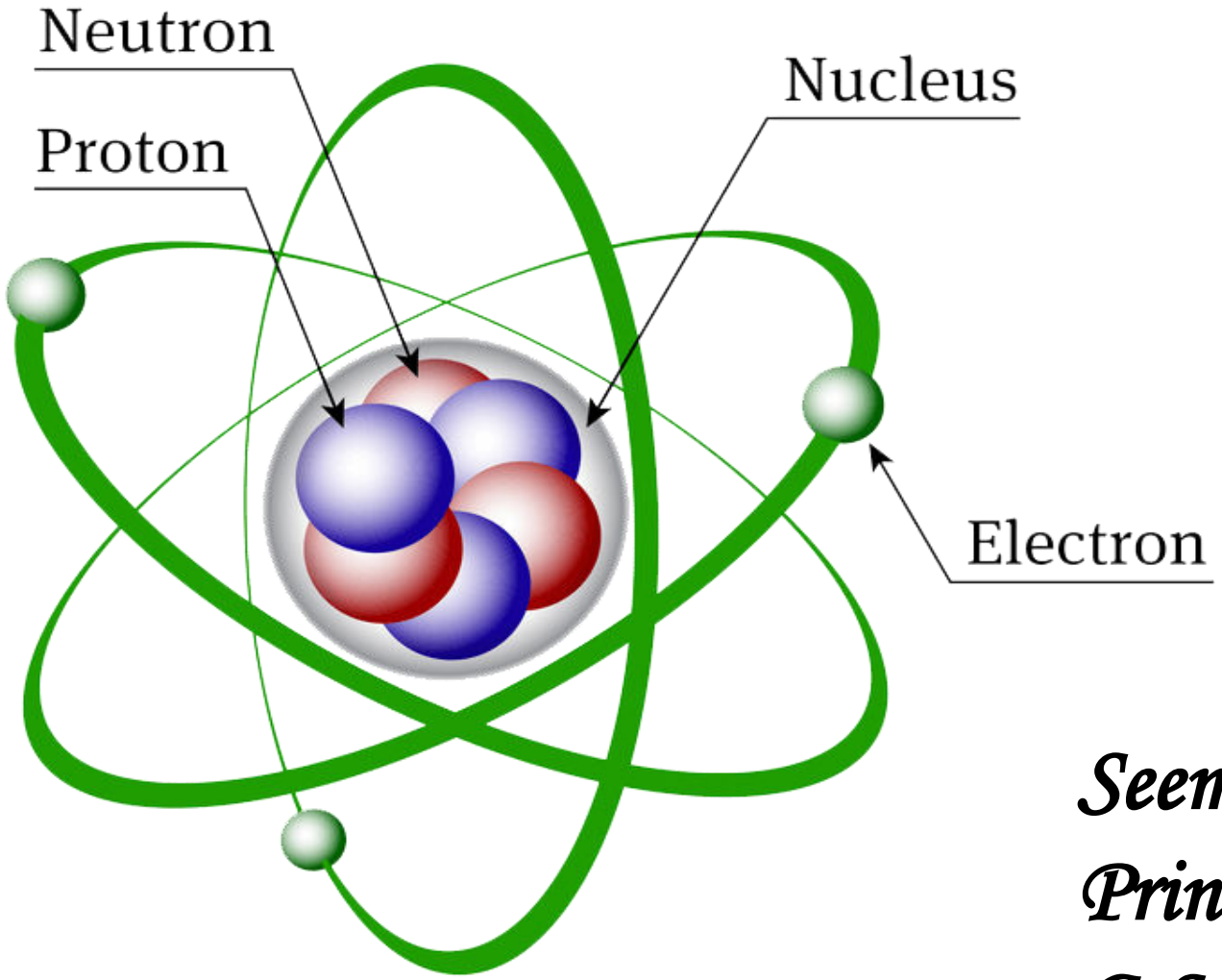
STRUCTURE OF ATOM



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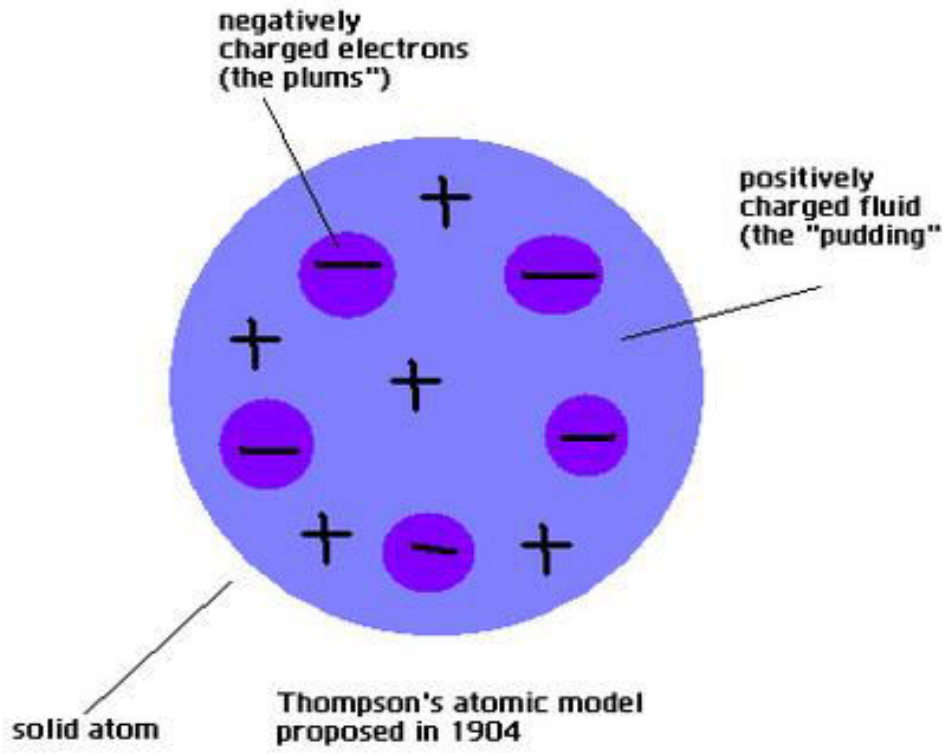
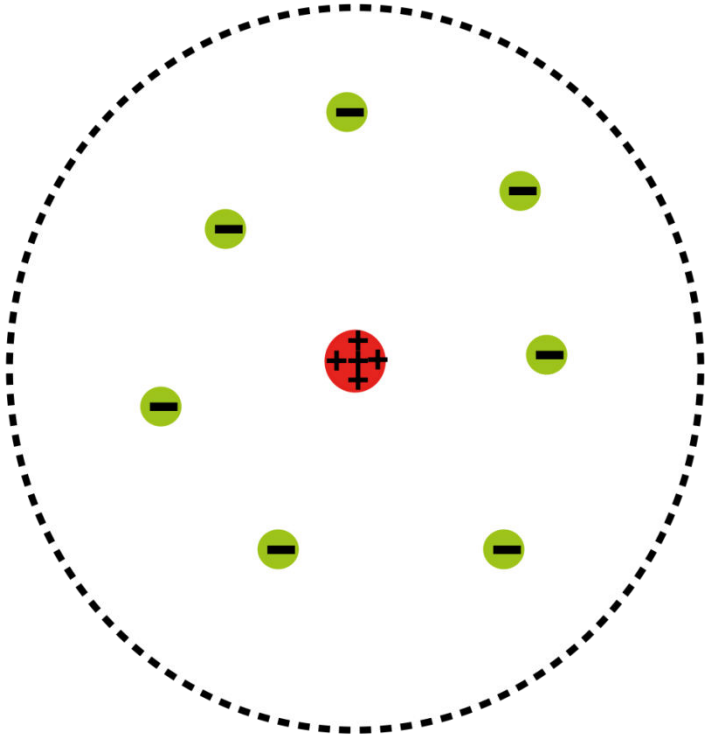
Structure Of Atom

Introduction : *Atom consists of three subatomic particles : electrons, protons and neutrons. These particles are regarded as fundamental particles.*

