ATOMIC STRUCTURE – 04

Computer Science (Sec – B)

11 – 03 – 2021 (1^{st} Period)

Limitations of Bohr's Atomic Model: The important limitations of Bohr's atomic model are following.

1. The Bohr's model of atom is applicable to the atoms or ions having one electron only i.e. the model is applicable to hydrogen atom and Hydrogen like ions.
2. The model fails to explain the spectra of multi-electron systems.
3. When atomic spectra is seen under high resolving power instruments one thick line was found to be sub-divided into several fine lines. The model fails to explain this fact.
4. The model also fails to explain the Stark effect and Zeeman effect.
5. The model also could not explain the de'Broglie wave-matter duality and Heisenberg's uncertainty principle.

Stark Effect: The splitting of atomic spectra into fine lines by the application of strong electric field is called Stark effect.

Zeeman Effect: The splitting of atomic spectra into fine lines by the application of strong magnetic field is called Zeeman effect.

- **Quantum numbers**: Quantum numbers are the pure numbers that characterise about the position, energy condition, angular momentum, orientation in space, spin etc. of the electron in an atom. In other words quantum number is the complete address of the electrons in an atom. The different types of quantum numbers are following.

1. Principal quantum number *(n)*
2. Azimuthal quantum number *(l)*
3. Magnetic quantum number *(m)*
4. Spin quantum number *(s)*

Principal quantum number *(n)*: This quantum number provides idea about the orbits and is represented by n. Following are the important features of principal quantum number.

1. This quantum number represents the orbits or energy levels to which an electron belongs.

i.e., $n = 1$ represents K – shell

$n = 2$ represents L – shell

$n = 3$ represents M – shell

$n = 4$ represents N – shell

2. This quantum number gives the maximum number of electrons that an orbit can accommodate which is given by $2n^2$.

For example:

The maximum no. of electrons in K – Shell = $2x1^2 = 2$

The maximum no. of electrons in L – Shell = $2x2^2 = 8$

The maximum no. of electrons in M – Shell = $2x3^2 = 18$

The maximum no. of electrons in N – Shell = $2x4^2 = 32$

3. This quantum number also provides idea about the radius of an orbit.
4. This quantum number gives the information about the energy of electron in an orbit.

Azimuthal quantum number *(l)*: This quantum number provides idea about the sub-shells and is represented by *l*. the important features of azimuthal quantum number are following.

1. The values of azimuthal quantum number depends upon the values of principal quantum number.
2. The values of azimuthal quantum number ranges from 0 to *(n-1)*.

   i.e., $l = 0$ - - - - - - -*(n-1)*, where *n* is the principal quantum number.

   Thus, For K ($n = 1$) shell; $l = 0$

   For L ($n = 2$) shell; $l = 0, 1$

   For M ($n = 3$) shell; $l = 0, 1, 2$

   For N ($n = 4$) shell; $l = 0, 1, 2, 3$
3. The total number of values of azimuthal quantum number is equal to the value of principal quantum number
4. Each value of azimuthal quantum number represents a sub-shell. i.e.

   $l = 0$ represents *s* sub-shell

   $l = 1$ represents *p* sub-shell

   $l = 2$ represents *d* sub-shell

   $l = 3$ represents *f* sub-shell
5. The total number of sub-shells in a particular shell is equal to the value of principal quantum number. i.e.

   K ($n = 1$) shell has *s* sub-shell only

   L ($n = 2$) shell has *s* and *p* sub-shells.

   M ($n = 3$) shell has *s, p* and *d* sub-shells.

   N ($n = 4$) shell has *s, p, d* and *f* sub-shells.
6. The maximum number of electrons in these sub-shells is given by $2(2l + 1)$. i.e.

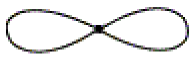
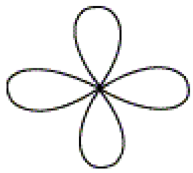
The maximum number of electrons in *s* sub-shell = 2

The maximum number of electrons in *p* sub-shell = 6

The maximum number of electrons in *d* sub-shell = 10

The maximum number of electrons in *f* sub-shell = 14

7. This quantum number also provides idea about the shapes of orbitals.

s – orbitals are spherical in shape.	
p – orbitals are dumbbell in shape	
d – orbitals are double dumbbell in shape	
f – orbitals are complicated in shape	---