Problem Set 1

Due Jan 21, 2021 at 11:59pm EST. Must be submitted to the Problem Set 1 Dropbox on LEARN. Marked out of 30 and worth 10% of your final mark.

1. **[0 marks]:** Read Chapter 13. Suggested problems: 13.2, 13.3, 13.5, 13.6, 13.7, 13.11. You do not have to hand these in; they will not be marked. Solutions will be provided.

2. **[15 marks]:**

   (a) (5 marks) The file *hipparcos.txt* contains parallaxes and magnitudes in three filters (B, V and I) for many nearby stars (see the file *hipparcos_cols.txt* for column definitions). Make a graph of absolute V magnitude (M_V) as a function of (B-V) colour. Orient your graph so brighter stars are at the top, and bluer stars are at the left.

   Hint: The file *template.py* will get you started to make a plot in `python`.

   (b) (5 marks) Use eq 13.36 to calculate the temperature of each star and plot $\log L_V/L_\odot$ as a function of $\log T$.

   (c) (5 marks) Use the Stefan-Boltzmann law to calculate L as a function of T for blackbodies of different radii: $R = R_\odot$, $R = 0.2R_\odot$ and $R = 5R_\odot$. Show these as lines on your graph from part b. What can you infer about how the radii of stars depends on their temperature?

3. **15 marks** The file W22_ps1_orbit.dat gives the orbital phase, the radial velocity (in km/s) of each star, and the apparent magnitude of an unresolved, double-lined spectroscopic binary system. The period is 50 days.

   (a) (2 marks) Make a graph of radial velocity as a function of time, over one full orbit. Show both stars on the same graph.

   (b) (3 marks) From the graph in (a), calculate the value of $m \sin^3 i$ for each star.

   (c) (2 marks) Make a graph of the logarithm of L/L_0 as a function of time, where L_0 is the luminosity when both stars are visible (no eclipse).

   (d) (3 marks) Using the graph and data from (c), calculate the ratio of temperatures of the two stars.

   (e) (5 marks) Using the graph and data from (c), calculate the radius of each star.