Problem Set 7

This Week: We will continue the discussion of quantum mechanics in greater than one dimension. The major topics of the next two weeks will be orbital angular momentum and the hydrogen atom.

Reading for March 21–25: Please read sections 1-3 of chapter 4 in the text.

Reminder: The second midterm will be given during the lecture period on Tuesday April 5. In a few weeks, I’ve posted a copy of the second midterm from last year on the course website as a study aid.

Problems: due Friday, March 25 by 5:00pm.

1. Calculate the commutation relations \([x_j, L_k]\) and \([p_j, L_k]\) for arbitrary Cartesian components \(j\) and \(k\).

2. Consider the potential that corresponds to a “rectangular wire” in which

\[ V(x, y, z) = \begin{cases} 
0 & 0 < x < L_x, \quad 0 < y < L_y \\
\infty & \text{otherwise}
\end{cases} \]

(a) Determine the elemental solutions to the time-independent Schrödinger equation for this potential.

(b) Determine the energy eigenvalues.

3. Consider the infinite-circle potential in two dimensions that is defined by

\[ V(x, y) = \begin{cases} 
0 & 0 < r < L \\
\infty & \text{otherwise}
\end{cases} \]

(a) Determine the elemental solutions to the time-independent Schrödinger equation for this potential.

(b) Determine the energy eigenvalues.