DAVISSON GERMER EXPERIMENT

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In 1923 Louise de Broglie suggested that like radiation matter also posses duel nature that are particle and wave. According to him a particle of mass m moving with velocity v always associated with a wave with wavelength $\lambda = h/p$ here h is Plank's constant and p is momentum of the particle.

In 1926Walter Maurice Elsasser suggested that wave like nature of matter might be invested by electrons scattering experiment in crystalline solids.

In 1927 Davisson and Germer proved that fast moving electrons show diffraction effect (property of waves)and calculated the wave length of electrons wave.

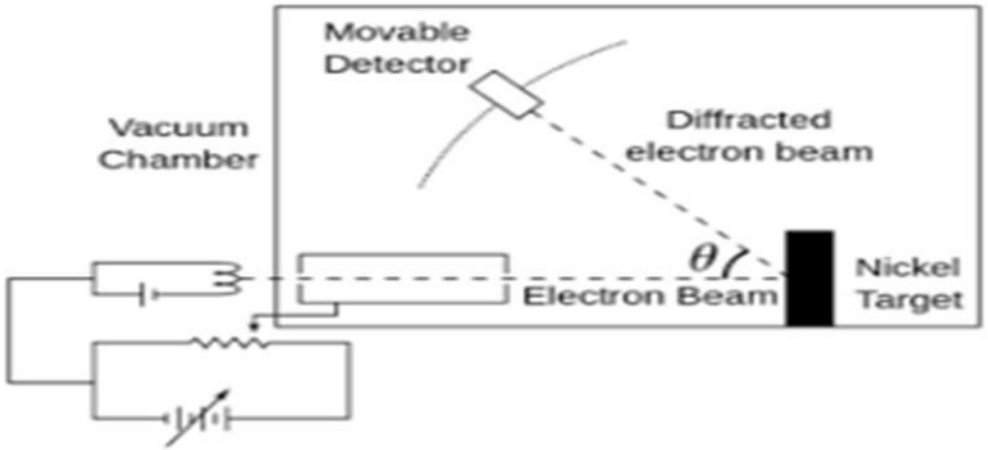
In the same time G P Thomson also proved experimentally the wave nature of electrons.

Davisson and Germer Experiment:

The Davisson and Germer experiment confirmed the earlier hypothesis of de Broglie which demonstrated the wave nature of the electrons,. This experiment confirms that electrons exhibit diffraction pattern when they are scattered from a crystal plane .

Davisson and Germer Apparatus:

In this apparatus the energy of the electrons in the primary beam can be varied with the angle at which they are incident upon the nickel crystal target . The crystal and the detector was kept on a rotating plane.



An electron beam from an electron gun then is fired at the nickel crystal.

The electron gun was a heated tungsten filament. The thermally excited electrons were then accelerated through an electric potential difference, giving them a certain amount of kinetic energy, towards the nickel crystal.

The experiment was conducted in a vacuum chamber to avoid collisions of the electrons with other atoms on their way.

To measure the number of electrons that were scattered at different angles, a faraday cup electron detector was used. The number of reflected electrons varied as the angle between the detector and the incident electron beam varied.

The detector was designed to accept only elastically scattered electrons with high velocity at angles between 20˚ and 90˚.

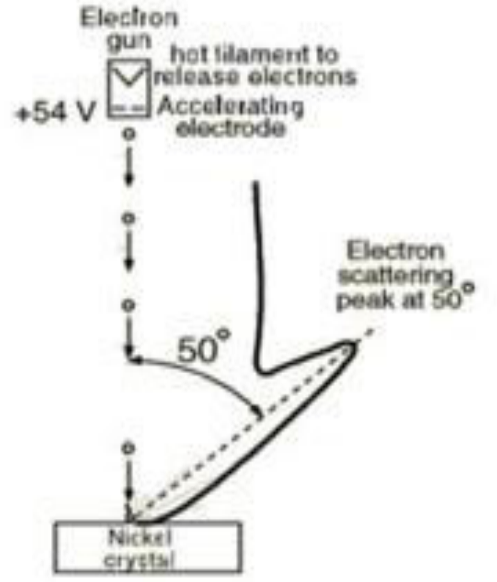
When the angle beween the incident beam and the scattered beam become 50 ° the detector shows maximum numbers of electron scattering. The maximum numbers of reflected electrons in the detector indicate that electrons are being diffracted. In such a case applying Bragg's law we can write ,

$2d \sin\theta = n\lambda$ here θ is Glancing angle

so $\lambda = 2 \times 0.91 \times \sin 65^\circ$ for nickel $d = 0.91$ A°

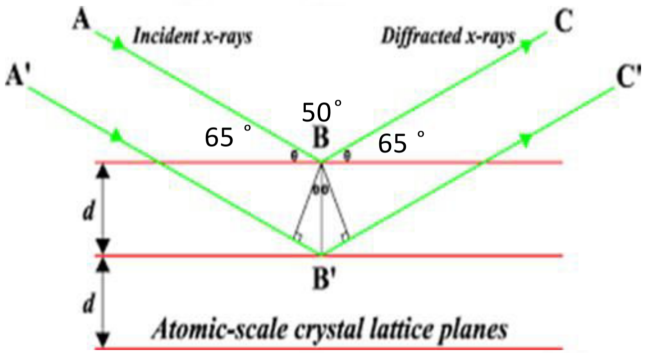
$= 1.82 \times 0.9063 = 1.65$ A° and for 1st order $n=1$

$\lambda = 1.65$ A° is the experimental value of wavelength associated with an electron considering it to be associated with a wave.



Theory

$\lambda = \frac{h}{mv} = 1.67$ Å for 54 V



Experiment

Pathlength difference

$d \sin \theta = 2 \times 0.91 \sin 65^\circ = \lambda = 1.65$ Å

for constructive interference

Davisson and Germer Experiment

Again the wave length associated with an electron, moving under a potential difference of 54 volt is calculated using de Broglie's hypothesis as E= 54 eV =54 x1.6x10^{-19} J

Now we know that de Broglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times54\times1.6\times10^{-19}}}$$

$$=1.66\ A^{\circ}$$

This shows that the wavelength of matter wave according to de Broglie hypothesis is very close to the wavelength measured for electrons classically applying Bragg's law. This prove that matter also associated with waves.

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Any queries ?

Thank You