Set 7 – due 10 March

The midterm will be Wednesday evening. March 8, in G-125 (our classroom) from 7 to 8:30 PM.

2) [40 points] Consider a one-electron atom in a $^2D_{3/2}$ state which decays by electric dipole radiation to a pair of states which are members of the same fine structure multiplet, the $^2P_{3/2}$ and $^2P_{1/2}$ states. (a) [15 points] The atom is in a small magnetic field B. Compute the pattern of spectral lines you expect to see in both transitions including the separations of the components due to Zeeman splitting, and the relative intensities of the members of each multiplet. The $D-P$ splitting is bigger than anything else, so the k^3 phase space factor is the same for all transitions. (b) [25 points] Now compute the relative intensities of the two lines in the absence of Zeeman splitting. This is longer than you might think at first reading. The reason is, that while you can compute the relative intensities in the individual multiplets in (a) using only a table of Clebsch-Gordon coefficients, the reduced matrix elements for the two sets of transitions (to $^2P_{3/2}$ and $^2P_{1/2}$) are not equal to each other although they do have many common components. In addition to the table of Clebsch-Gordon coefficients, the three-Y_l^m formula will be useful in finding their ratio. But most of all, this will tax your organizational skills, so try to block out the calculation before you start computing. My handwritten solution is six pages long, while the print version runs three pages.

Truth in advertising compels me to tell you that there is a whole formalism for dealing with problems like this, which experts know (and use).