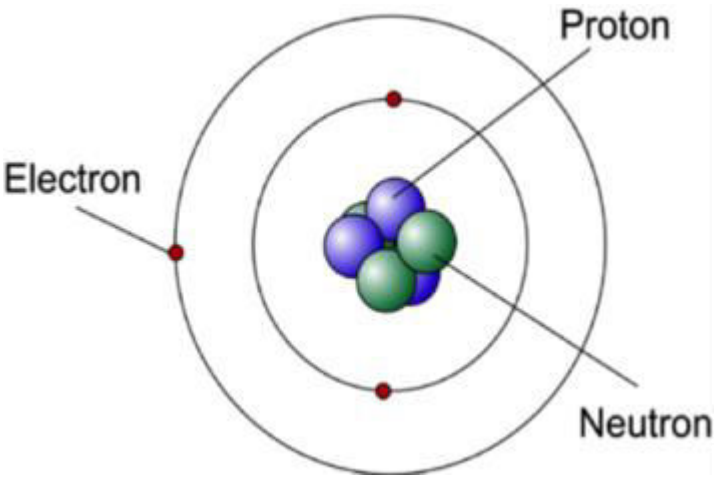


Thompsons Model



Rutherford Model

Bohr Model



- Electron revolve in a fixed circular path called orbit
- As long as it remains in the fixed orbit it does not gain or lose energy
- Angular momentum of the orbit is quantized have a fixed value i.e. whole no multiple of $h/2\pi$

Objection:

De Broglie & Heisenberg uncertainty : Concept of wave character of electron in addition to particle and pointed out that the motion of electron cannot be fixed or well defined. This lead to a new approach which is known as **wave mechanics or quantum mechanics.**

De Broglie Concept of matter waves:

Einstein in 1905 gave dual behaviour of **light**

Particle like character: black body radiation, photoelectric effect

Wave like character: reflection, refraction, dispersion, interference.

De Broglie in 1924 contradicted Bohr statement,. He suggested that just as light, all microscopic particles also exhibit dual behavior

Acc to De Broglie

$$\lambda = h/mv \text{ or } \lambda = h/p$$

Derivation of de Broglie Relation

Acc to Planck's

$E = h\nu$ ..... (i)

Acc to Einstein

$E=mc^2$.....(ii)

From eq. 1 and 2

$h\nu = mc^2$

$\nu = c/\lambda$

$hc/\lambda = mc^2$

$\lambda = h/mc$ or $\lambda = h/p$

Justification of Dual Nature

1. **Particle nature:** Electrons exhibit charactertics of particle i.e. they have mass, momentum , energy and charge.

2. Wave nature was experimentally verified by Germer and Davidson in1927 and George Thomas in 1928

Experimental verification of wave nature of experiment :

