Nuclear g-Factor of the 275.4-keV 5- Isomeric State in 212At

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journal or publication title	CYRIC annual report
volume	1982
page range	33-35
year	1982
URL	http://hdl.handle.net/10097/48687

I. 10 Nuclear g-Factor of the 275.4-keV 5^- Isomeric State in ^{212}At

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A recent study$^{1)}$ has revealed a new isomeric state in ^{212}At with a half-life of 32 ns and a spin and parity of 5^- at an excitation energy of 275.4 keV (Fig. 1). The isomeric state has been interpreted as a member of the multiplet arising from a valence-nucleon configuration of $(\pi h_{9/2})^3 \nu g_{9/2}$.

To confirm the configuration assignment we have measured nuclear g-factor of the 5^- isomeric state by the TDPAD (time differential perturbed angular distribution) method by making use of the ^{209}Bi(α,n)^{212}At reaction.

A thick ^{209}Bi target was placed in an external magnetic field produced by an electromagnet, and was bombarded with a pulsed beam of 24 MeV α-particles. The pulse repetition time of the beam was set at 210 ns. A 5-cm^3 hyperpure germanium detector was placed at 135° with respect to beam direction. The energy resolution of the detector was 600 eV for the 122 keV γ-ray from ^{57}Co. Since the 69.9 keV γ-ray directly de-exciting the 275.4 keV state is weak in intensity because of a large internal conversion coefficient, the 160.4-keV cascade γ-ray was used for the present TDPAD measurements. Figure 2 shows a time spectrum of the 160.4 keV γ-ray measured with an over-all time resolution of 4.0 ns. It has been found from this time spectrum that the intensity of the delayed component of the 160.4 keV γ-ray falls with a half-life of 32.0 ± 2.0 ns. This value is in good agreement with the half-life of the 275.4 keV state reported in Ref. 1).

The TDPAD measurements were performed at two different external magnetic fields B of 12.0 and 18.0 kG. The results at B=12.0 and 18.0 kG are respectively shown in Figs. 3(a) and 3(b), where the asymmetry ratio $R(t) = [N(t,-B)-N(t,+B)]/[N(t,-B)+N(t,+B)]$ is plotted as a function of time t. The quantities N(t,+B) and N(t,-B) are normalized yields of the 160.4 keV γ-ray observed at 135° with external magnetic field up and down respectively. Solid curves in the figures are least-squares fits of a function $R(t) = -[3A_2/(4+A_2)]\sin(2\omega_L t)$ to the data, where ω_L is the Larmor frequency, and parameter values obtained are listed in Table 1. The A_4 term and the relaxation of nuclear spin alignment are neglected in the present analyses. The beam deflection due to the external magnetic field is also neglected, because by means of compensation magnets$^{2)}$ the deflection angle at target was limited within $0.0 \pm 0.6°$ with beam position on target being fixed.

From the present experiment the sign of A_2 and accordingly that of ω_L cannot be determined, and the negative signs of A_2 and ω_L given in Table 1 is taken from Ref. 1). The nuclear g-factors obtained in the present study are also listed in Table 1. The two g-factors obtained at B = 12.0 and 18.0 kG are not in agreement within the experimental uncertainties, but the disagreement is probably due to statistics of the data. Taking a weighted mean of the two values, we finally obtain the nuclear g-factor of the 275.4 keV 5^- state in ^{212}At as

$$g = +0.31 \pm 0.04.$$

Dominant configurations of low-lying states in ^{212}At are expected to be $[(\pi h_{9/2})^3_{9/2}(\nu g_{9/2})_{9/2}]_I$, and it is interesting to compare the experimental g-factor of the 5^- state with the g-factor of the configuration with I=5 evaluated by the additivity relation using experimental g-factors of the $h_{9/2}$ proton and the $g_{9/2}$ neutron. Ingwersen, et al.$^{3)}$ have measured the g-factor of the 1416.3-keV $21/2^-$ state in ^{211}At which is the lowest seniority v=3 $[(h_{9/2})^3]_{21/2^-}$ state, and obtained the g-factor of the $h_{9/2}$ proton as $g(\pi h_{9/2}) = 0.917 \pm 0.016$. Baba, et al.$^{4)}$ have measured the g-factors of the 433-keV 7^- and 439-keV 5^- states in ^{210}Bi with dominant $[(\pi h_{9/2})(\nu g_{9/2})]_I$ configurations, and extracted the g-factor of the $g_{9/2}$ neutron as $g(\nu g_{9/2}) = -0.296 \pm 0.014$. Using these $g(\pi h_{9/2})$ and $g(\nu g_{9/2})$, we obtain by the additivity relation a g-factor of 0.311 ± 0.021 for the $[\pi(h_{9/2})^3_{9/2}\nu(g_{9/2})_{9/2}]_{5^-}$ configuration. This is in good agreement with the experimental g-factor of the 275.4-keV 5^- state in ^{212}At, which suggests that the dominant configuration of this state is $[\pi(h_{9/2})^3_{9/2}\nu(g_{9/2})_{9/2}]_{5^-}$.

