Central Forces Homework 7

Due 5/30/18, 4 pm

Sensemaking: For every problem, before you start the problem, make a brief statement of the form that a correct solution should have, clearly indicating what quantities you need to solve for. This statement will be graded.

REQUIRED:

1. Consider the following state for a quantum particle in the 2D infinite square well with equal side lengths:

   $|n_x, n_y\rangle = \frac{2}{3}|3,1\rangle - \frac{1}{3}|2,2\rangle + \frac{2}{3}|1,3\rangle$

   (a) Determine the probability of each possible outcome of an energy measurement.

   (b) Graph the probability density for this state at $t = 0$ and interpret it in words.

   (c) Determine whether or not your answers to the two previous parts depend on time. If either answer depends on time, include both symbolic and graphical representations of the time evolution.

   (d) Consider the alternate initial state:
   $|n_x, n_y\rangle = \frac{2}{3}|7,1\rangle - \frac{1}{3}|5,5\rangle + \frac{2}{3}|1,7\rangle$
   How do the answers to the first three parts for this state compare to the answers for the original state? What is "special" about this state?

2. Consider a quantum particle confined to the surface of a cylinder (not including the endcaps). Let the height of the cylinder be equal to its circumference.

   (a) Write down the Hamiltonian for this system, the Schrodinger equation, and any relevant boundary conditions.

   (b) Determine the energy eigenfunctions and energy eigenvalues of this system. (You may find it valuable to base your answer on systems you have previously studied!)

   (c) Explicitly write out the energy, the state in ket notation, and the full wave function (including time dependence) for the ground state and the next three excited states. Comment on any degeneracy you observe.

   (d) Choose one of the excited state wave functions you found in part c (not the ground state). Graph the wave function and the probability density at $t = 0$. Comment on how you expect each graph to change with time.