Homework 12

Reading

JJS 3.1-3.3, 3.5-3.7.

Problem 1

What is the expectation value of $\frac{1}{2}(L_xL_y + L_yL_x)$ in the state with angular part of the wave function given by $Y_3^2(\theta, \phi)$?

Problem 2

A D_2 is known to be in the state

$$\psi(\theta, \phi) = \frac{3Y_1^1 + 4Y_7^3 + Y_7^1}{\sqrt{26}}.$$

What values of L and L_z will measurement find and with what probabilities these values occur?

Problem 3

At a given instant of time, a rigid rotator is in the state

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

a) What possible values of L_z will measurement find and with what probability will these values occur?

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

c) What is $\langle \boldsymbol{L}^2 \rangle$ for this state?

Problem 4

How many linearly independent singlets can be constructed from four spin 1/2? From 6 spin 1/2?

Problem 5

What are the possible values of l for

a) Four p electrons?

b) Three p and one f ($l = 3$) electrons?

Problem 6

The energy of a rigid molecule, free to rotate about its center of mass, is given by

$$E = \frac{L_x^2 + L_y^2}{2I_1} + \frac{L_z^2}{2I_3},$$

where moments of inertia (I_1, I_2, I_3) are evaluated in principal axis with $I_1 = I_2$ and the origin at the center of mass.

Find the eigenenergies and eigenfunctions for this molecule.

Problem 7

Find the energy levels of a particle in a spherical box of radius R in the $l = 0$ sector.