, respectively. The γ-ray spectrum of the ^{150}Cs decay within 0.2 s after implantation is shown in Fig. 1. The estimated continuum background is overlaid. Two peaks at 100 and 597 keV were assigned as transitions in ^{150}Ba after a log-likelihood ratio test requiring 4σ significance. From the systematics of $^{144-148}$Ba, the 100-keV and 597-keV γ rays were assigned as $2_1^+ \to 0^+$ and $3^- \to 2_1^+$ decay, which are also consistent with their intensities.

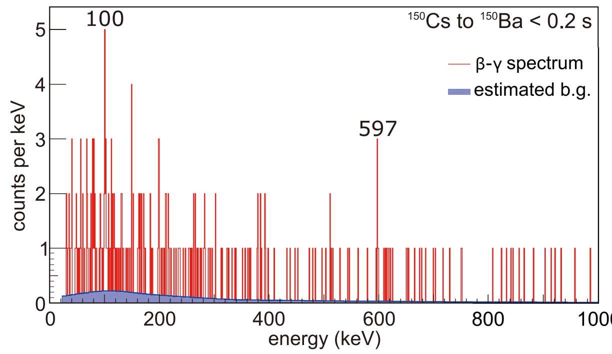

Fig. 1. A γ-ray spectrum from the β decay of ^{150}Cs.

A calculation with the Hartree-Fock method and the random-phase approximation (RPA) was newly performed.[7,8)] The calculation predicted that ^{150}Ba has a large ground-state octupole deformation, $\beta_{30} = 0.15$, as those of the even-even $A = 144$ to 148 isotopes. The RPA calculation predicted a $J = 3$ excitation of ^{150}Ba at 0.76 MeV, which may be the observed 697 keV state. The calculated state has $B(E3) = 35$ W.u., indicating that the state is an octupole collective state rather than a single particle one.

In summary, the newly measured $E(2_1^+)$ and possibly $E(3^-)$ of ^{150}Ba indicate that the quadrupole deformation of ^{150}Ba is larger than that of ^{148}Ba, and there may exist a negative-parity $J = 3$ band with a large octupole collectivity. A newly performed HF-plus-RPA calculation predicted a static octupole deformation in the $A = 140$ to 150 Ba isotopes and excited states with octupole collectivity at around 1 MeV. The results show that ^{150}Ba has a large octupole collectivity and that the region of octupole correlations around $Z = 56$, $N = 88$ may be wider than expected.[9,10)]

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