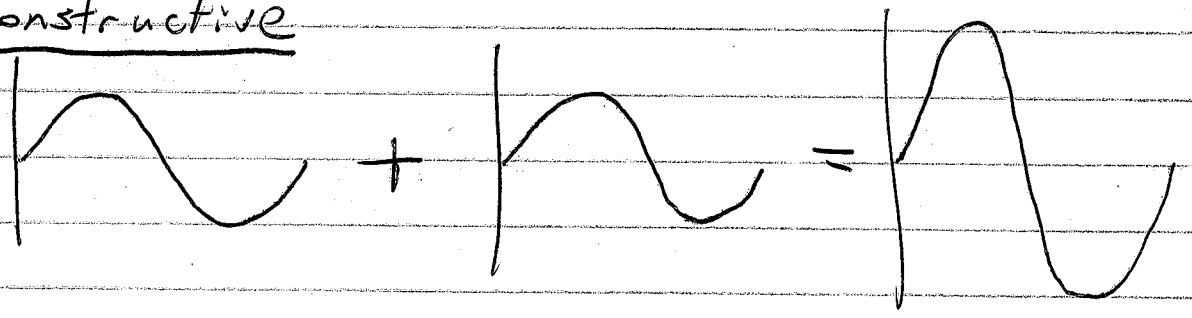
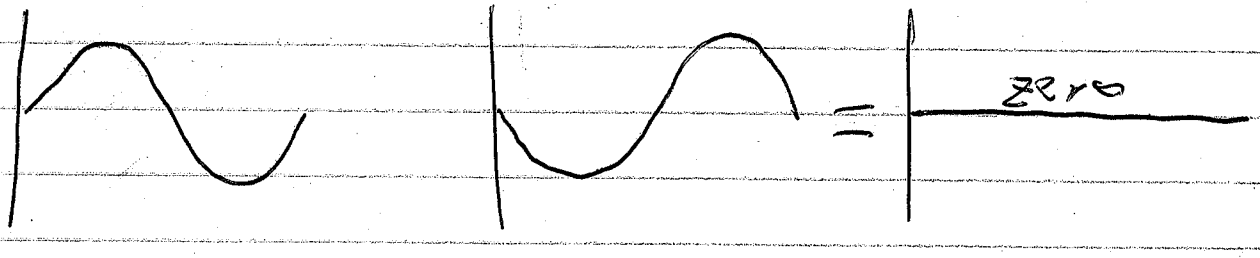
 Phys 1402 2015-11-24 Lec 26

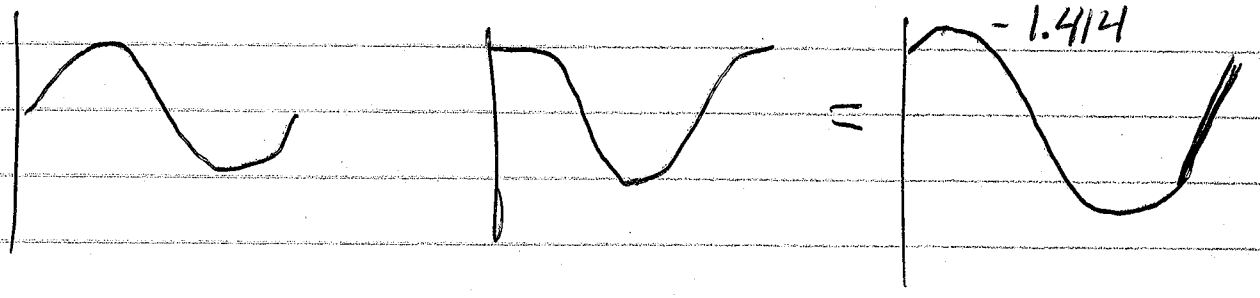
Interference - Adding sine waves doesn't usually add amplitudes.

