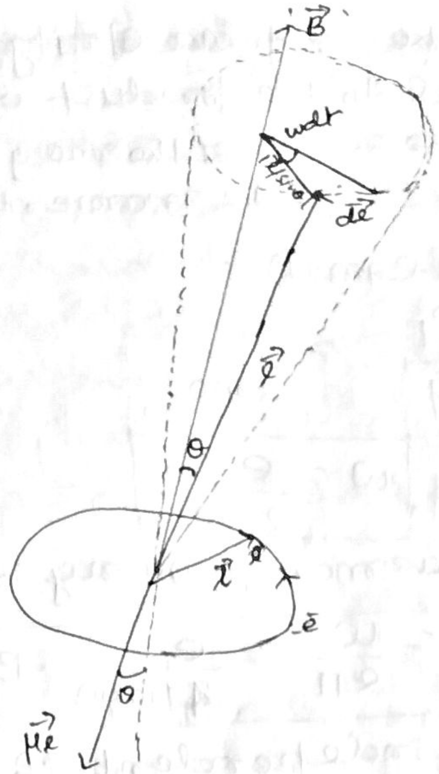
B.SC-III, Paper-VII, group-A

Larmor precession :—

An e moving around the nucleus of an atom is equivalent to a magnetic dipole. Hence, when the atom is placed in an external magnetic field, the electron orbit precesses about the field direction as axis. This precession is called the Larmor precession and the frequency of this precession is called the Larmor frequency.



The orbital dipole moment $\vec{\mu_l}$ of the $\bar{e}$ is

$$\vec{\mu_l} = -\frac{e}{2mc}\vec{I} \quad \text{—(I)}$$

$e \rightarrow$ charge of $\bar{e}$
$m \rightarrow$ mass of $\bar{e}$

$$\vec{\tau} = \vec{\mu_l} \times \vec{B} \quad \text{—(II)}$$

from (I) & (II)

Torque is always perpendicular to the angular momentum $\vec{I}$.

but $\vec{\tau} = \frac{d\vec{I}}{dt}$ i.e. change $d\vec{I}$ in $\vec{I}$ in a time dt.

The change $d\vec{I}$ is perpendicular to $\vec{I}$ (b'cz the change is in the direction of torque, and the torque is perpendicular to $\vec{I}$)

$$wdt = \frac{d\vec{I}}{|\vec{I}|\sin\theta} \qquad \text{angle} = \frac{\text{arc}}{\text{radius}}$$

$w \rightarrow$ angular velocity

$$\text{or } w = \frac{|d\vec{I}|}{dt}\frac{1}{|\vec{I}|\sin\theta} = \frac{|\vec{\tau}|}{|\vec{I}|\sin\theta}$$

from (II)

$$|\vec{\tau}| = |\vec{\mu_l}|\, B\sin\theta$$

$$\therefore \boxed{w = \frac{|\vec{\mu_l}|}{|\vec{I}|}\cdot B}$$

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Thus the angular velocity of Larmor precession is equal to the product of the magnetic field and the ratio of the magnetic moment to the angular momentum.

From eqn (I)

$$\frac{|\vec{\mu_e}|}{|\vec{I}|} = \frac{e}{2mc}$$

$$\therefore \boxed{\omega = \frac{e}{2mc} B}$$

The Larmor frequency is:

$$\boxed{f = \frac{\omega}{2\pi} = \frac{e}{4\pi mc} \cdot B}$$

→ It is independent of the orientation angle θ b/n orbit normal ($\vec{I}$) and field direction