de-Broglie dual nature of electron

- In 1923 Louis de-Broglie stated that electron has dual character like light, i.e., particle as well as wave character.
- The particle nature of electron can be proved by the photo electric effect.
- The wave nature of electron can be proved by Davison-Germer experiment

de-Broglie's theory and equation

de-Broglie equation has been derived by combining Planck's equation and Einstein's equation.

Consider a photon having energy E then

$E=h\nu$

$E=hc/\lambda$ ($\nu = c/\lambda$)-Planck's equation ----- 1

$E=mc^2$-Einstein equation ---------- 2

Combining equation 1 and 2, then

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

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

$$\lambda = \frac{h}{mc} \text{ ----------3}$$

Where m is the mass of the electron and c is the velocity of light.

For beam of electrons moving with velocity v cm/sec, then

$\lambda = h/mv$

$\lambda = h/p$ -------- 4 (i.e., $mv=p$)

Where p is the momentum of electrons. This equation is called de-Broglie's equation.

Heisenberg's uncertainty principle

One of the important consequences of the dual nature of an electron is the uncertainty principle developed by Werner Heisenberg. According to this principle, it is impossible to determine precisely both the position and the velocity (or momentum) of a moving minute particle like

electron. If Δx represents the error (or) uncertainty in the measurement of the position and Δp represents the uncertainty in the momentum of a minute particles like electron, then according to this principles, these two quantities are related as

$$\Delta x * \Delta p \geq h/4\pi$$

Where h is the Planck's equation and the sign $\geq$ indicates equal to (or) greater than.

Now since on account of the small size of the electron, if is not possible to know its exact position and velocity, generally the term probability of finding an electron with a probable velocity is used.