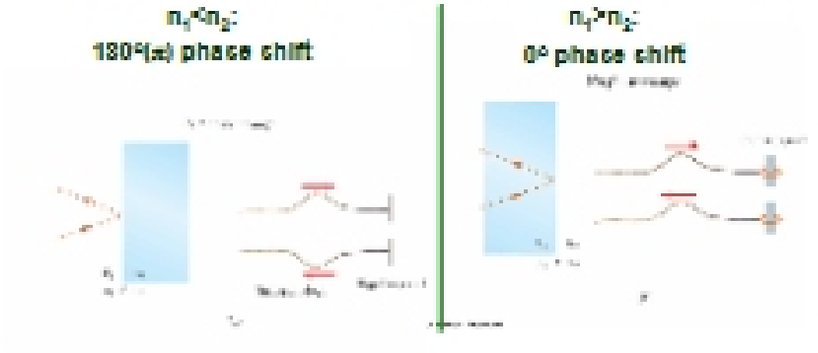
Physics 202, Lecture 27

Today's Topics

- Thin Film Interference
  - Change of Phase at Boundaries
  - Exercise on Thin Film Interference
  - Exercise on Non Reflective Coating
- Michelson Interferometer
- Diffraction
  - Single Slit Diffraction

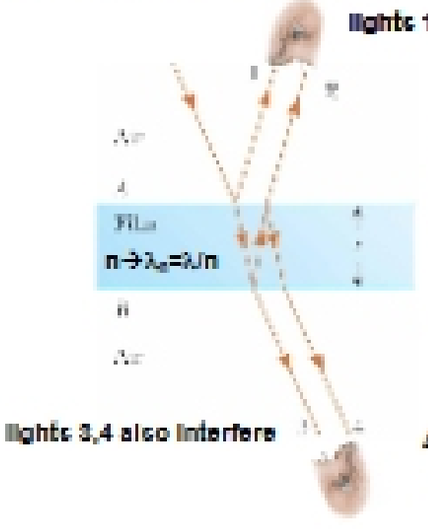
Possible Phase Change of 180° For Reflected Light

- When a light traveling in medium 1 of n_1 is reaches at a boundary with medium 2 of n_2:
  - The reflected light has a 180°(π) phase shift if $n_1<n_2$
  - There is no phase change for reflected light if $n_1>n_2$
  - In any change, no phase shift for refracted light



Thin Film Interference

- Thin film splits light → split lights then interfere



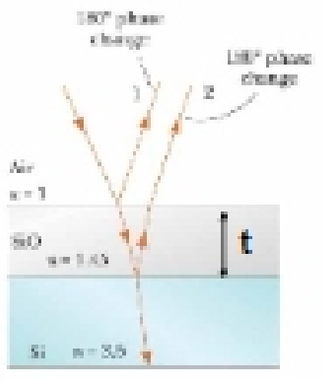
$\Delta\phi_{12} \sim 2\pi/\lambda_n\,(2t) + \pi$

Quiz: Constructive/destructive Conditions?

$\Delta\phi_{34} \sim 2\pi/\lambda_n\,(2t)$

Exercise: Non Reflective Coating

- Determine the minimum thickness (t) of SiO coating so a light of 550nm is non-reflective at the surface.



Solution (see board):
Non "reflective"
→1 and 2 cancel each other (destructive interference)

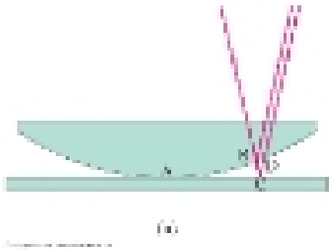
$\Delta\phi_{12} = 2\pi/\lambda_n\ 2t + 0° = \pi$

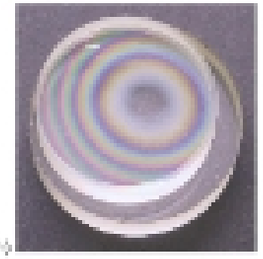
$\rightarrow t = \lambda_n/4 = \lambda/4n = 94.8$ nm.

Note t is λ dependent.

