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Magnetic dipole moments near ^{132}Sn: new measurement on ^{135}I by NMR/ON

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Abstract

On-line low temperature nuclear orientation (OLNO) experiments have been performed on the isotope ^{135}I using the technique of nuclear magnetic resonance on oriented nuclei (NMR/ON). The magnetic moment of the $7/2^+$ ground state has been measured to be $\mu(7/2^{+\,135}\mathrm{I}) = 2.940(2)\mu_N$, thereby extending the known data on these states in odd-A I isotopes up to the neutron shell closure at $N = 82$. Shell-model calculations have been performed for the magnetic moments of $7/2^+$ states in the $N = 82$ isotones using free-nucleon and effective g-factors. The effective g-factors are obtained from a perturbation calculation that includes corrections for core polarisation and meson-exchange currents. The proton number dependence of the magnetic moments in the sequence of $N = 82$ isotones ^{133}Sb–^{139}La is discussed in terms of blocking of the $0g_{9/2}$ to $0g_{7/2}$ core polarisation with increasing $0g_{7/2}$ occupancy. Systematics of all measured $7/2^+$ odd-proton moments for $74 \leqslant N \leqslant 82$ are reviewed. © 1998 Elsevier Science B.V.

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1. Introduction

Magnetic dipole moments are sensitive indicators of the composition of nuclear wave-functions and in favourable cases can throw light on the detailed description of nucleons in finite nuclear matter through their dependence on meson exchange interaction. Following our earlier work on the extreme single particle nucleus ^{133}Sb [1] (one $g_{7/2^+}$ proton outside double magic ^{132}Sn), we report a precise measurement of the magnetic dipole moment of the $7/2^+$ ground state of $^{135}_{53}I_{82}$ by the technique of nuclear magnetic resonance on oriented nuclei (NMR/ON). This result is a significant addition to knowledge of the systematic variation of the series of $g_{7/2^+}$ ground state moments close to the $N = 82$ shell closure. It completes the sequence for the proton numbers 51(Sb), 53(I), 55(Cs) and 57(La) as the $g_{7/2^+}$ orbital is filled. Shell model calculations are presented using free-nucleon and effective g-factors, the effective g-factors being obtained from a perturbation calculation that includes corrections for core polarisation and meson-exchange currents. The proton number dependence of the magnetic moments of the odd-Z sequence ^{133}Sb–^{139}La is discussed in terms of blocking of the $0g_{9/2}$ to $0g_{7/2}$ core polarisation with increasing $0g_{7/2}$ occupancy. Finally the systematics of all measured $7/2^+$ odd-proton moments as a function of N in the range of $74 \leqslant N \leqslant 82$ are reviewed.

2. Experimental details

Nuclear magnetic resonance on oriented nuclei (NMR/ON) is a very powerful technique for determining nuclear ground and isomeric state moments [2]. Nuclei are typically implanted or diffused into a ferromagnetic host and thus experience large hyperfine fields. At temperature of order 10 mK, achievable with a ^{3}He/^{4}He dilution refrigerator, splitting and unequal population of the hyperfine Zeeman levels produces a high degree of nuclear polarisation parallel to the host magnetisation.

The angular distribution of radiation from the polarised nuclear ensemble is given by

$$W(\theta) = 1 + f \sum_{\lambda=2}^{2L_{\max}} B_\lambda U_\lambda A_\lambda Q_\lambda P_\lambda(\cos\theta), \tag{1}$$

where all symbols have their conventional meaning in the context of LTNO [2]. The angle θ is relative to the direction of magnetisation of the host, defined by an applied field B_{applied} (the orientation axis). Generally the anisotropy at a given angle, $A(\theta)$ is defined as $A(\theta) = W(\theta) - 1 = [N_{\text{cold}}(\theta)/N_{\text{warm}}(\theta)] - 1$, where $N_{\text{cold,warm}}$ are counting rates when the sample is "cold" ($\sim$10 mK) and "warm" (1 K). In on-line experiments, when the absolute count rates vary with separator implantation beam strength, an alternative measure of anisotropy is used, namely $R = [W(0°)/W(90°)] - 1$. For <u>IFe</u>, the interaction is strong and appreciable anisotropies are observed below 100 mK.

