MLL253

Lecture 4

$$\sigma_0 = \frac{N_e e^2 \tau}{m} \qquad \sigma(\omega) = \frac{\sigma_0}{1 - i\omega\tau}$$

Skin Effect in conductors {HW}

↳ relevance of skin effect in AC conductivity.

→ THz : IR transmission in materials.
{EM transmission in materials}

$$k^2 = \frac{\omega^2}{c^2} \quad \text{\{free space light\}}$$

$$k^2 = \frac{\omega^2}{c^2}\left(1 - \left(\frac{\omega_p}{\omega}\right)^2\right) \qquad \omega_p = \text{plasma frequency} = \frac{N_e e^2}{m \varepsilon}$$

If $\omega < \omega_p$: $k^2 = -ve$: k is complex

$$E = E e^{-ikx + i\omega t}$$

EM in medium will decay or explode but not propagating

If $\omega > \omega_p$ $k^2 = +ve$: k is

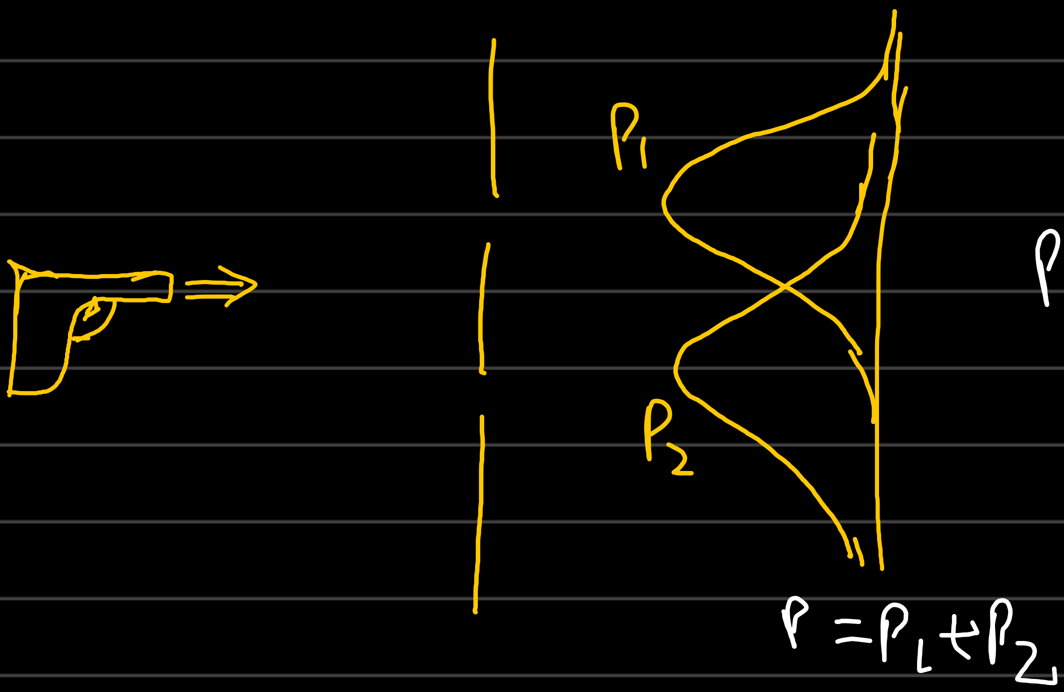
↳ E is oscillating in medium
↳ EM propagates in medium

↳ Transparent materials have low ω_p, hence visible light can transmit.

