Study of neutron-rich ^{142}Xe using β-decay spectroscopy

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Study of neutron-rich $_{54}$Xe isotopes with $N>82$ is very important for understanding shape evolution from spherical to prolate shapes for nuclei in the mass region beyond the doubly-magic ^{132}Sn nucleus. In particular, the $N=88$ nucleus of ^{142}Xe is expected to have octupole collectivity in low spin region, because the $^{144}_{56}$Ba nucleus ($N=88$) is well known for having the large octupole deformation[1]. In this work, to reveal various nuclear structures of ^{142}Xe, the low-spin states in ^{142}Xe were investigated using β-decay spectroscopy of ^{142}I ($Z=53$).

Neutron-rich ^{142}I was produced by in-flight fission of a ^{238}U beam at the RI Beam Factory (RIBF) in RIKEN. Particle identification for the fission fragments was performed based on the TOF-$B\rho$-ΔE method using the BigRIPS and the ZeroDegree spectrometer[2]. Nuclei were implanted in the 5 double-sided Si-strip detectors (WAS3ABi[3]) at F11. Beta rays and γ rays were measured using the WAS3ABi and the EURICA array consisting of 12 Cluster-type Ge detectors[3], respectively. In order to measure the half-life of the excited states in the time range from a few hundred picoseconds to a few nanoseconds, a fast timing detector system, which consists of 18 $LaBr_3$ detectors for γ rays and 2 plastic scintillators for β rays, was installed[4].

Figure 1 shows the decay curve obtained by the time difference between the implantation of ^{142}I and the detection of β rays in WAS3ABi gated on the known 287-keV γ rays ($2^+ \rightarrow 0^+$) of ^{142}Xe[5]. The half-life of the β decay of ^{142}I was determined to be 229(3) ms, which

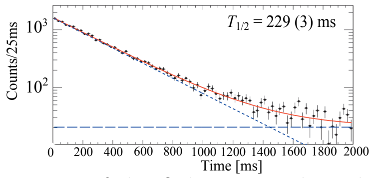

Fig. 1. Decay curve of the β decay gated on the 287-keV γ ray in ^{142}Xe.

was more accurate than the value of 222(12) ms in Ref. 6. Figure 2 shows the energy spectrum of γ-rays emitted after the β decay of ^{142}I. Three known transitions in ^{142}Xe are clearly observed with energies of 287, 403, and 971 keV. The B(E2) value of 0.6(3) e^2b^2 determined from the half-life of the 2^+_1 state, which was obtained as 0.22(9) ns by using the fast timing system, is in good agreement with the one obtained by Coulomb-excitation measurement of 0.7(1) e^2b^2 in Ref. 7. The deformation parameter β_2 was deduced to be 0.16(3) using the B(E2) value in this work. This indicates that the nucleus ^{142}Xe has a small prolate shape. The decay scheme after the β decay of ^{142}I was newly constructed in this work with 36 levels up to an excitation energy of 3.2 MeV. Two levels in this new decay scheme were assigned as candidates of the (1^-) and (3^-) states which are members of the $K=0^-$ octupole band, populated in high spin region by the spontaneous fission of ^{248}Cm in Ref. 5. A detailed analysis is in progress.

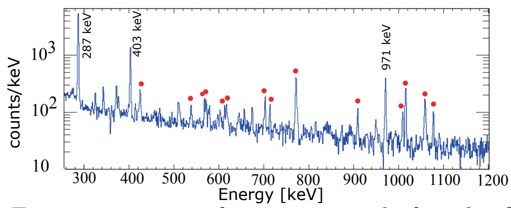

Fig. 2. Energy spectrum of γ-rays emitted after the β decay of ^{142}I. Peaks with closed circles indicate newly observed γ rays in ^{142}Xe.

References
1) W. Phillips et al., Phys. Rev. Lett. **57**, 3257 (1986).
2) N. Fukuda et al., Nucl. Instrum. Methods Phys. Res. B **317**, 323 (2013).
3) P.-A. Söderström et al., Nucl. Instrum. Methods Phys. Res. B **317**, 649 (2013).
4) P.-A. Söderström et al., JPS Conf. Proc. **1**, 013046 (2014).
5) W. Urban et al., Eur. Phys. J. A **16**, 303 (2003).
6) R. Kessler et al., GSI 2006-1, 154 (2006).
7) T. Kröll et al., Eur. Phys. J. A **150**, 127 (2007).

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