Interference of Light

B.Tech -I

Light's Nature

- Wave nature (electromagnetic wave)
- Particle nature (bundles of energy called photons)

Wave or Particle Nature

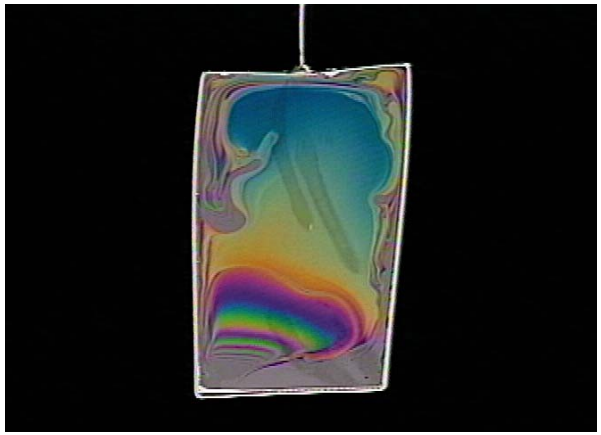
- **Corpuscular theory of Newton** (1670)
- Light corpuscles have mass and travel at extremely high speeds in straight lines

- Huygens (1680)
- Wavelets-each point on a wavefront acts as a source for the next wavefront

Wave Nature

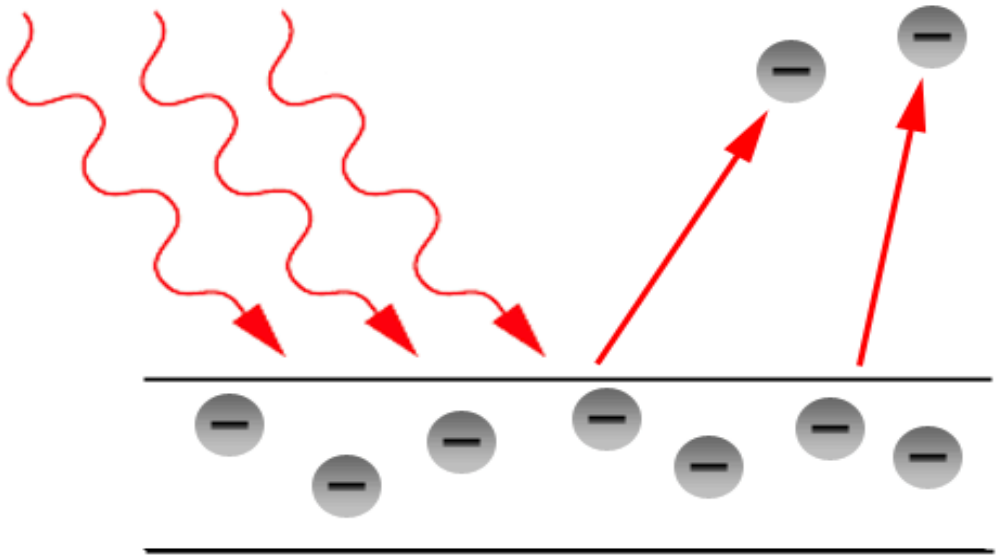
- Thomas Young's Double Slit Experiment (1807)
  bright (constructive) and dark (destructive) fringes seen on screen

- Thin Film Interference Patterns



Particle Nature: The Photoelectric Effect

- Albert Einstein 1905
- Light energy is quantized
- Photon is a quantum or packet of energy



