Homework 2

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1 Problem 4.25

If the electron were a classical solid sphere, with radius,

$$r_c = \frac{e^2}{4\pi\epsilon_o mc^2}$$

(the so-called classical electron radius, obtained by assuming the electron's mass is attributable to energy sotred in its electric field, via the Einstein formula $E = mc^2$), and its angular momentum is $\hbar/2$, then how fast (in m/s) would a point on the "equator" be moving? Does this model make sense? (Actually, the radius of the electrin is known experimentally to be much less than r_c but this only makes matters worse.)

Solution 1: Stationary states

Sol

2 Problem 4.26

- Check that the spin matrices 4,145 and 4,147 obey the fundamental commutation relations for angular momentum eqn 4.134
- Show that the Pauli spin matrices 4.148 satisfy the product rule

  $$\sigma_j\sigma_k = \delta_{jk} + i\sum_l \epsilon_{jkl}\sigma_l,$$

  where the indices stand for x, y, z and ϵ_{jkl} is the Levi-Civita symbol.

3 Problem 4.27

An electron is in the spin state,

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

- Determine the normalization constant A.
- Find the expectation values of S_x, S_y and S_z.
- Find the "uncertanties" $\sigma_{S_x}, \sigma_{S_y}$ and σ_{S_z}. (Note: These sigmas are standard deviations, not Pauli matrices!)
- Confirm that your results are consistent with all three uncertanty principles 4.100 and its cyclic permutations-only with S in place of L, of course.)

4 Problem 4.32 a)

If ypu measure the component of spin angular momentum along the x direction, at time t, what is the probability that ypu would get $+\hbar/2$?