Phys 5B: Diffraction

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Date March 13, 2017

- Diffraction: consequence of wave nature of light

  2-slit interference: narrow slits (width D)

  $D \ll d$ $\quad$ $D \ll \lambda$

  If D is not much less than λ, then light waves from different parts of slit interfere.

- If there is no panth length difference or no phase difference, then it is a constructive interference

  $\sin\Theta = 0$

- If top and bottom wave differ in path length by λ

  hey are both different by $\frac{\lambda}{2}$ compared to middle

  All desutrively interference $\lambda = D\sin\Theta \Rightarrow \sin\Theta = \frac{\lambda}{D}$ minima!

- In general, minima occur at $D\sin\Theta = m\lambda$

  Phase difference $\beta = \frac{2\pi}{\lambda} D\sin\Theta$

  Path length difference $D\sin\Theta$

- Maxima occurs at $D\sin\Theta = \left(m + \frac{1}{2}\right)\lambda$

- Path length difference $\Delta\text{PLD} = \Delta y \sin\Theta$

- Phase Difference $\Delta\beta = \frac{2\pi}{\lambda}\Delta y \sin\Theta$

- $N = \frac{D}{\Delta y}$

- if $\Delta\beta = 0 \Rightarrow (\Theta = 0)$

  $E_\Theta = N\Delta E_0 = E_0$ $\quad$ $\Delta E_0 = \frac{E_0}{N}$

  $\beta = N\Delta\beta$ $\quad$ Phase difference top vs bottom

- if $\Delta\beta > 0$,

  $E_\Theta < E_0$

  $\beta = N\Delta\beta = N\frac{2\pi}{\lambda}\Delta y \sin\Theta = \frac{2\pi}{\lambda} D\sin\Theta$

- $E_\Theta = 0$

  $N\Delta\beta = 2\pi$ $\quad$ $\frac{D}{\Delta y}\frac{2\pi}{\lambda}\Delta y \sin\Theta = 2\pi$

  $E_\Theta = E_0 \frac{\sin\left(\frac{\beta}{2}\right)}{\frac{\beta}{2}} \Rightarrow I_\Theta = I_0\left(\frac{\sin\left(\frac{\beta}{2}\right)}{\frac{\beta}{2}}\right)^2$ $\quad$ intensity for single slit

- Combine double slit

  $I_\Theta = I_0\cos^2\left(\frac{\beta}{2}\right) \Rightarrow I_\Theta = I_0\left(\frac{\left(\sin\left(\frac{\beta}{2}\right)\right)}{\frac{\beta}{2}}\right)^2 \cos^2\left(\frac{\beta}{2}\right)$ $\quad$ $\frac{\beta}{2} = \frac{\pi}{\lambda} D\sin\Theta$ $\quad$ $\frac{\beta}{2} = \frac{\pi}{\lambda} d\sin\Theta$