Production of isomers around ^{52}Fe nucleus via projectile fragmentation

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The nuclear responses of isomeric high-spin states are attractive topics. A recent theoretical study on the spin-isospin response of the 12^+ isomeric state in ^{52}Fe showed that the widths of the GT strength distributions from the ground and isomeric states may differ from each other due to the different collectivities,[1] which may call for the modification of a simple Brink hypothesis. To perform nuclear reactions on such isomers, isomeric nuclear beams should be prepared since the isomers are still short-lived nuclei.

Projectile fragmentation is a popular method to produce short-lived nuclei. In order to prepare the isomer beam, it is necessary to understand the production mechanism of isomers through the projectile fragmentation process. We studied the isomer ratios in the vicinity of ^{52}Fe as a function of the linear momentum transfer. Although the ratios are conventionally described by a classical model assuming the contribution of the angular momentum transfers during the projectile fragmentation process,[2] it is still not clear how the angular momentum is transferred to the fragmented particles. To learn the role of the angular momentum transfer, we studied not only the isomer ratio but also the momentum distribution of the isomeric state of the fragmentation process. In this paper, we report a new systematic measurement of production cross sections of the isomers ^{52}Fe(12^+),^{53}Fe($19/2^-$), ^{54}Co(7^+), and ^{54}Fe(10^+) by primary beams of ^{58}Ni(0^+) and ^{59}Co($7/2^-$).

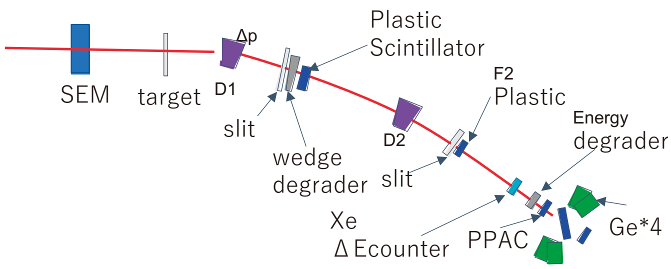

Fig. 1. Experimental setup in the SB2 course (16H362). The number of primary beams was counted by a secondary emission monitor (SEM), which consists of a thin Cu film. We identified the fragment by using the ToF-ΔE method. ToF was measured from F2 to F3, and ΔE was measured by a Xe scintillation detector. The number of isomers was counted by a Ge detector.

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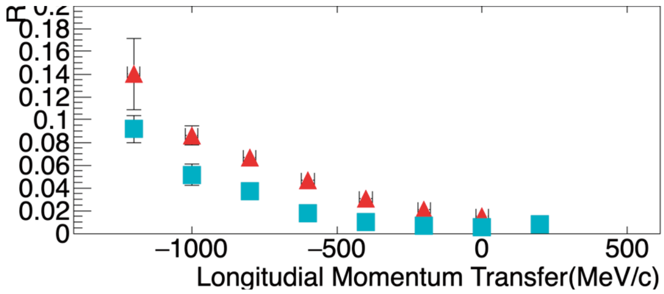

Fig. 2. Isomer ratio of ^{52}Fe(12^+). Red triangles show the result from the ^{59}Co($7/2^-$) beam, and the blue squares show the result from the ^{58}Ni(0^+) beam.

The experiment was performed at the SB2 course in HIMAC, a synchrotron facility in Chiba. Figure 1 shows the experimental setup at the SB2 course. The primary beams of ^{58}Ni and ^{59}Co at 350 MeV/nucleon bombarded a 14-mm-thick ^{9}Be production target. The fragments are separated and momentum analyzed by a fragment separator consisting of two dipole magnets and quadrupole magnets. In order to obtain isomer ratios, the number of fragments and γ rays from the isomers were counted. A Xe scintillator was used for counting the fragment, and four Ge detectors were used for detecting γ rays. The isomer ratio of a certain fragment nucleus is the ratio of the number of emitted gamma rays obtained after correcting for the efficiency to the number of fragments.

When the velocity of the fragment is the same as that of the projectile, no momentum is transferred to the fragment.

Figure 2 shows the preliminary result of the isomer ratio of ^{52}Fe(12^+). The momentum-transfer dependence of the isomer ratio is clearly observed. The isomer ratio with the ^{59}Co($7/2^-$) beam at each momentum is larger than that with the ^{58}Ni(0^+) beam. It is inferred that the initial angular momentum of the projectile has a significant effect on isomer production.

The data analysis is ongoing. The difference between the momentum distributions of isomers and non-isomers will be investigated in order to clarify the role of angular momentum transfer from the viewpoint of the correlation between the linear momentum transfers and angular momentum transfers.

References
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