PHY 203- PHYSICS III

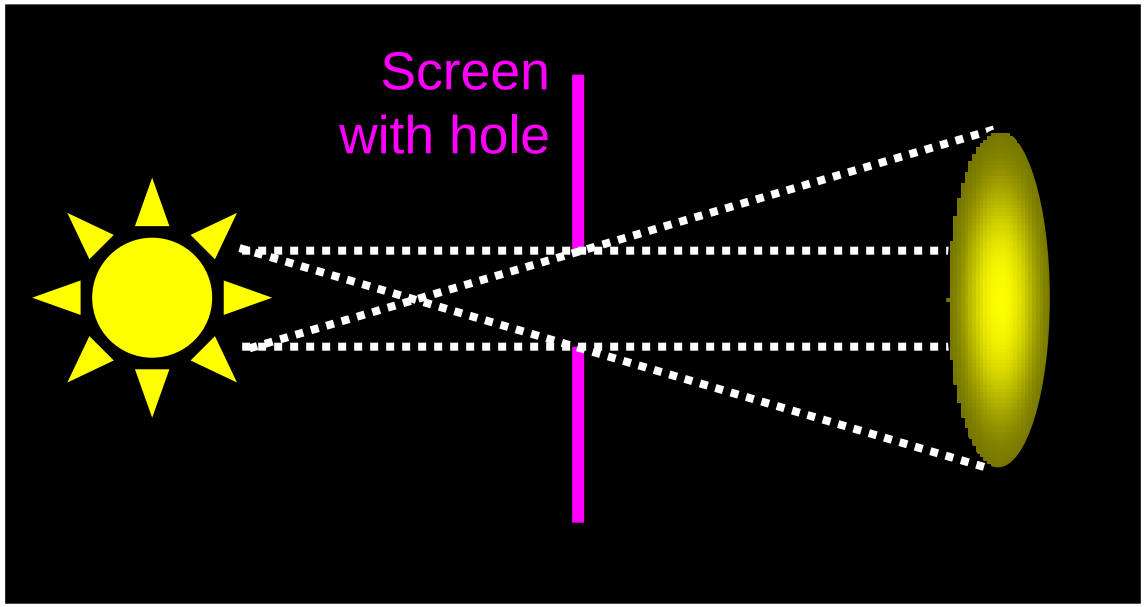
Difraction

Introduction to Diffraction Patterns

- We discussed the fact that light of wavelength comparable to or larger than the width of a slit spreads out in all forward directions upon passing through the slit.
- We call this phenomenon *diffraction*.
- A diffraction pattern consisting of light and dark areas is observed, somewhat similar to the iinterference patterns discussed earlier.

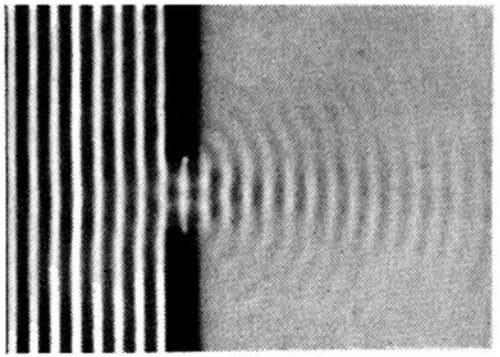
Why it's hard to see diffraction

- Diffraction tends to cause ripples at edges. But poor source temporal or spatial coherence masks them.
- Example: a large spatially incoherent source (like the sun) casts blurry shadows, masking the diffraction ripples.

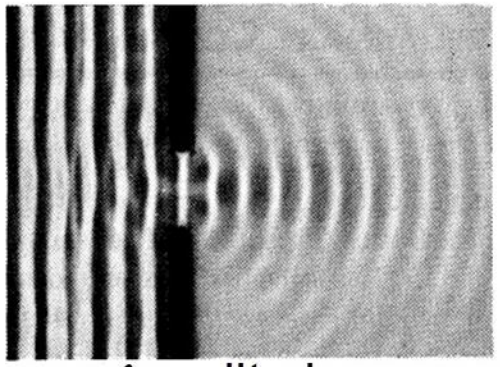


Diffraction of a wave by a slit

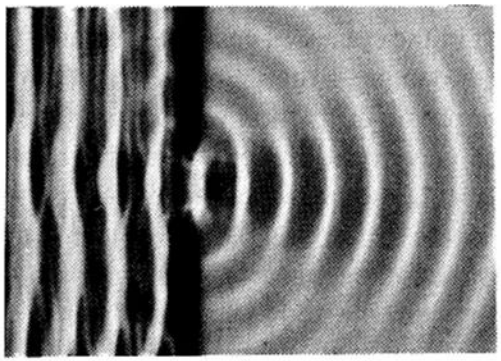
Whether waves in water or electromagnetic radiation in air, passage through a slit yields a diffraction pattern that will appear more dramatic as the size of the slit approaches the wavelength of the wave.



λ □ slit size



$\lambda <$ slit size



$\lambda \approx$ slit size

Diffraction and Huygens principle

- Diffraction pattern can be analyzed by Hugens principle. According to this principle, every point on a wave front act as a new source producing new waves. Diffraction pattern is formed by the interference of this new waves.
- If the source is close to the screen this is called near field or a ***Fresnel diffraction***. If the source is far from the screen this is called far field or ***Fraunhofer diffraction***.

Diffraction pattern of a narrow slit

Fraunhofer diffraction of a single slit

- Consider waves coming from different part of the slit.
- Every point on the slit act as a new wave source (Huygens principle).
- New waves coming from different part of the slit interfere with each other.
- Therefore intensity on the screen depends on θ.

Mathematichal expression of the diffraction pattern can be drived by considering the path differences of the rays from different part of the slit.

Diffraction Grating

- The diffracting grating consists of a large number of equally spaced parallel slits.
- A grating is characterized by the number of lines per millimeter.
- “Line” means here “slit” or “grove”. A typical grating contains several thousand lines per centimeter.
- This is also called grove density.