Problem Set 4

In this problem set, you'll start by completing some of the worksheet from class to understand various properties of the momentum operator for a 1D quantum system. Along the way, you will derive the standard Schrödinger equation for a particle in a potential, as well as the famous Heisenberg uncertainty principle. Next, you will get some practice with solving the Schrödinger equation by completing the second question on the worksheet. The extra problems include one for extra practice solving the Schrödinger equation.

Problem 0

Review the material up to now for a ten minute multiple-choice quiz next Thursday. There are practice quizzes posted.

Problem 1 (hand in Tuesday, participation credit)

Complete the worksheet handed out in class on Thursday, up to problem i). EXTRA: complete problem j). For the questions on the worksheet, it's useful to remember that the wavefunction for any state $|\psi\rangle$ is equal to the inner product $\langle x|\psi\rangle$ of the state with the position eigenstate $|x\rangle$.

Problem 2 (hand in Thursday)

For an electron in a magnetic field, the evolution of the spin is governed by a Hamiltonian

$$H = -c\vec{B} \cdot \vec{S} \tag{1}$$

where c is a constant, $\vec{B}$ is the magnetic field vector, and $\vec{S} = (S_x, S_y, S_z)$ are the spin operators. Suppose that the electron is in a state $|S_x = \hbar/2\rangle$ at $t = 0$. If $B = B_0\hat{z}$, and we measure the x spin S_x at some later time $t = T$, what values might we find and what are the probabilities of each?

Problem 3 (hand in Thursday)

Do the homework problem from the second page of the worksheet on the Schrodinger equation.