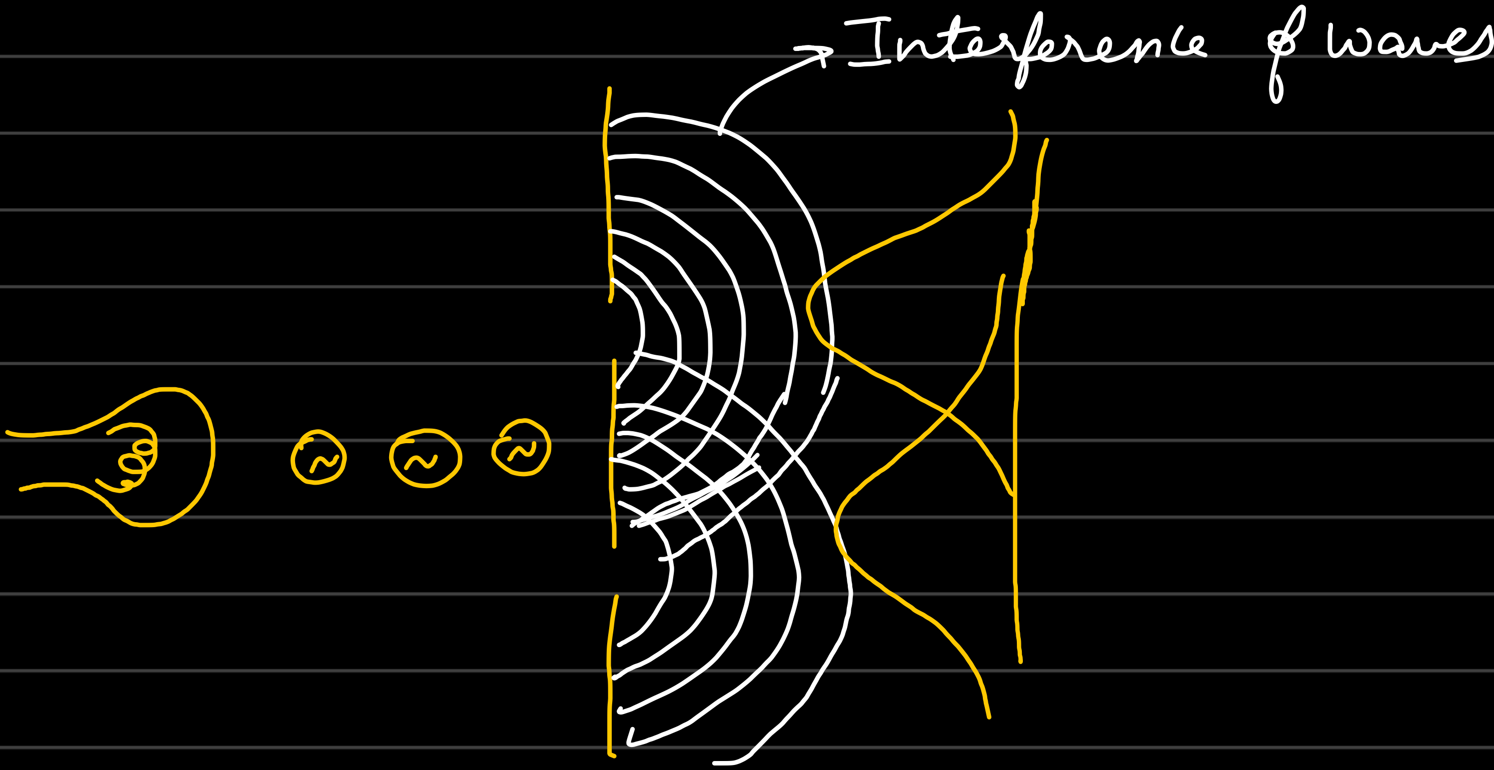
↳ Metals have high ω_p, deep UV light $\{\lambda < 140\,nm\}$ will propogate in metals.

↳ Richard Feynmann lectures on Properties of Matter.

Young's Double Slit Experiment



→ Above results satisfy particulate theory of matter.

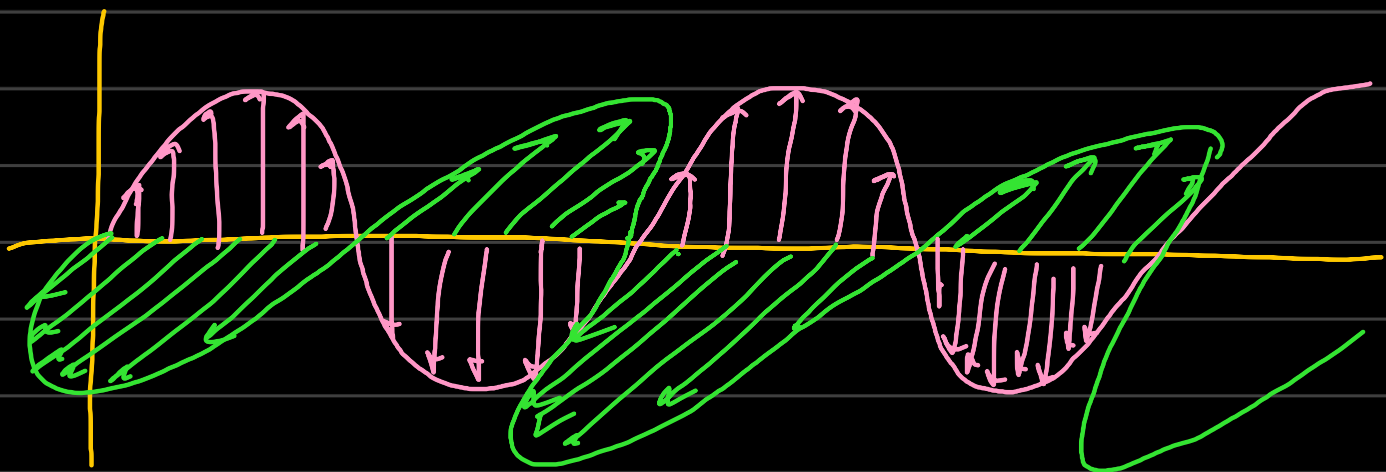


→ If wave packets are observed and monitored {we know which hole it will go through}

