1 Eigenvalues for Different Systems

(2, 4 pts)

(a) Fill in the following table with the appropriate eigenvalues for each operator for each system.

	$\lvert m\rangle$ particle on a ring	$\lvert \ell, m\rangle$ particle on a sphere	$\lvert n, \ell, m\rangle$ Hydrogen atom
L_z			
L^2			
H			

(b) Write the Hamiltonian for each of the following systems explicitly in the position representation (i.e., differential operators).

	$\lvert m\rangle$ particle on a ring	$\lvert \ell, m\rangle$ particle on a sphere	$\lvert n, \ell, m\rangle$ Hydrogen atom
H			

2 SP not Hybrid

(2, 2, 2, 2 pts)

A hydrogen atom is initially in the state $|\Psi(t=0)\rangle = \frac{1}{\sqrt{2}}\left(|1,0,0\rangle + |2,1,0\rangle\right)$.

(a) If you measure the energy of this state, what possible values could you obtain?

(b) What is $|\Psi(t)\rangle$, where $t > 0$?

(c) Calculate the expectation value $\langle \hat{L}^2 \rangle$ in this state, as a function of time. Did you expect this answer? Please explain your reasoning.

(d) Write $|\Psi(t)\rangle$ in wave function notation.

3 Hydrogen, Version 1

(2, 2, 2, 2 pts)

A hydrogen atom is initially in the superposition state

$$|\psi(t=0)\rangle = \frac{1}{\sqrt{14}}|2,1,1\rangle - \frac{2}{\sqrt{14}}|3,2,-1\rangle + \frac{3}{\sqrt{14}}|4,2,2\rangle. \tag{1}$$

(a) What are the possible results of a measurement of the energy and with what probabilities would they occur? Plot a histogram of the measurement results. Calculate the expectation value of the energy.

(b) What are the possible results of a measurement of the angular momentum operator L^2 and with what probabilities would they occur? Plot a histogram of the measurement results. Calculate the expectation value of L^2.

(c) What are the possible results of a measurement of the angular momentum component operator L_z and with what probabilities would they occur? Plot a histogram of the measurement results. Calculate the expectation value of L_z.

(d) How do the answers to (a), (b), and (c) depend upon time?

4 Confidence Rating

(1 pt) After solving each problem on the assignment, indicate your answers to the following questions for each problem. Answer for the problem as a whole, even if the problem has multiple parts.

(a) **Question Confidence** How confident are you that you are interpreting the problem the way the instructor intends?

1	2	3	4	5	6	7
Not confident at all			Somewhat confident			Extremely confident

For the rest of the questions, assume you have interpreted the problem correctly

(b) **Problem Confidence** How confident are you that you could independently come up with a correct solution process to a similar problem on a future problem set?

1	2	3	4	5	6	7
Not confident at all			Somewhat confident			Extremely confident

(c) **Answer Confidence** How confident are you that your final answer to this question is correct (not solution process)?

1	2	3	4	5	6	7
Not confident at all			Somewhat confident			Extremely confident

(d) **Makes Sense** To what degree do you understand how your answer fits (or does not fit) the physical or mathematical situation of the problem?

VN	N	LN	IDK	LF	F	VF
Very confident answer does NOT fit	Somewhat confident answer does NOT fit	Leaning toward the answer does NOT fit	Don't know if answer fits or not	Leaning toward the answer fits	Somewhat confident the answer fits	Very confident answer fits