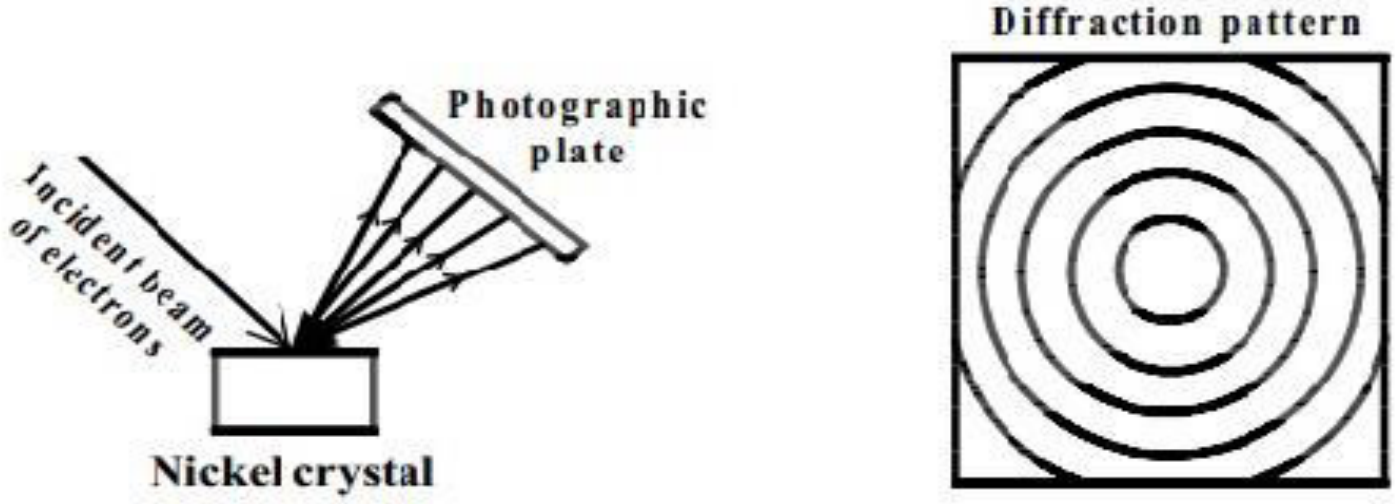
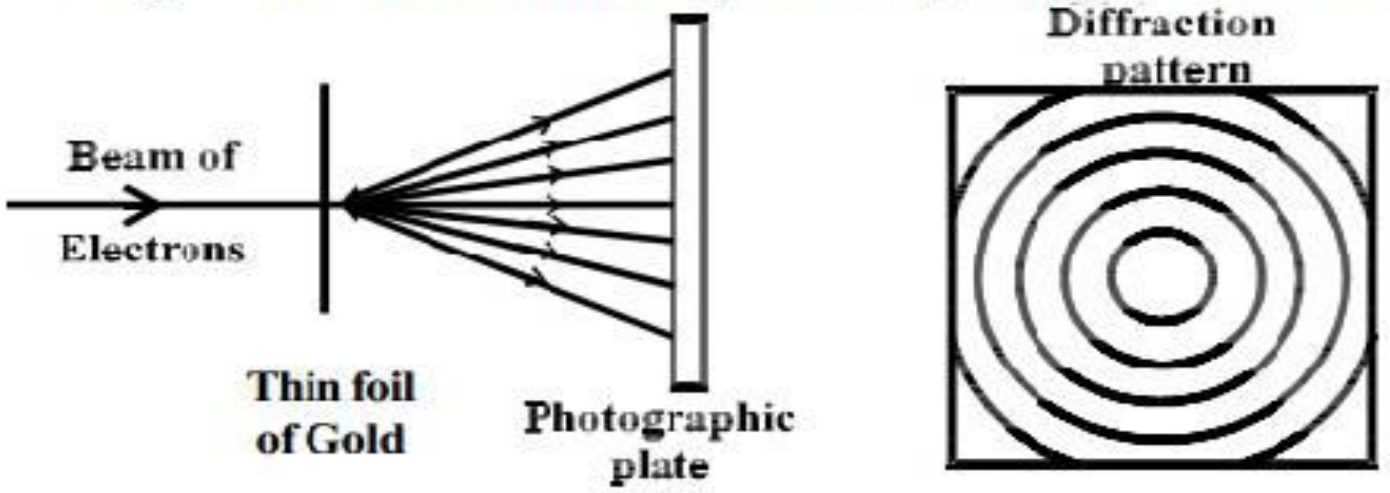


