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V–1 Magnetic Moment of the 265 keV Level in ^{75}As

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The ground state quadrupole moment of ^{75}As has been measured to be (0.27 ± 0.04) barns.[1] This large value clearly indicates the nucleus to be deformed. In spite of this one fails to see a clear rotational spectrum in the nucleus. There have been many calculations by different workers to explain the properties of this isotope.[2–5] Recent calculations of Imanishi *et al.*[5] have given very satisfactory agreement between the calculated and experimental spectra for the odd parity levels below 1 MeV and have also been able to explain the observed B(E2) values and the ground state quadrupole moment. We report here our measurements on the magnetic moment of the 265 keV $3/2^-$ level and compare it with the value to be expected on the basis of the calculations by Imanishi *et al.*[5] The integral method of the perturbed angular correlation technique has been used for the measurements.

Figure 1 shows a partial level scheme of ^{75}As levels populated in the decay of ^{75}Se, which is very well established. There is a strong 136–265 keV gamma cascade through the 265 keV level. The lifetime of this level has been measured to be (17.1 ± 1.0) psec by Langhoff and Schumacher[6] using resonance fluorescence technique. Because of such a short lifetime for this level, we have made use of the large hyperfine magnetic field acting at As nuclei in iron.[7–8]

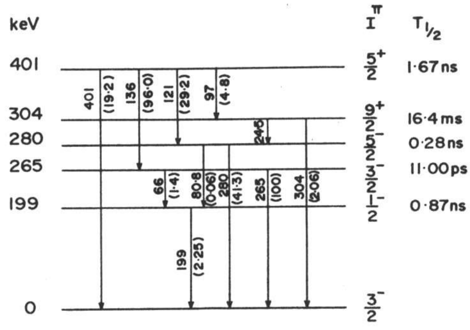

Fig. 1. Partial level scheme of ^{75}As levels populated in the decay of ^{75}Se.

^{75}Se ions of about 130 keV energy were implanted on to a thin annealed iron foil by means of a mass separator.* The magnetic field seen at As site in iron was measured from the perturbed angular correlation studies on the 121–280 keV gamma cascade. The field obtained was (319 ± 33) kG[8] using the known magnetic moment of the 280 keV level.[9,10]

A conventional Ge(Li)–NaI(Tl) coincidence system was used for the directional correlation and spin rotation measurements. The source foil was screwed in between the pole tips of an electromagnet mounted on to a angular correlation table. The angular correlation data was least squares fitted to the expression $W(\theta) = 1 + A_2P_2(\cos\,\theta) + A_4P_4(\cos\,\theta)$. The correlation coefficients obtained for the 136–265 keV cascade are $A_2 = -0.0327 \pm 0.0016$ and $A_4 = 0.0034 \pm 0.0021$. They are not corrected for finite geometrical corrections. The spin rotation was measured with the detectors fixed at ±135°. Coincidence counts were collected in both the quadrants simultaneously for each direction of the polarising field. The quantity R defined as

$$R = 2\frac{\text{Coinc(up)} - \text{Coinc(down)}}{\text{Coinc(up)} + \text{Coinc(down)}}$$

was obtained to be $R(+135) = -0.00140 \pm 0.00053$ and $R(-135) = +0.00183 \pm 0.00055$. The average of this gave $R = (16.1 \pm 3.8) \times 10^{-4}$. The rotation $\omega\tau$ was calculated to be $\omega\tau = (16.2 \pm 4.0)$ mrad, using the relation

$$R = \frac{4b_2\omega\tau}{1 + (2\omega\tau)^2}$$

where

$$b_2 = \frac{3A_2}{4 + A_2} \quad \text{for} \quad A_4 \ll A_2.$$

The value of the 'g' factor obtained for the state is $g = +(0.62 \pm 0.16)$ using the measured value of the hyperfine field $H = (319 \pm 33)$ kG for this

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Table I.

Energy of levels (keV)	Spin	Nilsson's model		Imanishi *et al.* μ (nm)	Experimental value μ (nm)
		$\eta=2$ μ (nm)	$\eta=4$ μ (nm)		
0	$3/2^-$	1.1	0.8	1.5	1.44
265	$3/2^-$	1.5	1.8	1.8	0.93 ± 0.24 (present work)
280	$5/2^-$	1.4	1.4	2.1	0.91 ± 0.12 (ref. 9)

sample.[8] The spin of the level being 3/2, its magnetic moment is obtained as (0.93 ± 0.24) nm. This value is in good agreement with the recently reported value of $\mu = (1.11 \pm 0.33)$ nm by Becker and Zawislak.[9]

The quadrupole moment $Q = (0.27 \pm 0.04)$ barns of the ground state corresponds to a deformation parameter $\eta = 2$ to 4 in the Nilsson model.[11] The ground and 265 keV excited state can be identified as 3/2 [312] and 3/2 [301] Nilsson state. Imanishi *et al.*[5] have calculated the energy level spectra and the electrical properties of the arsenic isotopes by taking into account pairing and Coriolis coupling in the Nilsson picture. We have calculated the magnetic moment of the ground state 265 keV and 280 keV states using the Nilsson wavefunctions and the wavefunctions given in ref. 5. Table I lists the magnetic moment of different states using Nilsson model and also wavefunctions given by Imanishi *et al.*[5] We have used $g_s = 0.6\ g_s$ (free) for all the calculations.

As is seen from the Table I, though Imanishi *et al.*[5] have obtained good agreement with the ground state magnetic moment the agreement with that of $3/2^-$ and $5/2^-$ states is very poor. However, using Nilsson model the overall agreement is not bad for $\eta = 2$ which is also consistent with the measured quadrupole moment of the ground state. It has been suggested by Becker and Zawislak[9] that the $3/2^-$ and $5/2^-$ states at 265 and 280 keV respectively, are the members of a rotational band on the $1/2^-$, 199 keV level. One can get good agreement for the magnetic moments of the $3/2^-$ excited state and the $5/2^-$ state using this suggestion, however, the value of the decoupling factor a obtained from the energy spacing and magnetic moment and the B(M1) values are not consistent. In fact one obtains very good agreement for the magnetic moment of the 265 keV state, if one assumes that it is formed due to the coupling of the odd particle in the ground state to the excited 2^+ core. Using the measured value of 1.44 nm for the ground state magnetic moment and $g_c = Z/A$. One obtains $\mu = 0.80$ nm for the 265 keV state which agrees very well with the measured value of $\mu = (0.93 \pm 0.24)$ nm.

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