Al-Mustaqbal University

Department of Optics Techniques

Medical and optical physics 1

First stage

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Light Interference

1. Introduction

Light interference is one of the fundamental phenomena in physical optics and provides clear evidence of the wave nature of light.
This phenomenon appears when two or more light waves overlap at a point in space, resulting in an increase or decrease in light intensity.

2. Definition of Light Interference

Light interference is a phenomenon resulting from the superposition of two coherent light waves, leading to a non-uniform distribution of light intensity on a screen, represented by bright and dark fringes.

3. Conditions for Interference

For light interference to occur clearly, the following conditions must be satisfied:

1-The two sources must be **coherent**, meaning they have:

- The same frequency
- A constant phase difference with time

2-The light must be **monochromatic** (single wavelength).

3-The two waves must have the **same polarization**.

4-The amplitudes of the two waves should be nearly equal.

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4. Types of Interference

First: Constructive Interference

Constructive interference occurs when two waves arrive at a point **in phase**, producing maximum intensity (a bright fringe).

Mathematical condition:

$\Delta = m\lambda \quad m = 0,1,2,3,\ldots$

- The path difference equals an integer multiple of the wavelength
- The waves arrive in phase

Second: Destructive Interference

Destructive interference occurs when two waves arrive **out of phase**, producing minimum intensity (a dark fringe).

Mathematical condition:

$\Delta = (m + \frac{1}{2})\lambda$

- The path difference equals an integer plus half a wavelength
- The waves arrive out of phase

5. Path Difference

Definition: The path difference is the difference between the distances traveled by two light waves from their sources to a specific point on the screen.

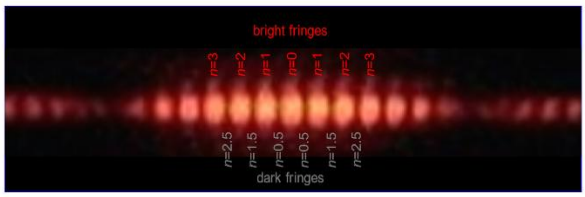
Symbol: Δ

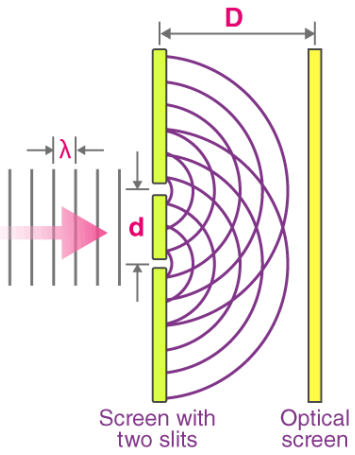
6. Young's Double-Slit Experiment

Young's double-slit experiment is one of the most famous experiments demonstrating the wave nature of light.

Principle of the experiment:

- Light passes through a narrow single slit to become coherent.
- It then falls on two closely spaced slits.
- Bright and dark fringes are formed on the screen due to interference.





7. Importance of Light Interference

1- Measurement of wavelengths.

2-Study of the wave properties of light.

3-Applications in optical devices .

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EX(1)

What type of interference occurs when the path difference between two light waves is equal to 2λ?

Solution:

Given: $\Delta=2\lambda$

$\Delta=m\lambda$

m=2(integer)

Comparing with:

$\Delta=m\lambda \Rightarrow \Delta=2\lambda$

Result:

The condition for constructive interference is satisfied

. Constructive interference

. Bright fringe

EX (2)

If the path difference between two light waves is $\frac{\lambda}{2}$, is the fringe bright or dark?

Solution:

Given: $\frac{\lambda}{2}$

$\Delta= (m+\frac{1}{2}) \lambda$

• m=0

• There is only half a wavelength

$\Delta = (0+\frac{1}{2})\,\lambda$

Result:

The condition for destructive interference is satisfied

$\Delta = (m+\frac{1}{2})\lambda$

. Destructive interference

. Dark fringe