Homework 3

Should be submitted to the course Moodle site by midnight on Tuesday, February 21.

1. Describe in your own words how each of the following properties of light vary across the electromagnetic spectrum: wavelength, frequency, speed, energy, and temperature of a blackbody emission source with a peak at that wavelength. For all properties except wavelength, use an equation to support your argument for how that property varies with wavelength, and describe the units used to measure it. One paragraph per property.

2. Complete the following table in your Jupyter notebook (use a markdown cell – notes on the syntax for tables can be found here) . Use the range of wavelength values given for radio, visible and gamma ray light to fill in the other quantities. In certain cases, noted in the table below, there are specific typically-used units for that wavelength range. Make sure you use these where noted (you may need to look up a conversion) and, in all other cases, use the typical units for that quantity. In lieu of scientific notation, use metric system prefixes. A cheat sheet of metric system prefixes can be found here

Property of light	Type of unit	Range of values for radio light	Range of values in visible light	Range of values for gamma rays	Order of magnitude variation across EM spectrum
Example: Wavelength	*Length*	*1mm – 100km*	*600nm-800nm*	*0.01am - 1nm*	*10^{-20} - 10^{5}m* *25 orders of mag.*
Frequency		*Give in GHz or MHz*			
Energy				*Give in eV (electron volts)*	
Temperature of Blackbody					

3. The only property of the emitting source encompassed in the Planck Function is the temperature of that source, but there is another important source property involved if we'd like to consider the **total** light emitted. That property can be seen directly in the units for spectral radiance as we've been writing them – J/s/m^2/nm (energy per unit time **per unit Area** per unit wavelength). The area here is the area of the emitting surface (generally spherical) of the light source. Based on the function that you developed at the end of Lab 5 to calculate the spectral radiance, write a new function that gives the spectral radiance *multiplied by* the surface area of the star (hint: radius of the star should be a new required input, and should be in units of solar radii – solRad in the astopy units module) and then use that new function to answer the following questions:

a. How many times larger than the sun would a cool star (say 4000K) have to be in order to emit the same **approximate** (ok to eyeball it, but include the plot) amount of light (area under the curve) as a sun-like star (T=6000K, R=1R_{sun}). Use a graph (with appropriate axis labels, title and legend) to support your answer.
b. Compare the ratio of temperatures of these two "equivalent light output" stars to the ratio of their radii. Which property of a star has a greater effect on the total amount of light emitted – its temperature or its size? How much bigger is one effect vs. the other?