Administration

30% Homework, 30% Midterm (Tentative Midterm Oct. 18), 40% Final.

Quizzes in section (monday), don't count towards the final grade.

The syllabus will track basically as follows:

1. Stationary Perturbation Theory (time independent)
2. Variational Principle (not in townsend)
3. WKB (semicalssical) approximation (not in townsend, may skip)
4. Time Dependent Perturbation Theory
5. Coupling of Quantum Particles + Electromagnetic Fields (Aharonov-Bohm effect)
6. Quantize Light, Physics of Photons and Photon-Atom interaction.

1 Review

1.1 State Vector, Kets, Bras

$|\psi\rangle, \psi(x)$, difference between the two. State vector $|\psi\rangle$ can be constructed out of other vectors. I.e. $|\psi\rangle = \sum_i c_i |\psi_i\rangle$.

Our hilbert space is over $\mathbb{C}$.

Bra objects are the dual of their respective kets.

$$|\psi\rangle \in \mathcal{H} \qquad\qquad \langle\psi| \in \mathcal{H}^*$$

$\mathcal{H}^*$ is the space of linear operators

$$\langle\psi| : \quad \mathcal{H} \to \mathbb{C}$$
$$\langle\psi|\psi\rangle = \langle\psi|\psi\rangle^* = ||\,|\psi\rangle\,||^2$$

We have to make a choice of basis in order to gain any useful information from this vector space.

A basis is any minimal collection of vectors whose span is the desired hilbert space.

Typically, we choose an orthonormal basis such that $\langle\psi_i|\psi_j\rangle = \delta_{ij}$

Under this expression, we have

$$|\psi\rangle = \sum_i \psi_i |\phi_i\rangle$$
$$\langle\psi|\psi\rangle \sum_i \sum_j \psi_i^* \psi_j \langle\phi_i|\phi_j\rangle = \sum_i |\phi_i|^2 = 1$$

Inner product is defined in the usual way.

We are allowed to have continuous bases. E.g. a particle on a 1-d line. We can attempt to measure a position of the particle on the line. We essentially use the same formalism, but with

$$\langle x|x'\rangle = \delta(x - x')$$

where δ is now the Dirac Delta function.

Similarly, we have

$$|\psi\rangle = \int dx \psi(x) |x\rangle \qquad\qquad \langle\psi| = \int dx \psi^*(x) \langle x|$$

Leading to the usual definition of the probability of $|\psi\rangle$ at a given x as

$$\langle x|\psi\rangle = \int dx' \psi(x') \langle x|x'\rangle = \psi(x)$$

and our other favorite

$$\langle\chi|\psi\rangle = \int dx \chi^*(x)\psi(x)$$