Physics 142 – November 23, 2008

Happy Thanksgiving

Enjoy those Full Body Scans!

- Exam 2
- Physical optics ?

- Presentations coming up

December 2
- Rail guns
- Superconductivity

December 7
- Electrical musical instruments
- Relativity

December 9
- EM in Chem + medicine
- Lasers

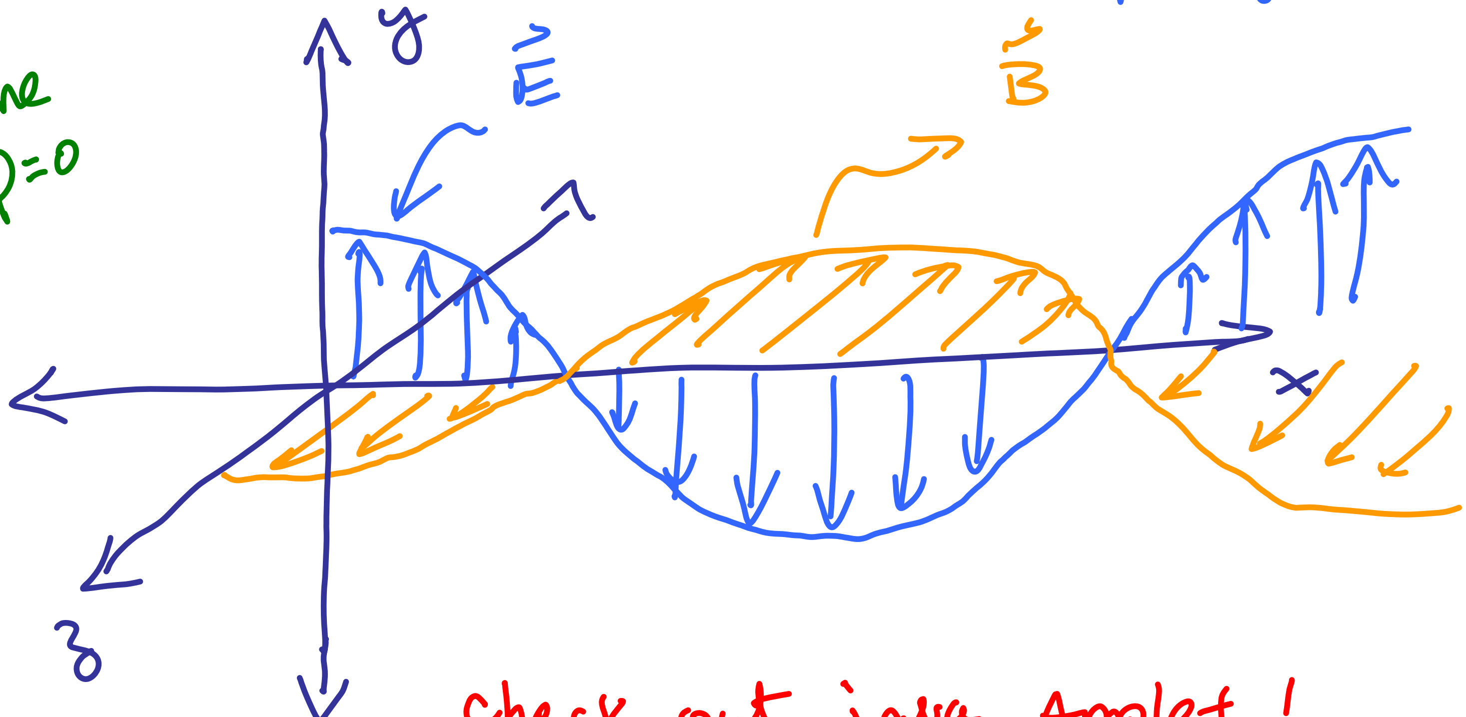
$$E_y(x,t) = E_{oy}\cos(kx - \omega t + \phi)$$

