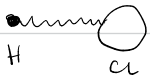
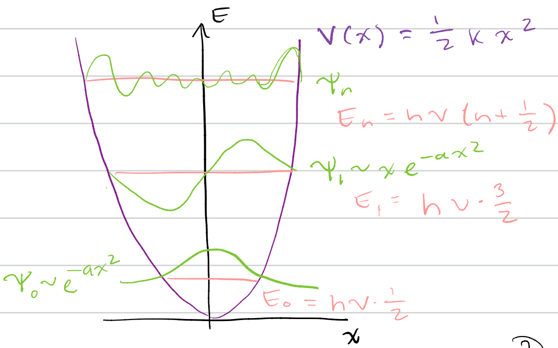
# Lecture 8

Last Time: Bond as Spring




$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \leftarrow \text{force constant}$$




① The Schrödinger equation $\hat{H}\psi_n = E_n\psi_n$ has multiple solutions that can be counted by a quantum number $n = 0, 1, \ldots$

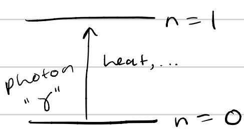
ex: $\psi_0 \sim e^{-ax^2}$, $E_0 = h\nu \cdot \frac{1}{2}$

② $\Delta x \Delta p = \frac{\hbar}{2} \Rightarrow$ zero point energy

③ Solve for $\psi_1, E_1, \psi_2, E_2, \ldots$

④ Energy "levels"

Today: "transitions" and hands-off measurement using quantum mechanics




$\Big\}\ E_1 - E_0 = h\nu$

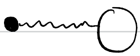
molecule

$$M(n=0) + \gamma \longrightarrow M(n=1)$$

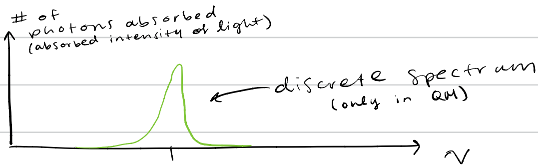
$$\Rightarrow \underbrace{\Delta E = E_{photon} = h\nu}_{\text{Planck's law}}$$

Can we determine the force constant "k" of the molecule "hands-off"?

H—Cl



$\nu \lambda = c$




$8.65 \times 10^{13}$ Hz

infrared light

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$k = m(2\pi\nu)^2 = 490 \ \frac{N}{m}$$

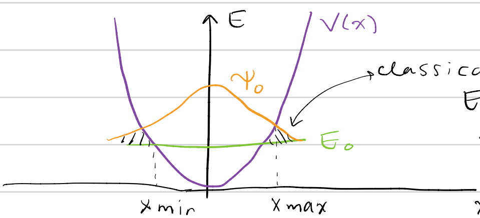
$m = 1 \text{ Da} \approx 1.66 \cdot 10^{-27}$ kg

- every molecule has a unique spectrum that can be identified hands-off, even light years away.

HW Q 2.3: calculate $\Delta x^2 \Delta p^2 = ?$ for $\Psi_0(x)$ of a spring

$\Rightarrow$ prove $\Delta x \Delta p = \frac{\hbar}{2}$

HW Q 2.4: "classically forbidden region"




classically forbidden region

$E = K + V$

$V > E \Rightarrow K < 0$

$$\int dx \, \Psi_0^*(x) \left[ \frac{-\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \right] \Psi(x) \geq 0$$

E, t conjugate variables

$$\Delta E \Delta t = \frac{\hbar}{2}$$

Thought: Can a real molecule really have a bond w/ $V(x) = \frac{1}{2} k x^2$