

CM

assume $V_{pot}(\vec{r})$ is known

m

$\vec{r}(t), \vec{p}(t)$

$\frac{d\vec{r}}{dt} = \frac{\vec{p}}{m} \quad \frac{d\vec{p}}{dt} = -\vec{\nabla} V_{pot}$

$H = \frac{\vec{p}^2}{2m} + V_{pot}$

$\frac{dr_i}{dt} = \frac{\partial H}{\partial p_i} \quad \frac{dp_i}{dt} = -\frac{\partial H}{\partial r_i}$

QM

\vec{r}, \vec{p} are random variables

$\Delta \vec{r}, \Delta \vec{p}$ = "uncertainty"

$\Delta \vec{r} \cdot \Delta \vec{p} \geq \frac{h}{4\pi} = \frac{\hbar}{2}$

Heisenberg!

$\Delta L_x \cdot \Delta L_z \geq \frac{\hbar}{2}$

QN: $i\hbar \frac{\partial |\psi\rangle}{\partial t} = H|\psi\rangle$

Schrödinger Equation

Operators to extract probabilities

Instead:

Probability Amplitude

= State Vector $|\psi\rangle(t)$

= Wave function

Prob $\sim ||\psi\rangle|^2$

Quantum Mechanics vs. Classical Mechanics in a nutshell

Max-well

$\vec{E}(\vec{r}, t) \stackrel{a.g.}{=} \vec{E}_0 \cos(\vec{k} \cdot \vec{r} - \omega t)$ Amplitude

\vec{k} axis of propagation

$|\vec{k}| = \frac{2\pi}{\lambda} \quad \omega = 2\pi \cdot f$

$f \cdot \lambda = \frac{\omega}{|\vec{k}|} = c_{phase}$

Energy $\sim \vec{E}^2$

of Photons $= \frac{\vec{E}^2}{hf}$

Modulus = Probability

Bus: $p(t) = \frac{1}{20 \text{ min}}$

$\langle t \rangle = \int_0^{20 \text{ min}} p_{avg} \cdot t \cdot dt$

Example for a wave (function) – electromagnetism. Amplitude vs, Probability (= Amplitude²).