$k = \frac{2\pi}{\lambda}$ $\qquad$ $\omega = \frac{2\pi}{T}$ $\qquad$ ϕ: Phase (initial condition)

$$B_z = \frac{k}{\omega} E_{oy} \cos(kx - \omega t + \phi)$$

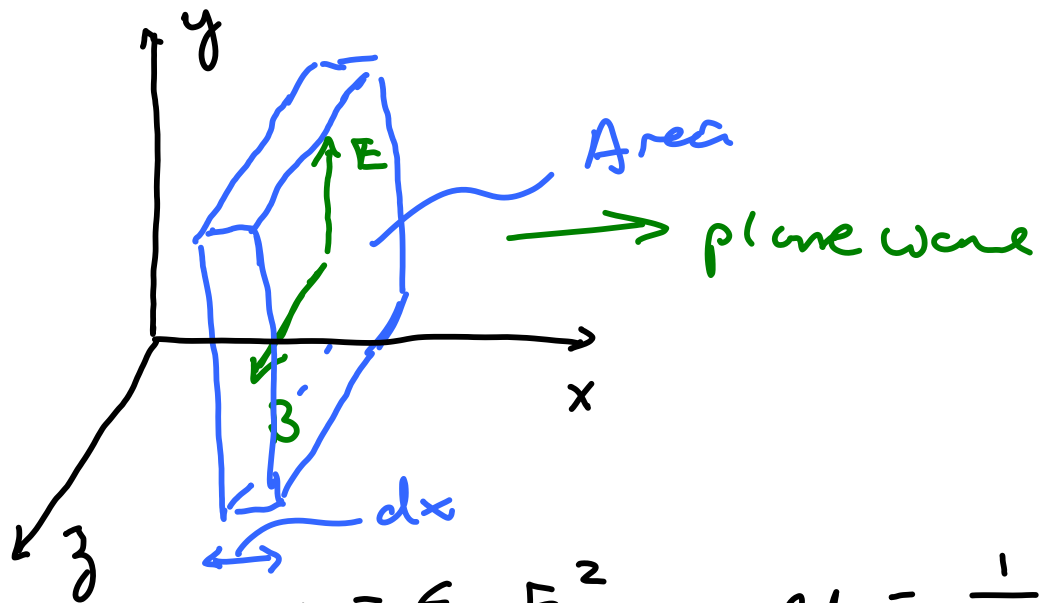
Freeze time

Assume $\phi = 0$



Check out java Applet!

Energy Flow

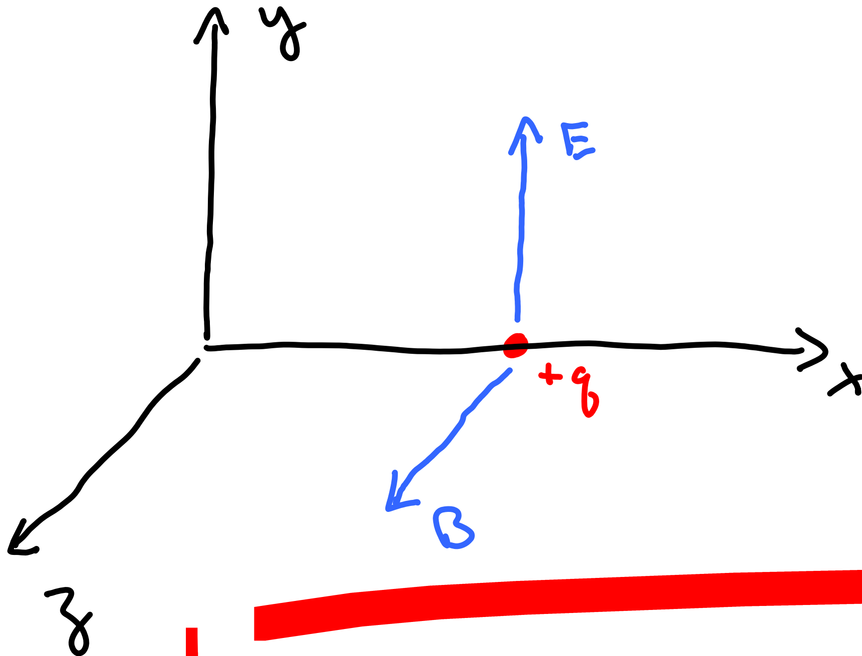


$$u_E = \frac{\epsilon_0}{2} E^2 \qquad u_B = \frac{1}{2\mu_0} B^2$$

$$\vec{S} = \frac{\vec{E} \times \vec{B}}{\mu_0} \equiv \text{Poynting vector}$$

$|\vec{S}| \equiv$ intensity $\quad \text{Power}/\text{m}^2 = \text{watts}/\text{m}^2 \cdot \text{s}$

$$\bar{S} \equiv \langle S \rangle = \frac{E_0^2}{2\mu_0 c} = \frac{c B_0^2}{2\mu_0}$$



