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}Tc, 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-$B\rho$-ΔE 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†. 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.

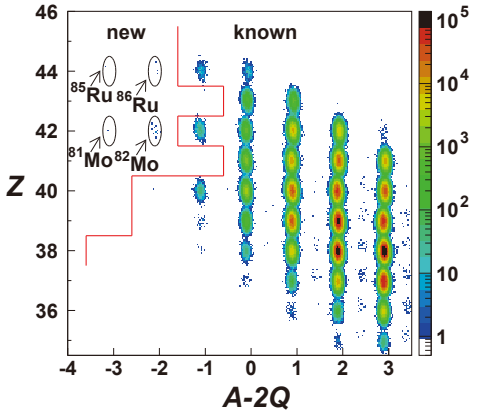

Fig. 1. The Z versus $A-2Q$ PID plot of the ^{85}Ru setting. The fully stripped events ($Z-Q=0$) are selected. The solid lines indicate the limits of known isotopes as of June 2017.

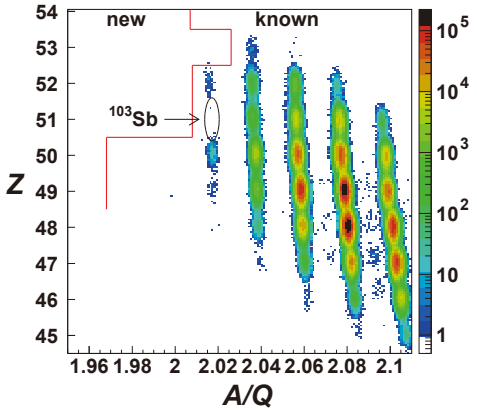

Fig. 2. The Z versus A/Q PID plot of the ^{105}Te setting.

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

References
1) T. Kubo, Nucl. Instrum. Methods Phys. Res. B **204**, 97 (2003).
2) N. Fukuda *et al.*, Nucl. Instrum. Methods Phys. Res. B **317**, 323 (2013).

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