de- Broglie's idea of dual nature of Matter

Louis de Broglie's idea of dual nature of Matter.

The Wave Mechanical Concept Comes in figure when L. de-Broglie(1924) in this thesis suggested that any moving Particle, whether microscopic or macroscopic, will be associated with a wave character. It is Called matter waves. Louis de Broglie Supported the Dual nature of electron i.e Particle and wave nature.

Now, the exactness of classical Mechanics has been replaced by Probability.

Dual Nature of Electron:-

According to Bohr's theory electron posses particle nature and revolving around nucleous in a Circular Orbit.

But de-Broglie pointed out in 1924 that electron like light behaves both as a Material Particle and also as wave.

de-Broglie's Equation:- de-Broglie derived an expression for Calculating the wave length λ of the electron wave. If m be the mass of the electron and it is revolving around nucleous with velocity c.

The velocity and wave length are related with following relation.

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

where h is plank's Constant $[h = 6.62 \times 10^{-34} \text{ Jule-sec}]$

$$\lambda = \frac{h}{p} \quad [\because mc = p]$$

where p is the momentum of the moving particle

The de-Broglie's relationship may be written as

$$p = \frac{h}{\lambda} \quad [\because h \text{ is a Constant}]$$

$$\text{or} \quad p \propto \frac{1}{\lambda} \quad \text{——— (2)}$$

This equation (2) is another form of de-Broglie's Equation. and it may be stated as follows.

" The momentum of a moving particle is inversally proportional to the wave length of the wave associated with it.

Proof of the de-Broglie's Equation:-

Let us Consider the Case of Photon.
If we consider it to be a wave of frequency ν, then its energy is given by Plank's quantum theory

i.e Plank Equation

$$E = h\nu \quad \text{——(i)}$$

Where ν is frequency, and related with velocity as

$$c = \nu\lambda \quad \text{or } c = \nu\lambda \quad \text{——(ii)}$$

$$\text{or } \nu = \frac{c}{\lambda}$$

If we Consider it as a Particle of Mass m, which is moving with velocity c, then its energy 'E' is expressed by Einstein Mass energy relation

$$\text{i.e } E = mc^2 \quad \text{——(iii)}$$

From equation (i) and (iii).

$$E = mc^2 = h\nu$$

$$\text{or, } mc^2 = h\nu \quad \text{——(iv)}$$

On substituting the value of 'c' from eqn (ii) in eqn (iv),

$$m.c.\nu.\lambda = h\nu$$

$$\text{or } m.c.\cancel{\nu}.\lambda = h\cancel{\nu}$$

$$m.c.\lambda = h$$

$$\text{or } \lambda = \frac{h}{m.c}$$

$$\text{or } \lambda = \frac{h}{p} \quad [\text{Where } m.c = p]$$

Where

λ = Wave length

h = Plank's Constant $[h = 6.62 \times 10^{-34} \text{ Jule-sec.}]$

p = momentum of the particle.