ATSC 5010 – Physical Meteorology I Lab
Lab 10 – Problems from Emission

In today's lab, we will work problems that require some amount of computer work for plotting functions, conducting numerical integrations, and interpreting graphs. This lab differs from our more traditional labs in that we will not work a single problem through a series of steps from beginning to end, but rather this lab is more closely related to problems that we may expect to work for standard homework assignments.

1. Consider a star with a temperature of 5780K (temperature of the sun)
    a. Plot the intensity of radiation as a function of wavelength (from 0.01 μm to 100 m) on a log-log scale with a yrange of 10^{-100} to 10^{+20}; note—plotting over such a large wavelength range will require you to be clever how you define your variable for wavelength. <u>You should have equal intervals in ***log*** space</u>.
    b. Compute (numerically) the percentage of the total emitted radiation that falls within the following spectrums as defined on page 58 of Petty:
        i. Extreme UV
        ii. Far UV
        iii. UV-C
        iv. UV-B
        v. UV-A
        vi. Visible
        vii. Near IR
        viii. Thermal IR
    c. Re-plot on a linear scale for that portion of the spectrum that falls between 0.2 and 4 μm. This comprises roughly 99% of the total emitted radiation.
    d. On both of the above graphs, indicate the visible band (lower and upper limits) by drawing a line for both and coloring that portion under the curve light blue. (To do this, you will plot over the top of the current plot {use overplot keyword} for lambda and radiation intensity for the range of wavelengths of interest and use keywords fill_color='light blue', fill_level=0, fill_background=1 in your call to PLOT)
    e. Compute the wavelength of maximum emission and indicate this on both of your graphs with a solid vertical line

2. Plot the intensity of radiation emitted as a function of wavelength on a log-log scale (from 0.01 μm to 100 m and 10^{-20} to 10^{10}) for the following temperatures: 6000, 3000, 2000, 1000, 500, 250, 100. Plots should all be on the same graph. Label each of the lines (using different colors and key)
    a. Using Wien's displacement law, add a dashed line that represents the maximum emitted radiation as a function of wavelength for different temperature curves (This should be one dashed line that passes through the maximum of each of the Planck curves).

3. The Rayleigh-jeans Approximation was shown in class to be valid for longer wavelengths. Produce two separate graphs for the intensity of emitted radiation as a function of wavelength, one for a blackbody of temperature 6000 K and one of temperature 300 K. On each graph over-plot the Rayleigh-Jeans approximation as a function of wavelength. Both plots should be on a log-log scale using the same ranges as used in problem 2.
    a. Calculate and indicate on the each plot the wavelength at with the Rayleigh-Jeans approximation is valid to 90%, 95% and 99%

4. Consider an object that has a temperature of 288K. Plot the brightness temperature as a function of emissivity (from 0 to 1) of this object at the following wavelengths:
    a. 1 mm (1000 μm)
    b. 100 μm
    c. 10 μm
    d. 1 μm