An electron is trapped in a magnetic field B, and circulating with a velocity V at a radius of r. Find an expression for e/m ratio as a function of the frequency of its circular motion.

Answer:

A charged particle moving in a B-field experiences a sideways force that is proportional to the strength of the magnetic field, the component of the velocity that is perpendicular to the magnetic field and the charge of the particle. This force is known as the Lorentz force, and is given by:

$$\overrightarrow{\boldsymbol{F_L}} = q * \left(\vec{\boldsymbol{v}} \times \vec{\boldsymbol{B}}\right)$$

According to the definition of the cross product:

$$F_L \perp v$$

$$F_L \perp B$$

$$F_L = q * v * B * \sin\Theta$$

where θ is the measure of the smaller angle between v and B

It means that the Lorentz force is always perpendicular to both the velocity of the particle and the magnetic field that created it. When a charged particle moves in a static magnetic field it will trace out a helical path in which the helix axis is parallel to the magnetic field and in which the speed of the particle will remain constant. Because the magnetic force is always perpendicular to the motion, the magnetic field can do no work on an isolated charge.

According to the 1-st Newton's law:

$$F = m * a;$$

For the circular motion:

$$a = \frac{v^2}{r}$$

So:

$$F = m * \frac{v^2}{r} = q * v * B * \sin\Theta$$

Thus:

$$v = \frac{q * B * \sin\Theta * r}{m}$$

The speed of the object traveling the circle is:

$$v = \omega r;$$

Where ω is angular frequency; So:

$$\omega = \frac{q * B * \sin\Theta}{m}$$

For electron:

$$q = -e$$

Thus:

$$\boxed{\frac{e}{m_e} = -\frac{\omega}{B * \sin\Theta}}$$

http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=179.0