Spectra Of Hydrogen Atom

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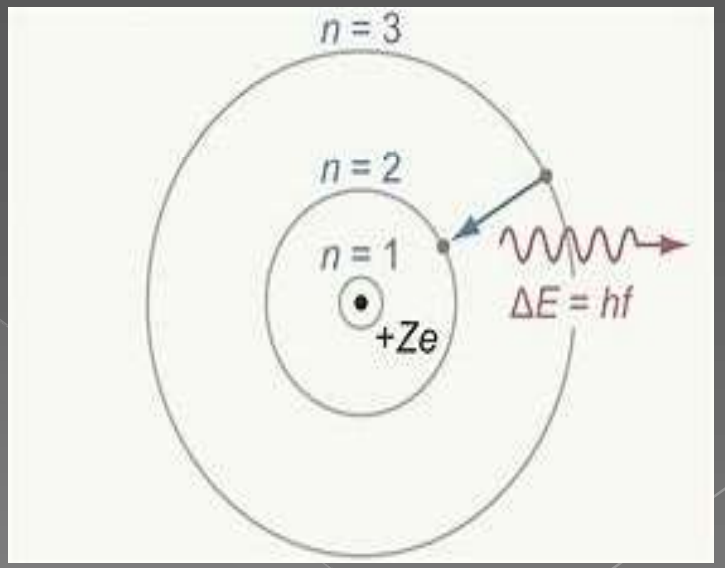
Bohr Postulates:

- Electrons can only revolve around the nucleus only in certain orbits (stationary orbits) with angular momentum **L=nh/2π**.

- The emission or absorption of radiation takes place when an electron jumps from one stationary orbit to other stationary orbit. The energy of radiation is **hf = E2 ~ E1**

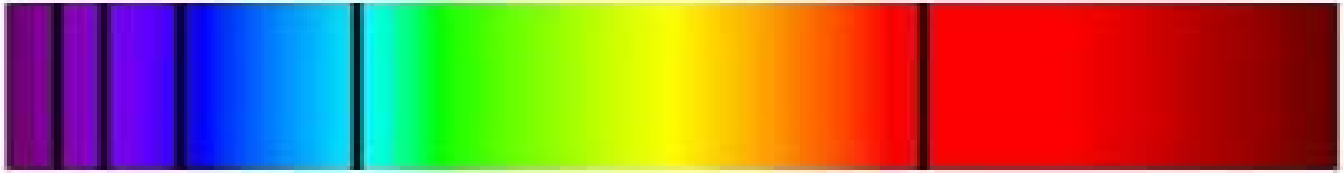
f =Frequency of radiation



THEORY OF ATOMIC SPECTRA

Atomic Spectra

Absorption spectra



Emission Spectra

Bohr's Theory Of Atomic Spectra

Energy of the Orbit:

$$E_n = -mz^2e^4/32\pi^2\varepsilon_0^2n^2\hbar^2$$

Frequency of emitted radiation:

