

Project 2

Remember to number your answers 1a, 1b., etc. so I know which questions you're answering. Be sure to show your work and reasoning for full credit.

1. You observe a star you identify to be a cepheid to have the light curve shown in Figure 1
 - (a) List the period in days and the average, maximum, and minimum apparent magnitudes. Double-check these, since your work in the next questions will depend on them!
 - (b) By what factor does the brightness change from minimum to maximum brightness? Show your work.
 - (c) Suppose the period-luminosity relation is given by

$$M_v = A(\log(P) - 1) - B,$$

where M_v is the absolute magnitude, P is the period in days, and the constants are given by $A = -2.43$ and $B = -4.05$. Using the period you found from analyzing the graph, what is the absolute magnitude of this cepheid star? (Pay attention to significant figures).

- (d) Using the distance modulus equation and the value you found for the average apparent magnitude, find the distance to the cepheid, in AU; show all work and remember significant figures.

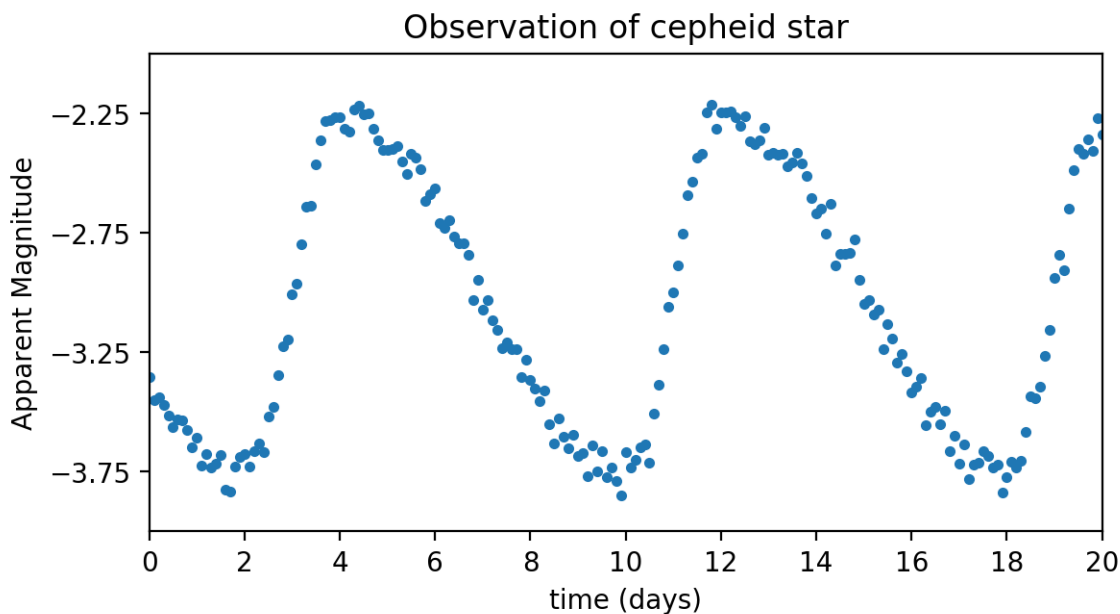


Figure 1: Apparent magnitude of a cepheid star.

2. Now we'll verify this distance calculation by comparing the star to the Sun in the equation

$$m_1 - m_2 = 2.5 \log \left(\frac{b_2}{b_1} \right) \quad (1)$$

to find its luminosity and flux, then find its distance using the relation,

$$F = \frac{L}{4\pi d^2}. \quad (2)$$

- (a) Showing your work, use the distance modulus equation to calculate the absolute magnitude of the Sun from its apparent magnitude given by $m_{\odot} = -26.7$.
- (b) Use this absolute magnitude and the absolute magnitude for the cepheid that you found in the previous problem in Equation 1 to find the luminosity of the cepheid, in units of L_{\odot} , keeping significant figures in mind and showing all work.
- (c) Showing your work and without plugging in for the luminosity of the Sun L_{\odot} , find its flux on Earth in units of L_{\odot}/AU^2 .
- (d) Repeat the same process as (b), but comparing apparent magnitudes, to find the flux of the cepheid in units of L_{\odot}/AU^2 .
- (e) You now have L_{cepheid} in units of L_{\odot} and F_{cepheid} in units of L_{\odot}/AU^2 . Plug them in to Equation 2 to find the distance d_{cepheid} . Do your results match those of Problem 1?

