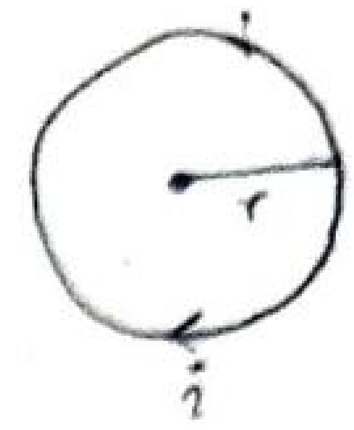
Magnetic dipole moment of Deuteron.

* Consider a current carrying loop



magnetic dipole moment $\mu = i \times (\pi r^2)$

(Circular current carrying loop)

* Particle of charge e moving in a circle

magnetic dipole moment $\mu = \frac{e}{2m} l$

l — orbital angular momentum; m — mass of particle

* Derivation for $\mu = \frac{e}{2m} l$.

Considering a charged particle with charge "e" moving in a circular path of radius 'r'

✓ Speed of the particle $= v$. —— (1)

✓ Time period $= \frac{2\pi r}{v}$ —— (2)

✓ Current associated with it $i = \frac{dq}{dt} = \frac{e}{T}$ —— (3)

Substituting (2) in (3) $\therefore$ $i = \frac{e}{(2\pi r/v)}$

$\therefore i = \frac{e v}{2\pi r}$

$\therefore$ Magnetic moment $\mu = \frac{ev}{2\pi r} \times \pi r^2 = \frac{e}{2} vr \times \frac{m}{m}$

$\therefore \mu = \frac{e}{2m} \times mvr$

we have $mvr = p \times r$

$mvr = l$

$\therefore \boxed{\mu = \frac{e}{2m} \times l}$

In quantum mechanics, Orbital angular momentum of a particle is quantized.

hence, Orbital angular momentum $= l\hbar$

$\therefore$ Magnetic dipole moment $\mu = \frac{e}{2m} \times l\hbar$

$$\mu = \frac{e\hbar}{2m} \times l$$

$\longrightarrow$ In case of e^-, $\mu = \mu_B \times l$.

$\mu_B = \frac{e\hbar}{2m_e}$

where μ_B is Bohr magneton, has the value

$(\mu_B = 5.7883 \times 10^{-5}\ eV/T)$

$\longrightarrow$ for proton, $\boxed{\mu_N = \frac{e\hbar}{2m_p}}$ ~~$\times l$~~

where $\frac{e\hbar}{2m_p} = \mu_N$, nuclear magneton.

& $\mu_N = 3.152 \times 10^{-8}\ eV/T$

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In general magnetic moment (due to its orbital motion)

$$\mu = g_l \, l \, \mu_N.$$

(g_l is a factor $g_l = 1$ for proton)

$g_l = 0$ for neutron (because it is electrically neutral)

⊛ Considering spin of Nucleon → It can also produce Magnetic Dipolemoment.

∴ we can write similar expression, $\mu = g_s \mu_N s$

(g_s - spin g factor)

∴ for proton, ~~μ~~ g_{sp} — experimentally found to be 5.5859

(as per Dirac eqn. g_s for spin half particles will be 2 where the spin half particle is considered as point particle but in case of nucleons they are composite particles ∴ g will be deviated from 2.)

for neutron $g_{sn} = -3.8261$

∴ for proton $\mu_p = g_{sp} \times s \, \mu_N = 2.793 \, \mu_N$

$\mu_N = g_{sn} \, s \, \mu_N = -1.913 \, \mu_N.$

Total Mag. dipole Moment $= [g_l \, l \, \mu_N + g_s \, S \, \mu_N]$

$= \mu_n + \mu_p$.

~~Spin Contribution~~

For Deuteron

n-p system relative angular momentum $l = 0$ or $l = 2$.

So wave fun. $\psi = a_s \psi(l=0) + a_d \psi(l=2)$ (superposition)

M.D.Moment $\mu_D = a_s^2 \mu(l=0) + a_d^2 \mu(l=2)$

experimentally $a_s^2 = 0.96$ &

$a_d^2 = 0.04$