Nuclear g-Factor of the 2972 keV Isomer in 130Xe

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I. 10 Nuclear g-Factor of the 2972 keV Isomer in ^{130}Xe

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Kusakari et al.[1] have made a systematic study of even-mass Xe isotopes and suggested that in these isotopes the 10^+ level of two-quasiparticle configuration $(\nu h_{11/2})^2$ decreases in energy with increasing neutron number and in ^{128}Xe it comes eventually lower than the 10^+ member of the ground-state quasi-rotational band to be the first 10^+ level.

The aims of the present experiment are to measure the nuclear g-factor of the 2972-keV $(10)^+$ level in ^{130}Xe with a half-life of 5.2 ns[2], and to obtain the information about its configuration to confirm the validity of the above suggestion.

Excited levels in ^{130}Xe were populated through the ^{130}Te $(\alpha,4n\gamma)^{130}Xe$ reaction at E_α = 48 MeV. A ^{130}Te target of 4 mg/cm^2 thickness was prepared by depositing isotopically enriched tellurium powder on a mylar foil of 4 μm thickness. The target was placed in the 20 mm pole gap of an electromagnet referred to as "PAD magnet". An external magnetic field of 20.40±0.07 kG perpendicular to the reaction plane was applied to the target with PAD magnet, and the angular distribution of the 275.5 keV γ-ray deexciting the 2972 keV level in ^{130}Xe (see fig. 1) was measured with a high purity Ge detector at seven angles in a range of 60 to 132°. A Ge(Li) detector was fixed at -90° for normalization of the γ-ray yields at different angles. The angular distribution measurement was repeated with an external magnetic field of the same magnitude and reversed direction, -20.4 kG. The strength of the external magnetic field was determined using a calibrated Hall probe of 0.25 % accuracy. The inhomogeneity of the external magnetic field was less than 1 % over a circular area of 1 cm diameter on the median plane. The change of the α-particle beam on target in position and direction due to the external magnetic field was compensated by a beam steering system.[3] Ray-tracing calculations indicate that this system enables one to confine the residual beam deflection on target to less than ±0.6°. A performance test[4] of this system has given a preliminary result quite consistent with the calculated result.

Fig. 2 shows the angular distributions of the 275.5 keV γ-ray measured at external magnetic fields of ±20.4 kG. The angular distribution data were fitted to the expression

$$W(\theta,\pm B) = b_0 + \frac{b_2}{\sqrt{[1+(2\omega\tau)^2]}} \cos[2(\theta\mp\Delta\theta_2-\delta)]$$

$$+ \frac{b_4}{\sqrt{[1+(4\omega\tau)^2]}} \cos[4(\theta\mp\Delta\theta_4-\delta)] \ ,$$

with

$$b_0 = 1+(1/4)A_2+(9/64)A_4 \ , \quad b_2 = (3/4)A_2+(20/64)A_4$$

and

$$b_4 = (35/64)A_4 \ ,$$

where ω is the Larmor frequency, τ the mean life of the isomer and δ the parameter representing the geometrical asymmetry in experimental arrangements. The Larmor frequency is expressed in terms of the nuclear g-factor g of the isomer, the perturbative magnetic field B and the nuclear magneton μ_N as $\omega = -\mu_N gB/\hbar$, and $\Delta\theta_n = (1/n)\tan^{-1}(n\omega\tau)$. The results of the least-squares fitting are shown in fig. 2 and table 1. Using a half-life of 5.17±0.14 ns[2], and assuming that B is equal to the strength of the external magnetic field, we obtain the nuclear g-factor of the 2972 keV isomer in ^{130}Xe as

$$g = -0.158 \pm 0.021 \ ,$$

where the experimental error includes uncertainties in detection angle, external magnetic field and life time, in addition to statistical uncertainties.

Experimental nuclear g-factors of $11/2^-$ levels in odd-mass Te and Xe isotopes are listed in table 2. When comparing the g-factor of the 2972 keV level in ^{130}Xe with those listed in table 2, one notes a reasonable agreement between them, which indicates a possibility that the 2972-keV $(10)^+$ level in ^{130}Xe has a predominant configuration of two-quasiparticle $[(\nu h_{11/2})^2]_{10^+}$ as suggested in ref. 1).

