Interference of Light

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

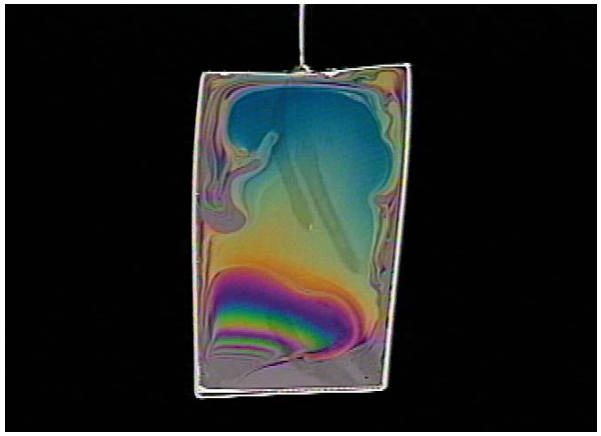
- Huygens (1680)
- Wavelets-each point on a wavefront acts as a source for the next wavefront

Wave Nature

- Thomas Young's Double Slit Experiment (1807)

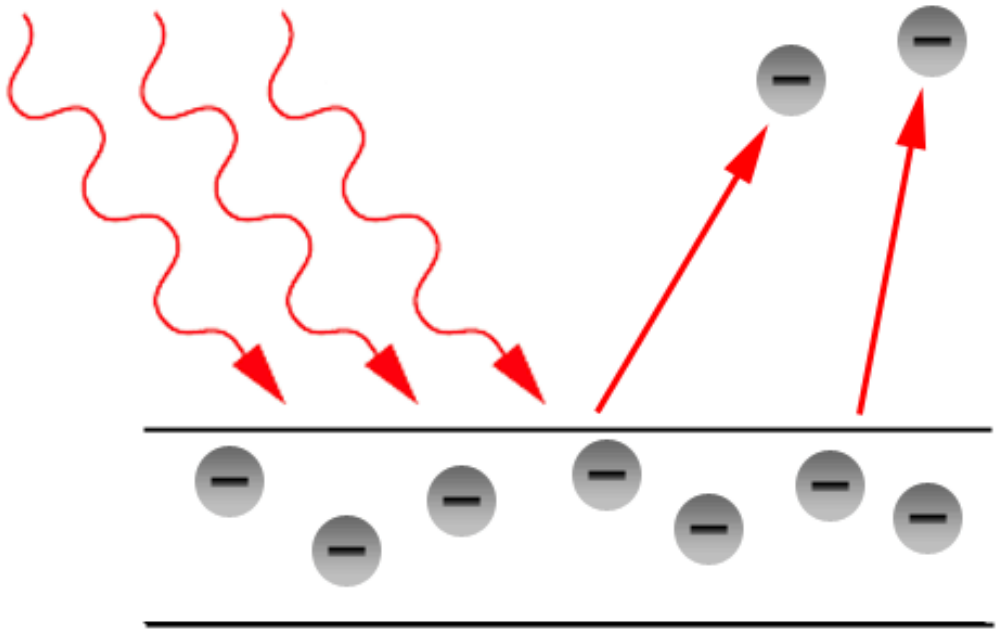
  bright (constructive) and dark (destructive) fringes seen on screen

