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Research Paper

Wrong interpretation of Davisson & Germer

Physics

KEYWORDS : Diffraction, wavelength, frequency, scattering

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ABSTRACT

Actually there is no wave associated with electron. λ= h/mv is not correct. Also there is no relation between Bragg law and de Broglie equation. They become same only when we take θ=65 and Kinetic energy is 54eV but in other cases they differ. Maxima occur at certain place due to reflection of electron not due to diffraction of electron. When we study the transverse waves of wave front in a river or sea or deal with the longitudinal waves of vibrating air column, we actually analyze the physical phenomenon of vibration of molecule concerned. In sound waves it is the pressure.

What is it that varies in case of matter waves? According to Arthur Beiser, shobhit Mahajani the wave associated with particles are mathematical constructs. It does not describe the space time variation of any measurable quantity like displacement or any characteristic present in a medium. Rather the waves relates to the probabilities of observing the particles at different space location as a function of time.

1. INTRODUCTION

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Wave picture given by Schrödinger equation represent the curve of probabilities of the entities to be at various phases away from the most probable phases of different point of time. The waves are here represented by a kind of graphical picture of probabilities for the entities to be in certain phases. They do not represent the real wave picture of moving electrons or photon, but the probabilities of particles to be in certain place in a wave like up and down form. To make this point clearer Max Born had called the Schrodinger wave as probability wave and not the waves of particle.

2. DAVISSION – GERMER INTERPRETATION OF, OUTCOME OF EXPERIMENT

Davisson and Germer verified de Broglie wave length with Bragg's law as follows:

Let a beam of 54 eV electrons was directed perpendicularly at the nickel target. The angles of incidence and scattering relative to the family of Bragg planes are both 65°.

According to Bragg law

$2d \sin\theta = n\lambda$

If $\theta = 65°$, $n = 1$, $d = 0.91$ nm

$\lambda = 2 \times 0.91\text{nm} \times \sin 65° = 0.165$ nm

Now we use de Broglie's formula - $\lambda = \frac{h}{mv}$

The electron momentum mv is

$$mv = (2mE_k)^{\frac{1}{2}}$$

$$= (2 \times 9.1 \times 10^{-31} \times 54 \times 1.6 \times 10^{-19})^{\frac{1}{2}}$$

$$= 4.0 \times 10^{-24} \text{ kg } \frac{m}{s}$$

The electron wave length is therefore

$$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{4 \times 10^{-24}}$$

= 1.66 x = 0.166 nm

Which aggress well with the observed wave length of 0.166 nm

Thus we are saying that particle has wave character.

3. **RIGHT INTERPRETATION:** In Davisson - Germer experiment initially there was a continuous variation of scattered electron intensity with angle. After accident air enters and oxidized the metal surface. To reduce the oxide to pure nickel, the target was baked in a hot oven. Now the results were very different. Instead of a continuous variation of scattered electron intensity with angle, distinct maxima and minima were observed.

Two questions come to mind immediately, what is the reason for this new effect. Why it did not appeared before baking?

If electron possesses wave character then initially also maxima and minima were observed but the result was different. Initially, the electron after collision with crystal ,reflect in all direction but heating of nickel at high temperature causes the many small individual crystal of which it is normally composed to form a single crystal, all of whose atoms are arranged in a regular lattice. Now due to regularity of atom, electrons reflected in particular direction. This may be the cause of maxima.

If we take K.E = 60 eV,

Then $mv = (2mE_k)^{\frac{1}{2}}$

$$= (2 \times 9.1 \times 10^{-31} \times 60 \times 1.6 \times 10^{-19})^{\frac{1}{2}}$$

$= 4.18 \times 10^{-24}$ kg m/s

The electron wave length is there fore

$$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{4.18 \times 10^{-24}}$$

= 0.158 nm.

But from Bragg law,

$\lambda = 2 \times 0.91\text{nm} \times \sin 65° = 0.165$ nm.

In this case the result is different.

If we decrease the angle of incidence relative to Bragg plane then λ of Bragg equation decrease but λ of de Broglie equation remain same. Again if we increase K.E of electron keeping the angle of incidence and scattering relative to the family of Bragg

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plane fixed, then λ of Bragg equation remain same, but λ of De Broglie equation decreases.

4. CONCLUSION

$$\text{Since } \lambda = \frac{h}{mv}$$

$$\lambda = \frac{h}{(2mE_k)^{\frac{1}{2}}}$$

$$\text{again } \lambda = 2d \sin\theta, \quad \text{for } n = 1$$

$$\text{So we can write } 2d \sin\theta = \frac{h}{(2mE_k)^{\frac{1}{2}}}$$

$$\text{Or } \frac{h^2}{2mE_k} = 4d^2 \sin^2\theta$$

$$\text{Or } \quad E_k = \frac{h^2}{8md^2 \sin 2_\theta}$$

Since m, h &d are constant. So from above relation we can say that K.E is inversely proportional to $\sin^2\theta$. But there is no relation between θ and K.E of electron , K.E depend on φ which is 50^0 in this case, then how Bragg law can be used to prove de Broglie hypothesis. So λ = is dimensionally correct not physically.

For example- let us consider two relation of Energy one is $E = mc^2$ and other is E= msT. In the second case, E is Heat energy, m is mass, s is specific heat & T is temperature. So from the above two relation we can say that $mc^2 = msT$ or $c^2 = sT$. In some case may sT and c^2 are same, this does not implies that s & c are related. Whether we use the relation, $E = msT$ to prove $E = mc^2$? No.

Further in Davisson- Germer experiment there is no diffraction of electron, it is the reflection of electron because sharp maxima occurs at an angle of 50 with original beam. Since angle of incidence and scattering (reflection) relative to family of Bragg plane are both 65^0. That is angle of incidence = angle of reflection. So maximum in electron distribution is not due to diffraction, it is due to reflection.

But if we increase K.E of electron beam there will be scattering of electron, so maximum in electron distribution will be changed, let it be 60^0 with the original beam. In this case there will no reflection because angle of incidence remains same (65^0) but scattering angle become 50^0.

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