3. *To find out more about this cepheid, you take measurements of the cepheid's light and find that with an ultraviolet filter, you obtain a magnitude of 1.2, with a blue filter, you obtain a magnitude of 2.1, and with a yellow filter, a magnitude of 1.1. Looking at Figure 2,*
- (a) *What is the star's B-V color index?*
 - (b) *What is the star's spectral class?*
 - (c) *What is the star's approximate temperature?*
 - (d) *What is the star's peak wavelength in nm (remember Wien's Law)?*
 - (e) *What is the cepheid's luminosity class?*
 - (f) *What is the luminosity of the cepheid (in units of L_{\odot})? Does this approximately match your results in the previous section?*
 - (g) *A planet is observed (through eclipsing and spectral methods) to orbit the cepheid with a semimajor axis of 10 AU and a period of 5 years. How many solar masses is our cepheid? Show your work, and keep in mind that Newton's reformulation of Kepler's third law requires certain units to work.*

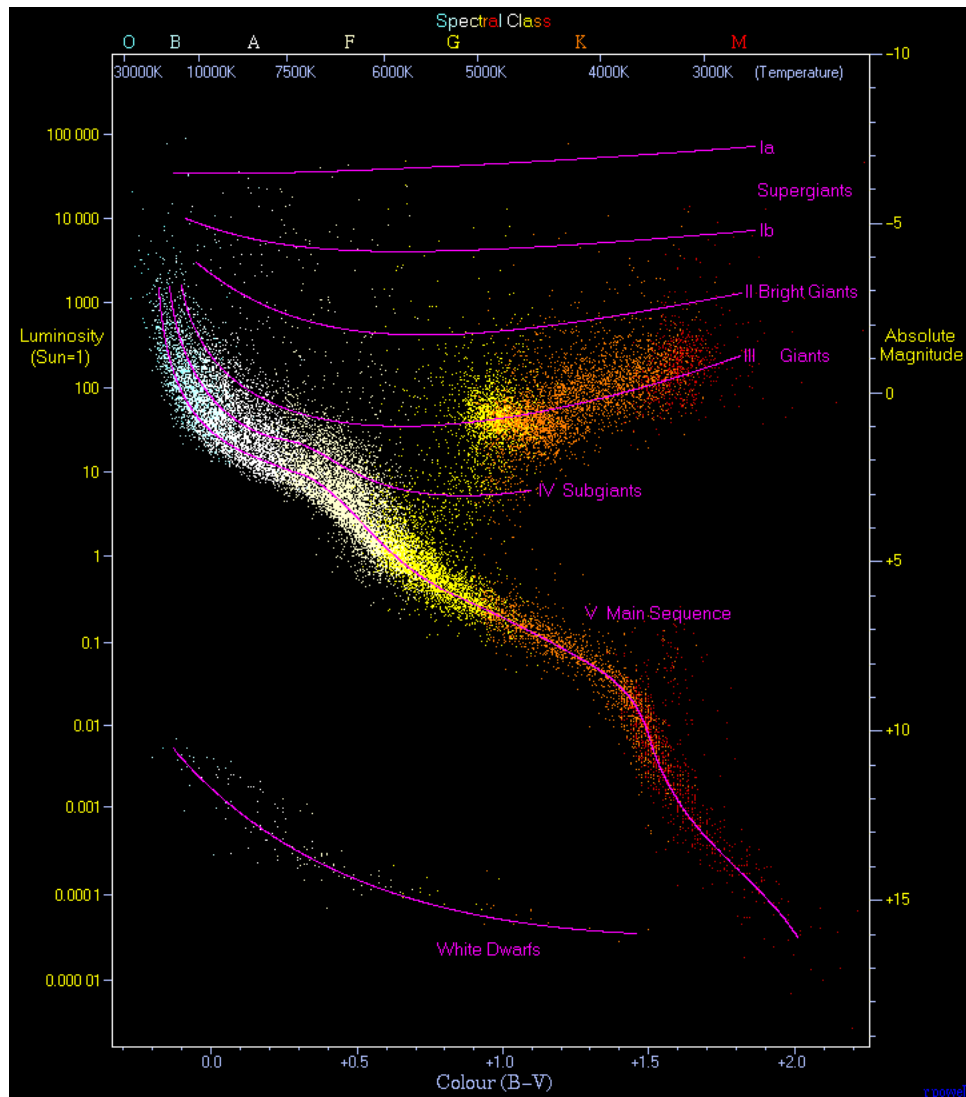


Figure 2: H-R diagram with several stars plotted. By Richard Powell - The Hertzsprung Russell Diagram, CC BY-SA 2.5, <https://commons.wikimedia.org/w/index.php?curid=1736396>