



ENGINEERING PHYSICS

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ENGINEERING PHYSICS

Unit I : Review of concepts leading to Quantum Mechanics



Week #2 Class #6

- Double slit experiment
- De Broglie hypothesis
- Dual nature of matter
- Concept of matter waves

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Unit I : Review of concepts leading to Quantum Mechanics



➤ *Suggested Reading*

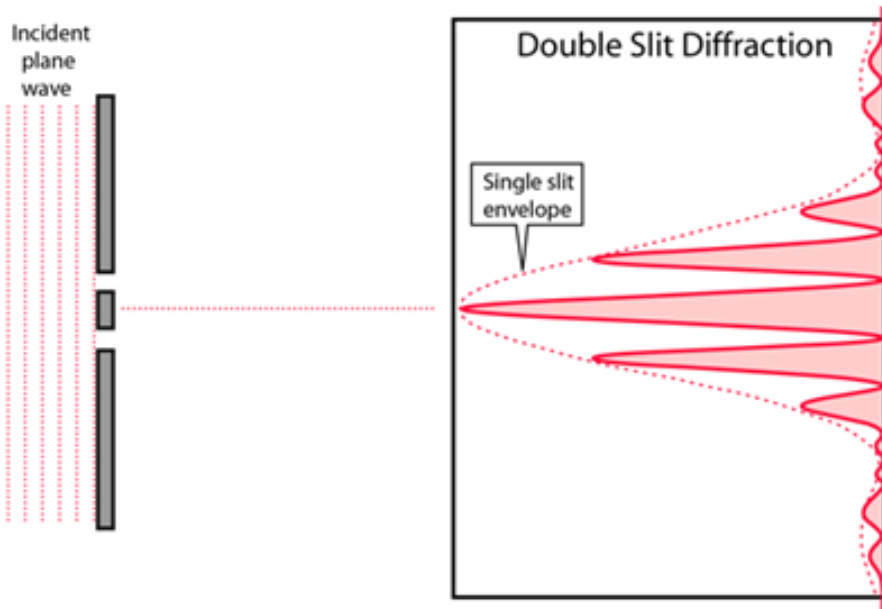
1. *Concepts of Modern Physics, Arthur Beiser, Chapter 2*
2. *Learning Material prepared by the Department of Physics*

➤ *Reference Videos*

1. *Video lectures : MIT 8.04 Quantum Physics I*

Young's double slit experiment

- *Young's classic double slit experiment on interference and diffraction of radiations*
- *Characteristic wave experiment*

