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°($\pi$) 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

$n_1<n_2$:
180°($\pi$) phase shift

$n_1>n_2$:
0° phase shift
Thin Film Interference

- Thin film splits light $\rightarrow$ split lights then interfere

\[
\Delta \phi_{12} \sim \frac{2\pi}{\lambda_n} (2t) + \pi
\]

\[
\Delta \phi_{34} \sim \frac{2\pi}{\lambda_n} (2t)
\]

Quiz: Constructive/destructive Conditions?
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)

\[ \Delta \phi_{12} = \frac{2\pi}{\lambda_n} \]
\[ 2t + 0^\circ = \pi \]

→ \( t = \frac{\lambda_n}{4} = \frac{\lambda}{4n} = 94.8 \text{ nm} \).

Note t is \( \lambda \) dependent.
Newton’s Rings

Demos

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 $\rightarrow$ Interference

$$E_p = \sum E_i$$

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

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

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

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

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

The text also offers a derivation using phasors.

Not to be examed but please read.
Where Are the Dark Fringes?

The dark fringes occur at:

\[ I = 0 \rightarrow \sin(\beta/2) = 0 \rightarrow \sin\theta_{\text{dark}} = m\lambda/D, \quad m = \pm 1, \pm 2, \pm 3, \ldots \]