Homework 3 – PHYS626

Reading Material:

5.6-electron spin and fine structure

5.7-hyperfine structure

5.8 to 5.10 – additional breadth material on hydrogen

6.5 – terms and adding momentum

6.6 – excitation, x-rays, autoionization

6.7-exotic 'hydrogen' systems

1) Give all the possible electron configurations with term assignments for three electrons, one in a k=1 (l=0,s) state, one in a k=2 (l=1,p) state and one in a k=3 (l=2,d) state.

2) How large is the internal magnetic field produced by the 1s electron in the H atom at the location of the proton that causes the splitting of the two hyperfine components observed in the λ=21cm transition.

3) In the classical model, the electron is described by a rigid sphere with radius r, mass m, and charge –e uniformly distributed. Use both the classical value of the radius ($r=1.4\ 10^{-15}$m) and the experimental value $r=10^{-18}$m in the following:

    a. What is the velocity of a point on the equator of this sphere when the angular momentum is $\sqrt{3}\hbar/2$
    b. What would be the rotational energy of this sphere be compared to its rest mass energy $E_0=m_ec^2$?

4) By what factor does the radius of the Bohr orbit increase if the hydrogen atom in its ground state is excited by:
    a. 12.09 eV
    b. 13.387eV

5) Show that within the Bohr model, the ratio $\mu_l/|L|$ of the orbital magnetic moment to the angular momentum is independent of the principle quantum number n.