Magnetic moment measurement of isomeric state in ^{99}Zr and characterization of the abrasion-fission mechanism

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The region of neutron-rich isotones N=59 is on the border of a sudden change of the ground state shape of nuclei[1,2]. A direct consequence is the existence of many nuclei with isomeric states in this region. These nuclei are well produced by fission. Measuring the magnetic moment of these states often allows a clear determination of their single-particle structure and allows us to determine the spin parity of the isomeric state.

The production of spin-aligned nuclei is primordial for these types of studies; however, the explanations of the production mechanisms of such nuclei are not well known. An alignment of 18(8)% was previously measured for isomers produced in the abrasion-fission reaction[4,5]. The purpose of the experiment described here is to probe different momentum regions and determine the one with the highest alignment rate. Owing to the high beam intensity delivered by RIBF, three different momentum selections of ^{99}Zr were probed with sufficient statistics accumulated.

Thus, the NP1306-RIBF99 experiment performed at RIKEN with the BigRIPS spectrometer has two aims. The first is to measure the magnetic moment of the ^{99}Zr isomeric state. The second is to measure the alignment ratio of the ^{99}Zr produced by the abrasion-fission reaction of a ^{238}U beam sent at 345 MeV/A on a 100-μm-thick target of ^{9}Be.

The time-dependent perturbed angular distribution (TDPAD)[3] method was used to perform such measurements. The ^{99}Zr nuclei were selected and identified through BigRIPS and were implanted in a non-disturbing copper crystal at F8. An external magnetic field of 0.250 T was applied to induce a Larmor precession of the nuclei. This perturbation modified the number of photons emitted at a given angle depending on the time. To detect this variation, 4 germanium detectors were placed around the crystal at 90° relative to each other.

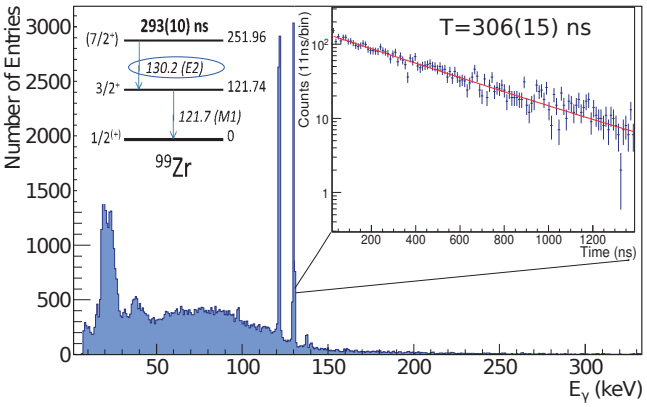

Fig. 1. Preliminary gamma energy spectra measured for ^{99}Zr with the decay curve associated to the 130.2 keV line.

The online analysis did not allow us to extract a preliminary magnetic moment measurement. The analysis is in progress. However, some basic observables could be preliminarily extracted to confirm the expected properties. In Fig. 1, the gamma energy spectra associated with ^{99}Zr is shown. We can see the two characteristic lines from the decay of the isomeric state at 251.96 keV. The fit on the decay curve for the line at 130.2 keV gives a lifetime of 306(15) ns, which is compatible with the adopted value of 293(10) ns.

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