Momentum of EM wave $p = U/c$

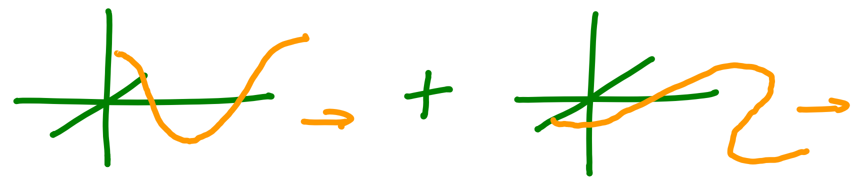
If wave absorbed

Radiation Pressure $= S/c$

Ave. Radiation Pressure $= \langle S \rangle / c$

x2 if wave is reflected

General Soln →

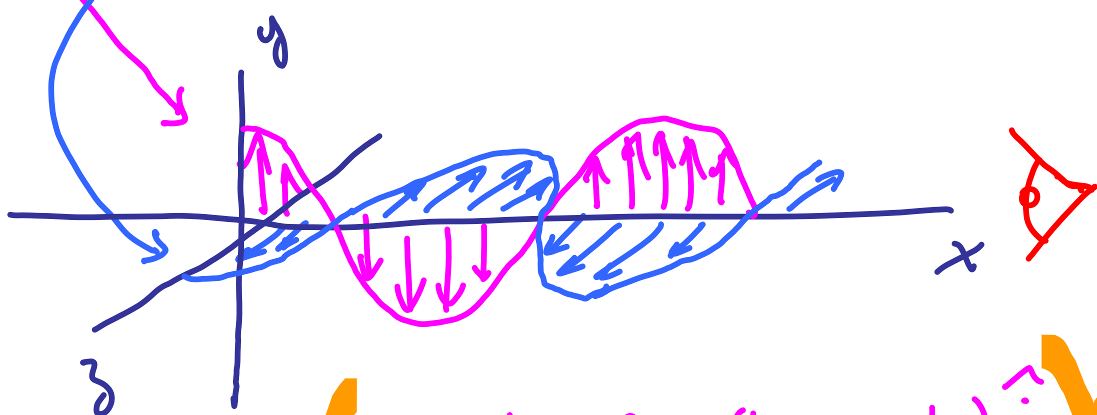


Superposition of two orthogonal waves

(Form a basis)

1 - plane polarized y Axis — $\vec{E}$ along y

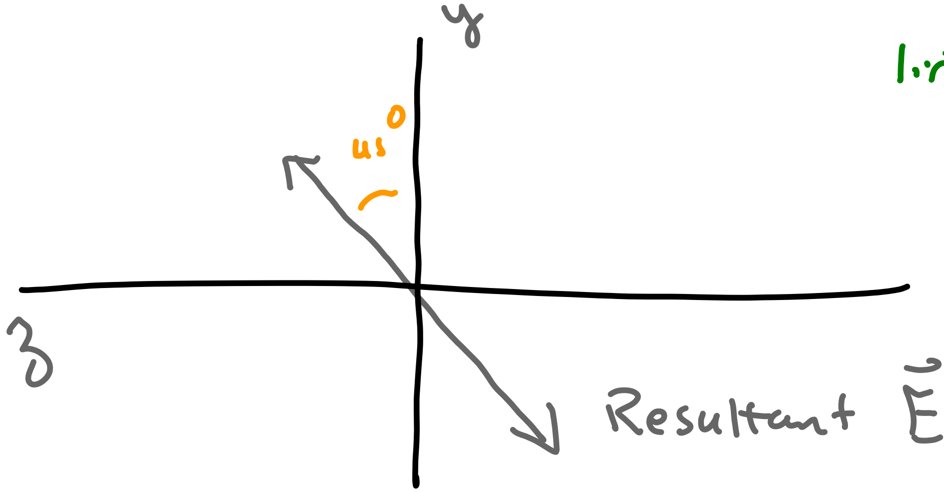
1 - plane polarized z axis — $\vec{E}$ along z