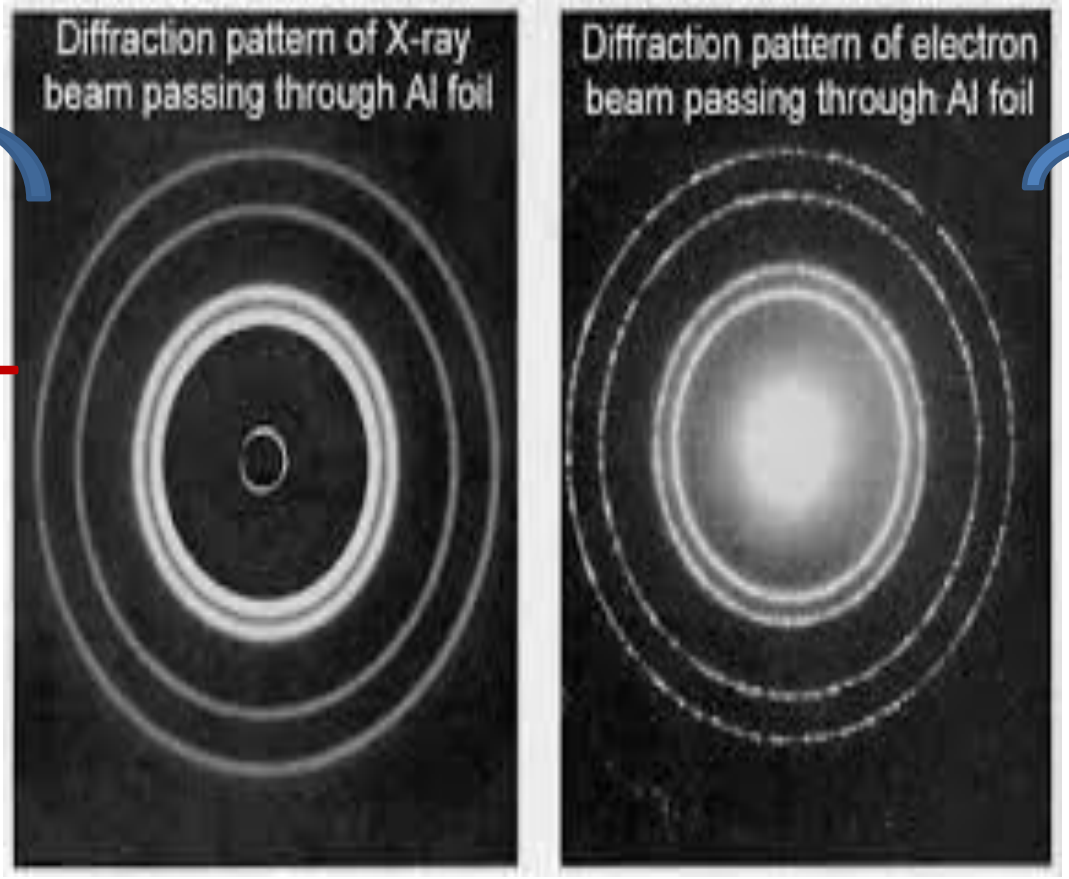
Fig. Electron diffraction experiment by Davisson and Germer



Diffraction of electron beam by thin foil of gold (G.P. Thomson experiment)

Experimental verification of wave nature of experiment :

Diffraction pattern of X-rays



Diffraction pattern of electrons

Estimation of de-Broglie wavelength

Assume that an electron having charge e is accelerated by a potential V.

The K.E. of the electron becomes Ve.

Substituting this value in the relation: K.E. = ½ mv^2 , we get

$$\frac{1}{2} mv^2 = eV$$

$$v = (2eV/m)^{1/2}$$

Substituting this value of v, in de-Broglie's equation

$$\lambda = h/mv$$

$\lambda = h/m(2eV/m)^{1/2}$

or

$\lambda = h/(2Vem)^{1/2}$

Substituting the values of

$h = 6.626 \times 10^{-34}$ kg $m^2 s^{-1}$,
$e = 1.02 \times 10^{-9}$C,
$m = 9.11 \times 10^{-31}$ kg

$\lambda = 1.226 \times 10^{-9} / (V)^{1/2}$

If the electron is accelerated by a V= 1kV (1000V) ,then

$\lambda = 1.226 \times 10^{-9} / (1000)^{1/2} = 3.88 \times 10^{-11}$ m =38.8 pm

This is comparable to normal bond length of molecule.

So e^- accelerated in this manner can be used in X-ray diffraction

Differences between Electromagnetic and Matter Waves

S.No.	Electromagnetic Waves	Matter Waves
1	Associated with electrical and magnetic fields.	Not associated with electrical and magnetic fields.
2	Can be emitted or radiated in space.	Neither radiated into space nor emitted by the particles. These are simply associated with the particles.
3	They do not require medium for propagation	They require medium for propagation.
4	Travel with the same velocity.	Travel with different velocities.
5	Velocity is equal to that of the velocity of light i.e. 3×10^8 ms^{-1}.	Velocity is different from that of light.
6.	The wavelength is given by $\lambda = c/\nu$, ν= frequency	The wavelength is given by $\lambda = h/mv = h/p$. v= velocity