NAME: _____ DATE: _____

Photographing the Constellation Cassiopeia

In this observing lab, you will photograph the constellation of Cassiopeia, examining the different colors and temperatures of the stars, and create a star trails image

Procedures for Photographing the Cassiopeia Constellation

1. At Night: Photographing the Constellation Cassiopeia.

Dr. Segre will help you with setting up the camera and computer to do this, but there are several things to pay attention to. The most important is the **exposure time** of the camera. The exposure time is how long the camera is recording the image. In normal daytime photography, in sunlight for instance, typical camera exposure times are only about $1/100^{th}$ of a second. At night however, because there is so little light, the camera needs much longer exposure times to collect enough light to form an image. Typical exposure times for star photography are 5 - 30 seconds.

1. Look towards the North East and locate the constellation Cassiopeia by eye. Cassiopeia looks like a distinctive "W" on its side in the sky. Check with the SkySafari app to make sure you see it.

2. Once you've found Cassiopeia, point the camera in its direction and take a series of test photographs with a short, 5 second, exposure while you move the camera around until you are sure that the whole constellation is in the field of view of the camera. Finally, increase the exposure time to 30 seconds and take a photo. You should able to see in the photograph most, if not all, of the stars that make up the constellation.

3. To make a star trail image of Cassiopeia, you will need to take consecutive photos of Cassiopeia over a 15 minute period. For example, if you find that you get a good single image with an exposure time of 30 seconds, then take 30 consecutive images, one after another, for 15 minutes total. This process can be done automatically using the intervalometer device that plugs into the camera. Later on, back in the lab, you will take those 30 images and create a star trail image using the software program StarStax.

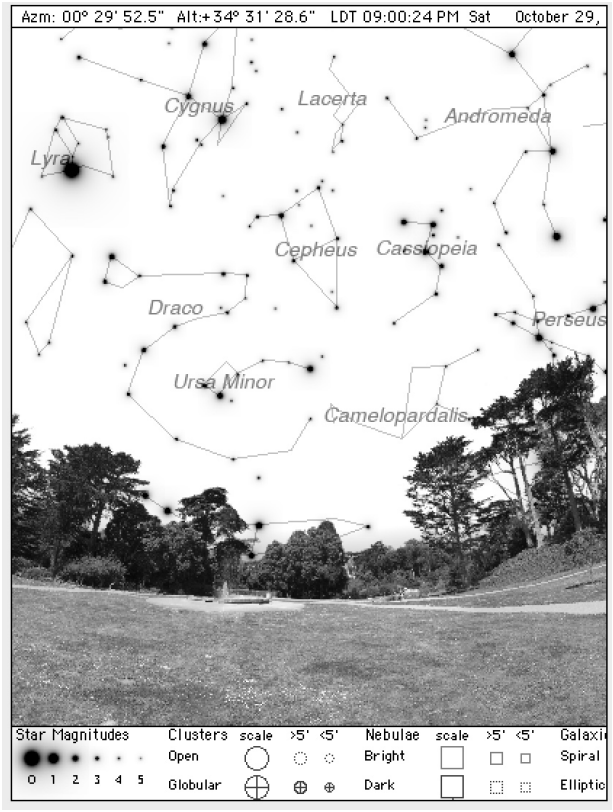


Photo Analysis Back in the Lab

To complete this observational lab, you will need to do two things:

1. Create an image of the constellation Cassiopeia with the names of all of the stars labeled.

2. Create a star trails image of Cassiopeia.

You will first need to get all of the photos that you took. To do that, go to the class webpage at **www.philsegre.com** and course **Intro. to Astronomy ASTR116 → ASTR116 Fall 2019**. Download the photos for your group onto your computer.

SLIDE #1: Photograph of Cassiopeia

Choose any one of your photos of Cassiopeia. The goal is to identify and label the main stars in the constellation Cassiopeia. To do this you will need to be able to write text and draw lines on the image, and this can be easily done in Powerpoint.

