Chapter 28
Physical Optics: Interference and Diffraction

Chapter Introduction

Being a wave, light can exhibit effects due to interference and diffraction. The study of the interference and diffraction of light is referred to as wave optics or physical optics, to distinguish it from geometrical optics, which deals with the straight-line motion of light and its reflection and refraction. In this chapter, we will study the wave nature of light.

Basic Terms

Linear superposition of light waves

According to the principle of linear superposition, two or more light waves can interfere constructively or destructively when they exist at the same place at the same time, provided they originate from coherent sources.

Coherent source

Two sources are coherent if they emit waves that have a constant phase relationship.

Young's double-slit experiment

In Young's double-slit experiment, light passes through a pair of closely spaced narrow slits and produces a pattern of alternating bright and dark fringes on a view screen. The fringes arise because of constructive and destructive interference. The angle \( \theta \) for \( m \)th higher-order bright fringe is given by \( \sin(\theta) = m\lambda/d \), where \( d \) is the spacing between the narrow slits, \( \lambda \)
is the wavelength of the light, and \( m = 0, 1, 2, 3, \ldots \). Similarly, the angle for the dark fringes is given by \( \sin(\theta) = (m + 1/2) \lambda/d \).

**Diffraction**

Diffraction is a bending of waves around obstacles or the edges of an opening. Diffraction is an interference effect that can be explained with the aid of Huygens' principle.

**Huygens' principle**

This principle states that every point on a wave front acts as a source of tiny wavelets that move forward with the same speed as the wave; the wave front at a later instant is the surface that is tangent to the wavelets.