Assignment #3 ESS471/503  
Due October 18, 2017  
Solar Radiation and the Hydrogen Spectrum

Use the H spectrum (see lectures on Solar Physics, and/or your beginning physics book to answer these questions:

1. What is the energy (in electron volts) of the lowest energy level of the Hydrogen atom? Explain what it means to have negative energy.

2. Using \( c=\lambda \nu \) where \( c \) is the speed of light, \( \lambda \) is the wavelength and \( \nu \) is the frequency, calculate the frequency of the light that is emitted for Hydrogen atom transitions between the first four adjacent energy levels (\( n=2 \) to \( n=1 \), and \( n=3 \) to \( n=2 \), and \( n=4 \) to \( n=3 \)).

3. What temperature would we estimate the sun to be if the sun were emitting blackbody radiation with a wavelength of peak intensity close to the Balmer alpha line of Hydrogen (energy released for transitions between \( n=3 \) and \( n=2 \) levels)? Why? (i.e. explain your answer) Hint: Remember, black body radiation is NOT emitted all at one wavelength. (Hint – read the question carefully. It is given that the imaginary sun in question is radiating as a black body. Then it gives the wavelength of the peak intensity, and asks what would be the temperature of the sun.)

4. The Lyman Alpha line (transition between \( n=2 \) and \( n=1 \)) is characterized in what wavelength band: a) X-ray b) ultraviolet, c) visible or d) infrared ?

[Hints: use the energy formula relating the energy of a photon to its wavelength \( E = h\nu = \frac{hc}{\lambda} \) where \( h \) is Planck's Constant= 6.63x10^{-34} \ Joule-sec, and \( c = \) speed of light = 3x10^{8} \ m/s. Then set \( E = kT \) where \( T \) is the temperature in Kelvin and \( k \) is Boltzman's Constant = 1.38x10^{-23} \ Joule/degree-Kelvin to solve for the temperature. You may also want to use Wein’s Displacement Law]

Extra Credit: 

5. Explain the Zeeman Effect, explaining how to tell the direction (toward or away) of the magnetic field (along the line of sight), and how to determine the magnitude of the magnetic field (may require a little research, if it is not in your physics book)