1. Click to open the first image that you took of Cassiopeia and try try increasing the **Brightness** and the **Contrast** to improve the brightness and visibility of the stars. Save the edited image.

2. Download and opening the file **Constellation-Lab-Template.pptx** from the class webpage.

3. Drag the constellation image onto the first powerpoint slide rescale the image to fill almost the entire page.

   (a) To properly label the stars in your photo, open the SkySafari app on your phone, set the time to the exact time the photo was taken, and scroll over to Cassiopeia.

   (b) If you don't see the constellation lines in SkySafari, goto **Settings→Constellations** and turn **Show Constellations** ON.

   (c) By comparing side by side your photo and the image in SkySafari, you should be able to identify the names of the 5 main stars in Cassiopeia; Caph, Shedar, Navi, Ruchbah and Segin.

   (d) Draw the outline of the constellation with white lines connecting between the constellation stars. Make sure that the lines that you draw do not cover over the stars, the stars should always be visible!

   (e) Write, using a textbox, the *names* and *temperatures* of the 5 main stars in Cassiopeia; Caph, Shedar, Navi, Ruchbah and Segin.

   (f) Put your name, photograph date and time, and constellation name on the Powerpoint slide.

SLIDE #2: Star Trails Image of Cassiopeia

To make a star trail image from your collection of sequential photos, use the software program **StarStax**.

1. Download and install the program StarStax from the link on our class webpage.

2. Begin by opening the StarStax program. Choose **File⇒Open Images** and select all of your Cassiopeia images. You should now see them all listed on the left panel of the program.

3. Click on the top purple icon on the upper right of the program window, this brings up the analysis panel.

4. Look on the panel on the right, make sure that the **Blending Mode** is set to **Lighten**. This is the option to make a star trail image.

5. Click on **Edit⇒Start Processing**. You should now see the star trails image on the screen.

6. Click on **File⇒Save As** to save your image.

7. Click to open your new star trails image and try editing the photo to make it brighter or improve the contrast, then save the edited image.

8. Put your star trail image onto the second powerpoint slide and resize the image to fit.

9. Put your name, date, and an appropriated title on the slide.

Star Colors, Distances, and Temperatures

1. Fill in data Table 1 using information found by selecting each star and looking at its Info page on SkySafari.

Table 1: Stars in the Constellation of Cassiopeia

Look up the information below from the SkySafari info pages for these main stars in Cassiopeia

Star	Distance d (pc)	Visual mag. m	Absolute mag. M	Luminosity (*Suns Visual)*	Temperature T (K)	Spectrum OBAFGKM	Main Sequence *or* Giant
Caph							
Shedar							
Navi							
Ruchbah							
Segin							

2. Fill in data Table 2 by (a) writing in the values for D/D_{sun} from the SkySafari info page for each star, (b) Calculating T/T_{Sun} using the value $T_{Sun} = 5780$K, and (c) Using columns 1 and 2 to calculate the star luminosities L/L_{sun}. Do your calculated luminosity values agree well with those listed in SkySafari from Table 1?

Table 2: Calculating star luminosities

Star	Diameter D/D_{Sun}	T/T_{Sun}	$\frac{L}{L_{Sun}} = \left(\frac{D}{D_{Sun}}\right)^2 \times \left(\frac{T}{T_{Sun}}\right)^4$
Caph			
Shedar			
Navi			
Ruchbah			
Segin			

3. Use the values for the apparent and absolute magnitudes m and M listed in Table 1 to calculate the star distances d using the magnitude distance relationship. Show all work. How do your calculated distances compare to those given in SkySafari?

