CCB 421/521: Homework 3

Due in class on Thursday, Feb. 17. (Note: these are problems from the book; I'm posting them here because the electronic/Kindle version of the text seems to have lots of typos. Let's hope I don't make typos myself!)

(4-22) Prove that, for a diatomic molecule, $I \equiv m_1 r_1^2 + m_2 r_2^2 = \mu R^2$, where $R = r_1 + r_2$ and r_i is the distance of mass m_i to the center of mass (see Fig. 4-5).

(4-27) The lowest microwave frequency absorbed by carbon monoxide ($^{12}C^{16}O$) is 115271 s^{-1}. *(a)* Compute the moment of inertia of CO and the average value of the C–O bond distance. *(b)* Estimate the frequency (in s^{-1} and cm^{-1}) at which the J=1 to J=2 transition is expected to occur. (Note expressing a frequency in cm^{-1} means to compute $1/\lambda$, where λ is the wavelength. Convince yourself that $1/\lambda$ is proportional to ν.)

(5-2) Given the solution of the Schrodinger equation of the one electron atom, what are the ground-state wavefunction and energy of positronium (e^+e^-)?

(5-6) The wavelenght 486.27 nm appears in the Balmer series of hydrogen. What state emits to produce this line? The line has a weak satellite line at 486.14 nm. Show that this is due to small amount of the isotope ^2H. (This is how deuterium was actually discovered.)