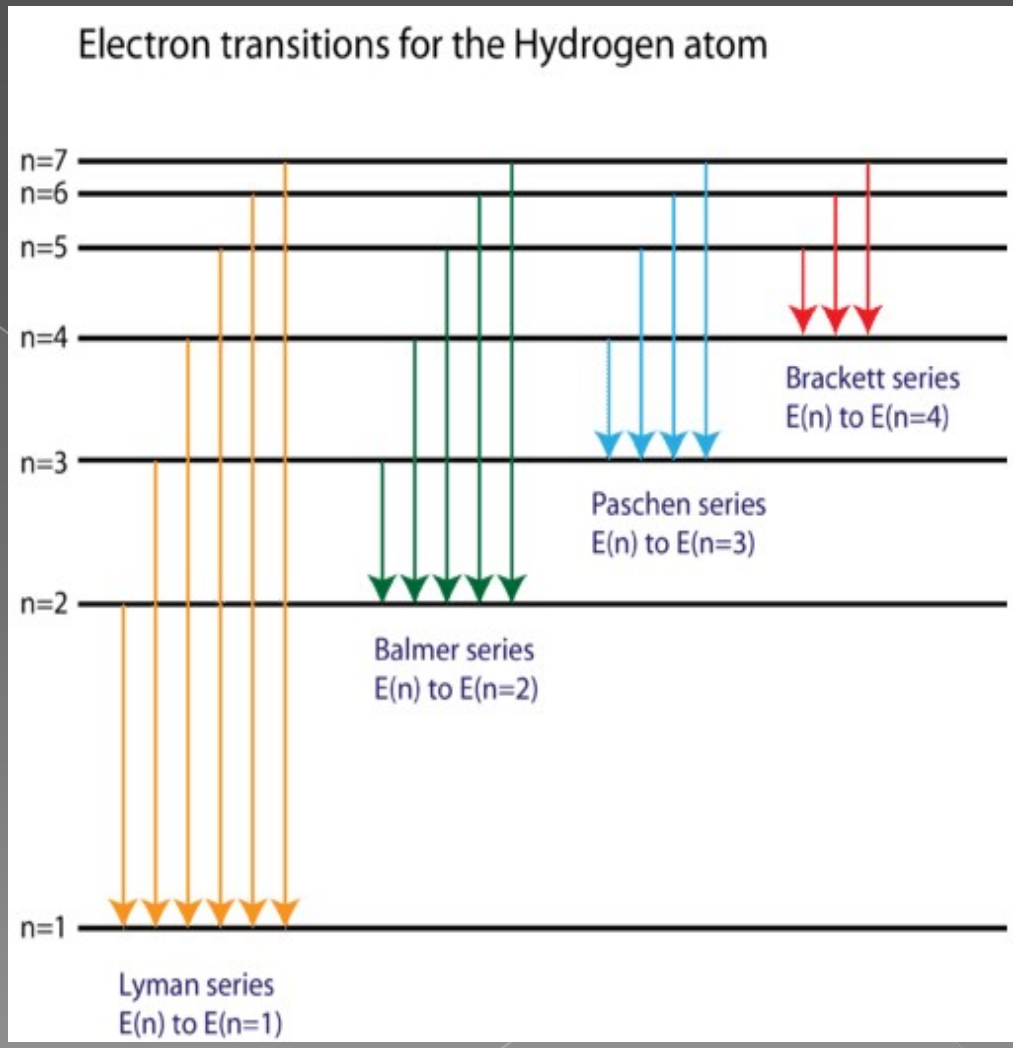
$$f = Ei\text{-}Ef/h$$

$$= mz^2e^4/64\pi^3\varepsilon_0^2[1/n_f^2 - 1/n_i^2]$$

Wave No:

$$1/\lambda = f/c = R_a z^2[1/n_f^2 - 1/n_i^2]$$

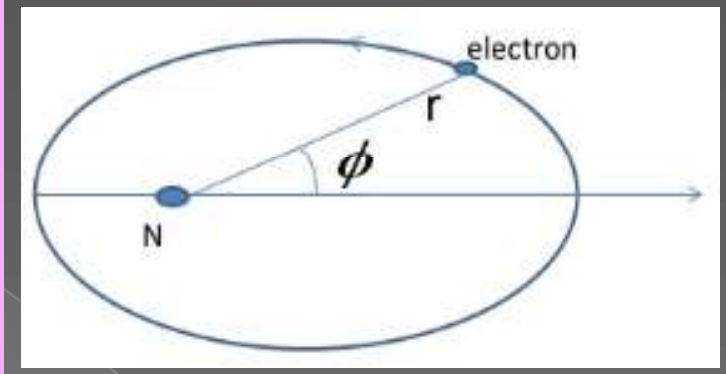
R_a = Rydberg Const.



Wilson-Sommerfeld Quantum Condition

- Existence of Elliptical Orbit for the electron with one focus at the nucleus of the atom.

- Electron in elliptical orbit has two degrees of freedom 'r' (radial distance) & 'φ' (azimuthal angle)



Wilson-Sommerfeld Quantum Condition

- Each Degrees of freedom is quantised by taking the action integral of each co-ordinate ovar a complete time period.

$\int p_r\, dr = n_r h$ & $\int p_\varphi\, d\varphi = n_\varphi h$

For Central force Field

$$p_\varphi = n_\varphi \hbar$$

n_r = radial quantum no.

n_φ=azimuthal quantum no.

- $n_r + n_\varphi = n$ (Principal quantum no.) ; n=1,2,3.....
- Only those elliptic orbits are permitted for the electron for which the ratio of major (2a) and minor (2b) axis is the ratio of two integer:

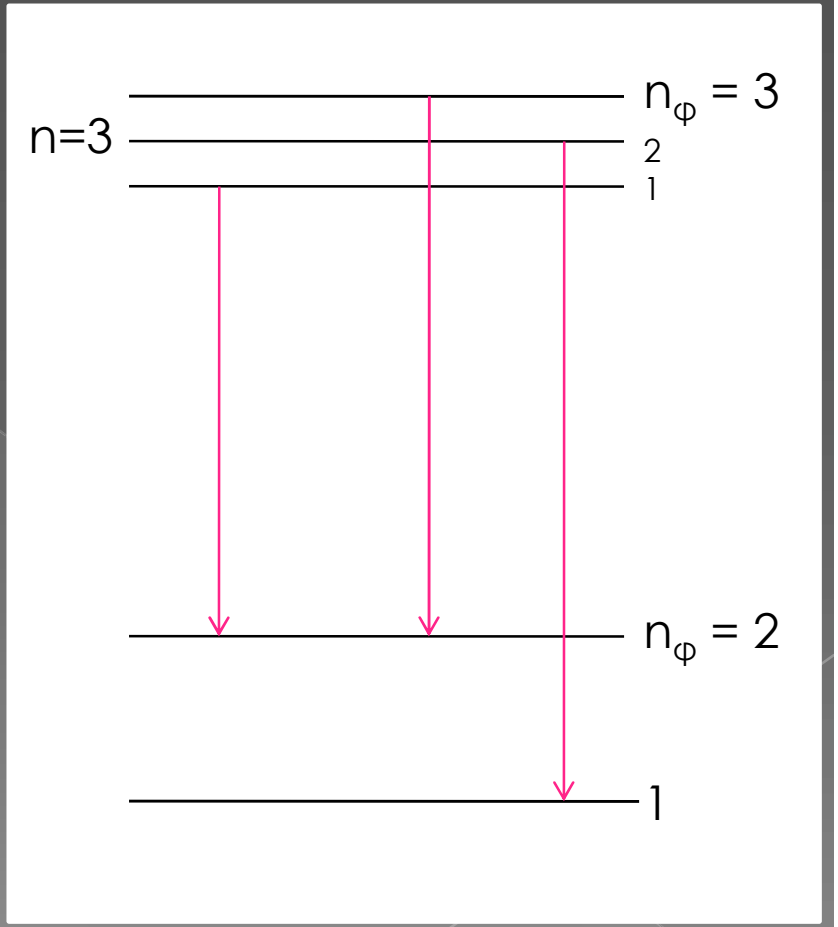
$$n_\varphi / n = b/a$$

(quantisation of orbit)

- **Energy is same as Bohr orbital energy**

Fine structure of H_α lines

- H_α lines emits when electron jumps from n=3 to n=2 level.
- n=3 level consists of three sublevels with n_φ = 1,2,3 and n=2 with n_φ = 1,2.
- Only those electron jumps are possible for which $\Delta n_\varphi = \pm 1$ (Selection Rule)



Relativistic Correction

- Velocity variation due to elliptic orbit.
- Maximum velocity at perihelion causes mass increment.
- Energy :
- $E_n = - RZ^2/n^2 - Ra^2Z^4/n^4 (n/n_\varphi - ¾)$

where R= Rydberg Const

a= fine structure const.

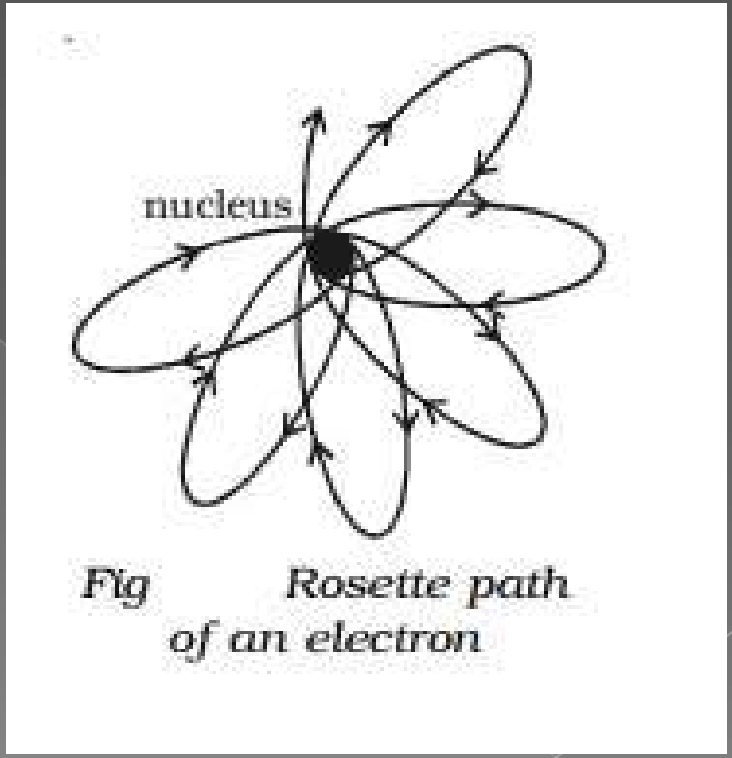


Fig Rosette path of an electron

Limitations

- Could not explain the fine structure of the spectral line.
- The theory is applicable only to one electron atoms. Fails to explain the spectra of atoms more than one valence electron
- Could not completely explain the effect of magnetic field on spectral lines.