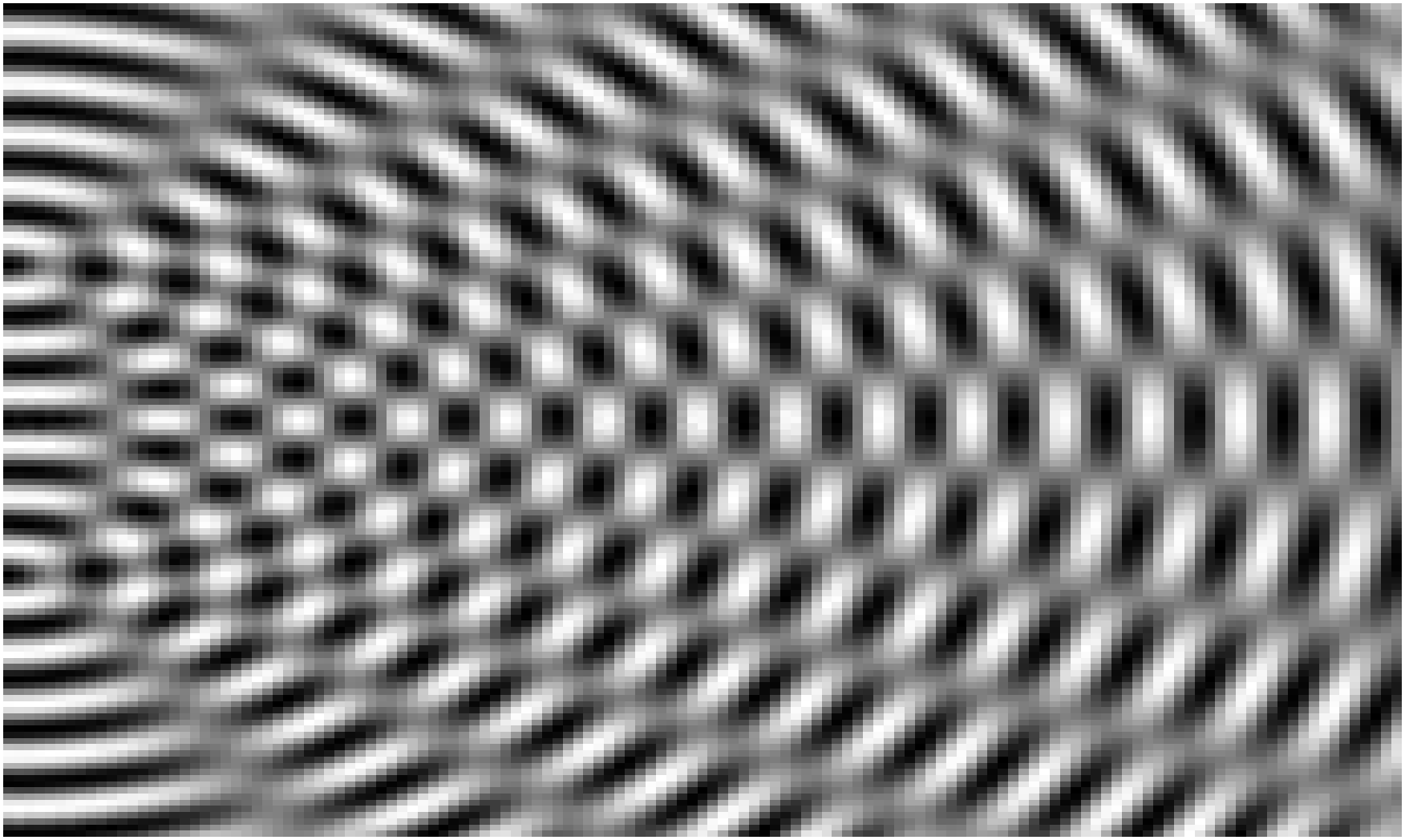
The Photoelectric Effect

- **Heinrich Hertz** first observed the **photoelectric effect** in 1887
- Einstein explained it in 1905 and won the Nobel prize for this.

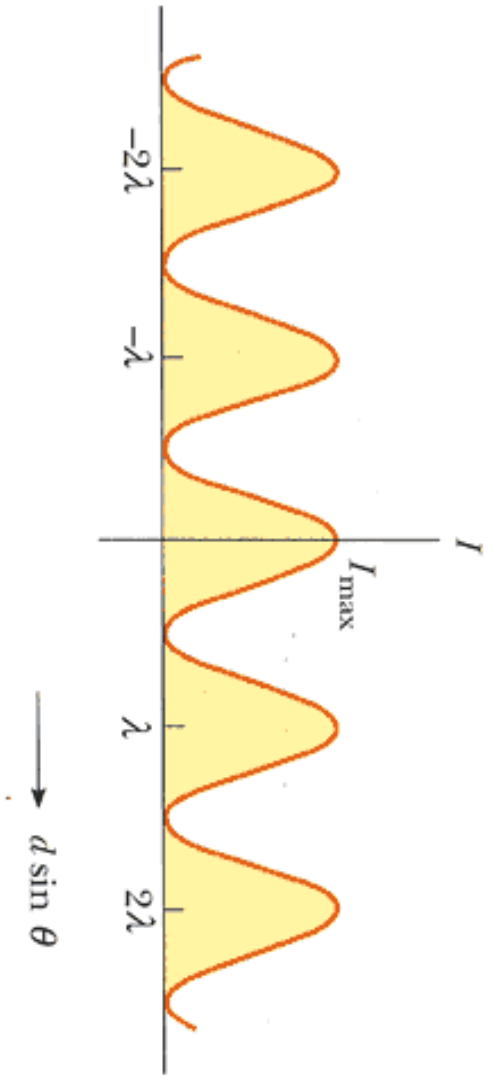
Thomas Young's Double Slit Interference Experiment

