Reminders 04-07-08:

-Lockdown Video

-Next POW Due Wednesday April 9

-Next Exam April 14, Chapters 33-36

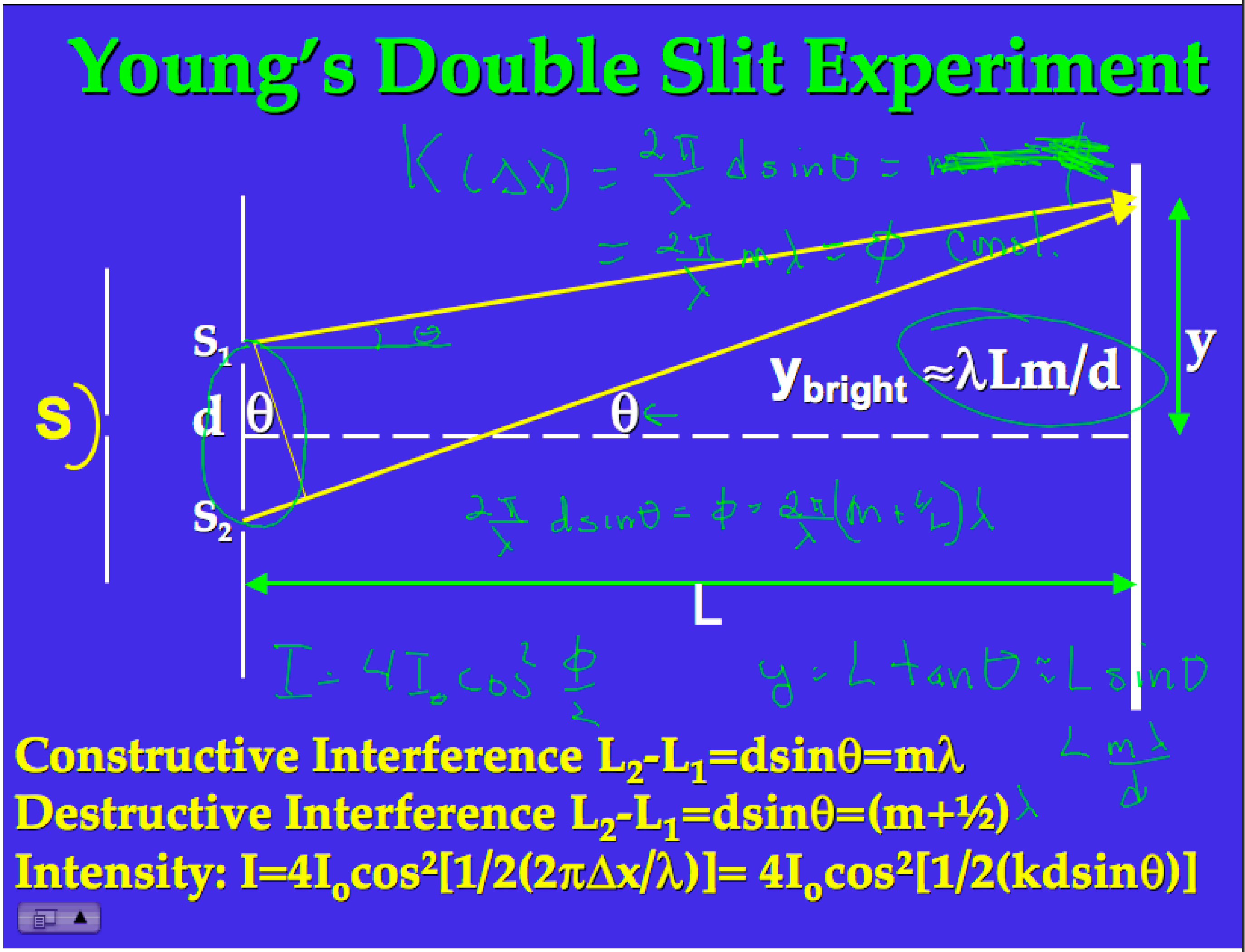
Outline:

-Young's Double Slit Experiment

-Thin Film Interference

-Introduction to Diffraction

-Properties of Single Slit Diffraction


Young's Double Slit Experiment
S
S1
d θ
S2
θ
y
ybright ≈λLm/d
L
Constructive Interference L2-L1=dsinθ=mλ
Destructive Interference L2-L1=dsinθ=(m+½)
Intensity: I=4Iocos²[1/2(2πΔx/λ)]= 4Iocos²[1/2(kdsinθ)]

- Red light from a He-Ne laser (λ=632.8nm) is incident on two narrow slits separated by 0.200mm. A fringe pattern is observed on a white sheet of paper held 1.00m away How far above and below the central axis do the first dark minima (minimum intensity) occur? Where is the 5th bright fringe.

$d \sin\theta = m\lambda$

$d \sin\theta = (m+\frac{1}{2})\lambda$

$y = L\frac{m\lambda}{d}$ cons.

