Communications

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g factor of the 879 keV state of ^{70}Ga†

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The g factor of the 879 keV state of ^{70}Ga has been measured by the time differential perturbed angular distribution method. The reaction $^{69}Ga(d,p)^{70}Ga$ on a target of liquid gallium was used to populate the state in a magnetic flux density of 20 kG. The anomalously small empirical result $g=-0.066\pm0.025$ can be explained in terms of configuration mixing.

[NUCLEAR REACTIONS $^{69}Ga(d,p)$, $E=5$ MeV; measured $\gamma(\theta,B,t)$, $B=20$ kG; deduced g (879 keV).]

The g factors of odd-odd nuclei, which seldom assume values consistent with additivity, provide a sensitive indicator of configuration mixing. The present communication reports a measurement of the g factor of the 879 keV state of doubly-odd ^{70}Ga by the pulsed beam time differential perturbed angular distribution technique.[1,2]

A target of natural gallium, mounted in a transverse magnetic flux density of 20 kG, was bombarded by a beam of 5 MeV deuterons pulsed with a 1 μs repetition time and a pulse width of less than 1 ns. The target was liquified in order to minimize perturbations due to quadrupole interaction with both the gallium lattice and field gradients arising from radiation damage. Delayed time spectra of the 188 keV γ ray which deexcites the 879 keV state[3,4] with a half-life of 22.7 ns (Ref. 5) were measured with a Ge(Li) detector at $-30°$ and $+60°$ to the beam direction. The time resolution of these spectra was approximately 6 ns full width at half maximum. Independent calibration of the magnetic field and the timing system was avoided by comparing the Larmor precession frequency ω_L of the 879 keV state of ^{70}Ga with that of the 197 keV state of ^{19}F measured under the same conditions.

The intensity ratio, plotted for both ^{70}Ga and ^{19}F in Fig. 1, is given by

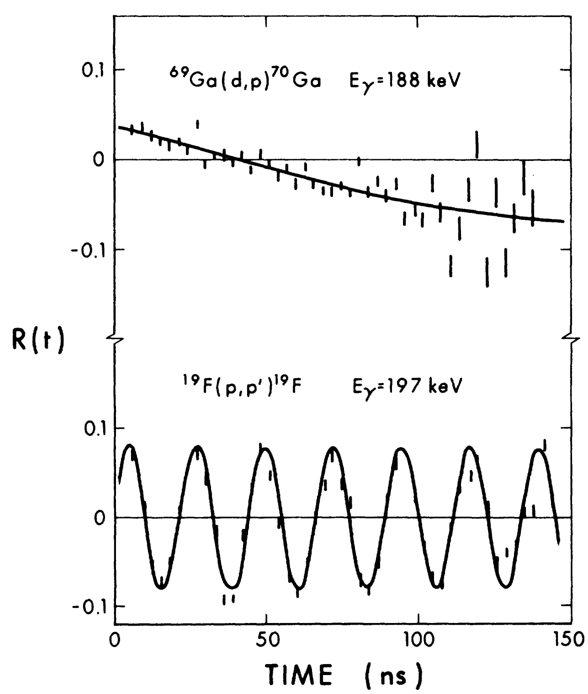

FIG. 1. Intensity ratio vs time delay for both ^{19}F and ^{70}Ga. The smooth curves are least squares fits to the data.