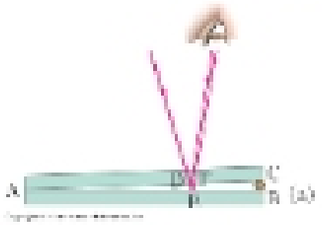
Demos

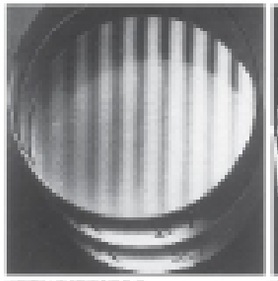
Newton's Rings





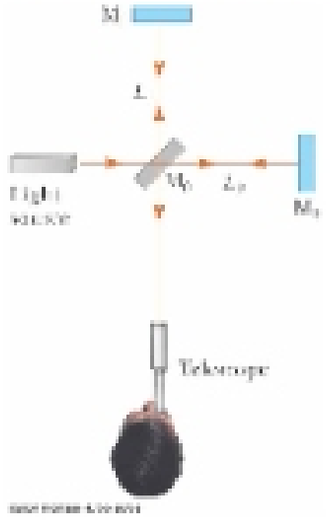
Testing glass for flatness



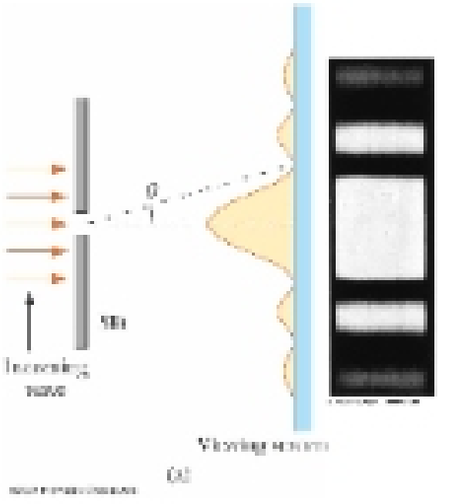


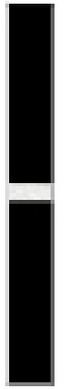
Colorful Interference Patterns

Demo: Michelson Interferometer



Single-Slit Interference (Single-Slit Diffraction)

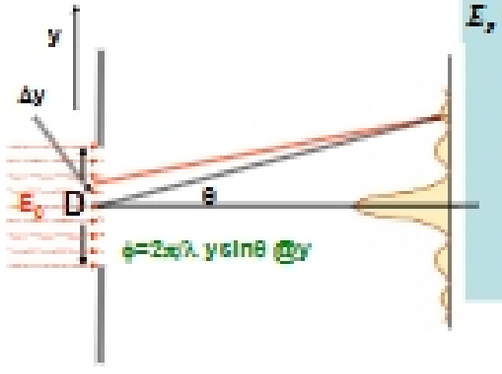




If lights were just rays

Single-Slit Diffraction Pattern Explained

☐ The slit is not a point source→ Interference



$$E_y = \sum E_i$$

$$= \sum \left(\frac{\Delta y}{D} E_0\right) \sin(\omega t + \frac{2\pi}{\lambda} y \sin\theta)$$

$$= \int_{-D/2}^{D/2} \frac{E_0}{a} \sin(\omega t + \frac{2\pi}{\lambda} y \sin\theta) dy$$

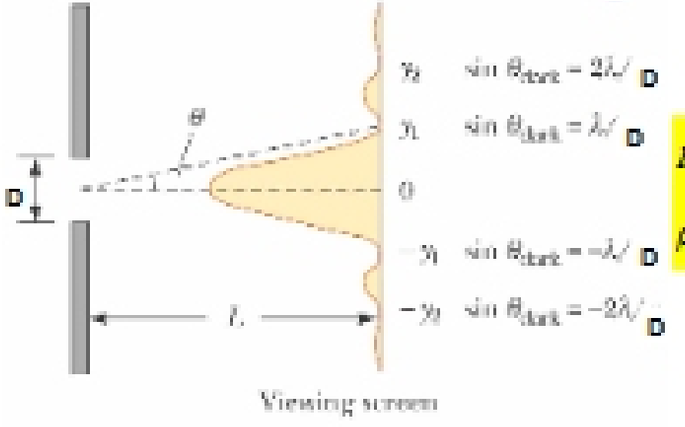
$$= \frac{2E_0}{D\frac{2\pi}{\lambda}\sin\theta} \sin\left(\frac{2\pi}{\lambda}\frac{D}{2}\sin\theta\right)\sin(\omega t)$$

$$I = I_0\left[\frac{\sin(\beta/2)}{\beta/2}\right]^2$$

$$\beta \equiv \frac{2\pi}{\lambda} D\sin\theta$$

The text also offers a derivation using phasors.
Not to be examed but please read.

Where Are the Dark Fringes?



$$I = I_0\left[\frac{\sin(\beta/2)}{\beta/2}\right]^2$$

$$\beta \equiv \frac{2\pi}{\lambda} D\sin\theta$$

☐ The dark fringes occur at :

$I=0 \rightarrow \sin(\beta/2)=0 \rightarrow \sin\theta_{dark}=m\lambda/D,\ m=\pm 1, \pm 2, \pm 3,...$