- Thin Film Interference Patterns



Particle Nature: The Photoelectric Effect

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



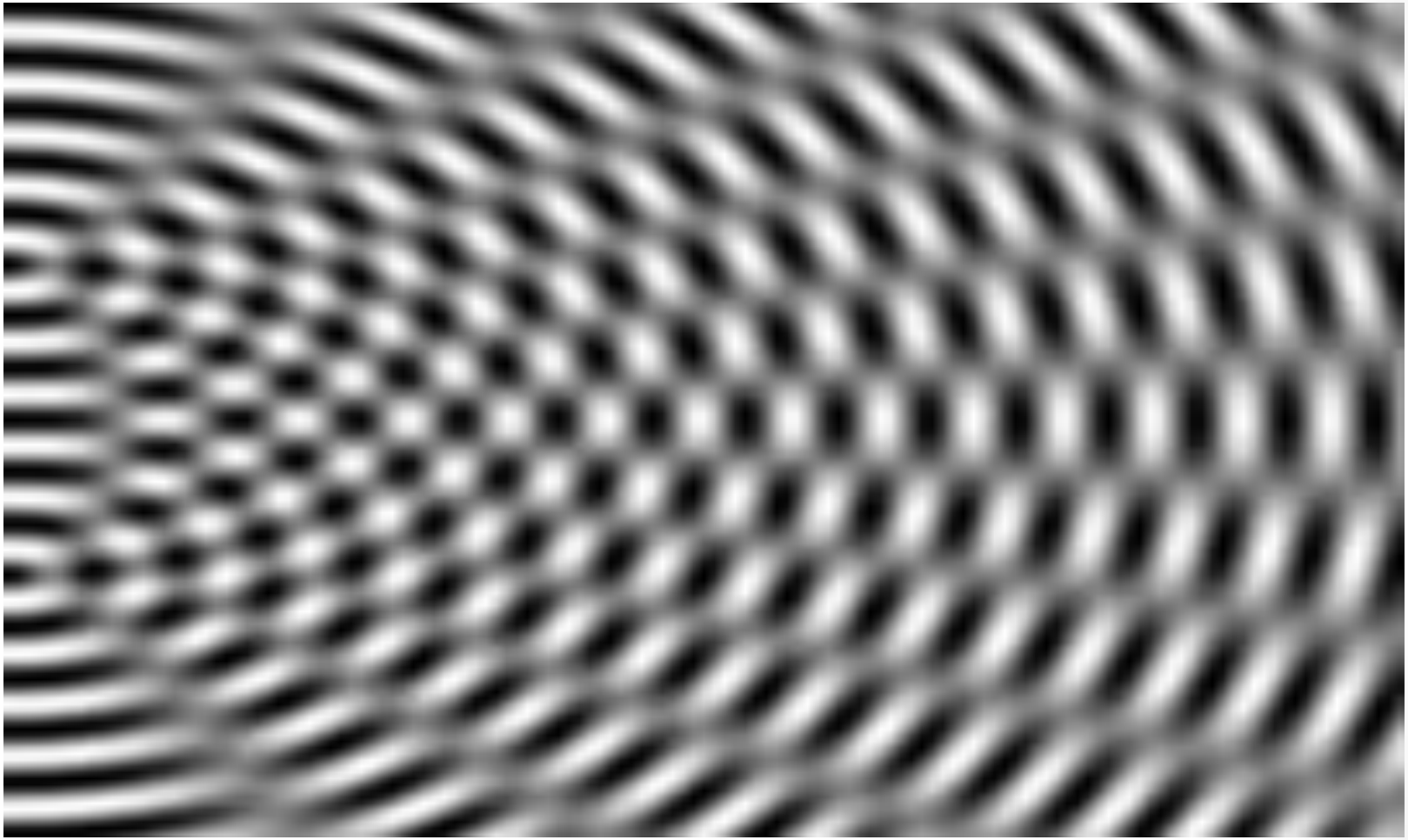
The Photoelectric Effect

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

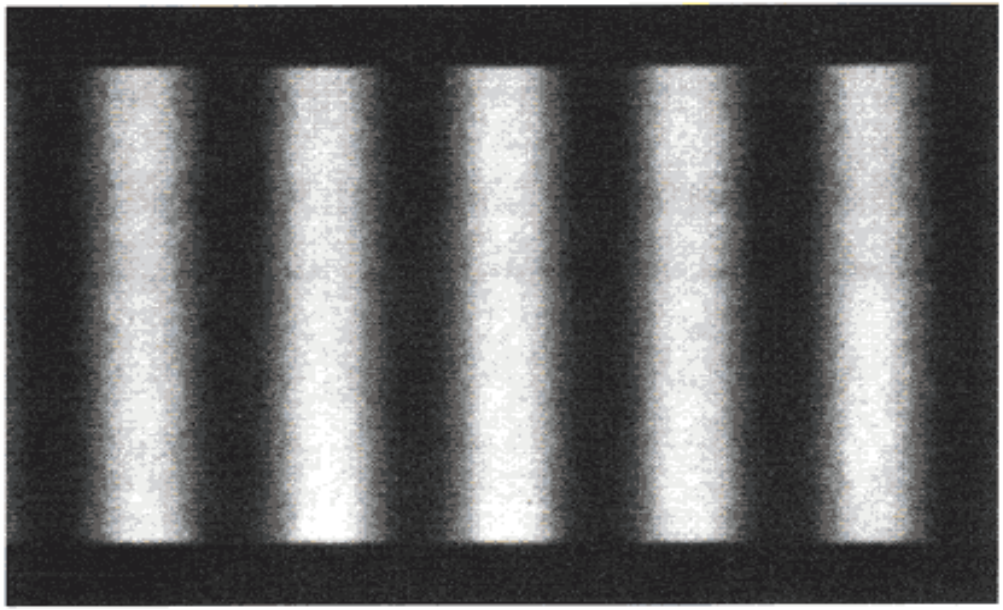
Thomas Young's Double Slit Interference Experiment

