MATTER WAVES

The wave nature associated with the material particle is known as matter waves

De Broglie's Hypothesis:

- Waves and particles are the modes of energy propagation.
- Universe is composed of matter and radiations.
- Since nature loves symmetry, matter and waves **must be symmetric.**
- If radiation like light which is a wave can act like particle, then materials like particles can also act like wave some time.
- Matter has **dual wave particle nature**. According to de Broglie hypothesis

$$\lambda = \frac{h}{p} = \frac{h}{mV}$$

- The energy of the particle with quantum concept is

$$E = h\nu$$

DE- BROGLIE WAVES AND WAVELENGTH

From Planck's theory

$$E = h\nu \ldots\ldots (1)$$

According to Einstein's theory,

$$E = mc^2 \ldots\ldots (2)$$

Equation (1) and (2)

$$h\nu = mc^2 \ldots. (3)$$

$$\frac{hC}{\lambda} = mc^2$$

Therefore

$$\lambda = \frac{hC}{mc^2} \qquad \lambda = \frac{h}{mC}$$

$$\lambda = \frac{h}{p} = \frac{h}{mV} \ldots\ldots (4)$$

Where **p is the momentum** of the particle

DE -BROGLIE WAVELENGTH INTERMS OF ENERGY

We know that Kinetic energy

$$E = \frac{1}{2}mv^2 \ldots\ldots (5)$$

Multiplying by **m** on both sides

$$Em = \frac{1}{2}m^2v^2$$

$$m^2v^2 = 2Em$$

$$\sqrt{m^2v^2} = \sqrt{2Em}$$

$$mv = \sqrt{2Em} \ldots\ldots (6)$$

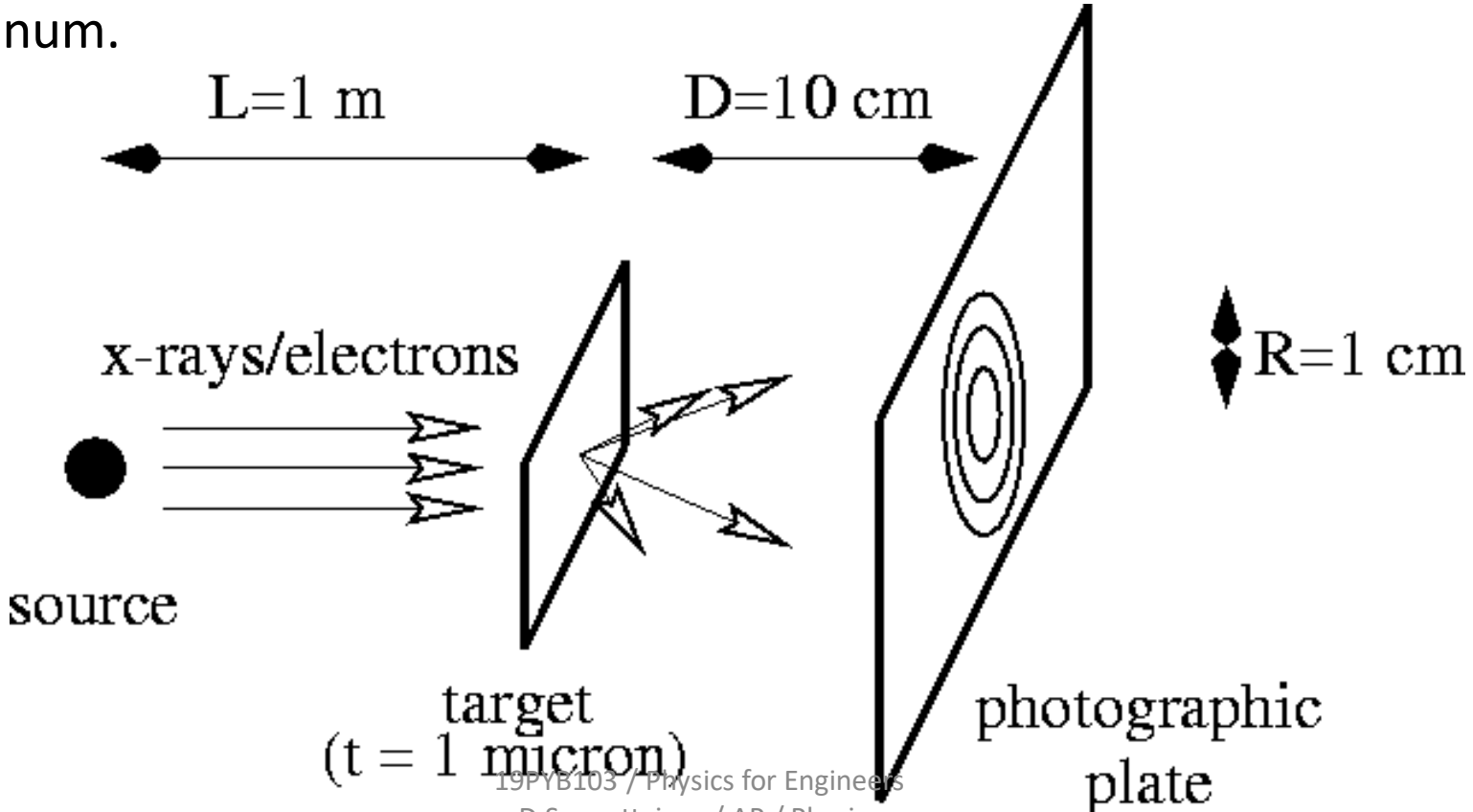
Substituting in (4)

