Physics 402
Spring 2019
Prof. Belloni
Discussion Worksheet for January 30, 2019

1. The electron in a hydrogen atom occupies the combined spin and position state

$$\Psi = R_{21}(r)\left(\sqrt{\frac{1}{3}}\,Y_1^0(\theta,\phi)\,\chi_+ + \sqrt{\frac{2}{3}}\,Y_1^1(\theta,\phi)\,\chi_-\right)$$

a) If you measured the orbital angular momentum squared (L^2), what values might you get, and what is the probability of each?
b) Same for the z component of orbital angular momentum (L_z)
c) Same for the spin angular momentum squared (S^2)
d) Same for the z component of spin angular momentum (S_z)

2. Show that it is impossible for a spin-1/2 particle to be in a state $\chi = \begin{pmatrix} a \\ b \end{pmatrix}$ such that: $\langle S_x \rangle = \langle S_y \rangle = \langle S_z \rangle = 0$.

Hint: start by examining $\langle \sigma_z \rangle \sim \langle S_z \rangle$.

Reminder: Pauli spin matrices: $\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$, $\sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$, $\sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$