

PHY 203- PHYSICS III

Diffraction

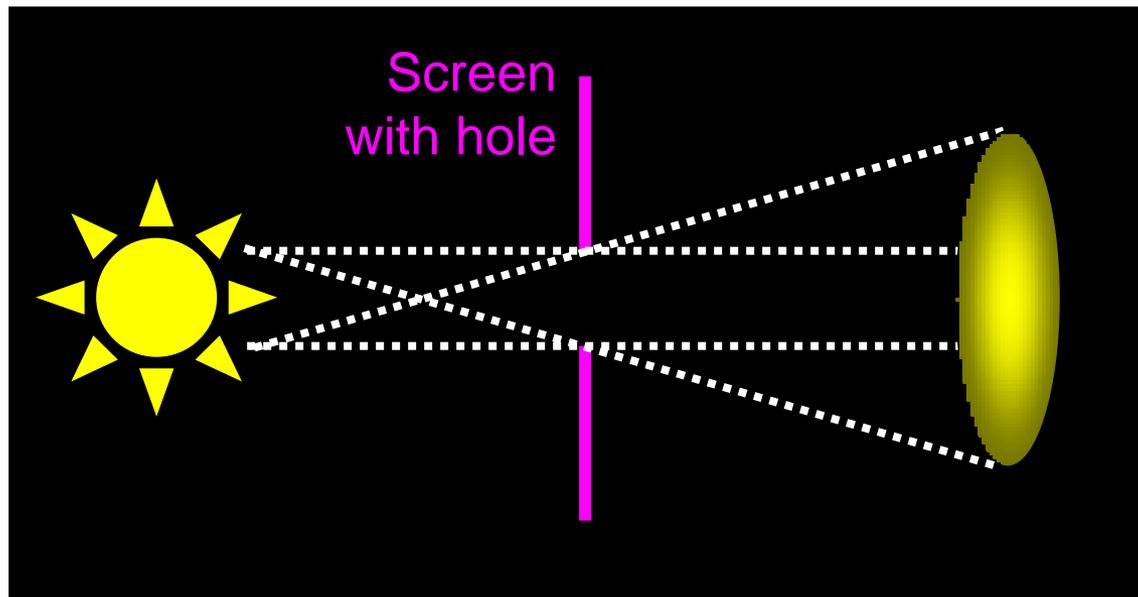


Introduction to Diffraction Patterns

- 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 interference patterns discussed earlier.

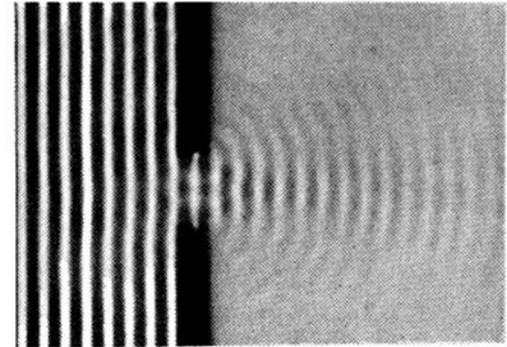
Why it's hard to see diffraction

- ▶ 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.

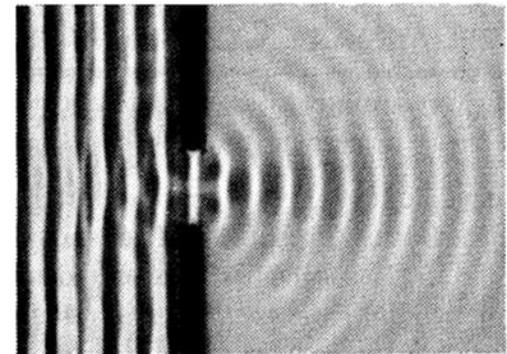


Diffraction of a wave by a slit

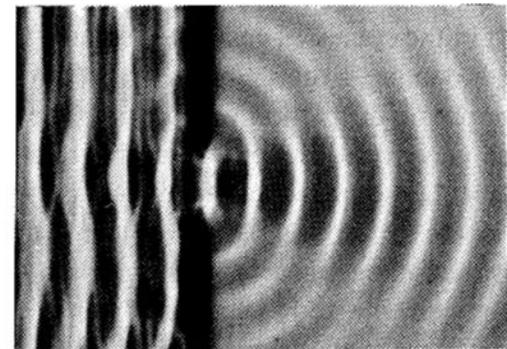
Whether waves in water or electromagnetic radiation in air, passage through a slit yields a diffraction pattern that will appear more dramatic as the size of the slit approaches the wavelength of the wave.



$\lambda >$ slit size



$\lambda <$ slit size



$\lambda \approx$ slit size

Diffraction and Huygens principle

- Diffraction pattern can be analyzed by Huygens 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 .

Mathematical expression of the diffraction pattern can be derived 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.
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