Polarisation of the sample can be destroyed by the application of a modulated RF field normal to the quantisation axis. As the RF frequency is varied, resonant absorption can be detected by reduction in the observed anisotropy. The technique is described in

Ref. [3]. A fit to the centre frequency ν_0 yields the magnetic moment of the oriented state through the relation

$$\nu_0 = \frac{|\mu|}{Ih}[B_{hf} + B_{applied}(1+K)], \tag{2}$$

where μ is the magnetic moment, I is the spin of the oriented state and K is the Knight shift. Taking the known Korringa relaxation constant for ^{131}I in iron [4] and its relationship to the Knight shift, the parameter K can be estimated to be $\leqslant 1\%$ in I in iron; sufficiently small to be neglected. The hyperfine field for ^{131}I in iron has been measured by NMR/ON [5], using the magnetic moment of ^{131}I measured by Lipworth et al. [6]. These two measurements yield a value of $B_{hf} = 114.50(5)$ T [7]. We adopt this value since any hyperfine anomaly $^{131}\Delta^{133}$will be $\leqslant 0.1\%$ between these very similar isotopes and can be neglected.

The experiments were performed at the on-line orientation facility at the OSIRIS mass separator of the Uppsala University Neutron Research Laboratory at Studsvik, Sweden. The ^{135}I activity was produced by thermal fission of neutron irradiated ^{233}U. After separation the $A = 135$ fission product beam was implanted at 40 keV into 99.99% pure Fe foils in the focal plane of the mass separator. The foils had previously been prepared by rolling 100 μm thick iron between steel sheets, annealing it and then rolling again. The final thickness of the foil was 10 μm. After implantation the foils were annealed at 400°C for 30 minutes in an atmosphere of argon, and then soldered to the cold finger of the dilution refrigerator. During the time taken to anneal the sample, the short-lived antimony and tellurium isotopes decayed, so the measured gamma-ray spectrum contained almost exclusively iodine transitions on a smooth background. The dilution refrigerator was cooled to base temperature of 10.9 mK at which a spectroscopic study of the angular distribution of all gamma transitions was made. The temperature of the sample was measured using a ^{54}Mn<u>Fe</u> nuclear orientation thermometer. Four intrinsic germanium detectors placed around the refrigerator, two positioned along the axis of polarisation and two perpendicular to it, were used to study the gamma-ray

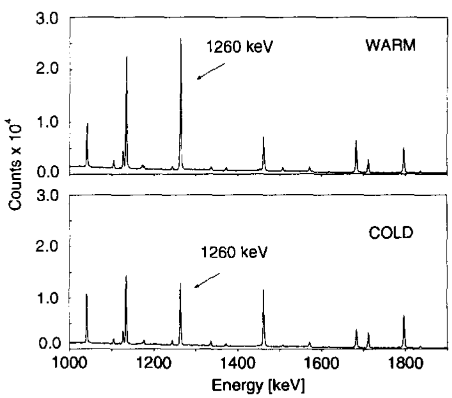

Fig. 1. "Warm" and "cold" γ-ray spectra of ^{135}I (normalized to source strength), taken at $\theta = 0°$, showing transitions of varying anisotropy.

angular distribution. Fig. 1 shows a section of the spectrum containing the most intense transition in the decay of ^{135}I, at 1260 keV, with the source at base temperature and when 'warm' at 1 K. The different gamma transitions show changes in count rate which reflect their particular $U_\lambda A_\lambda$ parameters. These will be discussed in a separate publication.

For the precision NMR/ON magnetic moment measurement, the sample was exposed to a transverse RF field and the temperature allowed to stabilise before a frequency sweep was started. The temperature during the resonance measurements varied slightly with RF frequency in the range 20–25 mK.

