Discovery of new isotopes $^{81,82}$Mo and $^{85,86}$Ru and a determination of the particle instability of $^{103}$Sb

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We discovered four new isotopes, $^{81,82}$Mo and $^{85,86}$Ru, using the BigRIPS separator$^1$ at the RIKEN RI Beam Factory. Furthermore, we obtained the first clear evidence for the particle instability of $^{103}$Sb. The upper limits of the half-lives of particle-unbound isotopes $^{81}$Nb, $^{85}$Te, and $^{103}$Sb were deduced.

Proton-rich radioactive isotopes (RI) were produced from a 345-MeV/nucleon 8–9 pnA $^{124}$Xe$^{52+}$ beam impinged on a 4-mm-thick Be target by projectile fragmentation. Two BigRIPS settings were conducted; one is $^{85}$Ru setting for producing the RIs with atomic numbers $Z = 42–44$, and the other is $^{105}$Te setting for $Z = 51–53$. We performed particle identification (PID) by deducing $Z$ and the mass-to-charge ratio, $A/Q$, of the fragments based on the TOF-$B_P$-$\Delta E$ method in the second stage of the BigRIPS.$^2$

In the $^{85}$Ru setting, four new isotopes $^{81,82}$Mo and $^{85,86}$Ru were observed as shown in Fig. 2 of the original article$^1$. The numbers of the observed counts were 1, 6, 1, and 35, respectively. To confirm the existence of the new isotopes, mass number, $A$, and charge number, $Q$, were deduced from TOF and TKE measured between the F7 and F12 foci downstream of the BigRIPS. Figure 1 shows the $Z$ vs $A – 2Q$ plot, in which the fully stripped events were selected. The new isotopes were clearly observed again. This re-identification strongly reinforces the discovery of the new isotopes especially for $^{81}$Mo and $^{85}$Ru, which were observed only 1 count each.

The $Z$ vs $A/Q$ PID plot of $^{105}$Te setting is shown in Fig. 2. No new isotopes were observed in this setting. $^{103}$Sb was not observed, although the other $N – Z = +1$ isotopes, $^{99}$In, $^{101}$Sn, and $^{105}$Te, were clearly observed, indicating the particle instability of $^{103}$Sb. The upper limit of the half-life of $^{103}$Sb was deduced from its expected production-yield based on the yield systematics of neighboring isotopes and the TOF between the target and the F7 focus. Assuming the observation limit of 1 count, the upper limit of its half life was deduced to be 46 ns.

The upper limits of the half-lives of $^{81}$Nb and $^{85}$Te were deduced to be 40 and 43 ns, respectively.

References

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Fig. 1. The $Z$ versus $A – 2Q$ PID plot of the $^{85}$Ru setting. The fully stripped events ($Z – Q = 0$) are selected. The solid lines indicate the limits of known isotopes as of June 2017.

Fig. 2. The $Z$ versus $A/Q$ PID plot of the $^{105}$Te setting.