$$\lambda = \frac{h}{\sqrt{2Em}} \ldots\ldots (7)$$

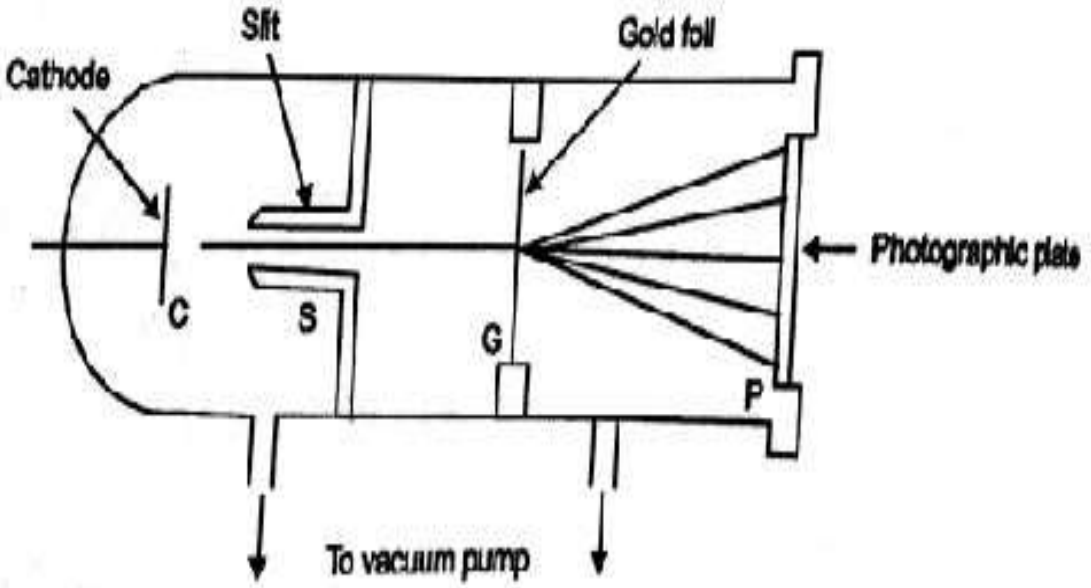
EVIDENCE OF DE- BROGLIE WAVES

G.P. THOMSON'S EXPERIMENT

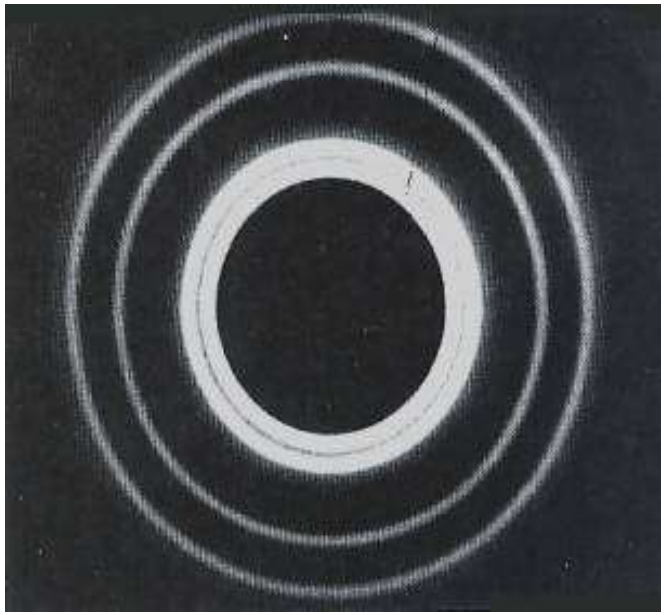
In 1927, George P. Thomson to demonstrate a diffraction pattern characteristic of the atomic arrangements in a target of powdered aluminum.



G.P. THOMSON'S EXPERIMENT



G.P Thomson's apparatus
for the diffraction of electrons



diffraction patterns

G.P. THOMSON'S EXPERIMENT

- A narrow beam of electrons is produced by **the cathode C.**
- the beam is **accelerated** by potentials up to50kV.
- These electrons rays after passing through a **slit S** are incident on a thin foil **G** of about thickness in the **order of 10^{-6}m**.
- The diffraction of the electrons takes place at G and the patterns is **photographed** using the **photographic plate P.**
- The diffracted electrons produce the **diffraction rings** as shown in diagram.