$y = L\frac{(m+\frac{1}{2})\lambda}{d}$ des.

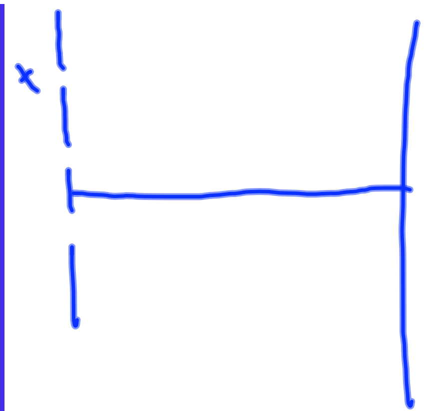
m = 0

$y = \frac{L(\frac{1}{2})\lambda}{d} = \frac{1(\frac{1}{2})(632.8\times10^{-9}m)}{.2\times10^{-3}} = 1.58\times10^{-3}m$

1.58mm

$y = 15.8mm$

- **Laser light falls on three evenly spaced very narrow slits. When one of the side slits is covered, the first order maximum is at 0.60° from the normal. If the center slit is covered and the other two are open, find the angle of the first order maximum, and the order number of the maximum that now occurs at the same angle as the fourth order maximum did before.**



1st

$d \sin\theta = 1\lambda$

$\sin .60 = \frac{\lambda}{d}$

2nd case

$2d \sin\theta = \lambda$

$\sin\theta = \frac{\lambda}{2d}$

$\frac{\sin .6}{\sin\theta} = \frac{\frac{\lambda}{d}}{\frac{\lambda}{2d}} = 2$

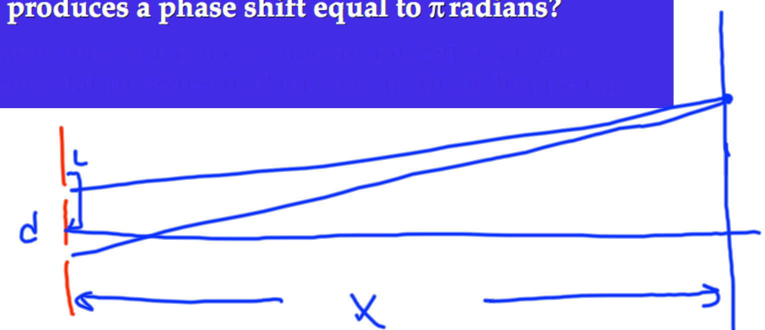
$\sin .6 = 2 \sin\theta$

$\theta = \sin^{-1}\left(\frac{1}{2} \sin .6\right)$

$= .3°$

Example

- In a Young's double slit experiment a piece of glass of index of refraction n and thickness L is placed in front of the upper slit.
  - What happens to the interference pattern?
  - Derive the expression for the intensity of the light reaching the screen.
  - Derive the values of θ that yield constructive interference.
  - What happens to central maximum if glass produces a phase shift equal to π radians?



Phase shift depends on the
1) Path Difference
2) Wavelength shifts in glass

Phase shift 2

$$\Delta k L = \left(\frac{2\pi}{\lambda_{glass}} - \frac{2\pi}{\lambda_{air}}\right)L$$

$$n = \frac{c}{v} = \frac{f\lambda_{air}}{f\lambda_{glass}} \qquad = \left(\frac{2\pi n}{\lambda_{air}} - \frac{2\pi}{\lambda_{air}}\right)L = \frac{2\pi}{\lambda_{air}}(n-1)L$$

$$\lambda_{glass} = \frac{\lambda_{air}}{n}$$

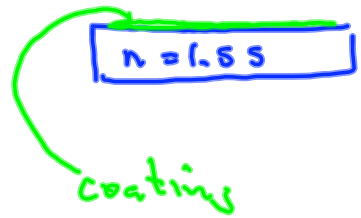
Phase shift 1

$$k\Delta x = \frac{2\pi}{\lambda_{air}} d\sin\theta$$

Total phase shift

$$d\sin\theta \frac{2\pi}{\lambda_{air}} + \frac{2\pi}{\lambda_{air}}(n-1)L = kd\sin\theta + k(n-1)L = \phi$$

- **A telescope lens with an index of refraction of 1.55 is to be coated with a MgF_2 (n=1.38) to increase the transmission of yellow light (λ =550nm). What is the minimum thickness of the coating? (Hint: the goal is to minimize reflection to maximize transmission)**



$$2t = \left(m + \tfrac{1}{2}\right)\lambda_n$$

$$m = 0$$

$$2t = \frac{\lambda_n}{2}$$

$$t = \frac{\lambda_n}{4} = \frac{\lambda_{air}}{4n}$$

$$t = \frac{550\,nm}{4(1.38)} = \underline{94.63\,nm}$$