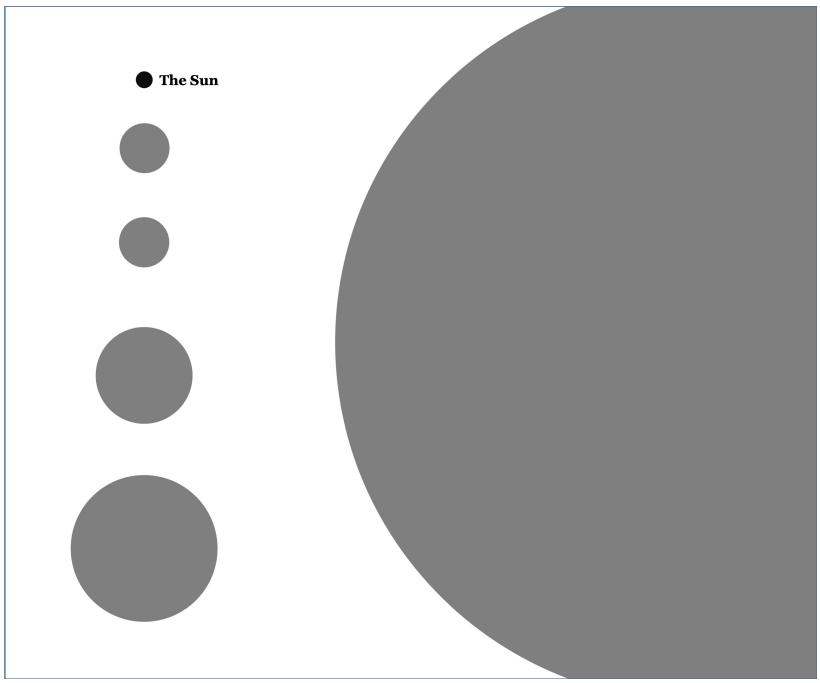
Table 3: Calculated star distances

(*Use the magnitude-distance relation* $d = 10^{1+0.2(m-M)}$)

.

Star	Visual mag. m	Absolute mag. M	Calculated Distance d (pc)
Caph			
Shedar			
Navi			
Ruchbah			
Segin			

4. The diagram below contains circles that represent the relative sizes of the stars in Table 1. Label the circles with the corresponding star names they represent.



5. Looking at the table, which stars in the Cassiopeia constellation appear to be the brightest, and dimmest, *as seen from Earth*?

6. If all of the stars in Cassiopeia were moved so that they are all *exactly the same distance away from us*, which star would be the brightest, and which would be the dimmest?

7. Compare the relative brightnesses of the stars Caph and Navi in your photographs. Is one star much brighter than the other or are they of similar brightness? Now look at their luminosities as listed in Table 1, which are vastly different. How is that possible? Explain.

8. If our Sun were moved out to *the same distance* as Caph is, would it appear to us on Earth to be brighter or dimmer than Caph? Explain how you can determine this using the data in Table 1.

9. Now calculate how bright our Sun would appear if it were moved out to *the same distance d* as Caph. To do that, we can rearrange the magnitude-distance relationship to solve for the apparent magnitude m of a star based on its absolute magnitude and distance d (in pc). *Note that the Sun has an absolute magnitude of $M = 4.83$. Comparing the Sun's apparent magnitude m to that of Caph, which one is brighter?

$$m = 5 \times \log(d) + M - 5$$

10. Given the value of the apparent magnitude m for our Sun at the distance of Caph, do you think it would be visible in the photograph that you took? Explain your reasoning why or why not.

11. Look at your star trails image. Are all of the line segments the same color? Explain the trends that you see in terms of the star temperatures.

12. Using the colors of the star trails as a guide, find 2 stars (other than those listed in Table 1) that are very hot and have temperatures greater than 12,000K. Label these stars in your photograph and fill in their information the Table below using data from SkySafari. Do the same things for 2 very cold stars, with temperatures less than 6,000K.

Table 4: Star Colors and Temperatures

	Star Name	Temperature	Star Trail Color
Hot Star #1 (T >12,000K)			
Hot Star #2 (T >12,000K)			
Cold Star #1 (T <6,000K)			
Cold Star #2 (T <6,000K)			