❖ **Limitations of Bohr's Theory**

❖ Bohr's biggest contribution in his model was to introduce quantum principles to classical physics, but his model had a few limitations:

1- **Spectra of Large atoms;** The Bohr model could only successfully explain the **hydrogen** spectrum. IT **could NOT** accurately calculate the spectral lines of larger atoms. The model only worked for **hydrogen-like** atoms, if the atom had **only one electron.**

2- **Relative Spectra Intensity;** Bohr's model could not explain why the **intensity of the spectra lines** were NOT **all equal.**

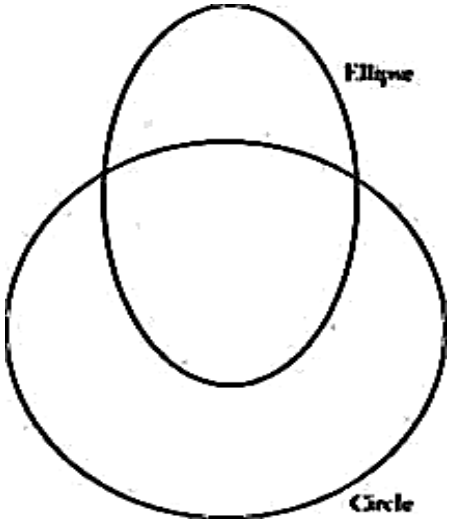
3- Hyperfine spectral lines; with better equipment and careful observation, it was found that there were previously undiscovered spectral lines. These were named hyperfine lines and they accompanied the other more visible lines. Bohr's model could not explain why this was the case due to the lack of equipment and development in quantum physics.

4- **The Zeeman Effect**; It was found that, when hydrogen gas was **excited in a magnetic field,** the produced emission spectrum was **split.** Bohr's model could not account for this. Solved by accounting for the existence of a tiny magnetic moment of each electron.

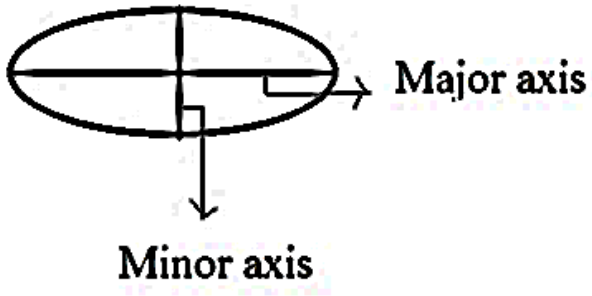
❖ Sommerfeld atomic model

This model explains the fine spectrum of Hydrogen atom. The important postulates of Sommerfeld atomic model are

1- The orbits may be both ***circular*** and ***elliptical***.

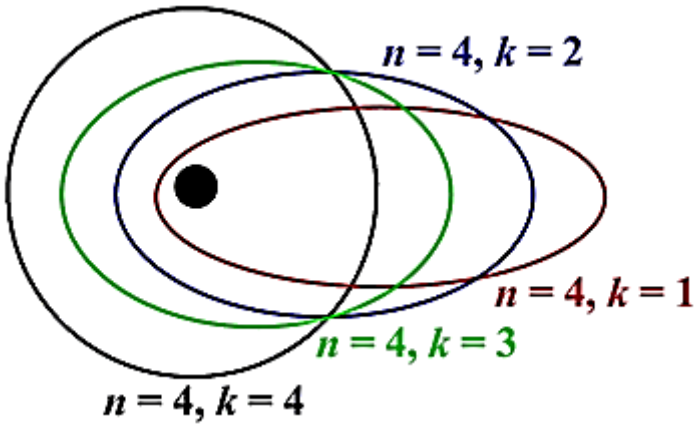


2- When path is elliptical, then there are two axis – major axis & minor axis. When length of major & minor axis becomes equal then orbit is circular.



3- The angular momentum of electron moving in an elliptical orbit is ($kh/2\pi$). Where k is an integer except zero. Value of k = 1, 2,3,4….. . (n/k) = length of major axis / length of minor axis.

With increase in value of k, ellipticity of the orbit decreases. When n= k, then orbit is circular.



4- Sommerfeld suggested that orbits are made up of sub energy levels. These are s,p,d,f. These sub shells possess slightly different energies.

*Bohr gave a quantum number '**n**', which determines the energy of electron.

*Sommerfeld introduced a new quantum number called Orbital or Azimuthal Quantum number (l) which determines the orbital angular momentum of electron.

* ***Values of l*** =0 to (n-1)

For, n=1 ; l=0 ; 1s sub shell

n=2 ; l=0,1 ; 2s , 2p sub shell

n=3 ; l=0,1 ,2 ; 3s , 3p , 3d sub shell

n=4 ; l=0, 1, 2 , 3 ; 4s , 4p , 4d , 4f sub shell

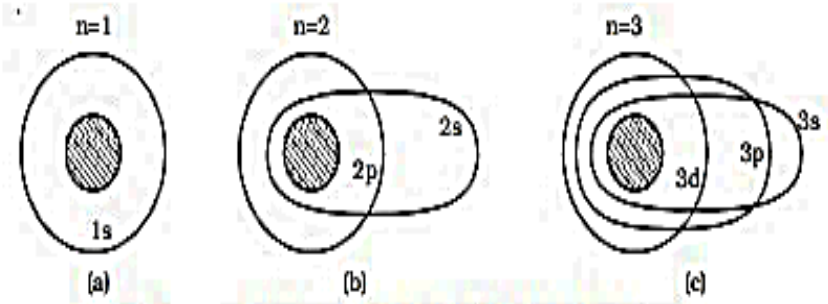


Fig Various sub-shells for the electrons

5- When an electron jumps from one orbit to another orbit, the difference of energy (ΔE) depends upon sub energy levels.

6- It explains the splitting of individual spectral lines of hydrogen & thus fine spectrum . It could not predict the exact number of lines which are actually present in the fine spectrum.

❖ Defects of Sommerfeld atomic model

1- This model does not explain the behavior of system having more than one electron.

2- This model does not explain the Zeeman & Stark effect.