3. NMR/ON results

We present a value for the magnetic moment of ^{135}I, significantly improved with respect to the previous non-resonant determination (2.66(6) μ_N) [8]. The resonance was observable on a number of gamma rays but most pronounced on the strongest, 1260 keV, transition. This is shown in Fig. 2. The resonance has a centre frequency of 733.7(1) MHz at $B_{\text{applied}} = 0.1$ T and FWHM of 1.8(3) MHz. The maximum destruction of the anisotropy at the peak of the resonance is only 1.3(2)%, indicating the sensitivity of the technique, which is favoured by the large hyperfine field of IFe. Using the above values of B_{hf}, B_{applied} and $I = 7/2$, the magnetic moment is found to be

$$\mu(7/2^+, {}^{135}I) = 2.940(2)\mu_N.$$

4. Theoretical calculations

In this section we will consider not only the newly measured magnetic moment of the $7/2^+$ ground state in ^{135}I, but also the $7/2^+$ states in other $N = 82$ isotones: ^{133}Sb, ^{137}Cs and ^{139}La. By examining this sequence of isotones, we are able to discuss the variation of the magnetic moment with the occupancy of the proton $0g_{7/2}$ orbital. We will discuss, first, the evaluation of the effective g-factors for the orbitals near the Fermi

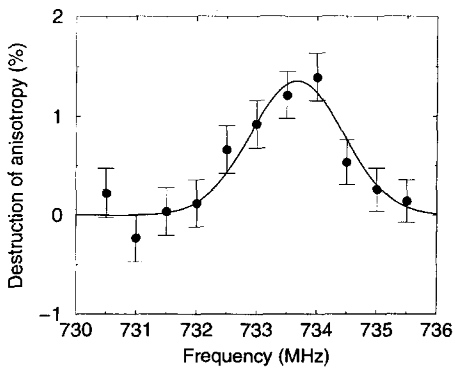

Fig. 2. NMR/ON resonance data for ^{135}I in Fe at $B_{\text{applied}} = 0.1$ T.

surface at the ^{132}Sn closed shell and, second, shell-model calculations that introduce configuration-mixing among these orbitals.

4.1. Effective g-factors

The magnetic moment operator in finite nuclei is modified from the free-nucleon operator due to core-polarisation and meson-exchange current (MEC) corrections [9,10]. The effective operator is defined as

$$\boldsymbol{\mu}_{\text{eff}} = g_{l,\text{eff}}\boldsymbol{l} + g_{s,\text{eff}}\boldsymbol{s} + g_{p,\text{eff}}[Y_2, \boldsymbol{s}], \tag{3}$$

where $g_{x,\text{eff}} = g_x + \delta g_x$, $x = l$, s or p, with g_x the free-nucleon, single-particle g-factor and δg_x the calculated correction to it. Note the presence of a new term $[Y_2, \boldsymbol{s}]$ absent from the free-nucleon operator, which is a spherical harmonic of rank 2 coupled to a spin operator to form a spherical tensor of multipolarity 1. The free-nucleon values are $g_l(\text{proton}) = 1.0$, $g_l(\text{neutron}) = 0.0$, $g_s(\text{proton}) = 5.587$, $g_s(\text{neutron}) = -3.826$ and $g_p(\text{proton}) = g_p(\text{neutron}) = 0.0$.

The corrections, δg_x, are computed in perturbation theory for the closed-shell-plus-or-minus-one configuration with the closed shell being ^{132}Sn. The first-order core-polarisation correction involves coupling the valence nucleon to the 1^+ particle–hole states: proton $(0g_{9/2}^{-1}, 0g_{7/2})$ and neutron $(0h_{11/2}^{-1}, 0h_{9/2})$. This term leads to a large quenching in the $g_{s,\text{eff}}$ value but only a small change in $g_{l,\text{eff}}$. The calculation is easily extended to all orders in the RPA series [9]. The residual interaction in these calculations is taken as a one-boson-exchange potential multiplied by a short-range correlation function. This modification is an approximate, but easy, way to obtain a G-matrix.

Meson-exchange current corrections arise because nucleons in nuclei are interacting through the exchange of mesons, which can be disturbed by the electromagnetic field. Since meson exchange involves two nucleons, the correction leads to two-body magnetic moment operators. In a closed-shell-plus-or-minus-one configuration, computation of this correction requires evaluation of the two-body matrix elements between the valence nucleon and one of the core nucleons, summed over all nucleons in the core. The results can be expressed in terms of an equivalent effective one-body operator, Eq. (3), acting on the valence nucleon alone. The details of the two-body MEC operators are described in Ref. [9] and updated in Ref. [11]. For consistency, the same mesons, coupling constants, masses and short-range correlations are used in the construction of the MEC operators as are used in the one-boson-exchange potential.

