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V–11 Magnetic Moments of Deformed Nuclei*

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The magnetic dipole moments are calculated using the deformed wave functions of the Hamiltonian:[1]

$$H = H_N + \frac{2\hbar\omega}{\sqrt{3}}(1-\rho^2)(1+2\rho^2)^{-1/2}\rho^{-2/3} \times \sqrt{\pi/5}\, r^2 Y_{20}$$
$$+ \frac{\hbar\omega}{5}\gamma\rho^{1/6}\left(\frac{3\rho^2}{1+2\rho^2}\right)^{3/4} r^3 \times\left[\left(\frac{1}{\rho^2}-1\right)\sqrt{\frac{4\pi}{3}}\,Y_{10} + \left(1+\frac{2}{3\rho^2}\right)\sqrt{\frac{4\pi}{7}}\,Y_{30}\right]$$
$$+ \frac{\hbar\omega}{6}\gamma^2\frac{\rho^4}{1+2\rho^2} r^4\Big[1-\frac{2}{3}(1-\rho^{-2}) + \frac{1}{5}(1-\rho^{-2})^2 - \left\{\frac{1-\rho^{-2}}{3}-\frac{(1-\rho^{-2})^2}{7}\right\}\sqrt{\frac{4\pi}{5}}\,Y_{20}$$
$$+ 8(1-\rho^{-2})\sqrt{\frac{4\pi}{9}\frac{1}{35}}\,Y_{40}\Big]. \qquad (1)$$

Here H_N is the Nilsson Hamiltonian,[2] the deformation parameter ρ, the ratio of the major axis a and the minor axis b, is related to δ of ref. 2:

$$\rho = \frac{a}{b} = \sqrt{\frac{3+2\delta}{3-4\delta}} \qquad (2)$$

and γ is the pear-shaped deformation parameter which represents the degree of deformation of the usual spherical harmonics Y's.

The zeroth order wave functions are obtained by diagonalizing the total Hamiltonian eq. (1), following the methods given in ref. 2. The second order correction to the wave function is also calculated. The magnetic dipole moments are calculated using both the zeroth order and the second order wave functions, and some examples are presented in Table.

It is seen from the Table that the agreement between theoretical and experimental values are good in the examples given. However, the results obtained in this calculation in some nuclei, such as Al^{27}, Lu^{175}, are quite poor. One notes that sets of values of γ, ρ are possible in some nuclei. Similar calculations are being carried out for the electric quadrupole moment, and preliminary results indicate that the deformation parameters ρ, γ obtained from the magnetic dipole moment and electric quadrupole moment calculation, and the energy minimization often differ from each other.

References

1) K. Lee and D. R. Inglis: Phys. Rev. **108** (1957) 774.
2) S. G. Nilsson: Mat. Fys. Medd. Dan. Vid. Selsk. **29**, (1955) No. 16.

Table I. Magnetic dipole moments.

Nucleus	μ_{exp}	μ_{theory}				
		γ	ρ	0th order	2nd order	Total
$_{10}Ne^{21}$	−0.66	0.00	1.10	−0.64	0.00	−0.64
		0.05	1.10	−0.64	0.00	−0.64
$_{11}Na^{23}$	+2.22	0.10	1.10	+2.21	+0.01	+2.22
		0.15	1.10	+2.22	+0.01	+2.23
$_{67}Ho^{165}$	+4.12	0.20	1.10	+3.48	+0.66	+4.14
$_{70}Yb^{173}$	−0.68	0.00	1.55	−0.65	−0.02	−0.67
$_{89}Ac^{227}$	+1.10	0.20	1.025	+0.67	+0.42	+1.10
$_{94}Pu^{241}$	−0.73	0.05	1.30	−0.70	−0.03	−0.73

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