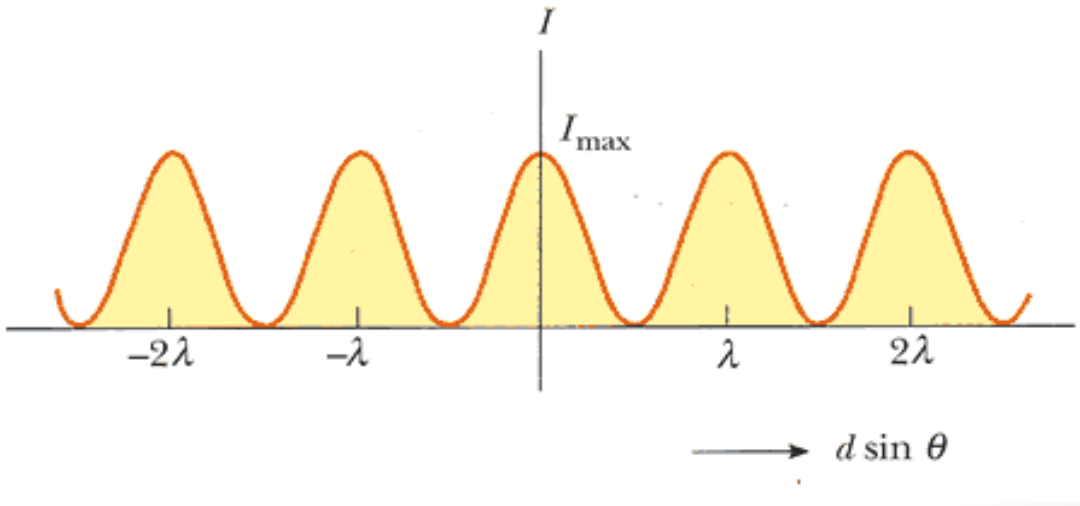
- Showed an interference pattern
- Measured the wavelength of the light

