Magnetic moment of the $13/2^+$ isomeric state in ^{69}Cu: Spin alignment in a single-nucleon removal reaction[†]

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The ^{69}Cu nucleus, having one proton outside the ^{68}Ni core, is a good probe for both the robustness of the $Z = 28$ shell closure and a possible enhancement of the $N = 40$ sub-shell gap. In order to provide direct information on the composition of the wave function of the $(13/2^+)$ isomeric state in ^{69}Cu and to compare it to large-scale shell-model calculations, the g factor of the state of interest was measured.

The experiment was performed at RIKEN with the RIPS fragment separator. A ^{70}Zn primary beam at 63.13 MeV/u was incident on a 101.46 mg/cm^2 ^{9}Be target at the entrance of the RIPS separator to produce the nuclei of interest. An Al achromatic wedge-shaped degrader of 84.99 mg/cm^2 was placed at the F1 focal plane of RIPS in order to select the fragments of interest. The purity of the secondary beam was adjusted by specific slit openings at the F2 and F3 focal planes.

The ^{69}Cu nuclei, produced by single-proton removal from the primary beam, were implanted in an annealed 1 mm thick Cu foil, positioned at the center of the set-up between the poles of an electromagnet. An external magnetic field of 0.50(1) T was applied to induce Larmor precession of the nuclei. Four coaxial HPGe γ-ray detectors were placed in a horizontal plane at polar angles $\theta = \pm 135°$ and $\theta = \pm 45°$ with respect to the beam axis in order to detect the intensity variation of the γ-rays as a function of time. A plastic-scintillator detector was used to provide the start $t = 0$ signal for the isomeric lifetime measurement.

The time-dependent perturbed angular distribution (TDPAD) method was used to extract the magnetic moment of the $(13/2^+)$ state in ^{69}Cu. Its g fac-
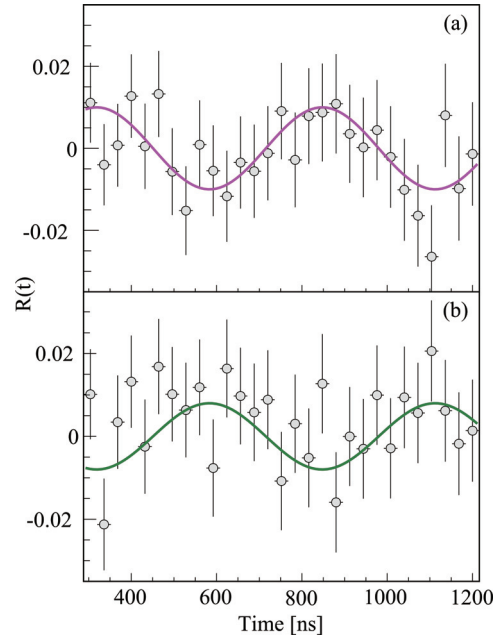
Fig. 1. $R(t)$ functions for (a) the sum of the $E2$ transitions and (b) the sum of $M1$ transitions following the decay of the $(13/2^+)$ isomer in ^{69}Cu for $\theta = \pm 135°$ detector combination.

tor was obtained by fitting the sum of the 189.7-keV and 1710.6-keV $E2$ transitions (see Fig. 1(a)) with a standard $R(t)$ function. As a result, a more precise value for $g(13/2^+) = +0.248(9)$ was deduced in the present measurement compared to a previous study.[1] The $R(t)$ function for the sum of the 470.2-keV, 485.7-keV, 657.6-keV, and 1212.6-keV $M1$ transitions, which have an opposite sign compared to the $E2$ transitions, is also shown in Fig. 1(b). The experimentally observed degree of spin alignment for the state of interest was obtained as $A = -3.3(9)\%$ in single-nucleon removal reactions even for multi-quasiparticle states. ANTOINE[2] shell-model calculations performed using the JUN45 and jj44b interactions both fall close to the measured g factor, indicating a mixed configuration with significant contributions from particle-hole excitations across the $N = 40$ sub-shell gap.

References
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