Langevin’s theory of Diamagnetism

Langevin gave a theory to explain the experimental results of curie . This concludes susceptibility of a diamagnetic material is independent of temperature and field strength .

According to him an electron revolving in a circular orbit in an atom is equivalent to a magnetic shell .

Let -e = Charge of an electron

ω = Angular velocity of an electron

a = Radius of the circular orbit

T = Time period of an electron

The equivalent current is given by

$$I = -e/T = -e/2\omega = -e\omega/2\pi \qquad (1)$$

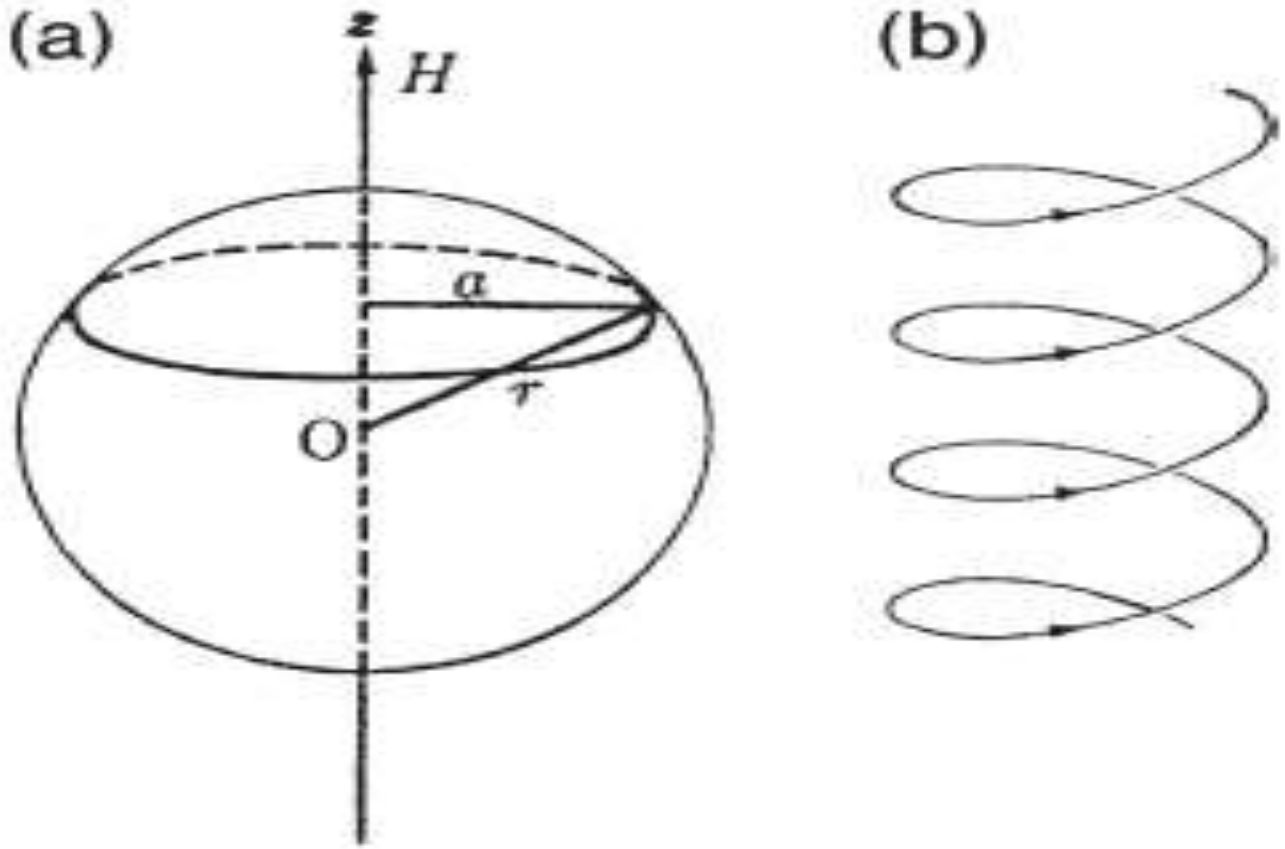

Figure (a) Electron rotation in the radius, *a* ;(b) cyclotron motion caused by the magnetic field.

Now the magnetic moment of the equivalent shell is

$M = IA = (e\omega/2\pi) \times \pi a^2$

Where $A = \pi a^2$ = Area

$\therefore \quad M = -1/2 \; e \; \omega \; a^2$ (2)

Since the electron is moving in a circular orbit , hence centripetal force acting on it

$$F = mv^2 / a$$

$$F = m\omega^2 a \qquad (3)$$

Where m = mass of an electron

This force is acting radially inward and it is given by the coulomb force of attraction between the nucleus and the electron .