

## **Bohr's Atom Model**

On the basis of quantum theory, Niels Bohr put forward a theory for atomic structure. Its main postulates are

1) Electrons are moving around the nucleus only in certain permitted circular orbits (or) shells called stationary states. Each orbit is associated with a definite energy. Therefore the orbits are also known as energy levels. They are designated as K, L, M, N etc orbits are shells.

2) Only those orbits are permitted for circular motion of electron for which the angular momentum of the electron is an integral multiple of  $h/2\pi$

Mathematically

$$mvr = nh/2\pi$$

Where  $m$  = mass of electron

$v$  = velocity of electron

$r$  = radius of the orbits

$h$  = Planck's constant

$n$  = integer

This generalisation is called quantisation of angular momentum.

3) So long as the electron revolves in a particular orbit, it neither absorbs nor emits energy i.e., the circular orbits are called stationary state.

- The revolving electron can absorb (or) emit energy when it jumps from one orbit to another. It absorbs (or) emits energy in quanta in the form of radiation.

$$\Delta E = E_2 - E_1 = h\nu$$

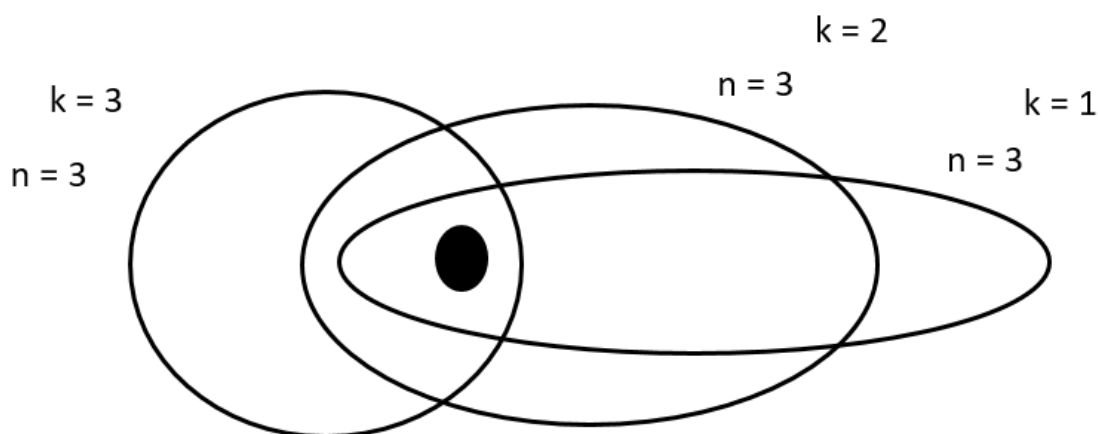
- Where  $E_1$  and  $E_2$  are two energy levels (or) orbits.

## **Limitations of Bohr's theory**

- 1) It fails to explain the spectra of atoms other than hydrogen.
- 2) It provides no explanation for the splitting of spectral lines in the magnetic field (Zeeman effect) and electric field (Stark effect).

- 3) 3) It is against Heisenberg's uncertainty principle that the position and velocity of the electron can not be specified simultaneously at a given time.
- 4) 4) It makes use of quantum theory and classical mechanics which are contrary to each other.

### Bohr-Sommerfeld Atom Model



In order to account for the fine structure of spectral lines Sommerfeld modified Bohr's theory. According to Sommerfeld

- i) electrons are revolving around the nucleus in elliptical orbits like the planet's around the sun.
- ii) An ellipse has two axes
  - a) major axis, b) minor axis .

The circular orbits are only special case of elliptical orbits in which the major and minor axes are equal.

$$\frac{n}{k} = \frac{\text{length of the major axis}}{\text{length of the minor axis}}$$

Thus, when  $n=k$ , the orbit is circular and it is elliptical when  $k < n$

- iii)  $k$  can have values from 1 to  $n$  when  $n=3$ , there are 3 values of  $k$  equal to 1, 2 and 3. Therefore there will be three sommerfeld orbits (one circular and two elliptical) as shows in the figure.

### Draw backs of the model

- The modern wave mechanics shows that the azimuthal quantum number can have values from 0 to  $n-1$  and not from 1 to  $n$  as proposed by Sommerfeld's theory.
- It does not explain the Zeeman effect and Stark effect.
- It fails to provide accurate values for the angular momentum of electrons which move in elliptical orbits.