* 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.

Scanned with Car

* 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—

$\frac{h}{2\pi}$, $\frac{h}{\pi}$, $\frac{3h}{2\pi}$ .... It can have only definite values.