Due: Thursday, 02/05

1. This problem gives exercises in atomic units, which are discussed in class.
a) What is the Bohr magneton in atomic units?
b) What is the atomic unit of electric field in volts/cm?
c) What is the atomic unit of magnetic field in gauss?
d) What are the ground state binding energies of positronium, muonium, atomic deuterium, singly ionized helium-four, in atomic units?

2. a) Use the uncertainty principle to estimate the radius of a hydrogen atom in the ground state. What is the characteristic value of the electron velocity in an atom in units of the speed of light? Is the electron relativistic?
b) Explain why the existence of a stationary planetary atom (like e.g. hydrogen in the ground state) contradicts classical physics. Use the formulae for the radiation of accelerating charge to estimate the time it would take a classical atom to collapse. How does this time scale compare to the electron revolution period?

3. For hydrogen-like ions with nuclear charge Z, find the scaling with Z of the expectation values of the following operators: r^n for n = 1,-1 and -3; the potential energy V; and the total energy E. Also find the scaling with Z of $|\psi(r=0)|^2$ and $\left|\frac{\partial\psi}{\partial r}(r=0)\right|^2$. (Hint: you shouldn't have to use any explicit wavefunctions; just consider the dimensions of the quantities of interest.)

4. Reading/reviewing assignment.
a) E-mail the Instructor to request text to read/review.
b) Read the text (which will be directly relevant to the material covered in class).
c) E-mail the Instructor with a review which should be as short as possible; however, would contain whatever critical comments you might have about the text.

Please note: you do not need to turn in Problems 1-3, but please keep the solutions neatly written for your future reference and possible inspection by the Instructor (if needed for grading). Consult the Instructor if you have difficulties solving the problems (these are actually designed to be easy but meaningful exercises to help you absorb the lecture material). Turn in Problem 4 by e-mail.