Lecture 22: Section 2

Friday, February 25, 2022 8:53 AM

• Wave shows particle nature.

$\boxed{E = nh\nu}$

→ Photoelectric effect

→ compton effect

→ Black body radiation

Debroglie waves: particles also show wave characteristic

$E^2 = m_0^2 c^4 + p^2 c^2$

$h\nu = E = pc \Rightarrow h = \frac{pc}{\nu} \Rightarrow \boxed{\lambda = \frac{h}{p}}$

$p = \gamma m v$, $\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$ $\Rightarrow \boxed{\lambda_{db} = \frac{h}{\gamma m v}}$

Particle:
- $e^- \rightarrow \sim 10^{-34}$
- neutron
- proton

Matterwaves: ?

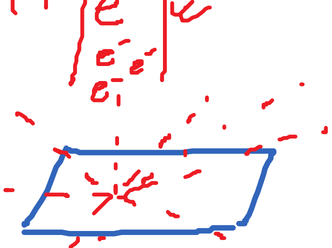
Davisson-Germer Experiment:

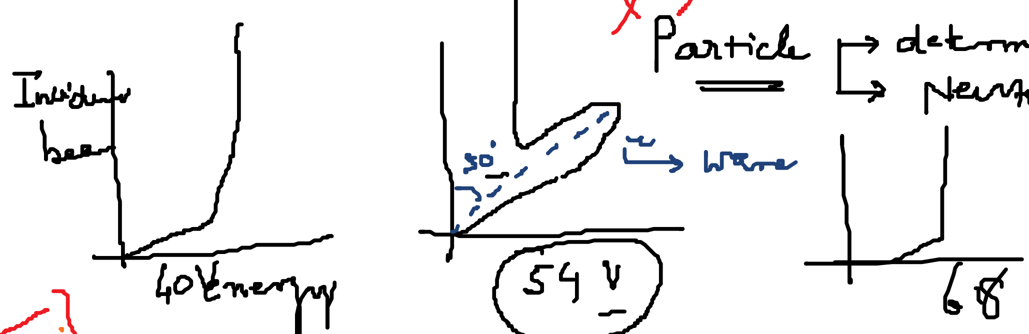
E.M.T

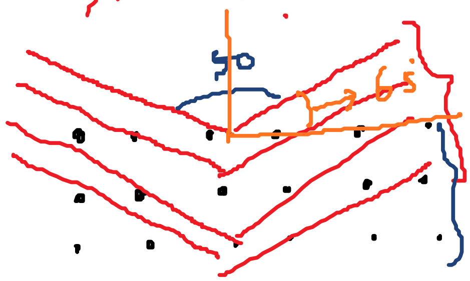
wave
- → Interference
- → Diffraction
- → Polarized

Particle
- → determinism
- → Newtonian

e^-







Bragg's diffraction: $n\lambda = 2d\sin\theta$

$n = 1$, $d = 0.091\,nm$

$\lambda = 2 \cdot 0.091 \times 10^{-9}\,m \sin 65$

$\boxed{\lambda \approx 0.165\,nm}$

$\lambda_{db} = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

$E = qV$

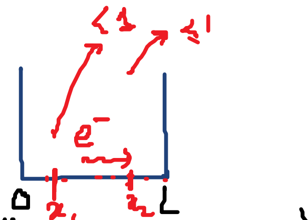
$p \quad \sqrt{2mE}$

$E = qV$

$p = \sqrt{2mE} = \sqrt{2 \times 9.1 \times 10^{-34}\,kg \times 54\,eV \times 1.6 \times 10^{-19}\,J/eV}$

$\cong 40 \times 10^{-24}\,kg\,m/s$

$\lambda = \frac{6.63 \times 10^{-34}}{} \approx 0.166\,nm$



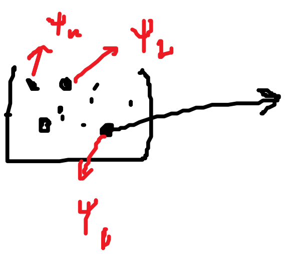
Matter Wave :- $\Psi(x, y, z, t)$: $A + iB$

$(A - iB)(A + iB)$

Probability density $= \Psi^* \Psi = |\Psi|^2 = A^2 + B^2$

$$\boxed{\int_0^L |\Psi|^2 dx = 1}$$

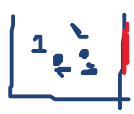
for Head, Tail: $\frac{1}{2} + \frac{1}{2} = 1$



$|\Psi|^2$

$y = \Sigma y_i$

$\Psi = \Sigma \Psi_i$ } wave packet



$\Psi_1 = A \cos(\omega t - kx)$, $v_1 = \frac{\omega}{K}$

$\Psi_2 = A \cos[(\omega + \Delta\omega)t - (K + \Delta K)x]$, $v_2 = \frac{\omega + \Delta\omega}{K + \Delta K}$

A =

$\Psi_1 + \Psi_2 = 2A \cdot \cos\left[\left(\frac{2\omega + \Delta\omega}{2}\right)t - \left(\frac{2K + \Delta K}{2}\right)x\right]$

$\Delta\omega = 1$
$\Delta k = 1$

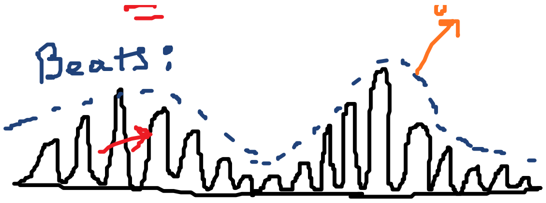
$\cos A + \cos B$
$=$
Beats :

$V_g = v$

$\cos\left[\frac{\Delta\omega}{2} t - \frac{\Delta K}{2} x\right]$

$\Psi = 2A \cos(\omega t - kx) \cos(\Delta\omega t - \Delta K x)$

Beats:



640 Hz, 642

10000, 1001

$$\psi = 2A\cos(\omega t - kx)\cos\left(\frac{\Delta\omega}{2}t - \frac{\Delta k}{2}x\right)$$

$$\left.\begin{array}{l} 2\omega + \Delta\omega \approx 2\omega \\ 2k + \Delta k \approx 2k \end{array}\right\}$$

$$V_{phase} = \frac{\omega}{k}$$

$$V_{group} = \frac{\Delta\omega}{\Delta k} \cong \frac{d\omega}{dk}$$

$$V_{phase} = \frac{\omega}{k} = \frac{2\pi\nu}{\frac{2\pi}{\lambda}} = \nu\lambda = \frac{\gamma mc^2}{h}\cdot\frac{h}{\gamma m v} = \frac{c^2}{v}$$

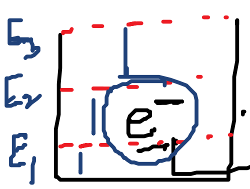
$$\lambda_{db} = \frac{h}{\gamma m v}$$

$$\nu = \frac{\gamma mc^2}{h} \rightarrow \gamma mc^2 = E = h\nu$$

$$V_{phase} = \frac{c^2}{v}\cdot v$$

$$V_{group} = \frac{d\omega(v)}{dk(v)} = \frac{d\omega/dv}{dk/dv} = v$$

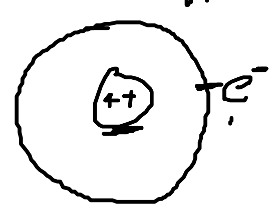
$$\lambda \rightarrow \frac{1}{\gamma}, \quad \gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$



$\rightarrow E_3 = (\ ) h\nu$

$\rightarrow |\psi_i|^2$

Atomic Str



Bohr

Other