Double Slit Interference
(slightly souped up)

\[ \frac{1}{d} = \frac{1}{k} \]

Amplitude: \( A \) \( \propto \) \( e^{i(kx - \omega t)} \)

\[ |k| = \frac{2\pi}{\lambda_0} \] in vacuum

\( Z \) (electric field strength)

Intensity \( \propto 4 \) times \( \left( \frac{1}{\text{slit}} \right) \)

\( \Rightarrow \) average over time

Zero: route 1 \( \frac{1}{\text{slit}} \) \( \Rightarrow \) \( r_1' \)

route 2 \( \Rightarrow \) \( r_2' \)

Intensity \( \propto \) intensity (compared to 1 slit)

\[ \Rightarrow \] average over time
The mathematical expression is:

\[ e^{i kr_1 - i \omega t} + e^{i kr_2 - i \omega t} = e^{i kr_2 - i \omega t} (e^{i k (r_1' - r_2')} - 1) \]

The amplitude is:

\[ |\text{Amplitude}| = |e^{i k (r_1' - r_2')} - 1| \]

It vanishes when:

\[ i k (r_1' - r_2') = \pi \]

\[ = \frac{2 \pi}{\lambda} (r_1' - r_2') = \pi \]

\[ r_1' - r_2' = \frac{1}{2} \lambda \]

The lens trick (look near slits):

\[ k \Delta r = \frac{2 \pi d \sin \theta}{\lambda} = \pi \]

\[ \Delta r = \frac{\lambda}{2 \sin \theta} \]

\[ \max \sin \theta = \frac{n \lambda}{d} \]

\[ \min \sin \theta = (n + \frac{1}{2}) \frac{\lambda}{d} \]
Coherence

About properties of source of light...

Atom \rightarrow \text{electron} \rightarrow \text{light} \rightarrow \text{atom}

atom \rightarrow \text{atom}

jostled = cT \ jostled

Typical T between jostles, times c is called the "coherence length"... if dsin\theta > L, cannot count on "stable phase relationship."

Intensity and Interference

\[ E_{\text{tot}} = E_0 e^{ikr - i\omega t} (e^{i(k(r - r))} + 1) \]
Like Fig. 9

\[ E_0 = \frac{2 E_0 \cos(\beta \cdot \theta)}{\sqrt{2}} \]

\[ E_{\text{tot}} = 2 E_0 \cos(\frac{2\pi}{2\sin \theta}) \]

\[ I_\theta = 4 I_0^2 \cos^2(\frac{2\pi}{2\sin \theta}) \]
Thin Films

Soap bubbles, oil on water.

\[ \frac{\lambda_0}{n} \]

\[ \lambda \rightarrow \frac{\lambda_0}{n} \]

\[ \text{flips like phase shift of } \pi/2 \]

\[ \text{extra } k/2 \]

\[ \text{air } n=1 \]

\[ \text{dense } n \]

\[ \text{air } n=1 \]

\[ d \rightarrow 0 \text{ think.} \]

\[ \text{assume } \theta = 0 \]

\[ \frac{2d}{(\lambda_0/n)} - \frac{1}{2} = 0, 1, 2, \ldots \]

\[ \begin{aligned} 2nd &= m + \frac{1}{2} \\
& \text{reflection at front} \\
& \# \text{ wavelengths} \end{aligned} \]

\[ d = \frac{\lambda_0}{2n} \left( m + \frac{1}{2} \right) \]

\[ \text{maximum } d \rightarrow 0 \]

\[ \frac{2d}{(\lambda_0/n)} - \frac{1}{2} = \frac{1}{2} \left( \frac{1}{2} \right) \frac{3}{2} > \frac{5}{2} \]

\[ d = \frac{\lambda_0}{2n} \cdot m \]

\[ \text{minimum} \]