Observation of new neutron-rich isotopes among fission fragments from in-flight fission of 345 MeV/nucleon ^{238}U: search for new isotopes conducted concurrently with decay measurement campaigns†

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The elucidation of the limit of nuclear existence is not only one of the fundamental subjects in nuclear physics but also a method of understanding the nature of nuclei. The search for new isotopes using the in-flight fission of a ^{238}U beam was conducted concurrently with decay measurements, during the so-called EURICA campaigns,[1] at the RIKEN Nishina Center RI Beam Factory. We have identified the following 36 new neutron-rich isotopes: ^{104}Rb, ^{113}Zr, ^{116}Nb, ^{118,119}Mo, ^{121,122}Tc, ^{125}Ru, ^{127,128}Rh, ^{129,130,131}Pd, ^{132}Ag, ^{134}Cd, ^{136,137}In, ^{139,140}Sn, ^{141,142}Sb, ^{144,145}Te, ^{146,147}I, ^{149,150}Xe, ^{149,150,151}Cs, ^{153,154}Ba, and ^{154,155,156,157}La.

The fission fragments produced via in-flight fission of the ^{238}U beam were separated and identified in flight using the BigRIPS separator.[2] We ran five different separator settings, which we refer to as the Sn, Pd, Rh, Nb, and Te settings, respectively, according to the subject of each EURICA experiment. The particle identification (PID) was performed by using the TOF-$B\rho$-ΔE method,[3] in which the mass-to-charge ratio A/Q and the atomic number Z of fragments were derived by measuring the time of flight (TOF), magnetic rigidity ($B\rho$), and energy loss (ΔE).

Figure 1 shows a two-dimensional PID plot of Z versus A/Q for the Sn setting. The red solid lines in the figures indicate the boundary between known isotopes and new isotopes. The relative root-mean-square (rms) Z resolutions and the relative rms A/Q resolutions achieved for fully stripped peaks are typically 0.37 and 0.038%, respectively, for the Sn setting. Owing to the excellent A/Q resolution and background removal that was achieved, we could clearly identify new isotopes.

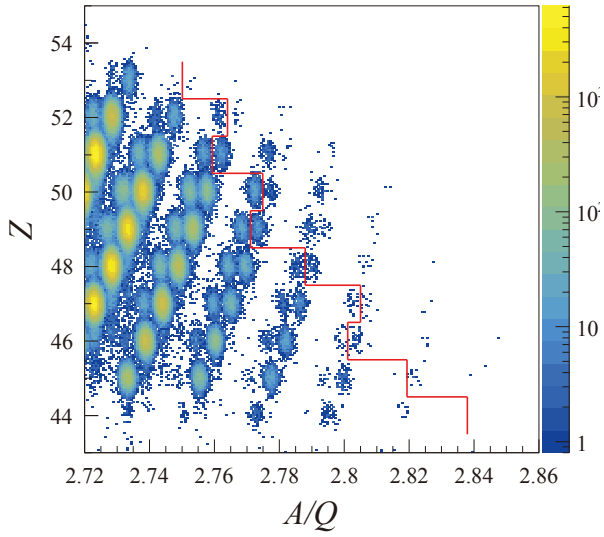

Fig. 1. Z versus A/Q particle identification plots for fission fragments produced in the ^{238}U+Be reaction at 345 MeV/nucleon. The red solid lines indicate the limit of known isotopes. The events whose charge state changed at the F5 focus were excluded.

† Condensed from the article in J. Phys. Soc. Jpn. **87**, 014203 (2018)

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