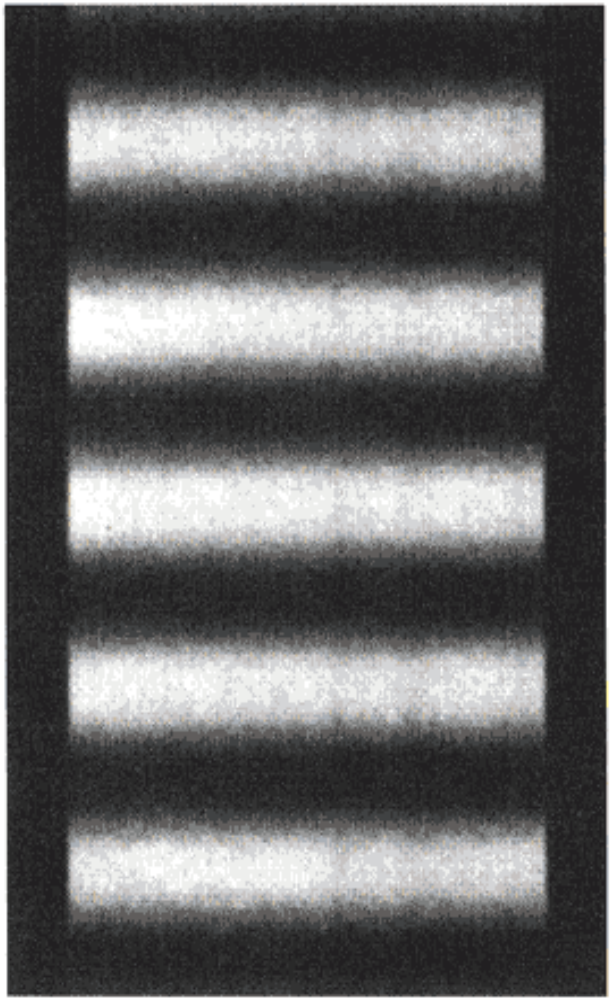
- Showed an interference pattern
- Measured the wavelength of the light

