

1 Eigenvalues for Different Systems

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

	$ m\rangle$ particle on a ring	$ \ell, m\rangle$ particle on a sphere	$ 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).

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

2 SP not Hybrid

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

- If you measure the energy of this state, what possible values could you obtain?
- What is $|\Psi(t)\rangle$, where $t > 0$?
- 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.
- Write $|\Psi(t)\rangle$ in wave function notation.

3 Quantum Cylinder

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

- 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 first excited state.