Al-Mustaqbal University

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Medical and optical physics 1

First stage

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Diffraction

This phenomenon occurs when light passes through a narrow slit or near the edge of an object, causing the light to bend and spread instead of traveling only in a straight line.

1. Definition of Diffraction

Diffraction is the bending and spreading of light waves when they pass through a narrow opening or around an obstacle, when the dimensions of the opening or obstacle are comparable to the wavelength of light.

2.When Does Diffraction Occur?

Diffraction becomes clearly noticeable when:

- The slit width is very small.
- The slit width is comparable to the wavelength of light.
- Light passes near the edges of objects.

The narrower the slit, the more pronounced and greater the diffraction effect.

3. Types of Diffraction

1. Single Slit Diffraction

This occurs when light passes through a single narrow slit, producing a pattern consisting of a bright central fringe and weaker side fringes.

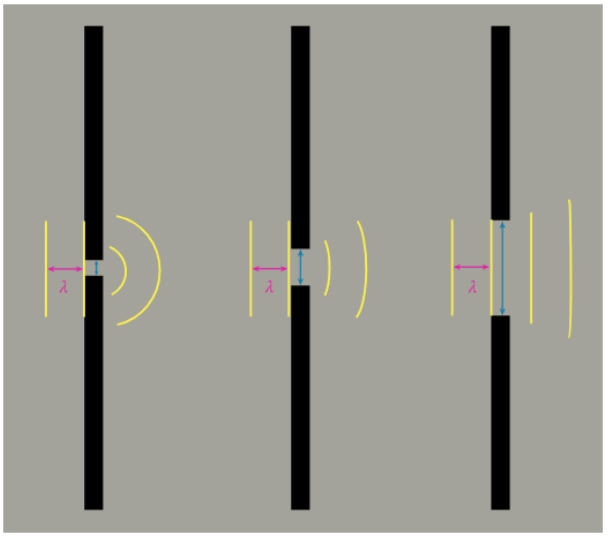
2. Double Slit or Multiple Slit Diffraction

This type combines both diffraction and interference effects and is observed in diffraction gratings.

4. Single Slit Diffraction

When monochromatic light falls on a narrow slit:

- A bright central fringe appears, which is wider than the other fringes.
- The intensity of light decreases as the distance from the center increases.
- Dark and bright regions are formed on the screen.



5.Mathematical Relation

The condition for the appearance of dark fringes in single slit diffraction is:

$m\lambda = a \sin\theta$

Where:

- a: slit width
- θ: diffraction angle
- λ: wavelength of light
- m: an integer (1, 2, 3, …)

EX/

Monochromatic light of wavelength λ=600 nm is incident on a single slit of width a=0.3 mm Calculate the diffraction angle of the first dark fringe?

Solution:

We use the single-slit diffraction condition for dark fringes:

$m\lambda = a \sin\theta$

For the first dark fringe:

m=1m

Unit Conversion:

$a=0.3 \text{ mm}=3\times10^{-4} \text{ m}$

$\lambda=600 \text{ nm}=6\times10^{-7} \text{ m}$

$m\lambda = a \sin\theta$

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

$\sin\theta=\frac{6\times10-7 \text{ m}}{3\times10-4 \text{ m}}$

$\sin\theta=2\times10^{-3}$

Angle $\theta\approx0.002$ rad

7. Difference Between Diffraction and Interference

Comparison	Diffraction	Interference
Number of slits	One slit or an obstacle	Two or more slits
Cause	Bending of waves	Superposition of waves
Pattern	Broad central fringe	Nearly equal fringes

8. Importance of Diffraction

- Determining the resolution of optical instruments
- Light analysis
- Lens design

9. Applications

- Microscopes
- Telescopes
- Lasers
- Diffraction gratings