Quantum Mechanics Fall 2003- Homework Set 3

Due Monday September 29, 2003 at 5:00.

Reading 4.3 and 4.4 except 4.4.3

Griffith's Problems

Note the first two problems are challenging, but after that the rest of the problems are more straight forward.

- 4.20 You may skip part (b) and assume the result. You are asked to do something very similar in A1.
- 4.21 You will need the generalization of the commutator results we proved in the first homework set.

  $$[R_i, F(P_i)] = i\hbar \frac{\partial F(P_i)}{\partial P_i}$$

  where $F(P_i)$ is some function of P_x, P_y, P_z.

  $$[P_i, G(R_i)] = -i\hbar \frac{\partial G(R_i)}{\partial R_i}$$

  where $R_i = \hat{X}, \hat{Y}$ or $\hat{Z}$.
- 4.25 Note for orbital angular momentum the normalized eigenfunctions are the spherical harmonics $|\ell m >= Y_\ell^m$ and only integer values of angular momentum are allowed. We will return to spherical harmonics in the second part of the class.
- 4.27 part (a)
- 4.28
- 4.30
- 4.32

Additional Problems

Problem A1 Show $\hat{L}_x$, $\hat{L}_y$ satisfy the commutation relation for angular momentum.

$$[L_x, L_y] = i\hbar L_z$$

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Problem A2 A system with angular momentum $\ell = 1$ and gyromagnetic ratio γ is prepared in the $|11 >_x$ state (the $\ell = 1$, $m = 1$ eigenstate of the L_x operator) at time $t = 0$. The system is placed in a magnetic field $\vec{B}_0 = B_0\hat{k}$.

(a) Calculate the possible outcome of a measurement of L_z and their probabilities as a function of time.

(b) Calculate the possible outcome of a measurement of L_x and their probabilities as a function of time.

Problem A3 A spin 1/2 system is prepared in the $|+>$ state and passed though a Stern-Gerlach apparatus whose field points in the $\hat{i}+2\hat{j}$ direction. Calculate the possible outcomes and probabilities.