Physics 652 Winter 2024

Homework #6

(due Wednesday, February 28, 2024)

1. (20 pts) Consider Example 3 of the lecture posted on 02/19. In particular,
   a. Find the probability to measure $S_x = \hbar/2$ and $-\hbar/2$.
   b. What is the expectation value of S_x?
   c. What are the possible outcomes of the measurement of L_z? What are their probabilities?
   d. What are the outcomes of the measurement of L^2? What are their probabilities?
   e. The measurement yielded $L^2=0$. What is the state of the particle after this measurement?

2. (10 pts) Consider recursion relations given by Eqs. (16.2) and (16.3) (lecture on 02/21, page 9). Eq.(16.2) was derived in class. Now derive Eq.(16.3) using Eq.(16.2) and orthonormality of angular momentum states.

3. (15 pts) Calculate the following Clebsch-Gordan coefficients:
   (a) $\langle 1,1;-1,1|2,0\rangle$
   (b) $\langle 1,1;1,-1|2,0\rangle$
   (c) $\langle 1,1;0,0|2,0\rangle$
   (d) $\langle 1,1;-1,1|1,0\rangle$
   (e) $\langle 1,1;1,-1|1,0\rangle$
   (f) $\langle 1,1;-1,1|0,0\rangle$
   (g) $\langle 1,1;0,0|0,0\rangle$

4. (10 pts) A hydrogen atom is in a $^2P_{3/2}$ state with the projection of the total angular momentum on the z-axis m = - 1/2. What is the probability to find the electron with spin up (i.e. m_s = + 1/2) ?

5. Reading assignment: Sakurai 3.8.