Name: ____________________

Astronomy 102 Lab: Properties of Stars

Pre-Lab Assignment: We've learned in class and in lab that you can determine a great deal of information about stars by looking at their spectra. In this lab, you will be using spectra to distinguish between different types of stars and to determine properties like a star's temperature and luminosity. Answer these questions before coming to lab.

A) If a star has a measured parallax of 0.02 arcseconds, what is its distance from us? Be sure to include units. Express your answer in both parsecs and light years.

B) Write a sentence or two describing what the Earth might be like if it orbited a class B star at a distance of 1 AU (the same orbit Earth currently has)? What about a class M star?

C) Describe how you can calculate a star's temperature by analyzing the light from that star.

D) Try this math problem and make sure you can do it. (Feel free to ask!)

1.4 – x = 4.3   What is the value of x?

The data tables you are using today are also available on the course website.

http://natsci.parkland.edu/ast/102/labs/properties_unknown_spectra.jpg
http://natsci.parkland.edu/ast/102/labs/properties_known_spectra.jpg
http://natsci.parkland.edu/ast/102/labs/stardistance.html
http://natsci.parkland.edu/ast/102/labs/MagLum.html

Introduction: When you think about it, the only things we can really measure from stars are their position and their light. That's it! All the information contained in our textbooks is derived from measuring position and analyzing light throughout the spectrum. In this lab, we'll pull together several concepts we've learned so far: luminosity, parallax, the spectrum, and temperature. Consider the following scenario…

"We have a problem! We have found Earth is becoming unlivable. Pollution and the depletion of the ozone layer have made it practically impossible to live here." … OK, it's a stretch, but read on. We'll have to leave soon, and your job is to find another home. We were spoiled in that the Sun was perfect for us. Larger stars, smaller stars, hotter stars, or cooler stars would have made it difficult to live on the third planet from the Sun.

Your observing assistant (everyone should have at least one) has searched the heavens with telescopes for a year's time. We have narrowed down our search to nine nearby stars. Your job is to reduce the data and determine which star is most like the Sun.

Data: The apparent magnitude (m) and parallax (in arcseconds) for each star is listed in the table below.

Star	Apparent Magnitude	Parallax
Example	1.0	0.045"
1	2.4	0.020"
2	4.3	0.120"
3	3.5	0.018"
4	4.0	0.037"
5	3.4	0.108"
6	4.7	0.022"
7	3.1	0.004"
8	1.8	0.029"
9	2.8	0.014"

The spectrum of each star will be available on the lab table.

Data Reduction: Choose a spectral type for each star by comparing the star's unknown spectra to the sequence of known spectral types shown on the lab table. From this chart, record the star's spectral type and temperature in the data table on the next page. The example shows a star whose absorption lines match those of a B5 star.

Recall that the distance to a star (in parsecs) may be determined after measuring its parallax. We used the following equation in the previous lab:

$$\text{Distance (pc)} = 1 / \text{parallax (")}$$

Calculate the star's distance (in parsecs) and record it in the data table on the next page. Remember that if you want to know the star's distance in light years, you can multiply its distance in parsecs by 3.26 to get the distance in light years. The example star has a parallax of 0.045", which corresponds to a distance of 22.2 pc or 72.4 ly.

Once we know the distance to the star and the apparent magnitude (m), we can calculate the absolute magnitude (M), or the "true brightness" of the star. Recall that the quantity, m – M, literally "m minus M," is called the "distance modulus" and is important for determining distance. If you know the distance, d, you can find the value of the distance modulus, m – M. If you know how to use logarithms, you can use this equation.

$$\log_{10} d = [(\mathrm{m} - \mathrm{M}) + 5] / 5$$

If you don't know how to use them, please use the table of distance moduli and distances provided. **Note:** If the distance is between the values given in the table, you will get a more accurate result if you estimate the distance modulus in that range, rather than choosing the value that corresponds to the nearest distance listed.

The example star's distance of 22.2 pc is close to 22.8 pc on the table, so we estimate that m – M = 1.73 instead of 1.8.

After finding the distance modulus and the apparent magnitude, you can calculate the absolute magnitude, M, using algebra. It will follow the method you calculated in the pre-lab, recalling that m – M means "m minus M." In the case of the example, m = 1.0, so 1 – M = 1.73. Thus, M = 1 – 1.73 = -0.73.

You can now use the absolute magnitude to estimate the star's luminosity, L, in terms of the Sun's luminosity, $L_\odot$. For example, if a star had the same brightness as the Sun it would have a luminosity of 1.00 $L_\odot$. Refer to the second table showing luminosities and magnitudes. **Note:** Again, you will get better results if you estimate rather than using the nearest value. **Our example star has a luminosity between 132 $L_\odot$ and 209 $L_\odot$, so we estimate its luminosity as 167 $L_\odot$, meaning it's over 150 times brighter than the Sun!**

After following the instructions above and filling in the data table, answer the questions at the end of the lab. Note especially how much information you can derive from the initial data. This is how we get all the information for that expensive textbook!

Data Table:

Star	Spectral Type	Temperature	Distance	m – M	M	Luminosity
Example	B5	19,000 K	22.2 pc	1.73	-0.73	167 $L_\odot$
1						
2						
3						
4						
5						
6						
7						
8						
9						

Questions:

1. Which star is the hottest?

2. Which star is the nearest?

3. Which star is most luminous?

4. How is it possible for a star to have a high luminosity but a low temperature? Explain your answer.

5. Considering both luminosity and surface temperature, which star is most like the Sun?

6. What is this star's luminosity, in terms of the Sun?

7. How far away is this star? Answer in units of light-years. (1 parsec equals 3.26 light-years.)

8. If "current" technology would allow us to travel through space at half of the speed of light, how much time would it take a scouting party to get to this star? (Hint: Think about how many light-years a craft would travel in one year at that speed.)

9. Which spectral type has the strongest metal absorption lines?

10. Which spectral type has the strongest hydrogen absorption lines?

11. All stars are essentially made up of the same materials. However, stars with different temperatures have very different spectra. Explain how the temperature of a star makes absorption lines stronger or weaker.

12. Describe in a few sentences what a world located 1 AU from star #4 might be like.