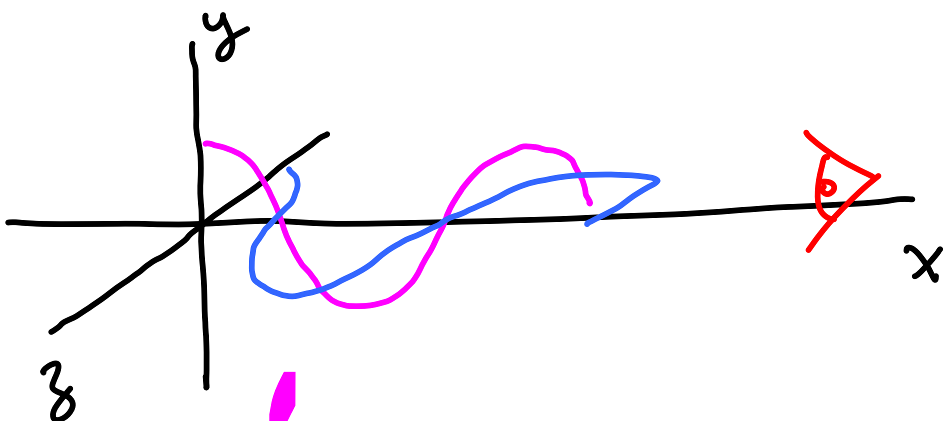
$$E_y = E_{0y} \cos(kx - \omega t)\,\hat{j}$$

