QUANTUM MECHANICS III

PHYS 518

Problem Set # 6

Distributed: Nov. 18, 2011

Due: Nov. 30, 2011

1. N.R. Hydrogen Atom: Compute the energy of the $1s$ ground state of the nonrelativistic hydrogen atom. Neglect spin and relativistic effects.

2. First Mass-Velocity Correction: Compute the relativistic "mass-velocity" correction ($\mathcal{O}(p^4)$) to the $1s$ ground state.

3. Finite Nuclear Size Effect: Compute the effect of the finite proton size on the energy of the $1s$ ground state.

4. Electron Delocalization: Compute the effect of electron delocalization on the $1s$ ground state.

5. Spin-Flip Transition: Compute the energy difference between the $f = 0$ and $f = 1$ levels in atomic hydrogen. Provide your answer in MHz

6. Magnetic Field Effects: Plot the 4 energy levels of the hydrogen atom ground states $1s, l = 0, j = 1/2, i = 1/2$ and $f = 0, 1$ over an interesting range of magnetic field values.

7. Second Relativistic "Mass-Velocity" Correction: Compute the effect of the next higher ($\mathcal{O}(p^6)$) mass-velocity correction to the hydrogen ground state energy.