Study of shape evolution in neutron-rich Cs isotopes using $\beta$-decay spectroscopy


Shape evolution in neutron-rich nuclei with the neutron number $N>82$ and the proton number $Z>50$ beyond the doubly magic $^{132}$Sn nucleus have been investigated along several isotopic chains. The EURICA project provides us with an opportunity to study extremely neutron-rich nuclei using $\beta$-decay and isomer-decay spectroscopy. We reported the results of the isomer-search experiment for neutron-rich Cs isotopes, where new isomers were found in $^{145}$Cs, $^{146}$Cs, $^{147}$Cs, and $^{148}$Cs. To understand the nuclear structure of these neutron-rich Cs isotopes in the low-spin states, we studied the $\beta$ decay of neutron-rich Xe to Cs isotopes.

The neutron-rich Xe isotopes were produced through in-flight fission reaction using a 345-MeV/nucleon $^{238}$U beam. Particle identification was performed using the mass-to-charge ratio ($A/Q$) and the atomic number deduced from the information of time-of-flight (TOF), magnetic rigidity ($B\rho$) and energy loss of fission fragments through BigRIPS and ZeroDegree Spectrometer. The isotopes were implanted into a stack of five double-sided Si-strip detectors (WAS3ABi)11. $\beta$ rays emitted from the isotopes were also detected by WAS3ABi. The parent nuclei of the $\beta$ decay were identified by position correlation on the WAS3ABi between the implanted fragments and the detected $\beta$ rays. $\gamma$ rays emitted after the $\beta$ decay were detected by the $\gamma$-ray detector array which is called EURICA1.

Figure 1 shows a spectrum of particle identification for the Xe ($Z=54$) isotopes as a function of $A/Q$. The fully-stripped $^{4+}$Xe ions are separated from the hydrogen-like $^{4+}$Xe ions owing to the high $A/Q$ resolution.

Coincidence data of $\gamma-\gamma$ and $\beta-\gamma-\gamma$ with particle identification of $^{143}$Xe, $^{144}$Xe, $^{145}$Xe, $^{146}$Xe, and $^{147}$Xe isotopes is analyzed. As an example, the $\gamma$-ray energy spectrum and the decay curve for the $\beta$ decay of $^{145}$Xe to $^{145}$Cs are shown in Fig. 2. We found 11 new $\gamma$ rays associated to the transitions in $^{145}$Cs emitted after the $\beta$ decay of $^{145}$Xe. These $\gamma$-ray peaks are represented as full circles in Fig. 2. Other peaks are mostly assigned to transitions in the granddaughter $^{145}$Ba nucleus. The inset in Fig. 2 shows the decay curve deduced by the time difference between the implantation of $^{145}$Xe and the detection of the $\beta$ rays gated on newly found 5 $\gamma$ rays in $^{145}$Cs. The half-life of the $\beta$ decay was determined to be 197(10) ms, which is consistent with the reported one in Ref. 4. Detailed analyses are in progress.

Fig. 1. $A/Q$ spectrum of neutron-rich Xe isotopes.

Fig. 2. $\gamma$-ray energy spectrum and decay curve of the $\beta$ decay of $^{145}$Xe to $^{145}$Cs.

References