$$E_z = E_{0z} \cos(kx - \omega t)\,\hat{k}$$

independent - Could have different Amplitudes + relative phase difference

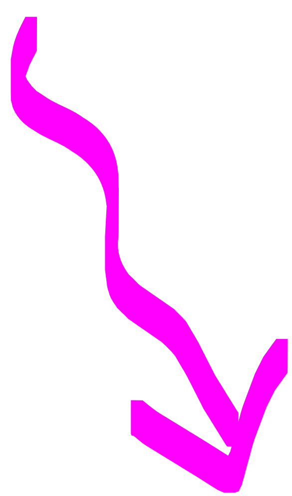


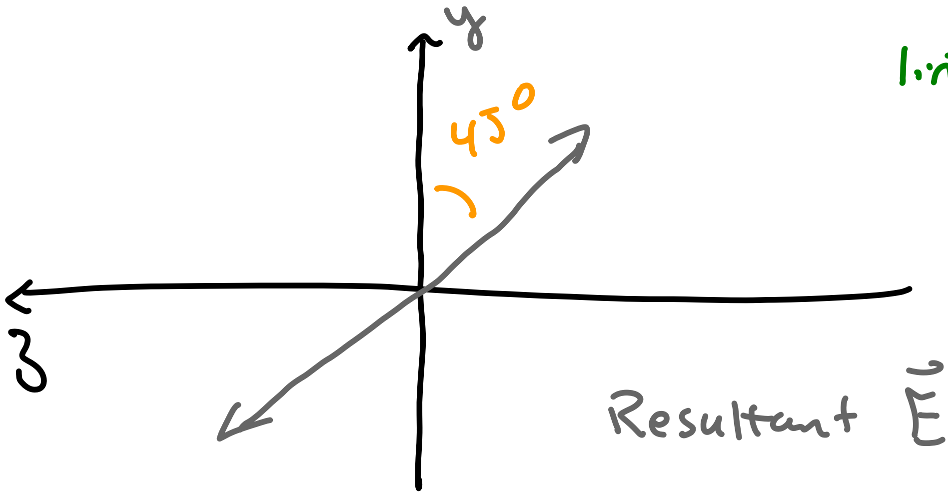
linear Polarization



$$E_x = E_{0x}\cos(kx - \omega t)$$

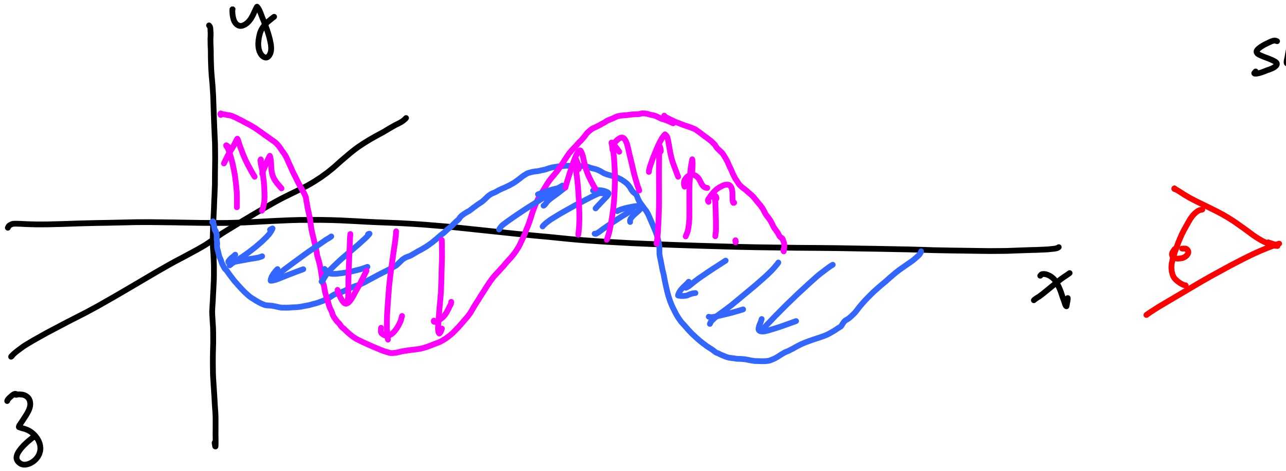
$$E_y = E_{0x}\cos(kx - \omega t + \pi)$$



