# Astronomy 16 – Modern Astrophysics

Fall 2014

Homework 3

due: Friday, October 3, 2 pm

It is very important to present your solutions neatly and clearly. Use units when appropriate, state where your numbers come from, explain what you're doing unless it's very obvious. Use sketches when you think they'd be useful. Quite a few of the questions are multi-part; make sure you answer each part.

When you have to make a graph or plot, think carefully how to best display the data or functions that you compute. And think carefully about how you label the axes and the functions you plot. Logarithmic axes are good for showing data that spans a wide range of values.

Hand in the homework in the box on the wall outside my office door by 2:00 pm on Friday.

1. Ryden & Peterson problem 5.5 (p. 145); do all three parts.

2. Ryden & Peterson problem 5.6 (p. 145). Note: you'll derive an equation that has to be solved numerically, graphically, or by trial and error. For full credit, you must describe/show your solution method. Guess and check is a perfectly fine method (and makes you think about what you're doing more than using, e.g., *Mathematica* would). If you solve it numerically (say, in *Mathematica*) do it neatly, with comments, and – for full credit – email your code to me when you hand in your

homework. Finally, no matter your method, I strongly recommend making a variable substitution for h*nu/kT.

3. Ryden & Peterson problem 5.7 (p. 145). Make sure you answer all the parts of this question.

4. Ryden & Peterson problem 5.8 (p. 145). And answer this follow-up question: given the temperature of the filament, would you expect a majority of the light it emits to be in the optical part of the spectrum? Justify your answer for this last part.

5. Using a spreadsheet or other graphing program (e.g. *Kaleidagraph*, *Python*, *Mathematica*, *Matlab*, or *Excel*), do the following:

    a. Compute and plot a blackbody spectrum of a $T$ = 5800 K star, from $\lambda$ = 1,000 Å to 15,000 Å (i.e.1.5 microns). Mark on your plot the boundaries of the visible part of the electromagnetic spectrum. Do the same for a 20,000 K star and for a 2500 K star. (You may want to extend your wavelength scale for the cooler star. And you should at least consider using logarithmic axes. All three functions must be plotted on the same graph.)

    b. Compute A(T), the slope of the Planck function $B_\lambda$, as a function of temperature. Approximate the slope between 4000 Å (blue) and 6000 Å (yellow), as:
    $$A(T) = \frac{\partial B}{\partial \boldsymbol{\lambda}} \approx \frac{B(6000, T) - B(4000, T)}{2000}$$

    c. Repeat part b., but this time compute and plot C(T), the *ratio* C(T) = B(4000,T)/B(6000,T), over the same range of temperatures. Again, what happens to C at infinite temperature?

d. Comment on the usefulness of A and C as indicators of the temperature of a blackbody. For example, think about what you would need to measure in order to calculate each one, say for a star.

Note: there are three plots that you have to make and hand in for problem 5.