

Physics 4803
Homework Assignment 3
Due Sept 17 at 5:00 pm

Problems:

1) At a given instant, a system is in the state

$$\Psi(\theta, \phi) = \sqrt{\frac{3}{4\pi}} \sin \theta \sin \phi$$

b) What possible values of L_z will be found in a measurement, and with what probabilities?

c) What is $\langle L_x \rangle$ for this state?

d) What is $\langle L^2 \rangle$ for this state?

2) Derive the matrix representation of L_x, L_y, L_z and L^2 for a spin 3/2 particle.

3) An electron is at rest in an oscillating magnetic field

$$B = B_o \cos(\omega t) \hat{k}$$

where B_o and ω are constants.

a) Construct the Hamiltonian matrix for this system.

b) The electron starts out (at $t=0$) in the spin up state with respect to the x-axis. (That is $\chi(0) = \chi_+^{(x)}$). Determine $\chi(t)$ at any subsequent time. Note this is a time-dependent Hamiltonian, so you cannot get $\chi(t)$ in the usual way from stationary states. Fortunately, in this case you can solve the time-dependent Schrodinger Equation

$$i\hbar \frac{\partial \chi}{\partial t} = H \chi$$

c) Find the probability of getting $-\hbar/2$ if you measure S_x .

d) What is the minimum field (B_o) required to force a complete flip in S_x ?

4) Check that the spin matrices obey the fundamental commutation relation for angular momentum $[S_x, S_y] = i\hbar S_z$

5) An electron is in the spin state:

$$\chi = A \begin{pmatrix} 3i \\ 4 \end{pmatrix}$$

a) Determine the normalization constant A

b) Find the expectation values of S_x, S_y and S_z