Lecture 2:

Motivation (not derivation) of Schrodinger Eq.

Phenomena of spectral lines vs. continuous spectrum (demo)

For hydrogen atom found simple rule:

$$hf = E_i - E_f \quad \text{(emission)}$$

$$E_n \propto -\frac{1}{n^2} \quad \text{(plot it)}$$

Lyman to $n=1$
Balmer to $n=2$
⋮

Bohr model: $L = mvr = n\hbar = \frac{nh}{2\pi}$

$$\Rightarrow \quad \frac{mv^2}{r} = \frac{ke^2}{r^2}, \quad v = \sqrt{\frac{ke^2}{mr}}$$

$$r = \frac{n\hbar}{mv} = \frac{n\hbar}{m}\left(\frac{rm}{ke^2}\right)^{1/2}$$

$$r = \frac{n^2\hbar^2}{mke^2} = n^2 a_0 \quad ; \quad a_0 = \frac{\hbar^2}{mke^2} \approx 0.5\,\text{Å}$$

$$E = \frac{1}{2}mv^2 - \frac{ke^2}{r} = \frac{1}{2}m\frac{ke^2}{mr} = -\frac{ke^2}{2r}$$

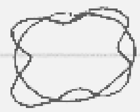
$$= -\frac{ke^2}{2a_0n^2} = -E_0\frac{1}{n^2}, \quad E_0 = \frac{mk^2e^4}{2\hbar^2} = \text{Rydberg}, 13.6\,\text{eV}$$

de Broglie Hypothesis:

$f = E/h \qquad \lambda = h/p$

$mvr = n\hbar = \frac{nh}{2\pi}$ for $n = 1, 2, \ldots$

$\rightarrow 2\pi r = \frac{nh}{mv} = \frac{nh}{p} = n\lambda$



Davisson-Germer - electrons on crystal

Schrödinger Eq.:

E&M: $\frac{\partial^2 E}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} \Rightarrow -k^2 = -\frac{\omega^2}{c^2}$

$\omega = kc$

$E = pc$

electrons (particles) $E = \frac{p^2}{2m} + V$

$\hbar\omega = \frac{\hbar^2 k^2}{2m} + V$

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

$P(x,t)\,d^3x = |\psi|^2 d^3x \qquad \int |\psi|^2 d^3x = 1$