

Section 4 - Elements of Quantum Mechanics

4.4 Formulation of Schrödinger's Equation

Gerhard Klimeck

gekco@purdue.edu



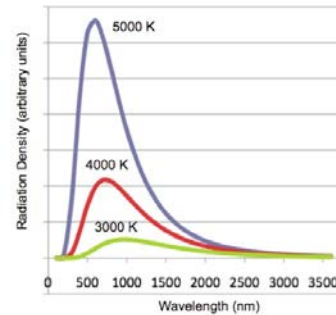
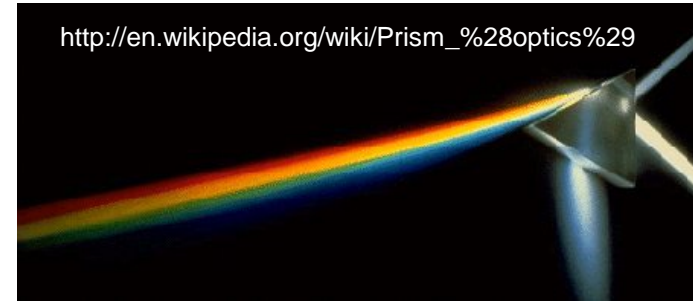
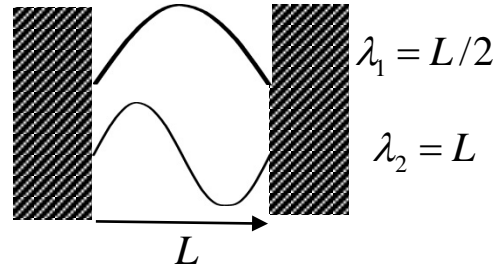
School of Electrical and
Computer Engineering

Section 4

Elements of Quantum Mechanics

4.1 Classical Systems

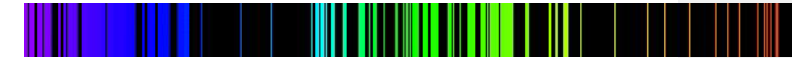
- » Particles
- » Propagating Waves
- » Standing Waves
- » Chromatography



4.2 Strange Experimental Results => The Advent of Quantum Mechanics

- » Black Body Radiation
- » Discrete Optical Spectra
- » Photoelectric Effect
- » Particle-Wave Duality

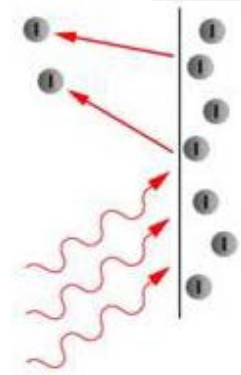
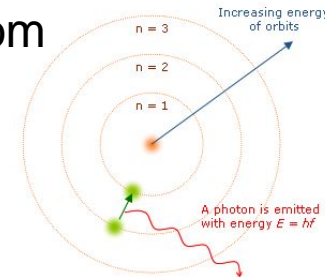
- => light emission is quantized
- => light emission/absorption quantized – Bohr Atom
- => light is described by particles



$$p = hf / c$$

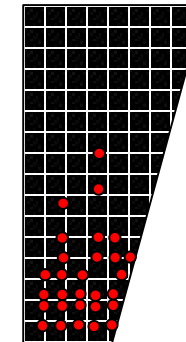
$$= h / \lambda \quad (\text{because } c = \lambda f)$$

$$= \hbar k \quad (\text{because } k = 2\pi / \lambda)$$



4.3 Why do we need quantum mechanics?

4.4 Formulation of Schrödinger's Eq.



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Schrödinger's Equation for electrons

$$E = \sqrt{m_0^2 c^4 + p^2 c^2} \approx m_0 c^2 \left[1 + p^2 c^2 / 2m_0^2 c^4 + \dots \right]$$

$$E - m_0 c^2 = V + (p^2 / 2m_0)$$

$$hf = \hbar\omega = V + (\hbar^2 k^2 / 2m_0)$$

$$\hbar\omega = (\hbar^2 k^2 / 2m_0) + V$$

Schrödinger's Equation (continued)

$$\hbar\omega = (\hbar^2 k^2 / 2m_0) + V$$

Assume, $\Psi(x, t) = A \exp(-i(\omega t - kx))$

$$d\Psi / dt = -i\omega\Psi \quad \text{and} \quad d^2\Psi / dx^2 = -k^2\Psi$$

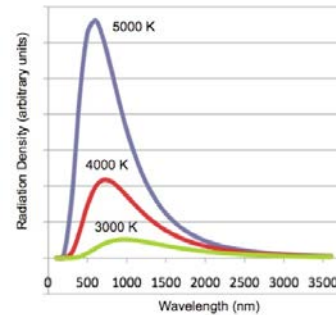
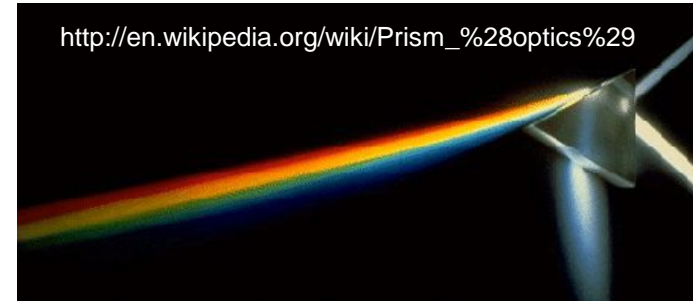
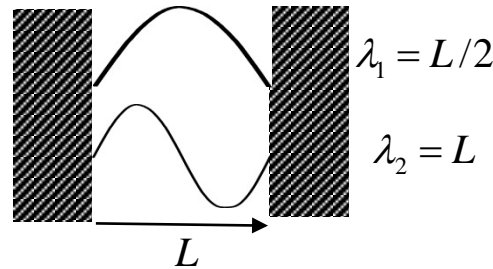
$$i\hbar \frac{d\Psi}{dt} = \left(-\frac{\hbar^2}{2m_0} \frac{d^2\Psi}{dx^2} \right) + V\Psi$$

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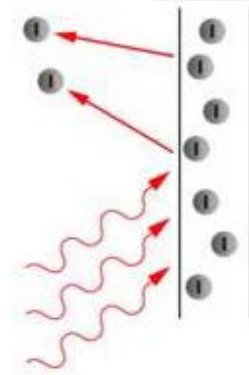
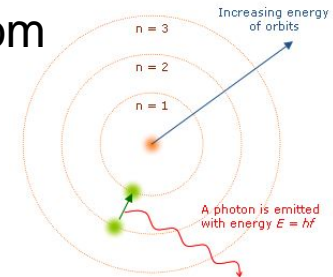
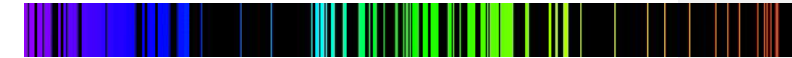
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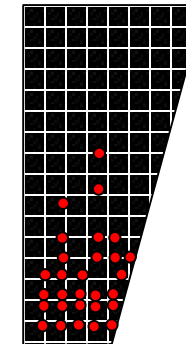


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