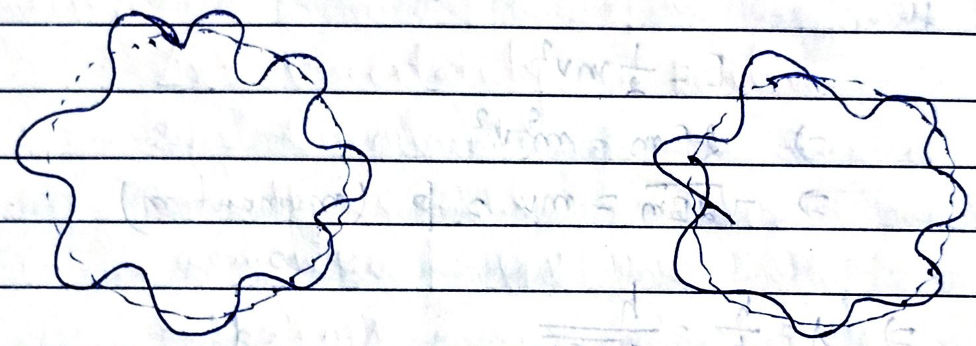
Bohr's theory versus de-Broglie equation

One of the postulate of Bohr's theory is that angular momentum of an electron is an integral multiple of $h/2\pi$. This postulate can be derived with the help of de-Broglie concept of wave nature of electron.

Consider an electron moving in a circular orbit around nucleus. The wave train of electrons may be continuously 'in phase' or 'out of phase'.



(a) wave in phase (b) wave out of phase.

(a) wave in phase :→

If the two ends of the electrons wave meet to give a regular series of crests and troughs, the electron wave is said to be 'wave in phase', i.e the circumference of Bohr's orbit is equal to whole number multiple of the wavelength of the electron wave.

So, $2\pi r = n\lambda$

$$\Rightarrow \boxed{\lambda = \frac{2\pi r}{n}} \quad \text{——— (I)}$$

From de-broglie eqn

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

Thus, $\frac{h}{mv} = \frac{2\pi r}{n}$

$\Rightarrow mvr = n \cdot \frac{h}{2\pi}$ where, v = velocity of electron & r = radii of orbit

i/e

Angular momentum $= n \cdot \frac{h}{2\pi}$ --- (iii)

This proves that the de-Broglie and Bohr-Concepts are in perfect agreement with each other.

(5) Wave out of phase :→

If the two ends do not meet to give a regular series of crests and troughs, it is said to be wave out of phase.

In this case, the wave would interfere destructively and cancel each other and, thus, destroy itself.