There are two further terms to consider. First is a mesonic correction in which the meson prompts the nucleon to be raised to an excited state, the Δ-isobar resonance, which is then de-excited by the electromagnetic field. This correction leads to a two-body operator that is handled like the MEC correction. Second is a relativistic correction to the one-body operator [9]. Both these corrections amount to only a few percent change to the magnetic moment, but are retained for completeness.

Finally there are other second-order core-polarisation corrections not contained in the RPA series that are difficult to compute because there are no selection rules to limit the number of intermediate states to be summed. A further correction of the same order in meson–nucleon couplings is a core-polarisation correction to the two-body MEC operator. Fortunately, as Arima et al. [12,13] have pointed out, the latter terms largely cancel the former. In our earlier work [1] this correction was not explicitly calculated, but effective g-factors from a comparable calculation in Pb were used. Here we have computed these terms, so our result differs a little from [1] but not significantly. The computation, however, was performed approximately. The closed shell was taken to be an LS closed shell, with $A = 140$, and the computation performed in LS coupling. This leads to a great saving in computation time and makes the calculation tractable. However, the neutron excess orbitals are not now treated correctly. The intermediate-state summation is explicitly computed up to $12\hbar\omega$ and geometrically extrapolated beyond that.

The resulting corrections to the g-factors from the sum of all these effects are listed in Table 1. All matrix elements have been evaluated with harmonic oscillator radial functions of characteristic frequency $\hbar\omega = 7.87$ MeV. Note that with a term $[Y_2, s]$, in the effective magnetic moment operator, Eq. (3), there are non-zero off-diagonal matrix elements between $0g_{7/2} - 1d_{5/2}$ and $1d_{3/2} - 2s_{1/2}$ orbitals. These l-forbidden matrix elements are zero with the free-nucleon operator but non-zero here. However, their impact in the present calculation is very small.

The results given in Table 1 differ a little from those given in Ref. [1] because the previous work used the same second-order corrections which were found for a ^{208}Pb closed core, whereas the present results are based upon a new calculation for a ^{132}Sn closed core. The last row in Table 1 gives an estimate of the error associated with each of the g-factor corrections. This error is based upon the observation that the most vulnerable parts of the calculations are those which involve a cancellation between the second-order core-polarisation terms and the core-polarisation correction to the MEC. For example, these two terms for the $0g_{7/2}\delta g_l$ correction are -0.193 and 0.156, respectively. Both of these pieces involve intermediate state summations which are not restricted by selection rules, and the summation convergence is slow. In addition, the LS coupling approximation was used for the second order terms. The errors given

Table 1
Effective proton g-factors from core-polarisation and MEC calculations

	δ terms			Δ terms		
Orbital	δg_l	δg_s	δg_p	Δg_l	Δg_s	Δg_p
0h	0.087	−1.988	1.549	0.002	0.727	−0.537
0g	0.131	−2.284	1.705	0.005	0.920	−0.105
1d	0.063	−2.167	1.681	0.003	0.775	−0.522
2s		−2.102			0.728	
0g–1d			3.329			
1d–2s			1.902			
error	0.019	0.13	0.05			

are based upon a 10% uncertainly in the second-order core-polarisation term.

The results given by δg in Table 1 strictly only apply to closed-shell-plus-or-minus-one configurations at a ^{132}Sn closed shell. We would like to extend the calculations to closed-shell-plus-or-minus-n configurations, where n would be a small number of valence particles or valence holes relative to the closed shell. The most critical component for this is the occupancy of the proton $0g_{7/2}$ orbital. If the number of particles in this orbital differs from one then there is a significant impact on the core-polarisation calculation because the 1^+ particle–hole excitations become partially blocked by the Pauli exclusion principle. In first order in perturbation theory the impact of this is proportional to n. The sums over the core in the MEC calculations are also impacted, but to a lesser extent, and again are proportional to n. We have evaluated an adjustment to the effective g-factors by redoing the perturbation calculations and using for the closed shell ^{132}Sn plus a full proton $0g_{7/2}$ orbital. Then the effective g-factors are adjusted in the following way. For an orbital other than a proton $0g_{7/2}$:

