Exploring Quantum Physics

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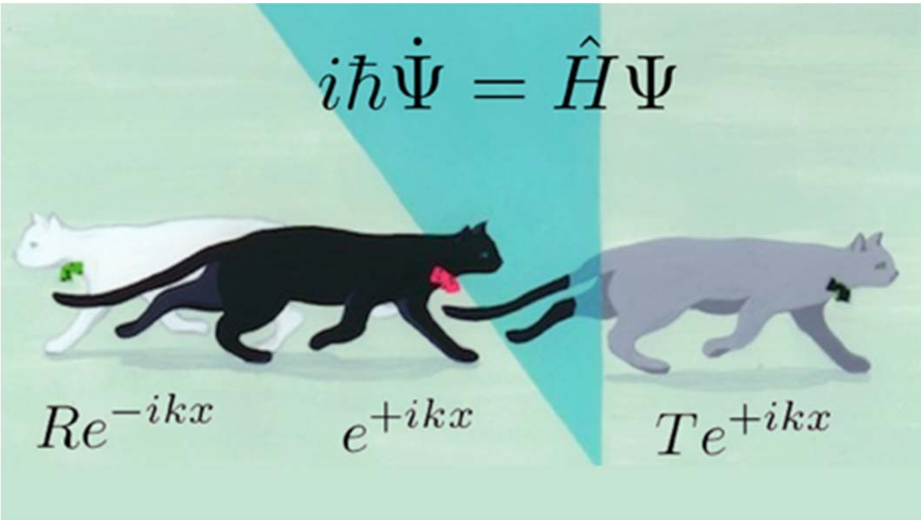
A physical interpretation of quantum theory

Part IV: Time-independent Schrödinger Eq. Eigenvalue problems



Getting rid of the time derivative, when it's not needed

- Time-dependent Schrödinger equation

$$i\hbar\partial_t\Psi(\vec{r},t) = \hat{H}\Psi(\vec{r},t) = \left[-\frac{\hbar^2}{2m}\nabla^2 + V(\vec{r})\right]\Psi(\vec{r},t)$$

- If the Hamiltonian is time-independent (static potential), we can separate the variables

$$\Psi(\vec{r},t) = \psi(\vec{r})e^{-\frac{i}{\hbar}Et}$$

$$i\hbar\partial_t\left[\psi(\vec{r})e^{-\frac{iEt}{\hbar}}\right] = E\psi(\vec{r})e^{-\frac{iEt}{\hbar}} = \left(\hat{H}\psi(\vec{r})\right)e^{-\frac{iEt}{\hbar}}$$

$$\hat{H}\psi(\vec{r}) = E\psi(\vec{r})$$

Operators, eigenvalues, and eigenvectors in QM: summary

- Physical observables in quantum mechanics are described by Hermitian (also, called self-adjoint) operators, $\hat{A}^\dagger = \hat{A}$

- Eigenvalues of a physical operator determines possible values of the observable that actually can be measured in an experiment.

$$\hat{A}\Psi_a(\vec{r}) = a\Psi_a(\vec{r})$$

- Eigenvectors form a basis in the sense that a wave-function can be expressed as their linear combination (see also, next video)

$$\Psi(\vec{r}) = \sum_a c_a \Psi_a(\vec{r})$$