

Ay 1 Problem Set 1 – DUE April 27

April 16, 2009

Please write the number of your section on the top of the work you turn in for this assignment.

Except for # 7, these problems should be answerable with quick back of the envelope calculations – so please don't belabor them. The point is to become agile at making such estimates and to develop physical intuition based on such estimates.

Stellar Properties – 10 pts

The star ϵ Aurigae has a parallax of 0.31 arcsec and it's emission peaks at a wavelength of 604nm. This star's apparent brightness is 6.73×10^{-13} times that of the sun.

- 1) Assuming the radius of the earth's orbit about the sun is 1.5×10^8 km, find the distance to this star.
- 2) Find the luminosity of this star (in the units of L_{sun}).
- 3) Estimate the surface temperature of the star assuming the emitted spectrum has a blackbody distribution.
- 4) Estimate the radius of the star relative to the radius of the sun ($R_{sun} = 6 \times 10^5$ km).
- 5) Draw an Hertzsprung-Russel diagram with axis values, main sequence and red giants and label the position of ϵ Aurigae.

Evolution of More Massive Stars – 10 pts

6) The central temperature of the sun is about 12×10^6 K and the core of the sun is burning hydrogen. Helium (He), on the other hand, requires much higher temperatures $\sim 100 \times 10^6$ K. Based on the properties of main-sequence stars and the scalings derived in lecture, estimate the mass (in solar units) required for a star to be able to burn helium in its center. Approximately how much more luminous is this star than the sun?

Sizes of Earth-Moon-Sun System – 15 pts

7) Use geometry, your understanding of gravity and your impressive creativity to devise techniques to **accurately** measure one of the quantities below. **Most importantly, you should devise a technique which minimizes the errors or uncertainties in the**

results and estimate the accuracy of the result – i.e. simply saying you will measure the size of the earth by walking or sailing around the globe and dividing by 2π is not sufficient.) Also, you should not simply look up standard techniques in a book or on the internet – but instead discuss creative (and hopefully new) schemes with your fellow students. (Your solution should not involve leaving the Earth or sending a spacecraft from the Earth but you can use modern communications and measurement tools on the earth with self-generated, reasonable estimates the accuracy of these tools. (Include illustrations as necessary.)

DO ONLY ONE OF a, b, or c !!

- a) Describe a technique to measure the diameter of the Earth.
- b) Describe a technique to measure the diameter of the Moon.
- c) Describe a technique to measure the distance of the Sun.