Quadrant II and related materials

Programme: T.Y.BSc.

Subject: Physics

Paper Code: PYD-101

Unit : I (Waves and particles)

Paper title: Quantum Mechanics

Module Name: G.P. Thomson experiment on electron diffraction.

Module :5

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Transcript

Hello Students,

Welcome to this presentation. Myself is Pradeep V. Morajkar, an Associate Professor in Physics. The topic of my presentation is G.P. Thomson experiment of electron diffraction and is for the Bachelor of Science program, semester V and the title of the unit is waves and particles. The outline of this program is G.P. Thomson experiment for diffraction of electrons and confirmation of de-Broglie's hypothesis. From this presentation the learner will be able to understand the wave nature of electrons, that the electrons can undergo diffraction and thus the confirmation of de-Broglie's hypothesis. The experimental demonstration of G.P. Thomson supports the de-Broglie's hypothesis which states that the particle of matter exhibit the wave nature and the wavelength of the wave associated with the particle is given by $\lambda = \frac{h}{p}$ where h is Planck constant and p is momentum of the particle.

The experimental arrangement consists of a filament F which is connected to a low-tension battery. The anode is connected to a high tension battery with a high potential difference of 10KV to 50KV.The target here is thin foil of gold or silver. the diffraction pattern is observed on a photographic plate. The filament, anode, thin metal foil, and the photographic plate are enclosed in an evacuated chamber or a tube.

When the voltage is applied across the filament the filament is heated and the beam of electrons emerges as a result of thermionic emission. This electron beam passes through high voltage collimator to hit the thin metal foil. The electrons are diffracted by the thin foil and a spot or a dot is observed on a photographic plate. The microcrystals are well arranged in a crystal as a result of which a concentric ring is formed with respect to the central bright spot obtained on the photographic plate. Due to the well-arranged microcrystals in various planes number of rings are formed on the photographic plate. The electron scattering is analogous to the Bragg's scattering in the direction of 2θ with respect to the incident beam. The ray diagram shows the electron beam diffracted on the photographic plate in a transverse direction producing concentric rings thus exhibiting the wave nature.

As a quantitative study, if R be the radius of the ring formed, then $\tan 2\theta = \frac{R}{D}$,where D is the distance of the photographic plate from the film. Here $2\theta = \frac{R}{D}$ since θ is small in this case. Using the formula of Bragg's diffraction 2dSin θ = n λ ,we obtain 2d θ = n λ. From the two equation we obtain the expression for the interplanar distance d=$\frac{n\lambda D}{R}$ .In this expression the value of λ =$\frac{h}{p}$ is substituted and value of d are measured for various metals. The comparative study is done form the result obtain from Bragg's diffraction by the crystal and the valued are found to be almost the same. Thus the G.P. Thomson experiment confirms the de-Broglie's hypothesis for wave nature of particle like electrons.

Additional information

If electrons behaved like particles in passing through the film, they would be deflected from their path and would give rise to a blurred patch on the photographic plate. The pattern observed on the photographic plate is very similar to the one obtained if the incident electron beam is replaced by an X-ray beam. This shows qualitatively that electrons behave like X-rays in traversing the thin film.