$$\delta g_x^{\text{adjusted}} = \delta g_x + N_g \Delta g_x / 8, \tag{4}$$

and for a proton in the $0g_{7/2}$ orbital

$$\delta g_x^{\text{adjusted}} = \delta g_x + (N_g - 1) \Delta g_x / 6, \tag{5}$$

where $x = l$, s or p, and N_g is the occupancy of the proton $0g_{7/2}$ orbital. The calculated values for δg_x and Δg_x are given in Table 1. (The 0g–1d and 1d–2s Δg values have a very small influence on the result and were not calculated.) The impact of these nucleus-dependent corrections is mainly on the spin g-factor because it is mainly the RPA calculation that is affected.

4.2. Shell-model calculations

The wave functions for the $7/2^+$ states in the $N = 82$ isotones were obtained in the model space $(0g_{7/2},1d_{5/2},1d_{3/2},2s_{1/2},0h_{11/2})^{Z-50}$ with the shell-model code OXBASH [14]. The matrix dimensions for $J = 7/2^+$ go up to 9024 for ^{139}La. The Hamiltonian is a realistic two-body G-matrix derived from interactions which are fitted to nucleon–nucleon scattering data. The G-matrix elements are renormalized by the Q-box method which includes all diagrams through third-order in the interaction G and sums up the folded diagrams to infinite order (see Ref. [18] for further details).

We have investigated the use of G matrix elements based upon the Bonn-A, Bonn-B [15], Nijmegen (Nijm-I) [17], and the charge-dependent Bonn (CD-Bonn) [16] nucleon–nucleon interactions. The results for the calculated magnetic moments were very similar. The results we report here are based upon the Nijm-I G-matrix. This was chosen because it reproduces the lowest energies of the lowest 2^+, 4^+ and 6^+ states in ^{134}Te and ^{136}Xe somewhat better than that of the Bonn-A which was used for previous $N = 82$ shell-model calculations [19,20]. We have not included the Coulomb interaction.

The experimental magnetic moments are compared in Table 2 to those obtained with the free-nucleon g-factors. The calculated values are remarkably constant as a function

Table 2
Experimental and calculated magnetic moments in nuclear magneton units for the $7/2^+$ states in the $N = 82$ isotones. The three calculations use the free-nucleon g-factors, the constant effective g-factors (δg) and the occupancy-adjusted effective g-factors (δg and Δg) from Table 1

Nuclide	Experiment	Free	Eff.	Adj-eff.	N_g
^{133}Sb	3.00(1)[a]	1.717	2.925	2.925	1.00
^{135}I	2.940(2)[b]	1.723	2.940	2.855	2.54
^{137}Cs	2.841[c]	1.731	2.943	2.795	3.74
^{139}La	2.783[c]	1.761	2.954	2.767	4.51

[a] Ref. [1].
[b] This work.
[c] Ref. [23], errors less than 1 part in last figure.

of Z and are all about half the experimental value. This is what one would expect if the wavefunction were purely $(0g_{7/2})^n$. The one-body transition density for these states is dominated by the diagonal $0g_{7/2}$ component with values of 1.000, 0.9968, 0.9962 and 0.9928 for $Z = 51$, 53, 55 and 57, respectively. This is a consequence of the dominance of the one-quasiparticle component in the these odd–even ground states [20]. The actual wave functions are, however, much more complicated than $(0g_{7/2})^n$. For example, the ^{139}La wave function is only 10.7% $(0g_{7/2})^7$ and its dominant component is 39.8% $(0g_{7/2})^5(1d_{5/2})^2$. The small increase in the free-nucleon magnetic moments shown in Table 2 comes mainly from the small $1d_{5/2}$ to $1d_{3/2}$ components in the one-body transition density.

As discussed in Ref. [1], the magnetic moment for the $0g_{7/2}$ single-particle state in ^{133}Sb is strongly modified by the effects of core-polarisation and mesonic exchange currents. The results obtained by using a constant set of effective g-factors (δg) from Table 1 appropriate for ^{133}Sb is shown in Table 2. The calculated values increase slowly with Z in contrast to the decreasing experimental result. The main effect left out at this stage is the blocking of the $0g_{9/2}$ to $0g_{7/2}$ core polarisation due to the increased occupancy of the $0g_{7/2}$ orbit. In order to take this into account we recalculate the magnetic moments using the adjusted g-factors from Eqs. (4) and (5) and Table 1. The results are given in column 5 of Table 2 and the calculated occupancy, N_g, of the proton $0g_{7/2}$ orbital is also given. These final results are in qualitative good agreement with experiment, both in the overall magnitude of the enhancement and with the small decrease as a function of increasing Z (see Fig. 3).