Constructive

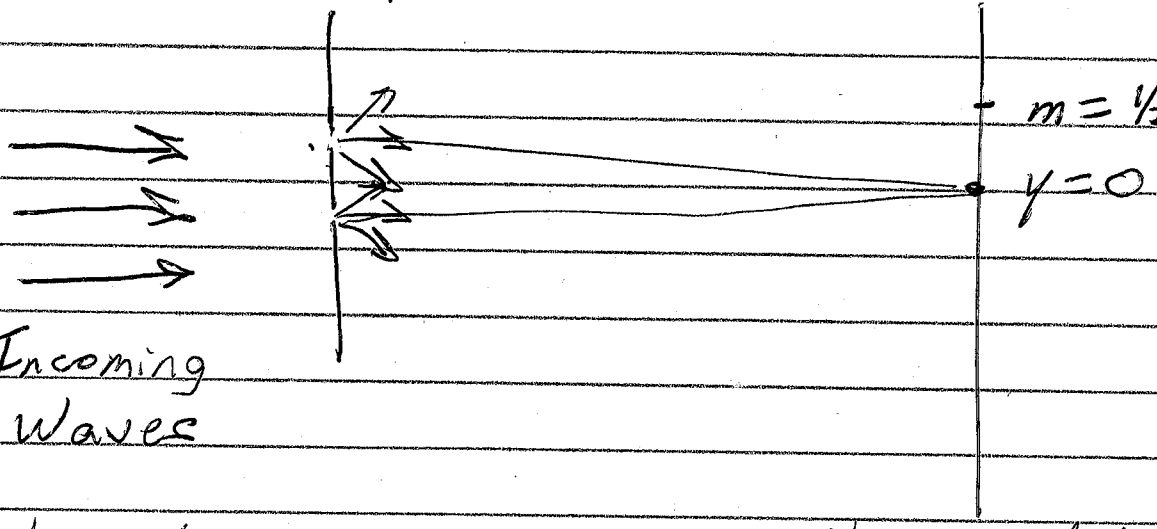


Destructive



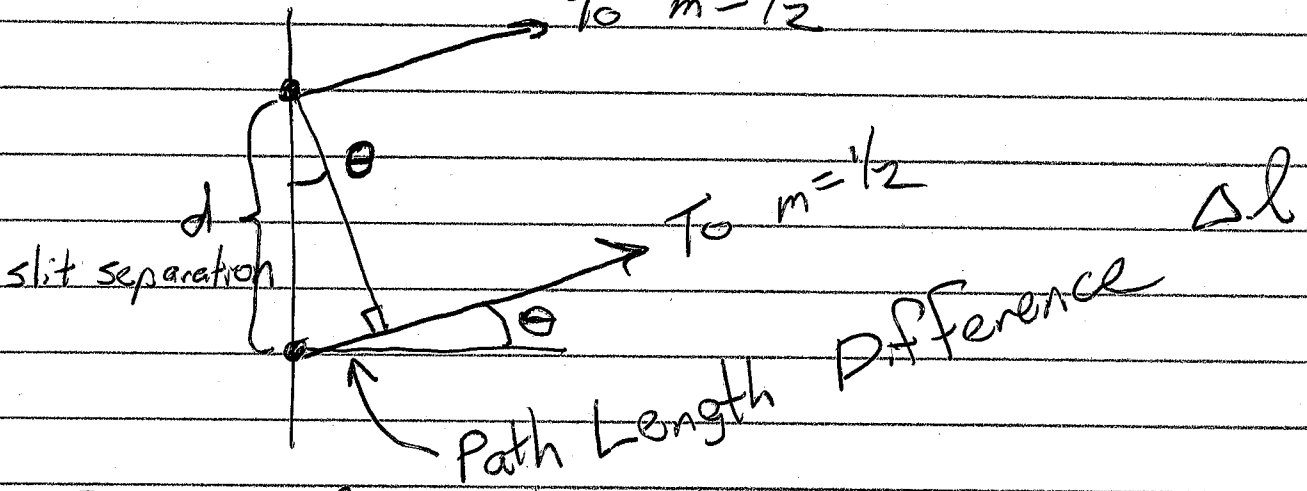


Two-Slit Experiment



When two waves arrive, they add as sinewaves.
At $y=0$, they are synchronized so the amplitudes add.

At $m = 1/2$, the lower wave travels further.



