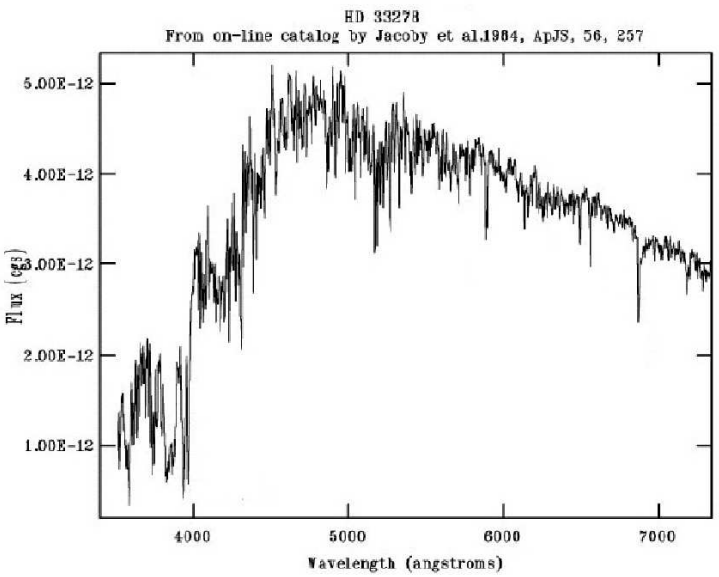
NAME

Astronomy 321
Homework 1
Due: January 25, 2023

Question 1

The star, HD 33278 (star 33278 in the Henry Draper Catalog), has spectrum



a. Estimate the surface temperature of HD 33278 using Wien's Law.

b. The surface temperature of HD 33278 may also be found from comparison of the intensity of the observed spectrum at two wavelengths. For small wavelengths, $hc/\lambda \gg kT$, show that

$$B(\lambda, T) \approx \frac{2hc^2}{\lambda^5} e^{-\frac{hc}{\lambda kT}}. \tag{1}$$

For small λ, show that

$$T = \frac{\frac{hc}{k}\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)}{\log_e\left(\left(\frac{\lambda_1}{\lambda_2}\right)^5 \left(\frac{I(\lambda_1)}{I(\lambda_2)}\right)\right)}, \tag{2}$$

where $\log_e$ is the natural logarithm, λ_1 and λ_2 are the wavelengths chosen for comparison, and $I(\lambda_1)$ and $I(\lambda_2)$ are the observed intensities at λ_1 and λ_2, respectively.

c. Evaluate the formula found in Part b for HD 33278. How does your T compare to that found in Part a?

d. What is the approximate spectral class of HD 33278?

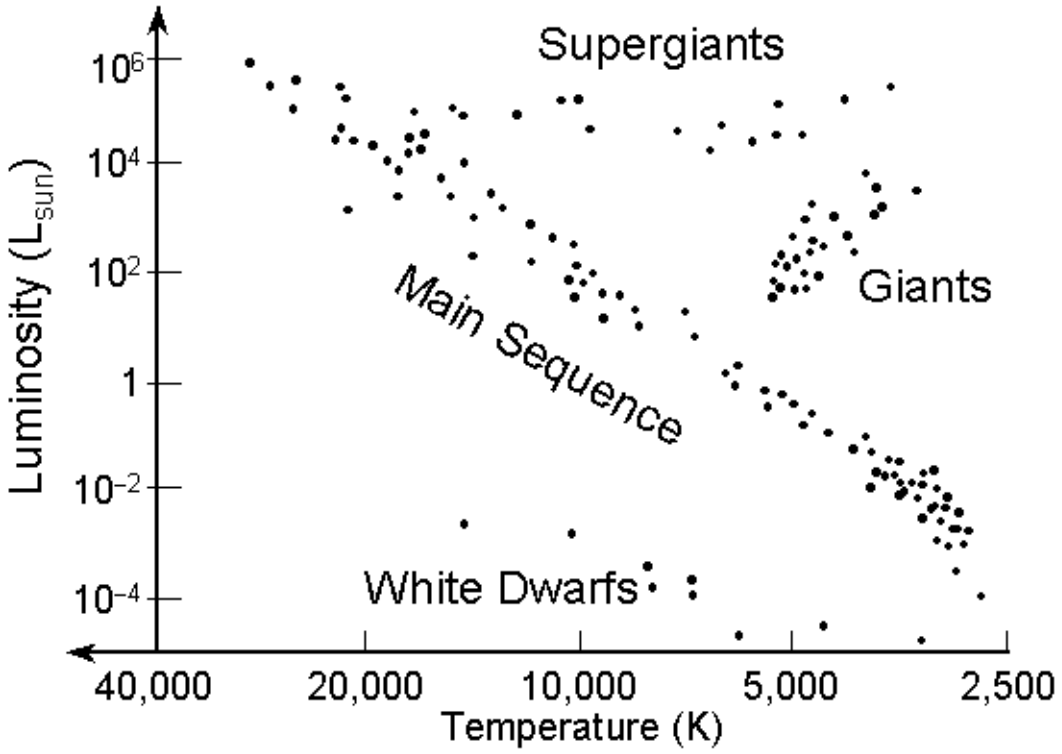
e. The *Hipparcos* satellite measured the parallax angle for HD 33278, finding $\pi = 0.00363$ arc seconds. Here, 1 arc second is 1/3600-th of 1 degree. Find the distance to HD 33278.

f. Find the flux measured at Earth for HD 33278, as inferred from the given spectrum by performing a rough integration over wavelength of the plotted spectrum. The units for the plotted spectrum are [erg per square centimeter per second per Angstrom].

g. Use your result from Part f to estimate the radius of HD 33278.

Question 2

A schematic Hertzsprung-Russell diagram constructed by plotting the luminosity of a star L_* versus its effective temperature T_{eff} is shown below.



a. The bulk of the observable stars in our Galaxy are found on the Main Sequence. Roughly, what fraction of observable stars is found on the Main Sequence and what is the significance of this result in terms of the evolution of a star?

b. Find the ratio of the radius of a K2 V (Main Sequence) star, and a K2 I (Supergiant) star. A star of spectral class K2 has surface temperature $\sim$ 5,000 Kelvin.

c. Compare the radius of a 5,000 Kelvin I star and that of a 20,000 Kelvin V star which have the same luminosity.

d. Show that $L_* \propto T_{\rm eff}^8$ looking at the plot.

e. Using this result, show that $R_* \propto L_*^{1/4}$. Given this result, how does R_* depend on M_* for stars on the lower Main Sequence, around the Sun, and on the upper Main Sequence?

Question 3, Problem 2.4

Question 4, Problem 3.8

Question 5, Problem 4.9