The overall scale for the magnetic moments is set by the single-particle value associated with ^{133}Sb. An increase of δg_l from 0.131 to 0.151 would make the agreement for this single-particle case perfect and would increase all of the $7/2^+$ moments by same amount, $+0.077\mu_N$. This small change in δg_l is consistent with the error estimate given in Table 1 and discussed above.

Between ^{133}Sb and ^{139}La, the experimental moments decrease by $0.22\mu_N$ compared to the theoretical decrease of $0.16\mu_N$. As discussed above, the change in magnetic moment with Z is a combination of effects within the shell-model calculation and the core-polarization calculation. For example, the amount of Z-dependence in the core-

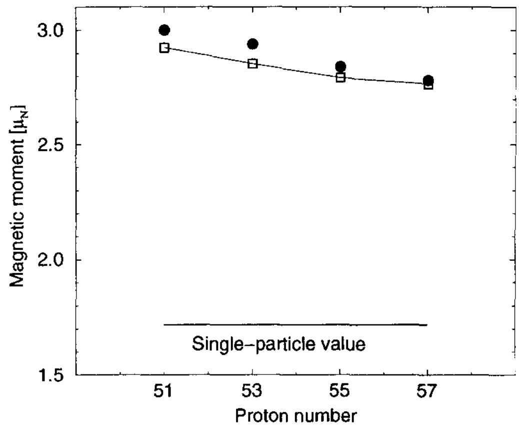

Fig. 3. Magnetic moments of the $7/2^+$ ground states as a function of proton number Z. The experimental values are given by the filled circles. The horizontal line is the $0g_{7/2}$ single-particle value and the squares connected by a line are the configuration mixing plus core-polarization results.

polarisation depends upon the occupancy of the $0g_{7/2}$ orbital. In the pure $(0g_{7/2})^n$ model, the occupancy for ^{139}La is $N_g = 7$ compared to the full configuration mixing value of 4.51. The reduction is mainly due to the scattering of pairs of particles from the $0g_{7/2}$ orbital into the $1d_{5/2}$ orbital. An effective occupancy of 5.7 would give a theoretical Z-dependence which matches experiment. Another way to make the theoretical Z-dependence agree with experiment would be to change the Δg_s value from 0.920 to 1.200. The Z-dependence also depends upon the influence of the $1d_{5/2}$ to $1d_{3/2}$ components in the shell-model transition densities whose effect is to increase the moments as Z increases. Combined (small) errors in all of these aspects could be responsible for the difference between the experimental and theoretical Z-dependence.

5. Systematics of neutron number dependence

The accurate measurement of the magnetic moment of the $7/2^+$ $(0g_{7/2})^3$ ground state of ^{135}I, as well as completing the $N = 82$ series of $(0g_{7/2})^n$ odd-proton moments, also provides the final component of the full range of $(0g_{7/2})^n$ moments in the region $74 \leqslant N \leqslant 82$. These are shown in Fig. 4 and listed in Table 3.

A full discussion of the N-dependence of the $^{125-133}Sb$ moments has been given previously [1] in terms of a collective approach using the Particle-Core-Model. Table 3 also includes the results of shell model calculations where these have been done at and near closed shell $N = 82$. We remark on the good quantitative agreement between the theoretically predicted difference $(0g_{7/2})^1_{Sb}-(0g_{7/2})^3_I$ at $N = 82$, of $+0.070\mu_N$ (see Table 2) and the average and quasi-constant experimental separation between isotones of these elements of $+0.062\mu_N$. The actual value and the constancy of this separation are fully consistent with the core polarisation (see Section 4) quenching mechanism which also predicts the parallel behaviour seen for the Cs and La isotopes. (N.B. for

