UNIT - II: Quantum Mechanics

Author : Physics Department **Date :** 2025

Matter Waves and de Broglie Wavelength

Louis de Broglie proposed that particles exhibit wave-like behavior. The de Broglie wavelength is given by:

$$\lambda = \frac{h}{p}$$

where h is Planck's constant, and p is momentum.

Heisenberg's Uncertainty Principle

The principle states that it is impossible to precisely measure both the position and momentum of a particle:

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

Physical Significance of Wave Functions

The wave function $\psi(x,t)$ represents the probability amplitude of a particle. The probability density is given by:

$$|\psi(x,t)|^2$$

Schrödinger Wave Equation

The fundamental equation of quantum mechanics:

- Time-dependent form:

$$i \hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi + V\psi$$

- Time-independent form:

$$-\frac{\hbar^2}{2m} \nabla^2 \psi + V\psi = E\psi$$

Application to Particle in a One-Dimensional Box

A particle confined in a box with length L has energy levels given by:

$$E_n = \frac{n^2 h^2}{8mL^2}, \quad n = 1,2,3,...$$

Tunnel Diode

Quantum tunneling allows particles to pass through potential barriers. Tunnel diodes utilize this effect for high-speed switching.