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$$|\psi(t)\rangle = \hat{U}(t,t_0)|\psi(t_0)\rangle$$

$$i\hbar \frac{\partial}{\partial t}\hat{U}(t,t_0) = \hat{H}(t)\hat{U}(t,t_0)$$

$$\hat{U}(t=t_0) = 1$$

For time independent Hamiltonian $\hat{H}$

$$\hat{U}(t,t_0) = \exp\left(-i\frac{t-t_0}{\hbar}\hat{H}\right)$$

In the eigenbasis of $\hat{H}$, $\hat{H}|n\rangle = E_n|n\rangle$

$$\hat{H} = \sum_n |n\rangle E_n \langle n|$$

$$\hat{U}(t,t_0) = \sum_n |n\rangle \exp(-i(t-t_0)E_n/\hbar)\langle n|$$

suppose @ t_0 $|\psi\rangle(t_0)$ is an eigenstate $|n\rangle$

@ later t, $|\psi\rangle(t) = \cancel{\exp} \, e^{-i(t-t_0)E_n/\hbar}|n\rangle$

$|\psi\rangle(t) = e^{i\,\text{phase}}\,|\psi\rangle(t_0)$