References

1) Kusakari H., Kitao K., Sato K., Sugawara M. and Katsuragawa H., Nucl. Phys. A401 (1983) 445.
2) Kusakari H., private communication.
3) Kawamura N., Sugawara M., Shibuya S., Fujioka M., Orihara H. and Ishimatsu T., CYRIC Ann. Rep. 1981, p. 88; Kawamura N., Fujioka M., Sugawara M., Shibuya S., Iura K. and Ishimatsu T., Proc. sixth int. conf. on hyperfine interactions (July 1983, Groningen), to be published in Hyp. Interactions.
4) Kawamura N., Sakai F., Iura K., Wada M., Hayashibe S., Fujioka M. and Ishimatsu T., CYRIC Ann. Rep. 1983.
5) Silverans R. E., Coussement R., Schoeters E. and Vanneste L., Nucl. Phys.

A210 (1973) 307.
6) Silverans R. E., Coussement R., Dumont G., Pattyn H. and Vanneste L., Nucl. Phys. A193 (1972) 367.
7) Schoeters E., Coussement R., Geerts R., Odeurs J., Pattyn H., Silverans R. E. and Vanneste L., Phys. Rev. Lett. 37 (1976) 302.
8) Silverans R. E., Coussement R., Pattyn H., Schoeters E. and Vanneste L., Z. Physik 267 (1974) 145.

Table 1. Results of the least-squares fitting analysis

A_2	A_4	δ (rad)	$\omega\tau$ (rad)
0.303±0.030	-0.072±0.031	-0.0091±0.0095	0.115±0.015

Table 2. Experimental g-factors of $11/2^-$ states in several odd-mass Te and Xe isotopes

Nucleus	Level energy (keV)	g	Ref.
^{123}Te	248	-0.182±0.009	5)
^{125}Te	145	-0.169±0.009	6)
^{127}Te	88	-0.165±0.009	5)
^{129}Te	106	-0.209±0.009	5)
^{129}Xe	236	-0.154±0.005	7)
^{131}Xe	164	-0.145±0.018	8)
^{133}Xe	233	-0.158±0.022	8)

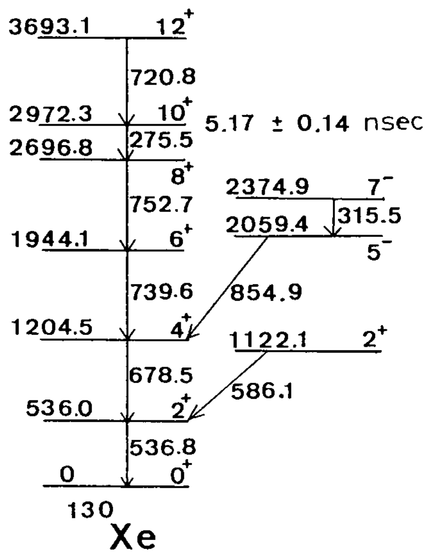

Fig. 1. Partial level scheme of ^{130}Xe; ref. 1).

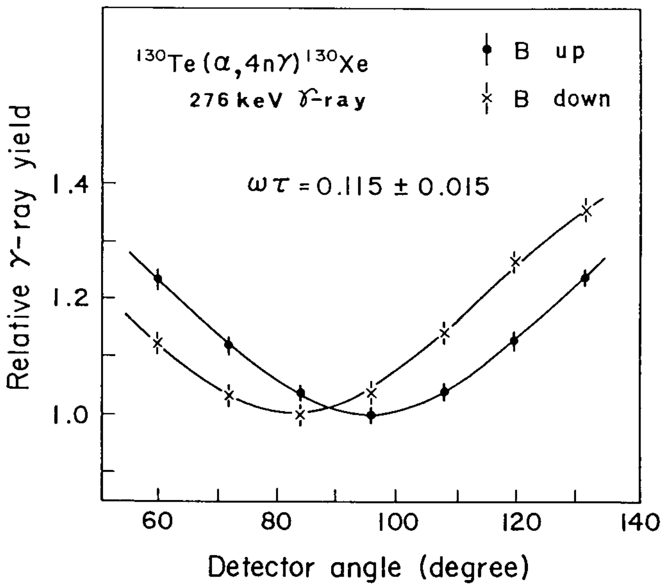

Fig. 2. The angular distributions of the 275.5 keV γ-ray measured at external magnetic fields of ±20.4 kG. Curves are the results of least-squares fitting analysis.