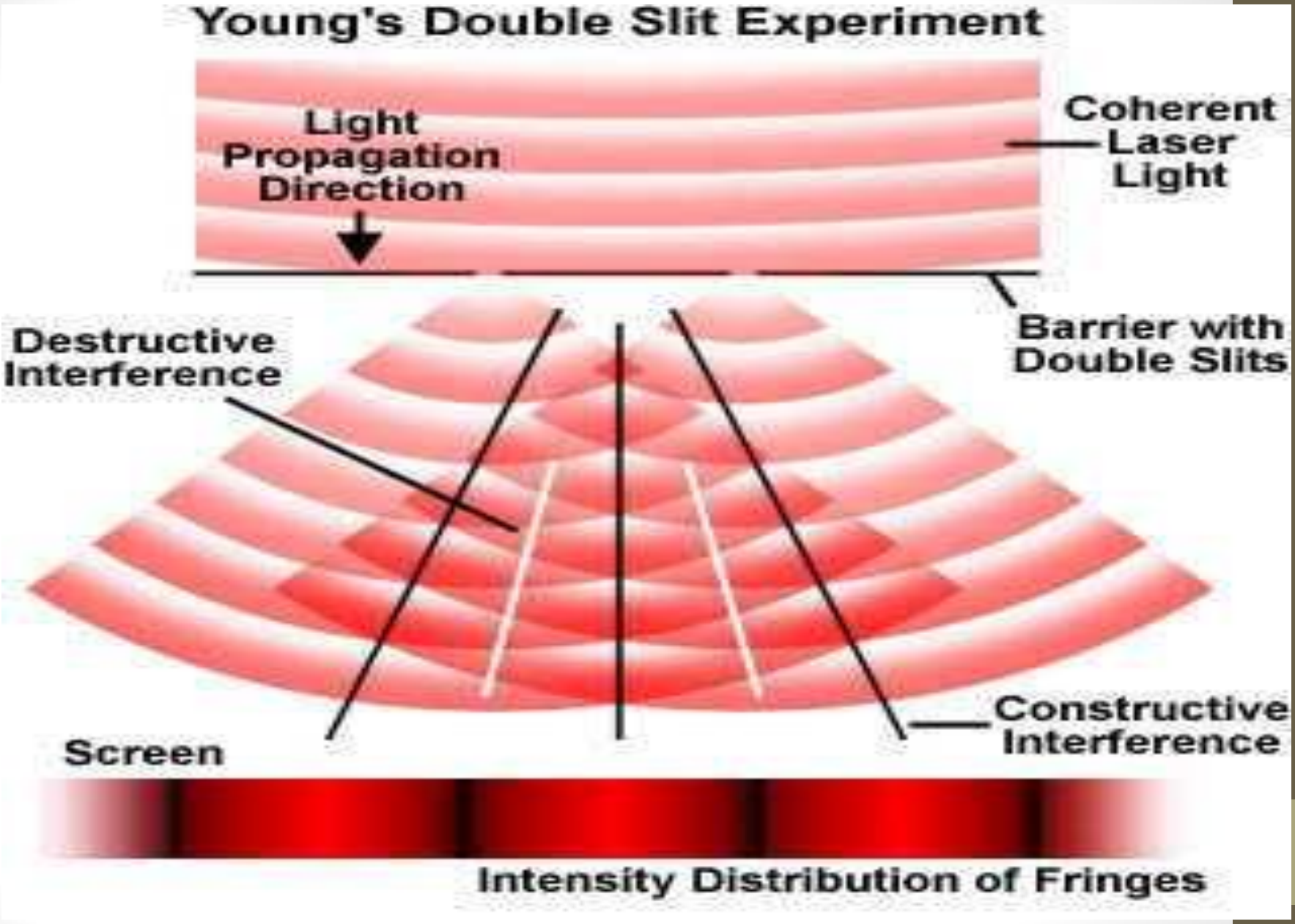
Two Waves Interfering



Young's Double Slit Interference Pattern






Young's Double Slit Experiment
Light Propagation Direction
Coherent Laser Light
Barrier with Double Slits
Destructive Interference
Constructive Interference
Screen
Intensity Distribution of Fringes

Interference

- Young's Double Slit Interference

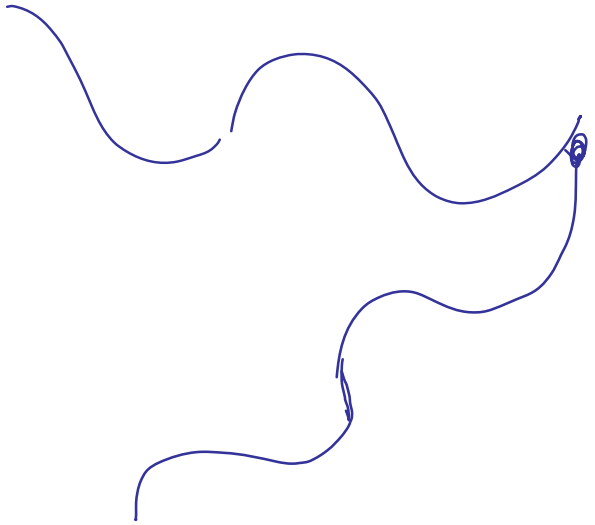
For Constructive Interference:

