Magnetic moment measurement of isomeric state in ^{75}Cu

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The ^{75}Cu nucleus has attracted much attention because the ground-state spin parity changes from $3/2^-$ to $5/2^-$[1)] as a result of the migration of the $5/2^-$ levels along the Cu isotopic chain[2)]. The ^{75}Cu nucleus has two isomeric states[3)] at 62-keV and 66-keV levels directly decaying to the ground state[4)], one of which is expected to have a spin parity of $3/2^-$ inherited from the ground state of ^{73}Cu. In order to investigate the wave function of the $3/2^-$ state and to compare it with the $5/2^-$ ground state[1)], the magnetic moment of the isomeric state of ^{75}Cu was measured.

The experiment was carried out at the BigRIPS at the RIBF. The two-step fragmentation scheme with momentum-dispersion matching[5)] was employed to produce highly spin-aligned ^{75}Cu. In the reaction at F0, ^{76}Zn was produced by a fission reaction of a 345-MeV/nucleon ^{238}U beam on a ^{9}Be target with a thickness of 1.29 g/cm^2. The secondary ^{76}Zn beam was introduced to a second target of wedge-shaped aluminum with a mean thickness of 0.81 g/cm^2, placed at the momentum-dispersive focal plane F5. The ^{75}Cu nuclei including those in isomeric state ^{75m}Cu were produced through one-proton removal from ^{76}Zn. The ^{75}Cu beam was subsequently transported to F7 under the condition that the momentum dispersion between F5 and F7 was matched to that between F3 and F5.

The g-factor of ^{75m}Cu was determined by means of the time-differential perturbed angular distribution (TDPAD) methods. The TDPAD apparatus, placed at F8, consists of a dipole magnet, a Cu crystal stopper, Ge detectors, and a plastic scintillator. The dipole magnet provided a static magnetic field of $B_0 = 0.200$ T. ^{75m}Cu was implanted into the Cu stopper, and γ rays were detected with four Ge detectors located perpendicular to B_0 at a distance of 7.0 cm from the stopper and at angles of ± 45 and ± 135 degrees with respect to the beam axis. The plastic scintillator of 0.1 mm in thick was placed upstream of the stopper, the signal from which provided the time-zero trigger.

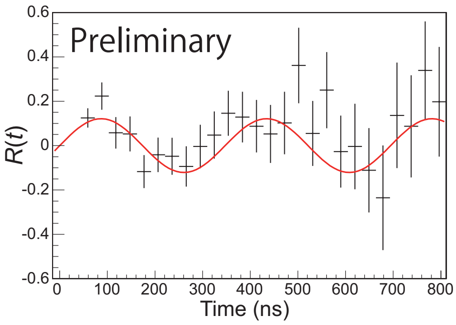

Fig. 1. Preliminary result of $R(t)$ ratio for the 66-keV γ ray. The solid line represents the sine function after fitting to the the experimental $R(t)$ ratio.

The $R(t)$ ratio representing the change of anisotropy of γ rays synchronized with the spin precession was obtained according to

$$R(t) = \{N_{13}(t) - \epsilon N_{24}(t)\}/\{N_{13}(t) + \epsilon N_{24}(t)\}, \quad (1)$$

where $N_{13}(t)$ and $N_{24}(t)$ are the sums of the photopeak count rates at the two pairs of Ge detectors placed diagonally to each other, and ϵ denotes a correction factor for the difference in the detection efficiency. In this experiment we observed an oscillation pattern only for the 66-keV γ ray with over 5σ significance, as shown in Fig. 1. The magnitude of spin alignment was found to be larger than 50%. The detailed analysis and the deduction of the g-factor is in progress.

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References

1) K. T. Flanagan et al.: Phys. Rev. Lett. **103**, 142501 (2009).
2) S. Franchoo et al.: Phys. Rev. Lett. **81**, 3100 (1998).
3) J. M. Daugas et al.: Phys. Rev. C **81**, 034304 (2010).
4) C. Petrone et al.: Acta. Phys. Pol. B **44**, 637 (2013).
5) Y. Ichikawa et al.: Nature Phys. **8**, 918 (2012).