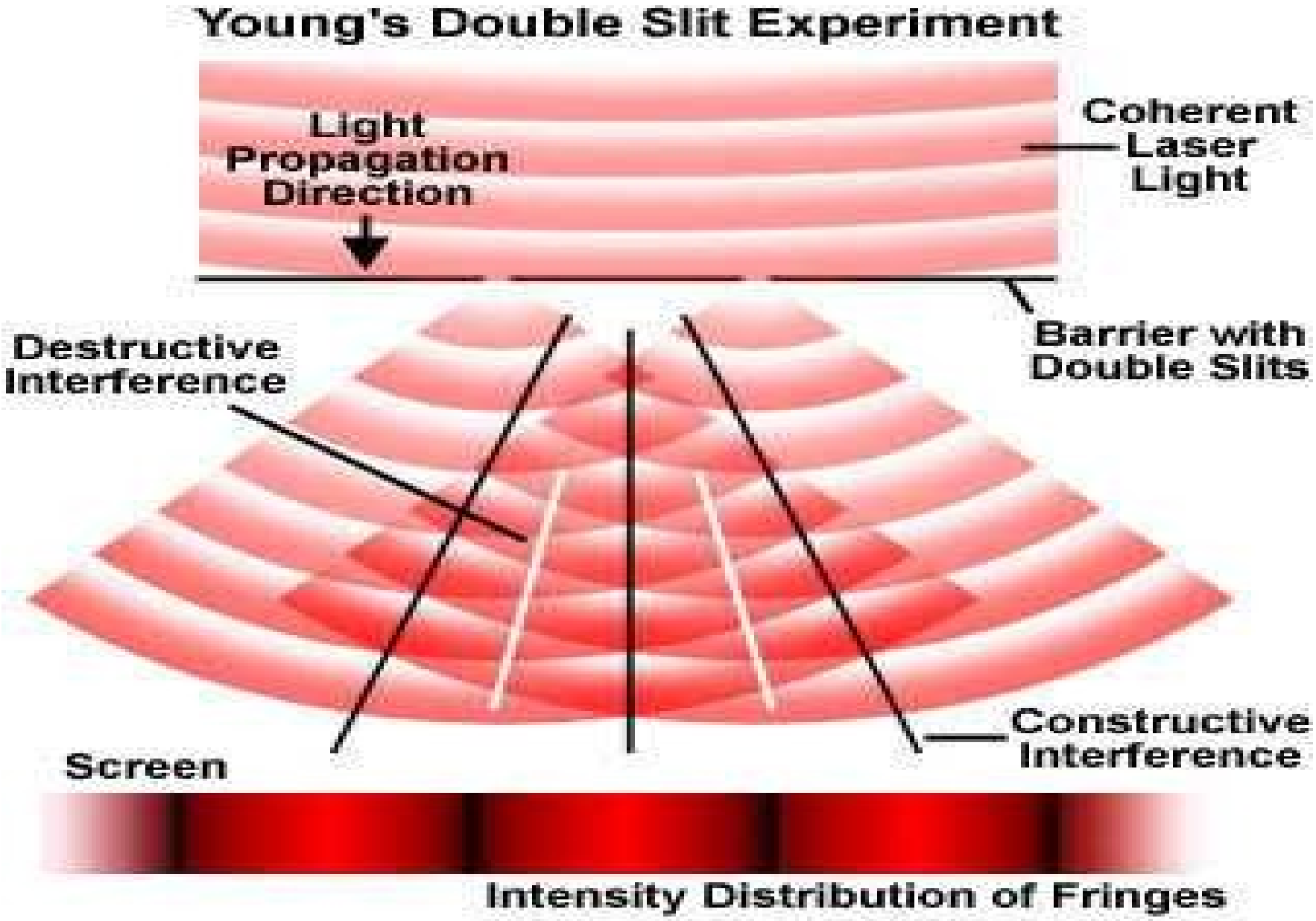
Two Waves Interfering



Young's Double Slit Interference Pattern





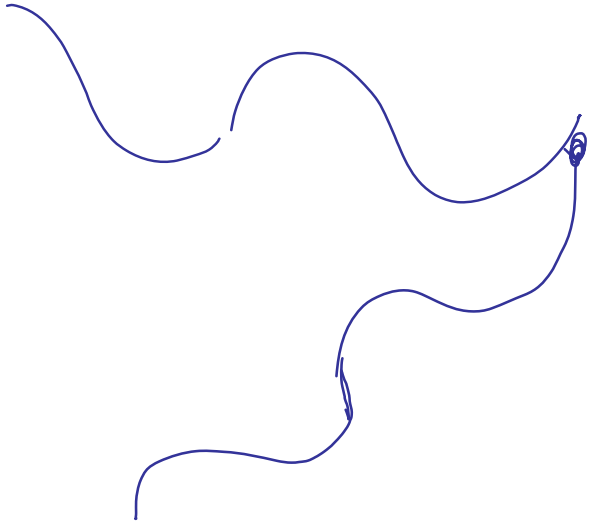


http://galileo.phys.virginia.edu/classes/USEM/SciImg/home_files/introduction_files/doubleslit.jpg

Interference

- Young's Double Slit Interference

For Constructive Interference:



The waves must arrive to the point of study in phase.

So their path difference must be integral multiples of the wavelength:

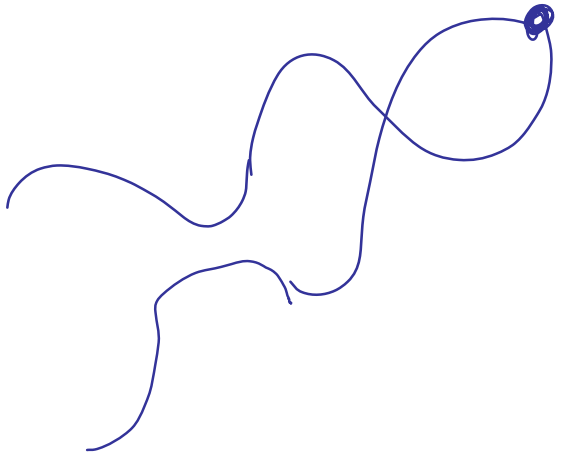
$\Delta L = n\lambda$

$n = 0, 1, 2, 3, \ldots\ldots$

For destructive interference:

, the waves must arrive to the point of study out of phase.

