* de-Broglie wave associated with Bohr-Orbit in H-atom

In Bohr's theory, electron is treated as a particle, But de-Broglie's theory suggested that matter and therefore, electron also, has a dual character, both as material particle and as a wave. He derived an expression for calculating the wave length λ of a particle of mass m · moving with velocity v. A/c to which –

$$\lambda = \frac{h}{mv} \quad \text{——} (1)$$

A/c to Einstein's mass-energy relationship–

$$E = mc^2 \quad \text{——} (2)$$

and A/c to plank's eqs –

$$E = h\nu = \frac{hc}{\lambda} \quad \text{——} (3)$$

on equating eqs – (2) & (3)

$$\frac{hc}{\lambda} = mc^2$$

or $$\lambda = \frac{h}{mc}$$

on replacing c by v we have –

$$\boxed{\lambda = \frac{h}{mv} = \frac{h}{p}}$$

Where, p is the momentum of the particle.

* Bohr's angular momentum from de-Broglie's eq-

Let us consider an electron moving in a circular orbit of radius 'r' around a nucleus. The wave train would be shown as –

If the wave is to remain continually in phase, the circumference of the circular orbit must be an integral multiple of wave length 'λ'. i.e.

$$2\pi r = n\lambda = \frac{nh}{mv} = \frac{nh}{p}$$

Thus, the angular momentum –

$$\boxed{L = mvr = \frac{nh}{2\pi}}$$

Thus an electron can move only in those orbit for which the angular momentum is an integral multiple of $h/2\pi$. It is the reason that electrons are allowed to move only in certain fixed orbit.

The angular momentum of electrons in atoms is quantised. For $n = 1, 2, 3 \ldots\ldots$ the angular momentum will be –

$$\frac{h}{2\pi}, \frac{h}{\pi}, \frac{3h}{2\pi} \ldots\ldots\ldots$$

. It can have only definite values.