PHSX 461: HW11

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Griffiths 4.12

Work out the radial wave functions of R_{31}, using the recursion formula. Don't bother to normalize them.

$$c_{j+1} = \frac{2(j+l+1-n)}{(j+1)(j+2l+2)} c_j \qquad \text{(Equation 4.76)}$$

Griffiths 4.15

a) *Find $\langle r \rangle$ and $\langle r^2 \rangle$ for an electron in the ground state of hydrogen. Express your answers in terms of the Bohr radius.*

b) *Find $\langle x \rangle$ and $\langle x^2 \rangle$ for an electron in the ground state of hydrogen.*

c) *Find $\langle x^2 \rangle$ in the state $n = 2, l = 1, m = 1$.*

Griffiths 4.16

What is the most probably value of r, in the ground state of hydrogen?

Griffiths 4.27

Two particles (masses m_1 and m_2) are attached to the ends of a massless rigid rod of length a. the system is free to rotate in three dimensions about the (fixed) center of mass.

a) *Show that the allowed energies of this rigid rotor are*

$$E_n = \frac{\hbar^2}{2I} n(n+1) \quad (n = 0, 1, 2, ...) \quad \text{where } I = \frac{m_1 m_2}{m_1 + m_2} a^2$$

is the moment of inertia of the system

b) *What are the normalized eigenfunctions for this system? (Let θ and ϕ define the orientation of the rotor axis.) What is the degeneracy of the nth energy level?*

c) *What spectrum would you expect for this system?*

d) *According to the figure given in the text, what is the frequency separation between adjacent lines? Look up the masses of ^{12}C and ^{16}O, and from m_1, m_2, and $\delta\nu$ determine the distance between the atoms.*

Griffiths 4.64

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

$$R_{21}(\sqrt{1/3}Y_1^0\chi_+ + \sqrt{2/3}Y_1^1\chi_-)$$

a) *If you measured the orbital angular momentum squared, what values might you get, and what is the probability of each?*

b) *Same for the z component of angular momentum.*

c) *Same for the spin angular momentum squared.*

d) *Same for the z component of spin angular momentum.*

e) *Same for the energy of the electron.*

Griffiths 4.30

An electron is in the spin state

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

a) *Determine the normalization constant A*

b) *Find the expectation values of* S_x, S_y, *and* S_z

c) *Find the "uncertainties"* σ_{S_x}, σ_{S_y}, *and* σ_{S_z}

d) *Confirm that your results are consistent with all three uncertainty principles.*