AST 207 Homework 5 Due 18 October 2010
at beginning of class.
No late papers.

1. **Hot-plate model of a star**. Imagine that you have made "stars" out of hot plates and you are plotting them on a Hertzsprung-Russell diagram

   a. (3 pts.) How can you make two hot plates with the same spectral class and differing absolute magnitude?

      Change the hot plates size. For all parts, the key idea is that the H-R diagram is a plot of absolute magnitude or luminosity $L = R^2T^4$ and temperature.

   b. (3 pts.) If you moved the hot plate to a greater distance, how would its place on the HR diagram change?

      It would not, the HR diagram depends on the absolute magnitude, not on the apparent magnitude or the stars distance from us.

   c. (3 pts.) If you turned the setting on the hot plate from "high" to "medium," how would its place in the HR diagram change?

      It would move to the right and down. Doing this would first, decrease the temperature, thus reddening the star and moving it to the right, and second, decrease its luminosity. Moving it down.

2. **Life on Deneb**. Here you will find out what it means to live near a giant like Deneb. Recall that the luminosity of a star $L = R^2T^4$, where T is its temperature and R is its radius.

Star	App. Mag.	Abs. mag.	Distance (pc)
Sun	-26.74	4.83	1/200,000
Deneb	1.25	-7.3	500

   a. In class we found that a star 10 times fainter has a magnitude +2.5 greater. This relationship between the flux f_A and f_B of two stars A and B and their magnitudes can be expressed mathematically as $m_A–m_B= –2.5 \log(f_A/ f_B)$. (3 pts.) How much brighter is Deneb than the sun if both are placed at the same distance? (2 pts.) What quantity makes this comparison in the most direct manner?

      $m_A–m_B= –2.5 \log(f_A/ f_B)$, where m_A will be Deneb, and m_B will be the sun, solving for the ratio of their fluxes, we get

$$\frac{f_A}{f_B} = 10^{\frac{(m_A - m_B)}{-2.5}} = 10^{\frac{(7.3+4.83)}{2.5}} = 71000$$

      Deneb is 71000 times as bright at the sun.

      Absolute magnitude makes this comparison in the most direct way. If you used apparent magnitude, you would have to account for distance.

   b. The temperature of the sun is 5700K, and the temperature of Deneb is 9800K. (2 pts.) How much larger is Deneb than the sun? (3 pts.) Explain the principle(s) that you use and where you got the values.

      We know $L = R^2T^4$. Use the ratio of the luminosity of Deneb to that of the sun.

$$\text{Therefore: } 71000 = \frac{{R_{Deneb}}^2{T_{Deneb}}^4}{{R_{Sun}}^2{T_{Sun}}^4} = \frac{{R_{Deneb}}^2(9800)^4}{{R_{Sun}}^2(5700)^4}$$

      Solving for the radii ratio we get:

$$\frac{R_{Deneb}}{R_{Sun}} = \sqrt{71000}\left[\frac{T_{Sun}}{T_{Deneb}}\right]^2 = \sqrt{71000}\left[\frac{5700}{9800}\right]^2 = 90$$

Deneb is 90 times the radius of the sun.

To answer this we needed to know the ratio of luminosities from part a, and luminosity's relationship to the radius and temperature of a star. The temperatures came from the data given.

c. (2 pts.) The sun subtends ½ degree in the sky. If Deneb replaced the sun, what angle would our replacement subtend? (2 pts.) Explain the principle(s) that you use and where you got the values.

The half-angle of the sun is $\theta = R/D$, where R is its radius and D is its distance. If Deneb replaced the sun, the radius is larger by a factor of 90. Therefore the angle subtended by the replacement sun is $90 \times 0.5° = 45°$.

The radius was from part b.

3. **M15.** Figure 1 is the Hertzsprung-Russell diagram of the star cluster M15.

a. (2 pts.) What is the absolute magnitude of the hottest main-sequence stars?

From the HR diagram, the hottest main sequence stars are about 3.5

b. (3 pts.) Why are there no hotter main-sequence stars?

There are no hotter stars on the main sequence because they all already used up their hydrogen cores and left the main sequence. Hotter stars use up their fuel faster.

c. Stars with a color B-V=0.6 span a range of 5 magnitudes. (2 pts.) What property of the stars accounts for this observation? (3 pts.) What is the range of this property?

Their size (or radius) accounts for this range in observation.

Since color is related to temperature, the temperatures are the same.

5 magnitudes is two steps of 2.5 mag, which is two factors of 10 in luminosity, or 10^2, or 100.

So if luminosity (L) increases by a factor of 100, and temperature (T) stays constant, then using $L = R^2T^4$, 100 = R^2, or R=10.

Therefore the radius covers a factor of 10. The radius of the giants is ten times that of the dwarfs.

M_V

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