Production cross section measurement for radioactive isotopes produced from \(^{78}\text{Kr}\) beam at 345 MeV/nucleon by BigRIPS separator

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We have measured the production rates and the production cross sections for a variety of radioactive isotopes (RIs), which were produced from a \(^{78}\text{Kr}\) beam at an energy of 345 MeV/nucleon using the BigRIPS separator\(^1\), for the first time. Proton-rich isotopes with atomic numbers \(Z = 22–37\) were produced by the projectile fragmentation of the primary beam on a 5-mm-thick Be production target. The particle identification of RIs was based on the TOF-\(B^\rho - \Delta E\) method in the second stage of the BigRIPS\(^2\).

The production cross sections were deduced from the measured production rates and the transmission efficiency in the BigRIPS separator, which was simulated with the calculation code LISE\(^++\))\(^3\). In the LISE\(^++\) simulation, the parametrization for momentum distribution of the RIs was adjusted, because the exponential tails in the low-momentum regions observed in the experiment fell off faster than those calculated by the LISE\(^++\) with the original parametrization. In preliminary, we used the parameters of the momentum distribution, which were obtained in the production cross-section measurement of proton-rich nuclei produced from the 345-MeV/nucleon \(^{124}\text{Xe}\) beam. The parameters of the angular distribution were not changed from the original values in the code.

Figure 1 shows the production cross sections of RIs obtained in the \(^{78}\text{Kr}\)-beam campaign. The solid and dashed lines in Fig. 1 show the cross sections predicted from the empirical formulae \(\text{EPAX3.1a}\)\(^4\) and \(\text{EPAX2.15}\)\(^5\), respectively. \(\text{EPAX3.1a}\) predicts the cross sections better than \(\text{EPAX2.15}\), which overestimates most of them. The measured cross sections of RIs with a wide range of \(Z\) are fairly well reproduced by \(\text{EPAX3.1a}\); however, some isotopes show systematic discrepancies around the very neutron-deficient region. In the case of \(^{87}\text{Kr}\), which is the most neutron-deficient Kr isotope in our measurement, the experimental cross section is \((3.2 \pm 1.4) \times 10^{-12}\) mb (preliminary), while the value calculated using the \(\text{EPAX3.1a}\) formula is \(4.25 \times 10^{-10}\) mb. Further, we also observe that the discrepancy becomes significant with increasing \(Z\) number. These discrepancies were also observed in proton-rich RIs produced from the 345-MeV/nucleon \(^{124}\text{Xe}\) beam\(^6\).

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Fig. 1. Production cross sections of RIs produced in the \(^{78}\text{Kr} + \text{Be}\) reaction at 345 MeV/nucleon with the predictions of \(\text{EPAX3.1a}\) and \(\text{EPAX2.15}\). Solid and dashed lines show the values predicted using the \(\text{EPAX3.1a}\) and \(\text{EPAX2.15}\) formulae, respectively.

References

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