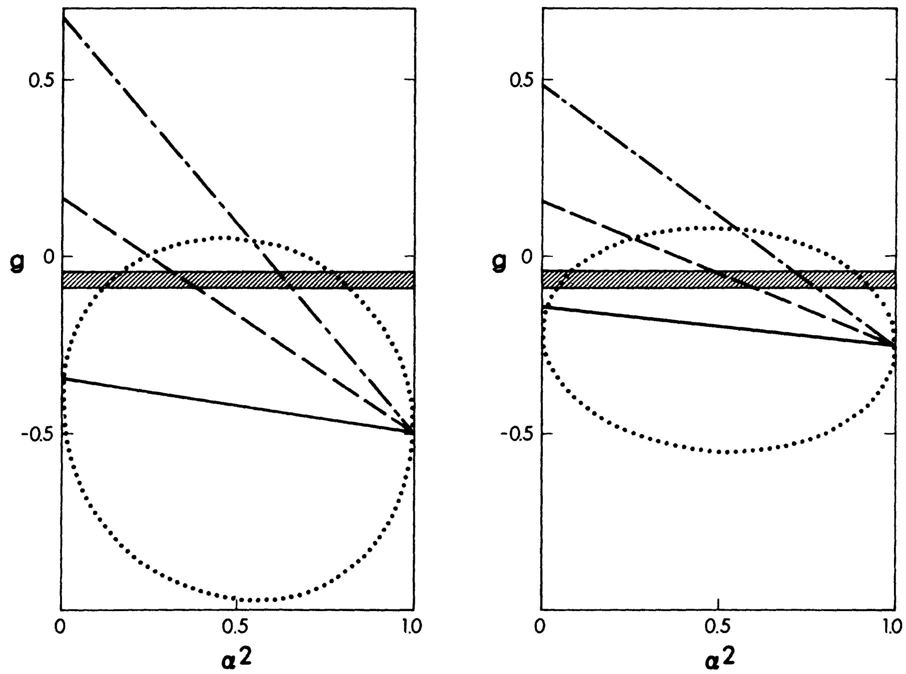

FIG. 2. The g factor of a spin-parity 4^- state as a function of the squared amplitude (defined in text). The solid, dotted, dashed, and dot-dashed curves correspond to admixtures of $|\pi f_{5/2}\nu g_{9/2}\rangle$, $|\pi p_{1/2}\nu g_{9/2}\rangle$, $|\pi p_{3/2}\nu(g_{9/2})^n{}_{7/2}\rangle$, and $|\pi p_{3/2}\nu(g_{9/2})^n{}_{5/2}\rangle$ configurations, respectively. The plot on the left was calculated with free nucleon g factors while that on the right is based on effective nucleon g factors. The cross-hatched region represents the experimental result.

$$R(t)=\frac{I(t,-30°)-I(t,+60°)}{I(t,-30°)+I(t,+60°)}\ .$$

A least squares fit to these data yields $\omega_L(^{70}\mathrm{Ga})/\omega_L(^{19}\mathrm{F})=-0.046\pm0.017$ which corresponds to $g(^{70}\mathrm{Ga})=-0.066\pm0.025$ [assuming $g(^{19}\mathrm{F})=1.442\pm0.024$].[2] Knight shift and diamagnetic corrections were not significant.

Measurements of γ ray angular distributions and polarizations, following the $^{70}\mathrm{Zn}(p,n\gamma)^{70}\mathrm{Ga}$ reaction,[3,4] have been used to assign spins and parities to states of ^{70}Ga. In particular, spin-parity 4^- has been proposed for the 879 keV state and subsequently supported by a study of the time dependence of the γ ray angular distribution.[5] Single neutron transfer data[6] indicate a dominant $|\pi p_{3/2}\nu g_{9/2}\rangle$ configuration (the quantum numbers of nucleons coupled to spin-parity 0^+ are suppressed). Assuming free nucleon g factors, we calculate for the above configuration $g=-0.50$, far in excess of the experimental result. Substituting effective nucleon g factors, derived from adjacent nuclei,[7] approximately halves the calculated value, leaving a discrepancy of a factor of 4. The source of the remaining discrepancy is suggested by the pickup and stripping spectroscopic factors[6] which are consistent with a roughly 35% admixture of some undetermined configurations. An examination of the low-lying states of adjacent nuclei reveals that protons are readily excited from the $p_{3/2}$ orbital to the $f_{5/2}$ and the $p_{1/2}$ orbitals and that neutrons occupying the $g_{9/2}$ orbital frequently couple to spin-parity $\frac{5}{2}^+$ and $\frac{7}{2}^+$ rather than $\frac{9}{2}^+$. The results of calculations with some wave functions of the form $\alpha|\pi p_{3/2}\nu g_{9/2}\rangle\pm(1-\alpha^2)^{1/2}|\pi l_{j_p}\nu(g_{9/2})^n_{j_n}\rangle$ are shown in Fig. 2. The g-factor measurement is not sufficient to determine the nature of the admixed configurations but if the value of α^2 is to be consistent with the direct reaction data[6] the wave function probably includes either a $|\pi p_{1/2}\nu g_{9/2}\rangle$ or a $|\pi p_{3/2}\nu(g_{9/2})^n{}_{5/2}\rangle$ component.

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