Table 3
Measured and calculated moments of $(0g_{7/2})^n$ states

Z		N = 74		N = 76		N = 78	
		Exp	Theory	Exp	Theory	Exp	Theory
51	Sb $(0g_{7/2})^1$	2.635(35)	2.663 [a]	2.70(2) [c]	2.769 [a]	2.79(2) [c]	2.873[a] 2.780[b]
53	I $(0g_{7/2})^3$	2.54(5)		2.6210(3)		2.742(1)	
55	Cs $(0g_{7/2})^5$	–		–		2.5820	
57	La $(0g_{7/2})^7$	–		–		–	

Z		N = 80		N = 82	
		Exp	Theory	Exp	Theory
51	Sb $(0g_{7/2})^1$	2.89(1) [c]	2.950 [a] 2.853 [b]	3.00(1) [c]	3.00 [a] 2.925 [b]
53	I $(0g_{7/2})^3$	2.856(5)	2.757 [b]	2.940(2) [d]	2.855 [b]
55	Cs $(0g_{7/2})^5$	2.7324(2)		2.8413(1)	2.795 [b]
57	La $(0g_{7/2})^7$	2.695(6)		2.7830	2.767 [b]

[a] PCM calculation see Ref. [1], value for $N = 82$ taken from experiment.
[b] Shell model, this work and Ref. [22].
[c] From Ref. [1].
[d] This work.
Other experimental values from Ref. [23]. Where no error is given it is less than 1 in the last figure.

lower N than shown in Fig. 4 the ground state spins in all four elements become $5/2^+$).

In addition to the proton–proton interaction discussed above, the shell-model calculations for $^{129-133}$Sb and ^{135}I depend on the proton–neutron and neutron–neutron interactions. The G-matrix elements for the neutron–neutron interaction have been previously studied [21], but the proton–neutron interaction has not been previously established. Our work is based upon starting with the Nijm-I proton–neutron G-matrix elements and

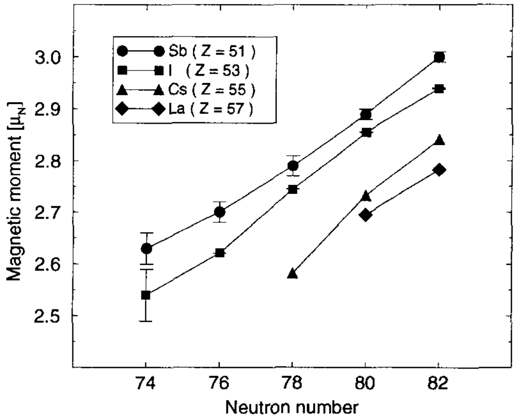

Fig. 4. Systematics of all odd-proton $7/2^+$ (zeroth order $(0g_{7/2})^n$) magnetic dipole moments as a function of neutron number for $N \leqslant 82$.

multiplying the $T = 0$ part by an overall factor of 0.7 in order to improve the agreement with the spectrum of the odd-odd nucleus ^{132}Sb; details will be given elsewhere [22].

Between ^{133}Sb and ^{129}Sb the experimental moments decrease by $0.22\mu_N$ compared to the calculated decrease of $0.15\mu_N$. The main source of this change is an additional part of the wave function coming from the coupling of the $0g_{7/2}$ orbital to the 2^+ state of the Sn core, which is the same as assumed in the particle-core model used in Ref. [1]. The theoretical moments of the Sn 2^+ states are about $-0.2\mu_N$ which agree approximately with the empirical value needed for the particle-core coupling model [1].

The main source of theoretical error in the N-dependence of the moments is the strength of the neutron-proton interaction. As mentioned above, we needed to reduce the $T = 0$ G-matrix elements by a factor of 0.7 in order to obtain better agreement for the levels in ^{132}Sb. However, the N-dependence of the theoretical moments would be in better agreement with experiment without this reduction. This aspect of the calculations remains to be fully explored.

6. Summary

This paper has presented a new precise value for the magnetic dipole moment of ^{135}I. Theoretical interest in this result, completing the series for odd-proton configurations $(0g_{7/2})^n$, n odd, at $N = 82$ is fully discussed and the overall systematics of odd-A $7/2^+$ moment for $74 \leqslant N \leqslant 82$ are reviewed.

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