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

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

$\Delta L = n\lambda$

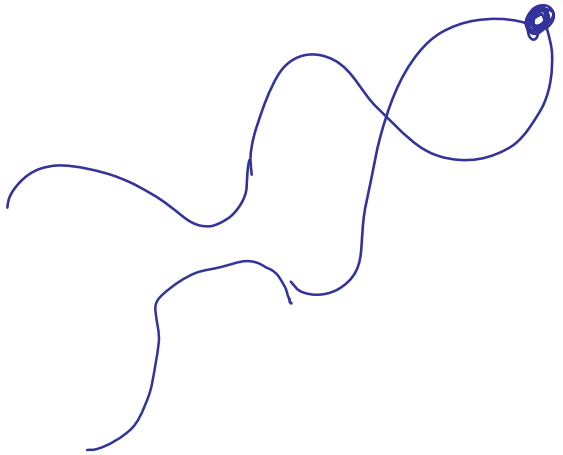
$n = 0, 1, 2, 3, \ldots\ldots$



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

$x = L\tan\theta$

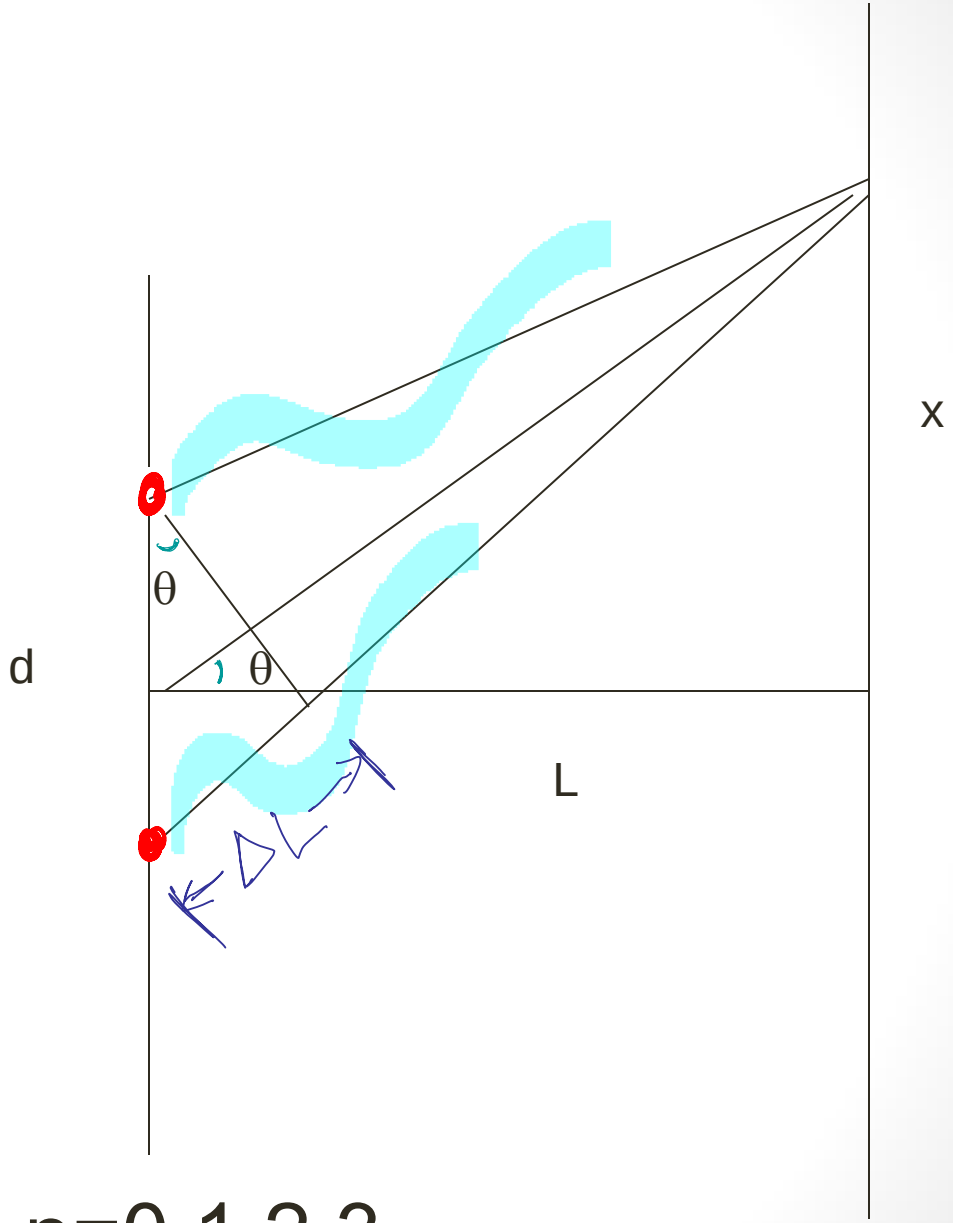
$\sin\theta = \Delta L/d$

$\Delta L = n\lambda$

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.