References

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Table 1. Summary of the experimental results

B_{ext} (kG)	A_2	ω_L (rad/ns)	g
12	-0.041 (3)	-0.016 (1)	+0.283 (13)
18	-0.037 (5)	-0.030 (2)	+0.348 (17)

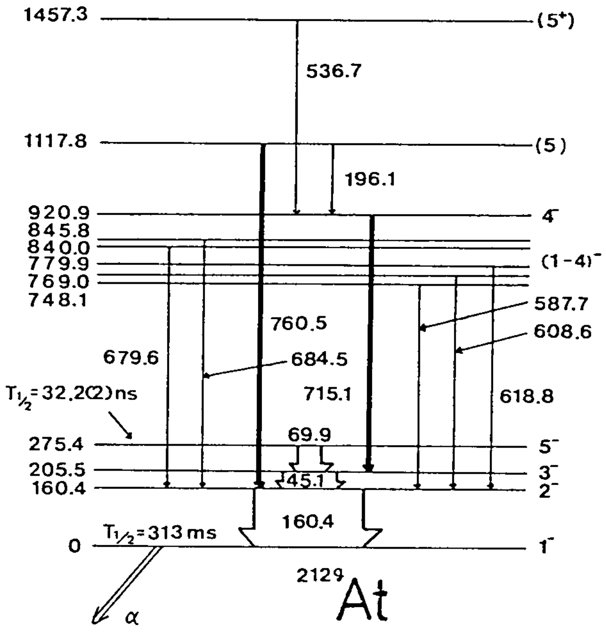


Fig. 1. The level scheme of ^{212}At taken from Ref. 1).

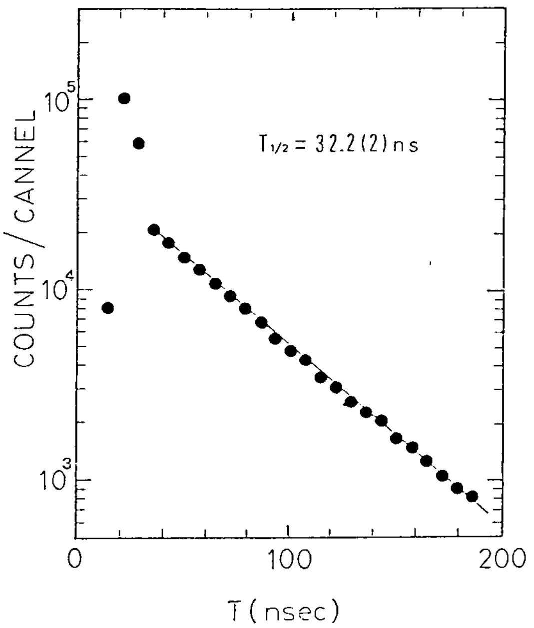
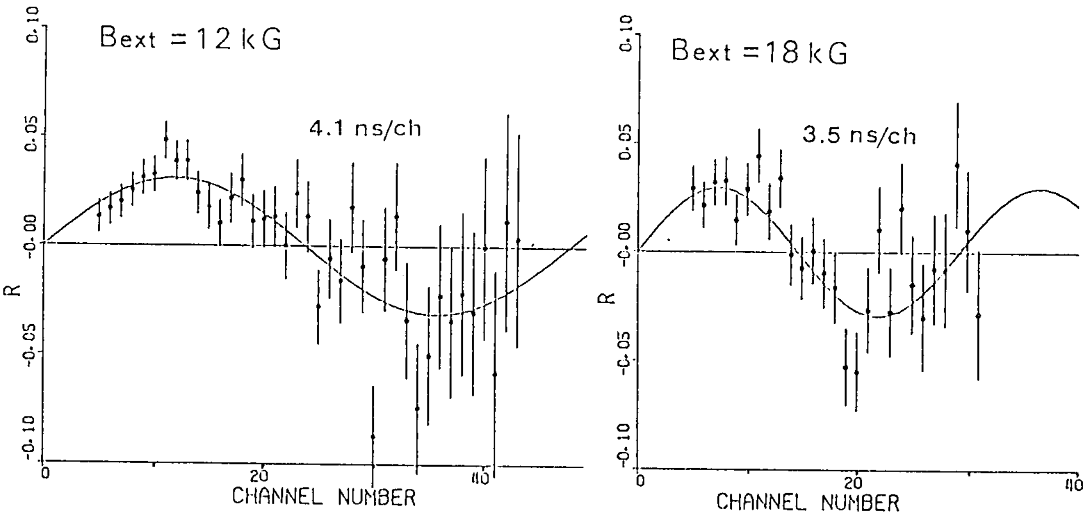


Fig. 2. Time spectrum of the 160.4 keV γ-ray. The solid line is a least-squares fit to the data.



(a)

(b)

Fig. 3. Experimental results of the 160.4 keV γ-ray at external magnetic fields of (a) 12 and (b) 18 kG. The solid curves are least-squares fits to the data.