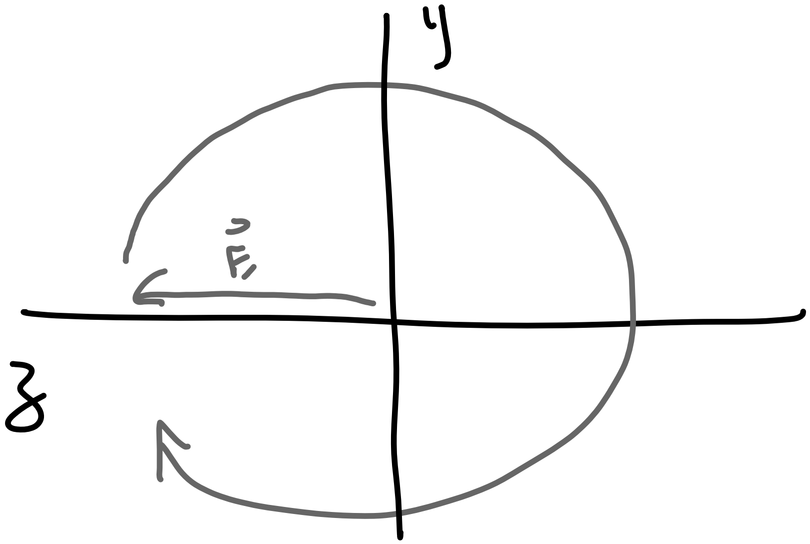


linear

Polarization



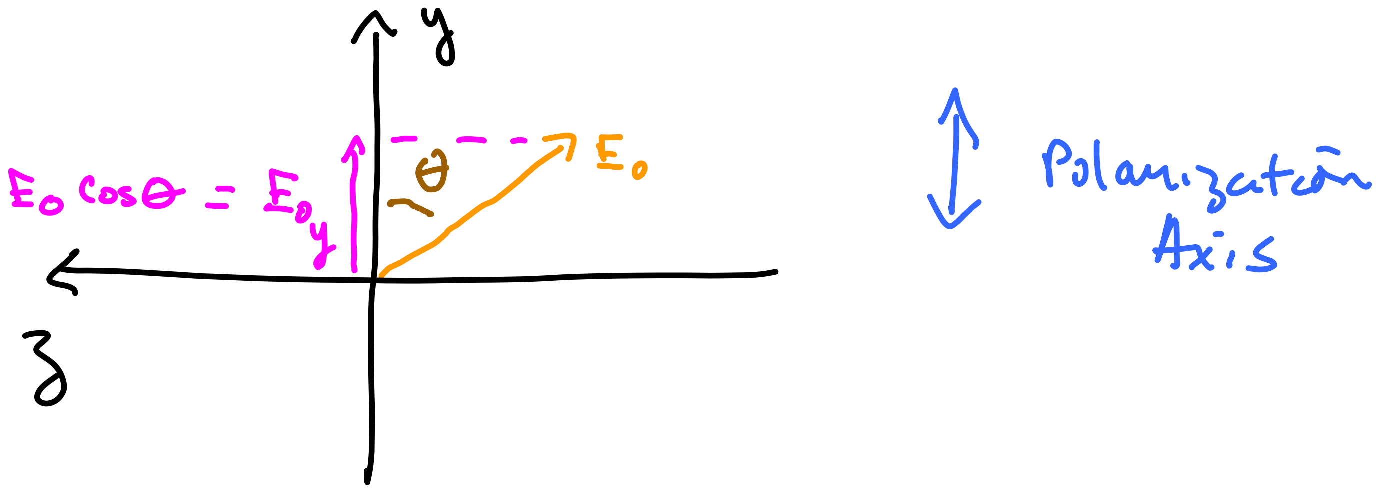
Shift by $\pi/2$



Clockwise Rotation

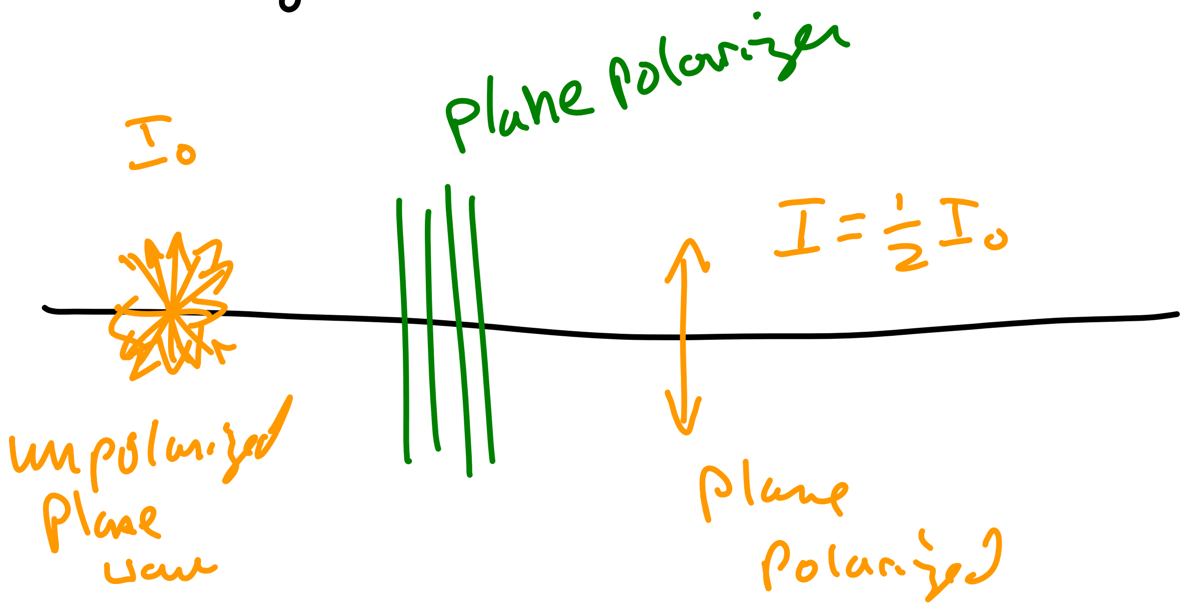
Right Circular Polarization

See java applet

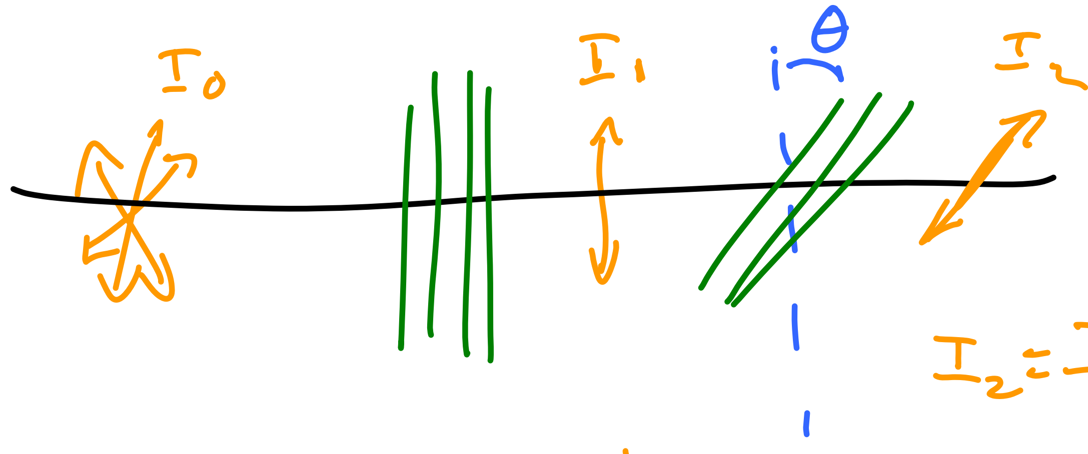


$$I_{new} = E_0^2 \cos^2\theta \sim I_{\text{intensity initial}} \cos^2\theta$$

Intensity



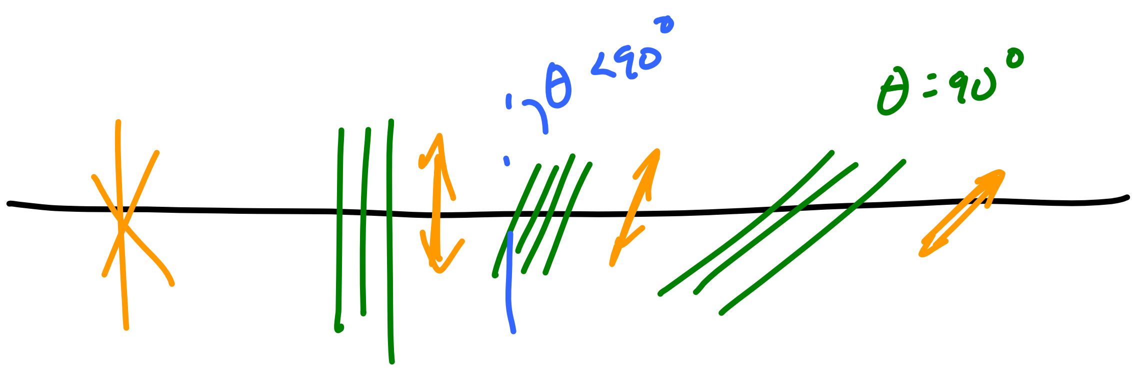
Send initially unpolarized light thru 2 linear polarizers at angle θ

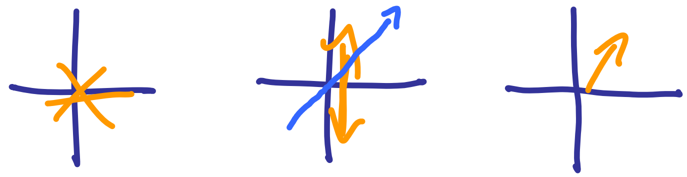


$$I_2 = I_1 \cos^2\theta$$

$$I_1 = \frac{1}{2} I_0$$

$$I_2 = \left(\frac{1}{2} I_0\right) \cos^2\theta$$





EM waves + laws of optics

Vacuum

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

Material

$$v = \frac{1}{\sqrt{\epsilon \mu}}$$

n = index of Refraction $= \frac{c}{v}$

Vacuum

$$\lambda_0 \nu = c$$

Material

$$\lambda \nu = v$$

$$\lambda \nu = \frac{c}{n}$$

$$\lambda_{material}\, n = \frac{c}{\nu} = \lambda_0$$

$$\lambda_0 = \lambda_{material}\, n$$