Homework 1

All Things Stars

Although the homeworks aren't graded, keep in mind that this is the only way to get comfortable with the way we ask questions on the midterm and the exam.

Opportunity to ask questions about the questions in this homework set will be given in Tutorial 3.

Problem 1: The Magnitude System

Question 1.
Explain how the scale of the magnitude system works and explain why the scale goes in the "wrong" direction compared to the conventional scales.

Question 2.
Consider the following objects.

- The Sun
- The Moon, consider the full moon
- Andromeda Galaxy
- Betelgeuse
- Supernova 1987A, use the peak apparent magnitude

Answer the following questions with these objects.

a) Look up the apparent magnitudes in the V band of the objects and arrange them from the brightest to faintest. Include the value for magnitude you found.

b) What if they were all placed at 10 parsec away from us? Calculate the absolute magnitudes of the objects and arrange them again.

Question 3.
At what distance would the Sun have to be in order for it to have the same apparent magnitude as a 100 Watt light bulb found 20 m away? Express your answer in meters, lightyears and parsec.

Question 4.
A binary star system is observed, and since the separation between the two stars is much smaller than the distance of the system from the observer, it can be that both stars are found at the same distance from Earth. For the first star, the absolute magnitude is determined to be -1.0, while its apparent magnitude is 3. If the apparent magnitude of the second star is 5, what is its absolute magnitude? At what distance, in lightyears, is the binary system from the observer?

Problem 2: Luminosity, Radius and Temperature

Question 1.
How could you estimate the temperature of a very hot object, e.g.; a metal rod, without touching it? Explain.

Question 2.
What is the luminosity of a star A with 5 times the solar temperature and ½ the solar radius? Give your answer in solar luminosities ($L_\odot$).

Question 3.
Suppose a star M is twice as hot and three times as far as a star N, but they have the same apparent magnitude. What is the ratio of their radii, $\frac{R_2}{R_1}$?

Question 4.
A red giant star has a temperature of $3500K$ and a luminosity $L = 300L_\odot$. Roughly, what is its radius in terms of solar radii $R_\odot$?

Problem 3: Distances

Question 1.
Answer the following questions regarding stellar parallax.

a) Explain the principles behind stellar parallax and how astronomers use this technique to measure astronomical distances.

b) What are the limitations of this technique?

Question 2.
Imagine a highly unlikely scenario where Earth is at its perihelion and some other planet is at its aphelion and is in conjunction with Earth. You and the observer standing on the other planet both measure the parallax angle of a known star to be 0.23 arc-seconds. You find in your favorite astronomy book that the distance to this star is 37 lightyears. What planet is the observer measuring from?

Problem 4: Hertzsprung-Russell Diagram

Question 1.
Explain the significance of the HR diagram in astronomy. How and why is it used by astronomers?

Question 2.
Make a rough sketch of a HR diagram and use it to answer the following questions.

a) Indicate where you would find the following stars;

- Hot and luminous,
- Hot and dim,
- Cool and luminous,
- Cool and dim,
- The Sun.

b) Put labels on your diagram to mark;

- The Main Sequence,
- Red Giants,
- Blue Supergiants,
- Red Dwarfs.

Problem 5: Stellar Parameters

Question 1.
Sirius A is a well known star amongst astronomy students at our University. It has a parallax of $p = 379$mas. Assume it is a spherical blackbody with radius $R = 1.711 R_\odot$ and a surface temperature $T = 9940K$. Compute the following properties of Sirius A;

- Luminosity in erg/s and $L_\odot$.
- Absolute Magnitude.
- Apparent Magnitude.
- Distance Modulus.
- Peak wavelength $\lambda_{\max}$
- Indicate on the HR diagram from the previous questions where one would find Sirius A.

Problem 6: Getting the Distance (*Last-years midterm question*)

Question 1.

a) You want to determine the distance to our neighboring disk galaxy M31 (the Andromeda Galaxy). Your method of choice would be:

- **(A)** Parallaxes
- **(B)** Cepheids
- **(C)** Type Ia supernovae
- **(D)** Hubble's Law

b) For **every** answer you have **not** chosen above, explain why this would not be the best method in 1 or 2 sentences.