So the path difference must be an odd multiple of $\lambda/2$:



$\Delta L = n\,\lambda$

$m = 1/2, 3/2, 5/2, \ldots$

Fo Constructive Interference of Waves from Two Sources

$x = L\tan\theta$

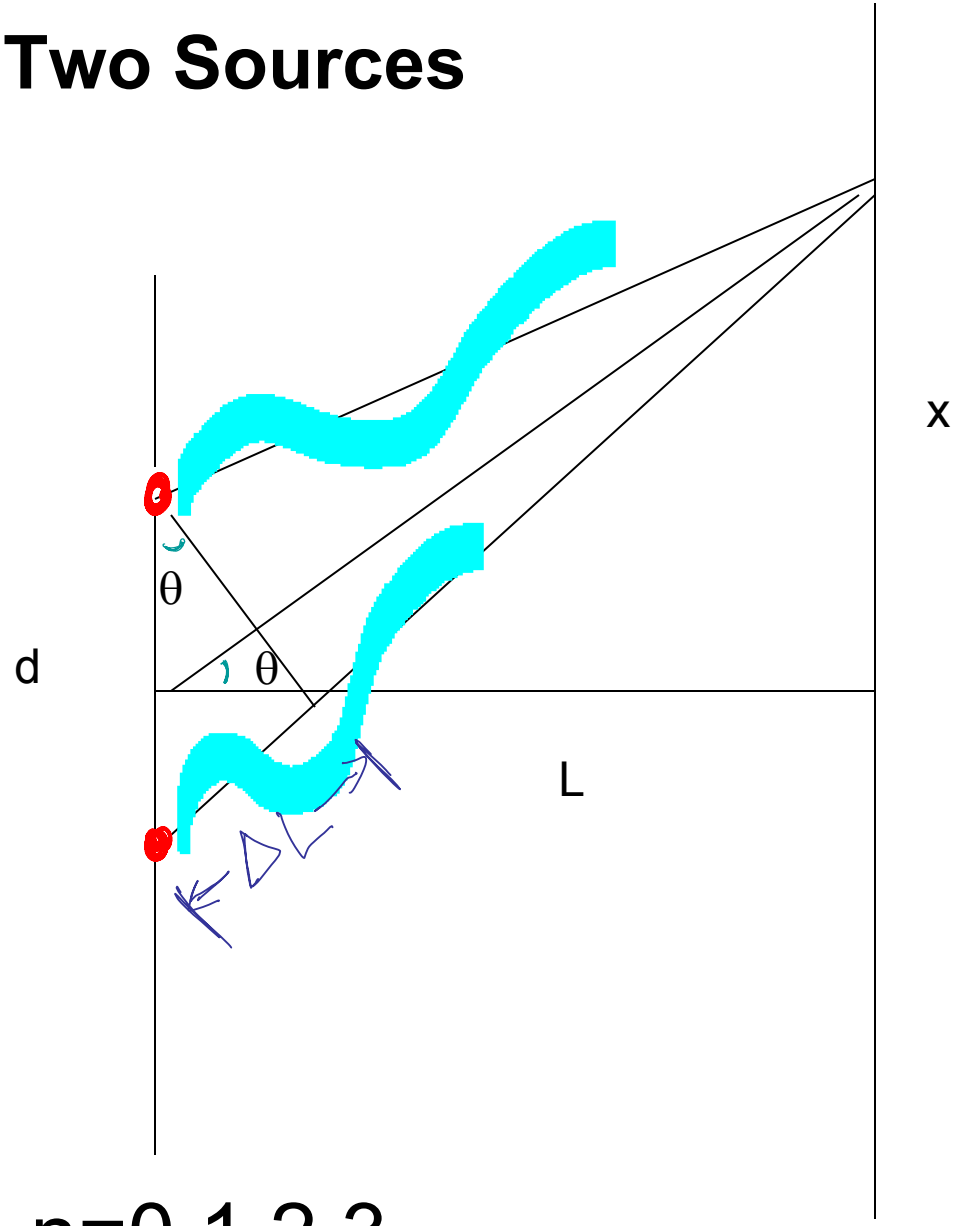
$\sin\theta = \Delta L/d$

$\Delta L = n\lambda$

For small angles:
$L\sin\theta \sim L\tan\theta$

$$d\sin\theta = n\lambda$$

$$n\lambda = \frac{dx}{L}$$



n=0,1,2,3,…

Double Slit Interference

$$d\sin\theta = n\lambda$$

$$n\lambda = \frac{dx}{L}$$

Constructive (brights) n=0,1,2,3,…..

Destructive (darks) n=1/2, 3/2, 5/2,…..

Note:

To find maximum # of fringes set θ to 90^o for n.