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ENGINEERING PHYSICS

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ENGINEERING PHYSICS

Unit I : Review of concepts leading to Quantum Mechanics

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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***

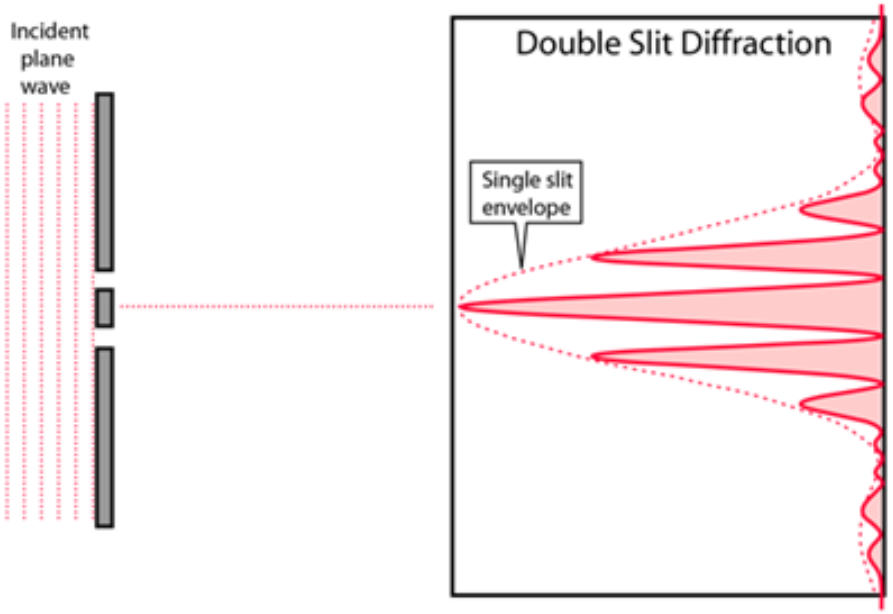


Image courtesy **Hyperphysics, Wikipedia**

de Broglie hypothesis

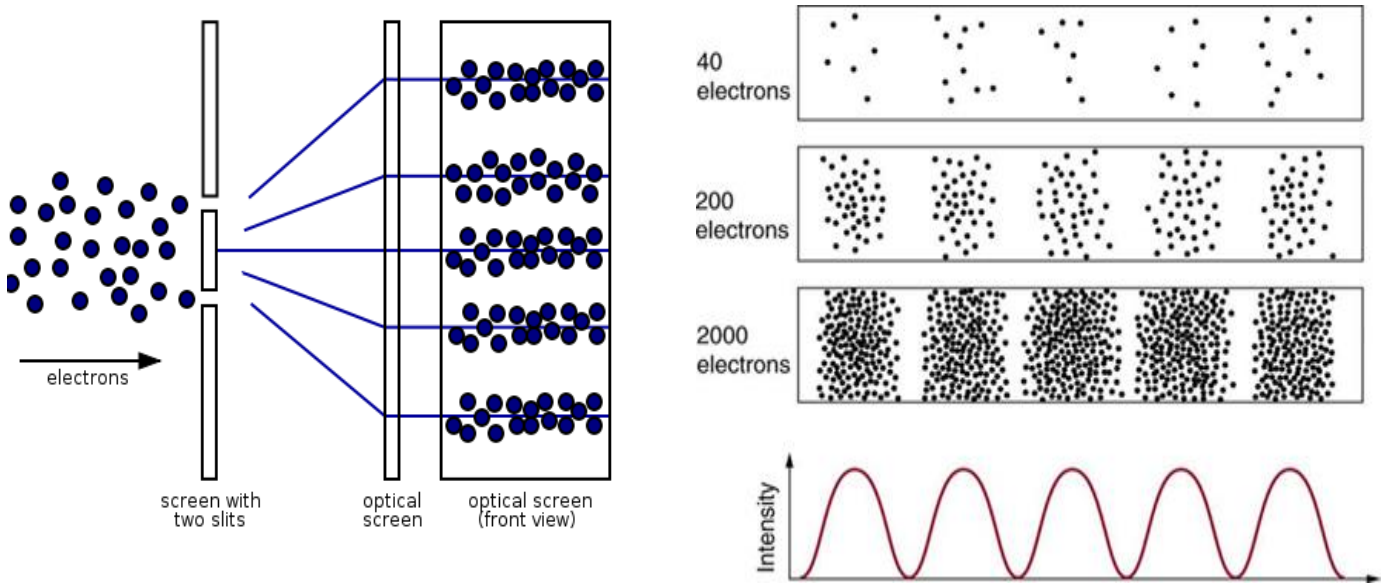
- *Louis de Broglie hypothesis*
  - *Moving matter should exhibit wave characteristics*
  - *Wavelength of the associated waves* $\lambda = \frac{h}{p}$ *where* p *is the momentum of the particle*
- *Wavelengths of macro particles are extremely small to be measured*
- *Wavelengths of moving sub atomic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

Dual nature of matter

- *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*



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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*

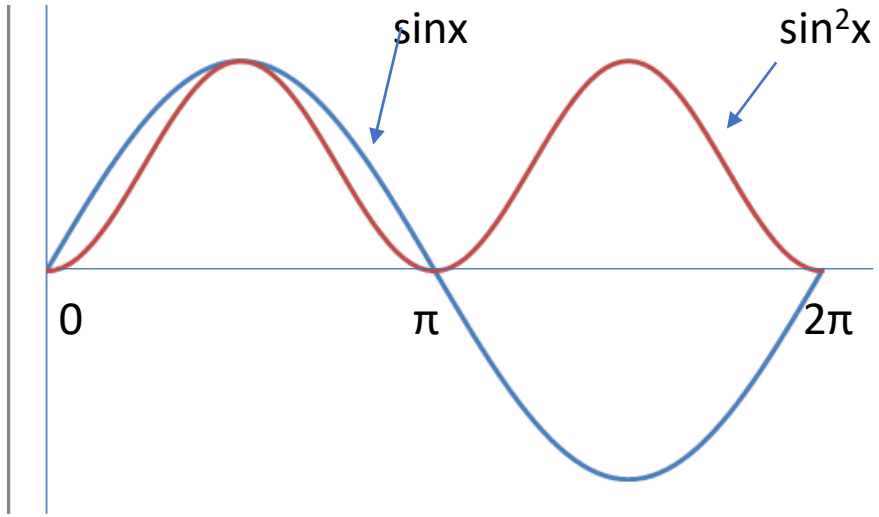
$$v = \frac{dx}{dt}$$

Concept of Matter waves

- *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 !

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Class #6 …….. Quiz….

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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