If $\Delta l = m\lambda$, with m = integer, there is constructive interference

$\Delta l = d \sin\theta$

$m\lambda = d \sin\theta$

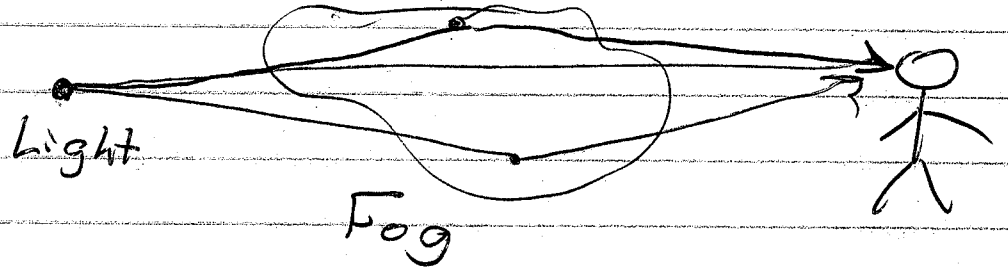
Why does diffraction happen at all?

Huygens Principle - the wave is coupled oscillations.

Ex: Sound Wave - every point in the room has varying pressure. Every point emits the sound in every direction. Every point is a source of waves. This is how waves propagate.

What prevents the wave from randomly changing direction? This can happen - scattering.

Changes in index of refraction cause scattering, reflection, refraction.



Having a uniform index of refraction avoids scattering.

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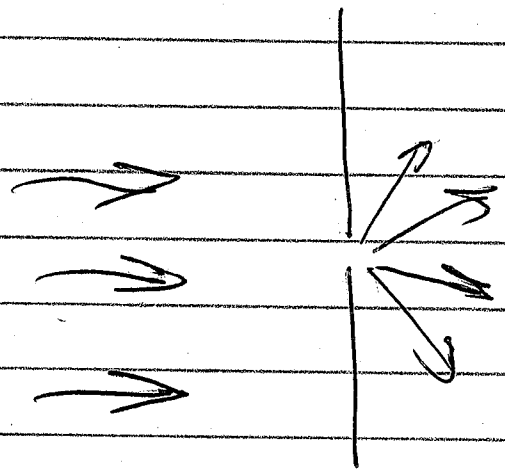
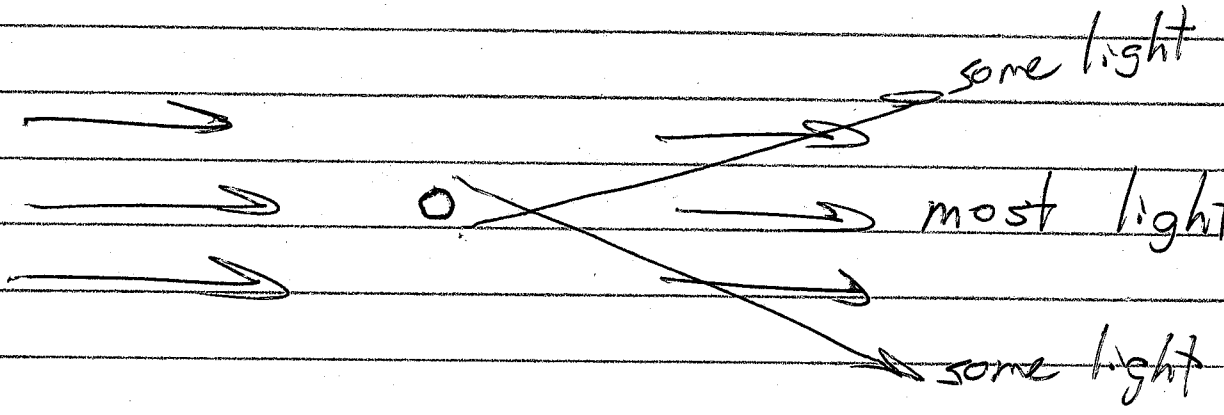
In diffraction, we are blocking some of the destructive interference

Single-slit Diffraction



Diffraction around a hair



Here: $m\lambda = a \sin\theta$

a ← diameter of slit or hair

m = integer is dark spots

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Circular Diffraction - Airy rings

Light thru pupil diffracts in all directions.

Angular resolution $\theta = 1.22 \frac{\lambda}{D}$

Ex: $\lambda = 500$ nm

$D = 3$ mm

$$\theta = 1.22 \frac{500 \times 10^{-9} \text{ m}}{3 \times 10^{-3} \text{ m}}$$

$$= 0.0002 \text{ radians}$$

At 40 cm, $\tan\theta = \frac{y}{L}$

Can use $\tan\theta \approx \theta$

$$y = L \tan\theta = (40 \text{ cm})(0.0002)$$

$$= 8 \times 10^{-5} \text{ m}$$

$$= 0.08 \text{ mm}$$

Smallest thing we can see.