→ We then will have results catering particulate nature of matter.

→ If we do not monitor wave packet, we obtain interference results.

→ Consider light propagating in x-direction.



$$E(x,t) = E_0 e^{-i(kx-\omega t)}$$

$$E(r,t) = E_0 e^{-i(kr-\omega t)}$$

phase velocity: $v_p = \left.\frac{\partial x}{\partial t}\right|_{\phi}$

$$\frac{\partial E}{\partial t} \cdot \frac{\partial x}{\partial E} = \frac{\omega}{k} \quad \therefore \boxed{v_p = \frac{\omega}{k}}$$

Crompton Effect:

$$\underline{K - K' = p}$$

→ X-ray imparted momentum p to e^-

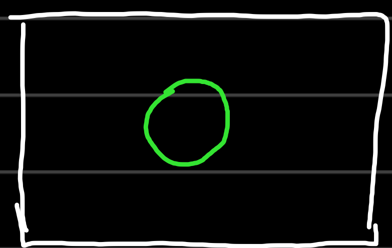
→ Hence light behaves like particles.

* Dual nature of light:

↳ Idea of packets of known frequency.

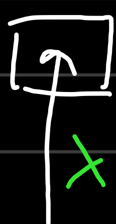
$$\underline{E = h\nu}$$

Wave nature of light:



Either transmit or absorption.

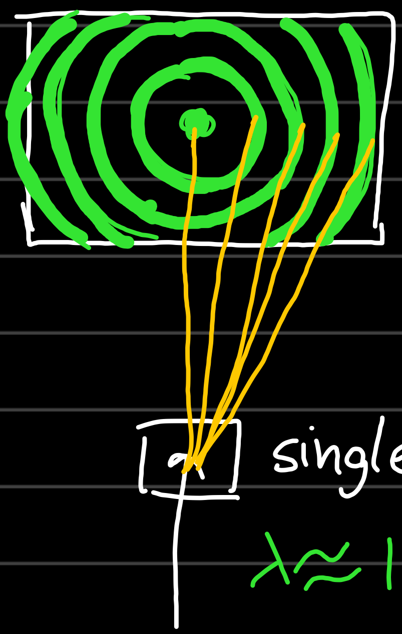
λ larger than interatomic spacing



single crystal

$\lambda > 100nm, > 1\mu m$

λ comparable to interatomic spacing.

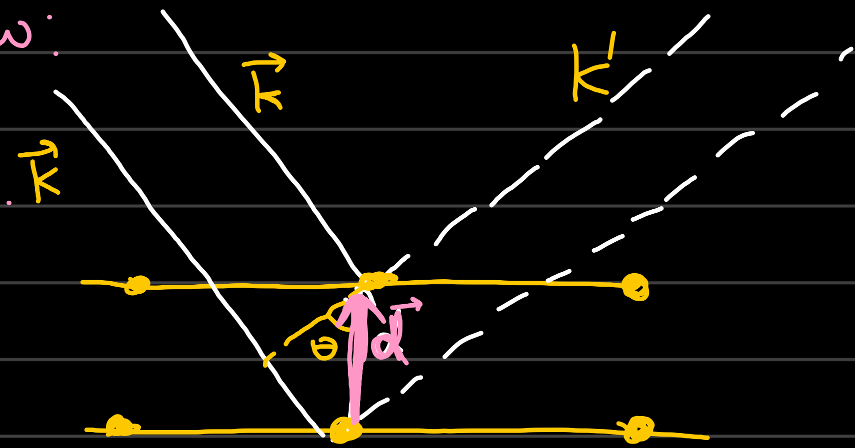


2D Gaussian of fringes obtained.

single crystal

$\lambda \approx 1-10\,A^{\circ}$

Braggs Law:



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

{Constructive Interference}

$\vec{d}\cdot\vec{k} - \vec{d}\,\vec{k}' = n\lambda$