Orbital Magnetic Moment

The orbital motion of the electron is equivalent to a current loop which produces a magnetic field ⊥r ~~too~~ to the plane of the orbit. The direction of the magnetic field is given by the Left hand rule fig (a). The magnetic field is characterised by a magnetic dipole moment. The magnetic moment associated with the current loop is,

$$\mu_e = IA \quad \text{——— (1)}$$

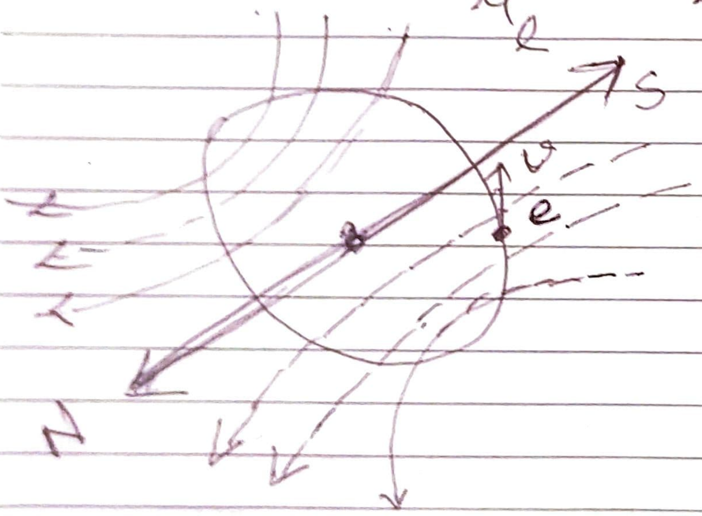

fig (a)

orbiting electron produces magnetic field

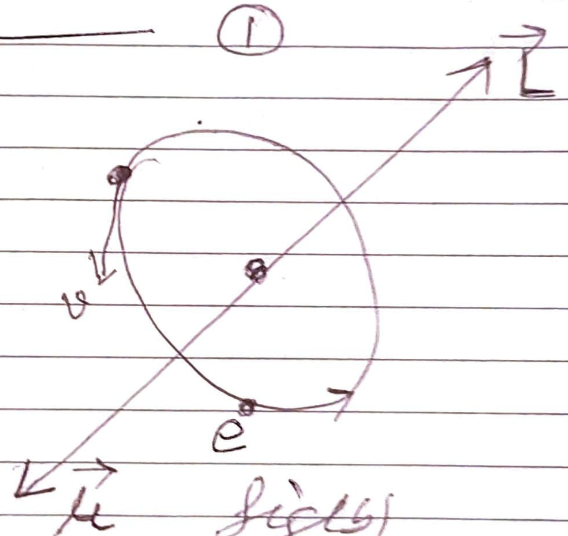

fig (b)

$\vec{L}$ and $\vec{\mu}$ are opposite direction

But, $I = e/T$ and $A = \pi r^2$, where r is the radius of the electron orbit and T is the time period of revolution of the electron.

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$$\therefore \mu_e = \frac{e}{T}\pi r^2 \quad \text{——— (1)}$$

If v be the orbital vel. of the electron, then $\frac{2\pi r}{v} = T$

$$\therefore \mu_l = e\pi r^2 \left(\frac{v}{2\pi r}\right) = \frac{evr}{2}$$

or, $$\mu_l = \frac{e}{2m}(mvr) = \frac{e}{2m} P_l \quad [\because P_l = mrv]$$

$$\therefore \mu_l = \left(\frac{e}{2m}\right) l\hbar \qquad \text{——— (2)}$$

But, $$\frac{e\hbar}{2m} = \mu_B, \text{ the Bohr Magneton}$$
$$= 9.273 \times 10^{-24}\ Am^2$$

$$\therefore \boxed{\mu_l = \mu_B l}$$

The ratio of $\frac{\mu_l}{P_l} = G$, is called gyromagnetic ratio and is given by,

$$G = \frac{\mu_l}{P_l} = \frac{e}{2m} \qquad \text{——— (3)}$$

or, $$G = g_l \, e/m \qquad \text{——— (4)}$$

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where, g_l is called the Lande splitting factor and is equal to 1 for orbital motion of the electron.