Status of the study of masses and half-lives of ^{252}Cf fission fragments by the MRTOF-MS

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The nuclear data of neutron-rich nuclei, *e.g.*, mass, lifetime, and neutron-capture cross section, are important for understanding the rapid neutron-capture (r-) process, because a balance of net neutron-capture rate and β^--decay rate is crucial to determine its path. Thus, accurate and high-precision nuclear data about both neutron-rich isotopes' mass and half-life are required.[1]

The multi-reflection time-of-flight mass spectrograph (MRTOF-MS) has been developed for not only mass measurement but also isobar separation. Here, we briefly report the present status of the mass measurement of neutron-rich isotopes and, in addition, the half-life measurement as an application of the MRTOF-MS.

The mass measurement study of the neutron-rich ^{252}Cf-fission-fragments with the MRTOF-MS[2] was presented in the previous report.[3] We had used the 350 kBq ^{252}Cf source and newly installed a more intense source (9.25 MBq). More than 200 isotopes have been confirmed in the time-of-flight spectra and are shown in Fig. 1. In addition, many long-lived isomers were also observed during the measurements. The mass resolving power of the MRTOF-MS reaches $R_m > 5 \times 10^5$; thus, the measurements were achieved with precision better than 10^{-7} in most of the cases.

We have developed a decay-scheme-independent half-life measurement method with the MRTOF-MS. The experimental setup consists of a cryogenic gas-cell, the MRTOF-MS, and a suite of ion traps with a quadrupole ion guide (QPIG), a linear trap, and a flat trap used as an injector for the MRTOF-MS. By changing the operation cycle of the linear trap, the ion storage time of the linear trap can be changed, making it possible to measure the lifetimes of short-lived isotopes. We briefly discuss here the lifetime measurement of ^{92}Br as an example of this "storage method." Figure 2 shows the storage time dependence of the yields of ^{92}Br$^+$ ions normalized by the ^{92}Rb$^+$ ion yields for canceling out the efficiency reduction due to increasing of the storage time. A decreasing trend of ^{92}Br$^+$ ion yields is clearly observed and the ^{92}Br$^+$'s half-life is measured to be 349(178) ms through a fit with the theoretical curve. This value is in agreement with the value in the literature of 314(16) ms. In this analysis, we assumed that an influence of the decay loss of the ^{92}Rb$^+$ ion is negligibly small because its half-life (4.48 s) is sufficiently long compared to the storage time.

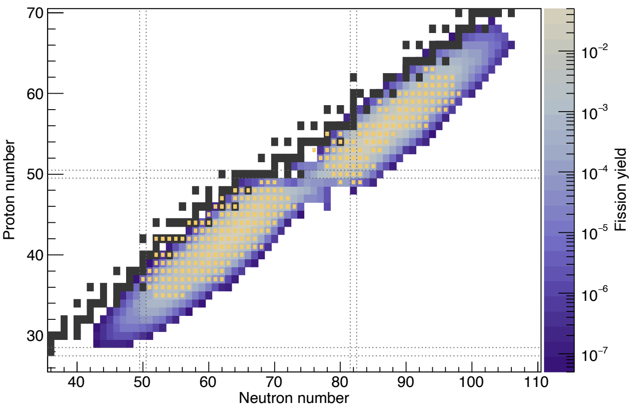

Fig. 1. Location of the observed isotopes on the nuclear chart. The observed isotopes are indicated with orange-colored squares. The black squares represent the stable isotopes. The contour map shows the fission yield of ^{252}Cf.[4]

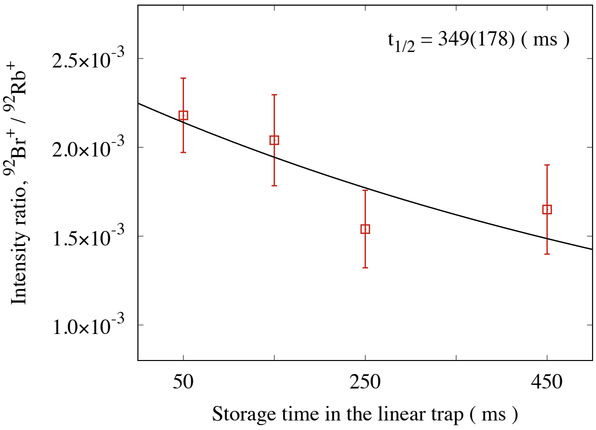

Fig. 2. Intensity ratio of ^{92}Br$^+$/^{92}Rb$^+$ as a function of storage time in the linear trap. A black line shows a fit result. The measured half-life, 349(178) ms, is consistent with the value in the literature of 314(16) ms.

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