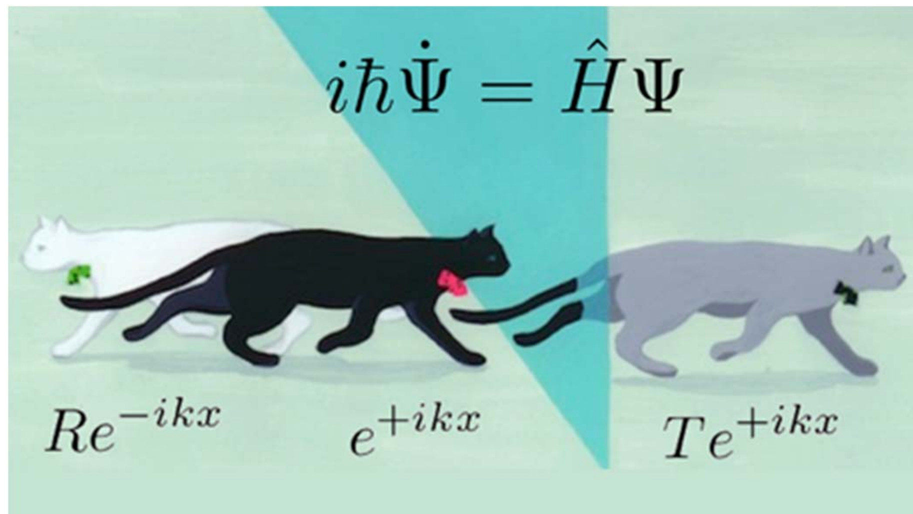
Exploring Quantum Physics

Coursera, Spring 2013 Instructors: Charles W. Clark and Victor Galitski

Feynman path integral
Part II: *Propagator*



Trajectories in quantum mechanics

- Consider a particle localized at a point, $\vec{R}_i$, at $t = 0$:

$$|\Psi(0)\rangle = |\vec{R}_i\rangle$$

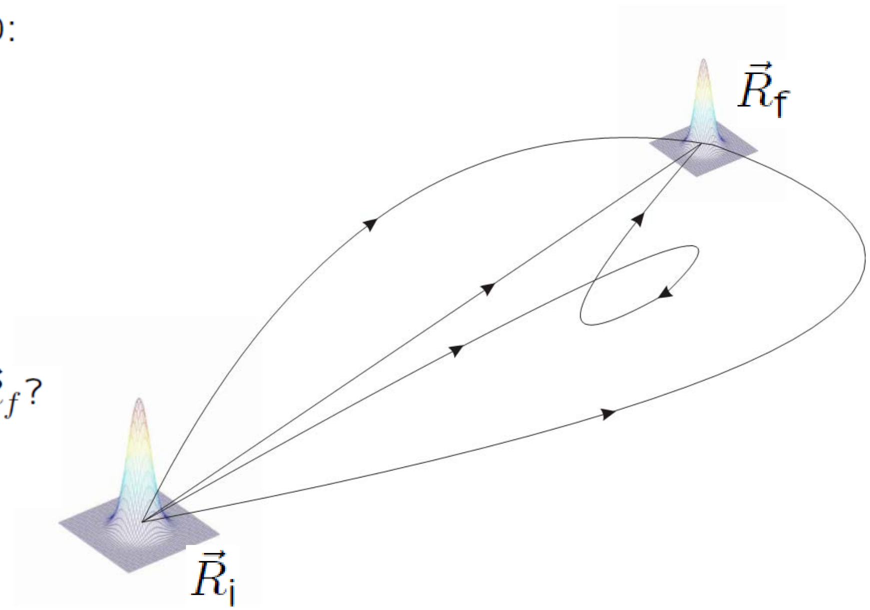
- Let it evolve according to the Schrödinger Eq.

$$i\hbar\partial_t |\Psi\rangle = \left[\frac{\hat{\vec{p}}^2}{2m} + V(\hat{\vec{R}})\right] |\Psi\rangle$$

- What part of it will propagate it to a final point, $\vec{R}_f$?

$$\langle\vec{R}_f|\Psi(t)\rangle = ?$$

- How will the particle get there?



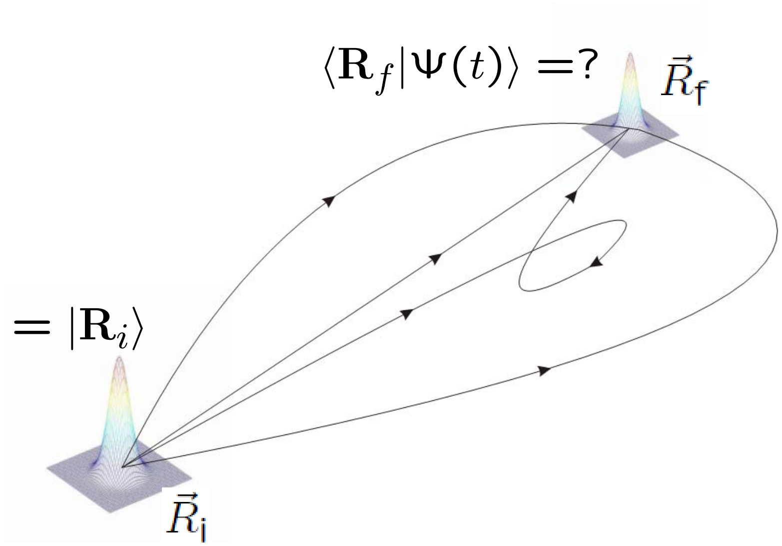
Evolution operator

$$i\hbar\partial_t |\Psi(t)\rangle = \widehat{H} |\Psi(t)\rangle$$

$$|\Psi(0)\rangle = |\Psi_0\rangle$$

$$|\Psi(t)\rangle = \widehat{U}(t) |\Psi(0)\rangle$$

Propagator



$$|\Psi(t)\rangle = \hat{U}(t)\,|\Psi(0)\rangle = e^{-\frac{i}{\hbar}\hat{H}t}\,|\mathbf{R}_i\rangle$$

Propagator

$$G(\vec{R}_i, \vec{R}_f; t) = \langle \vec{R}_f|\, e^{-\frac{i}{\hbar}\hat{H}t}\,|\vec{R}_i\rangle$$