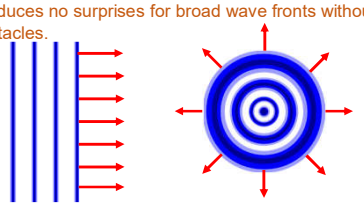
Diffraction

Light can "bend" around edges.

Each point of a "wave front" behaves as an independent source of light.

- Produces no surprises for broad wave fronts without obstacles.



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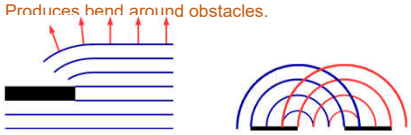
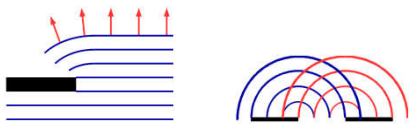
- Produces no surprises for broad wave fronts without obstacles.
- Produces bend around obstacles.



Diffraction

Light can "bend" around edges.

Significant when object dimensions are comparable to wavelength.

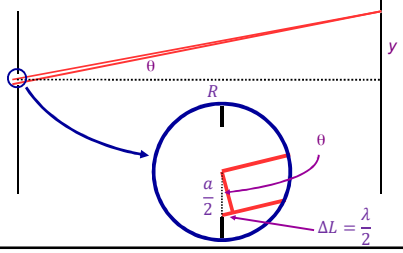


Single Edge

Narrow Gap

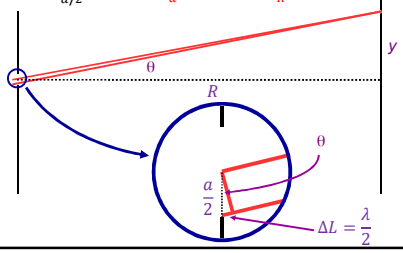
Single Slit Diffraction

Light passing through a narrow gap. Consider ray from bottom of gap and ray from just above middle of gap.



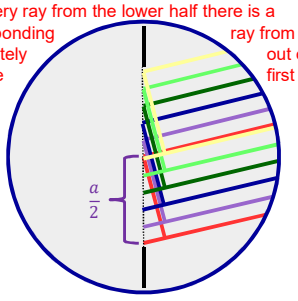
Single Slit Diffraction
Destructive Interference

$\frac{\Delta L}{a/2} = \sin\theta$ $\frac{\lambda/2}{a/2} = \sin\theta$ $\frac{\lambda}{a} = \sin\theta$ $\frac{y}{R} = \tan\theta$



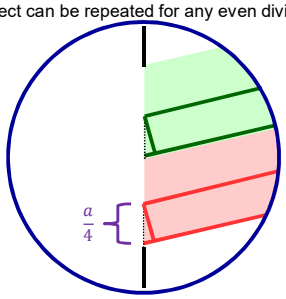
Single Slit Diffraction

For every ray from the lower half there is a ray from the upper corresponding out of phase completely first ray at the with the screen.



Single Slit Diffraction

The effect can be repeated for any even division of the gap.



$$\frac{\lambda/2}{a/2m} = \sin\theta$$

Destructive Interference:

$$\frac{m\lambda}{a} = \sin\theta$$

$$\frac{y}{R} = \tan\theta$$

Single Slit Diffraction

Phase difference as a function of angle:

$$\beta = \frac{2\pi}{\lambda} a \sin\theta$$

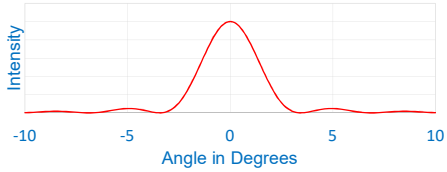
Intensity as a function of phase difference:

$$I = I_0 \left[\frac{\sin(\beta/2)}{\beta/2}\right]^2$$

Single Slit Diffraction

Phase difference as a function of angle: $\beta = \frac{2\pi}{\lambda} a \sin\theta$

Single Slit Intensity vs. Angle



Intensity as a function of phase difference: $I = I_0 \left[\frac{\sin(\beta/2)}{\beta/2}\right]^2$

Example: 633 nm laser light is passed through a narrow slit and a diffraction pattern is observed on a screen 6.0 m away. The distance on the screen between the centers of the first minima outside the central bright fringe is 32 mm. What is the slit width?

Single Slit Diffraction
In Each of the Double Slits?

If the slit width is comparable to wavelength instead of much smaller then one must also consider single slit diffraction in the double slit experiment.