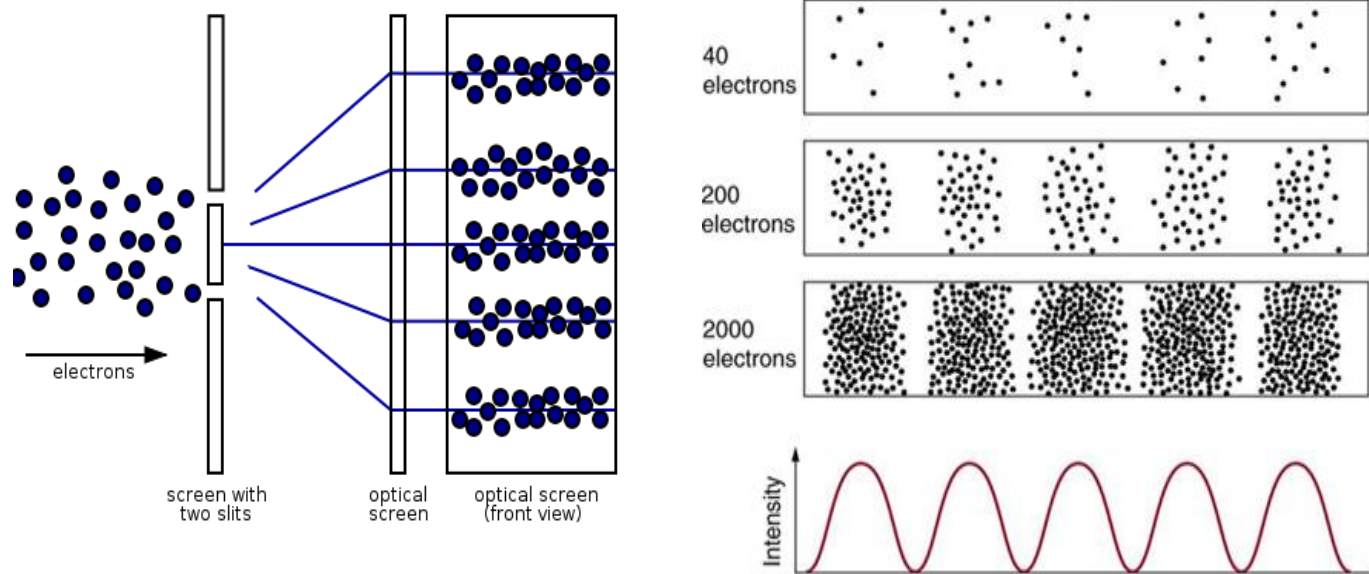


- *Louis de Broglie hypothesis*
 - *Moving matter should exhibit wave characteristics*
 - *Wavelength of the associated waves $\lambda = \frac{h}{p}$ where p is the momentum of the particle*
- *Wavelengths of macro particles are extremely small to be measured*
- *Wavelengths of moving sub atomic particles can be in the measurable range ($\sim 10^{-10}m$)*

- *Davisson and Germer's experiment with electron scattering by Ni crystals*
- *de Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2meV}}$*
- *Electron diffraction confirmed at particular settings*
- *Satisfy Bragg's law $\lambda = 2d \sin \theta$*
- *Dual nature of matter!*

Double slit experiment with electrons

- *Feynman's intuition of double slit experiment with electrons*
- *Diffraction is characteristic wave experiment*
- *Single photon diffraction also confirm particle diffraction*

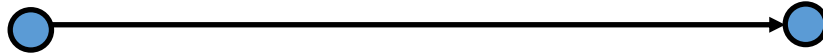


Concept of Matter waves

- *Position and momentum are the two generalized parameters needed to describe the state of any system*
- *Position and momentum are conjugate parameters*

(x_1, t_1)

(x_2, t_2)



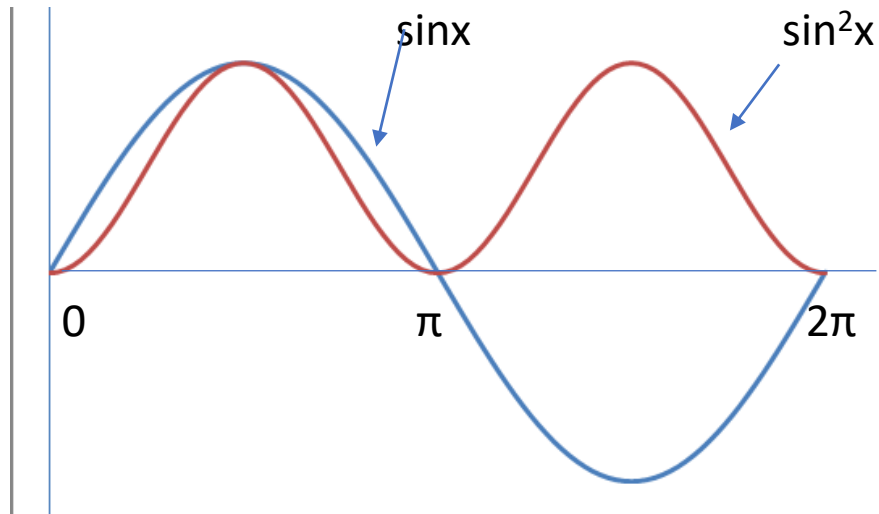
$$v = \frac{dx}{dt}$$

- *Wave phenomena need a mathematical concept to describe the state of the system*
- *Any representative wave should be able to give information about the position and momentum of the system*

Concept of Matter waves

- *Simple sine or cosine waves fall short*

- *Momentum can be inferred from wavelengths $p = \frac{h}{\lambda}$*
- *Position is not well defined*



Important - the sine wave is not the path of the particle

Need for a new wave format for matter waves !

The following concepts are not true of matter waves

- 1. de Broglie wavelength of moving particles cannot be measured**
- 2. Double slit experiments cannot be performed with particles**
- 3. Single photon experiments can be performed**
- 4. Sine or cosine waves can describe particle motion accurately**
- 5. The momentum of a particle is independent of the position of the particle**



THANK YOU

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