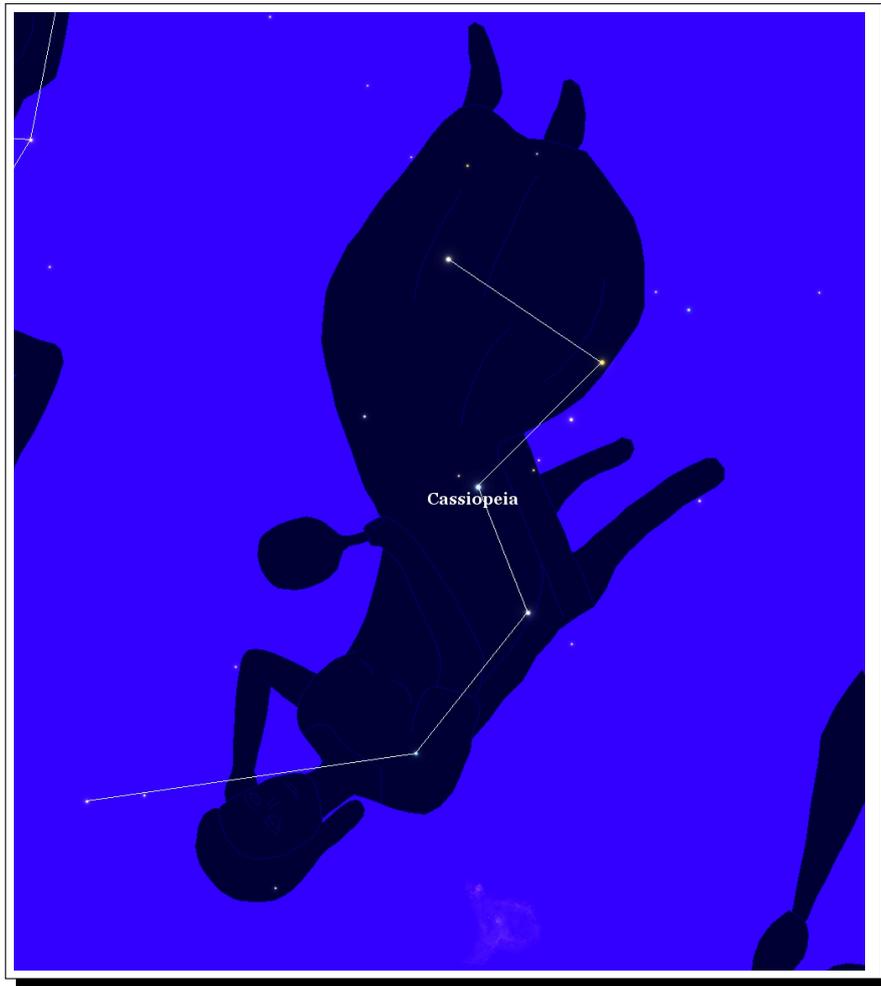


NAME: _____

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 be 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.

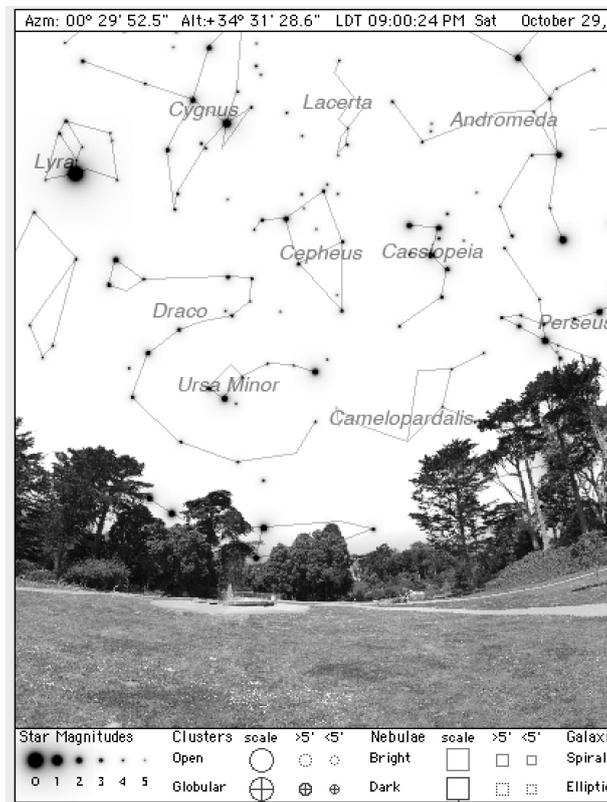


Photo Analysis Back in the Lab

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 2017**. 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. Begin by downloading and opening the file **Constellation-Lab-Template.pptx** from the class webpage.
2. Drag any one of your Cassiopeia images onto one of the pages and rescale the image to fill almost the entire page. To increase the brightness of the image, **right click on the image** then choose **Format Picture**, then try increasing the **Brightness** and the **Contrast** to improve the brightness and visibility of the stars.
 - (a) To properly label the stars in your photo, open the Skygazer program, set the time to the exact time the photo was taken, and scroll over to Cassiopeia. By comparing side by side your photo and the image in Skygazer, you should be able to identify the names of the 6 main stars in Cassiopeia; Caph, Shedar, Navi, Ruchbah, Segin and 50 Cassiopeia.
 - (b) 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!
 - (c) Write, using a textbox, the *names* and *temperatures* of 6 main stars in Cassiopeia; Caph, Shedar, Navi, Ruchbah, Segin and 50 Cassiopeia.
 - (d) Put your name, photograph date and time, and constellation name on the Powerpoint slide.

SLIDE #2: Rotating Sky: Star Trail 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 StarStax. 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, 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. To help improve the contrast of your star trail image, you can also subtract from your star trails image a picture of the average background sky (i.e. the sky without the stars). To do that, clear out all of the images in Starstax and load in only two images: (1) Your star trails image and (2) the file *Background-Sky.jpg* found in your picture folder. Change the blending mode in Starstax to *Subtract* and click on **Edit** ⇒ **Start Processing** (note that if the screen is totally black, check the box *process images in reverse order*). You should now see your star trail image with a much darker background to it.
8. Put your star trail image onto the second powerpoint slide and resize the image to fit.
9. To increase the brightness of the image, **right click on the image** then choose **Format Picture**, then you can increase the **Brightness** and **Contrast** to whatever you think improves the image quality.
10. Put your name, date, and title on the slide.

Star Colors, Distances, and Temperatures

Use the SkySafari app on your phone, or Skygazer/Voyager on your computer, to fill in the information about the following stars in Cassiopeia.

Table 1: Data from Skygazer on the Stars in the Constellation of Cassiopeia

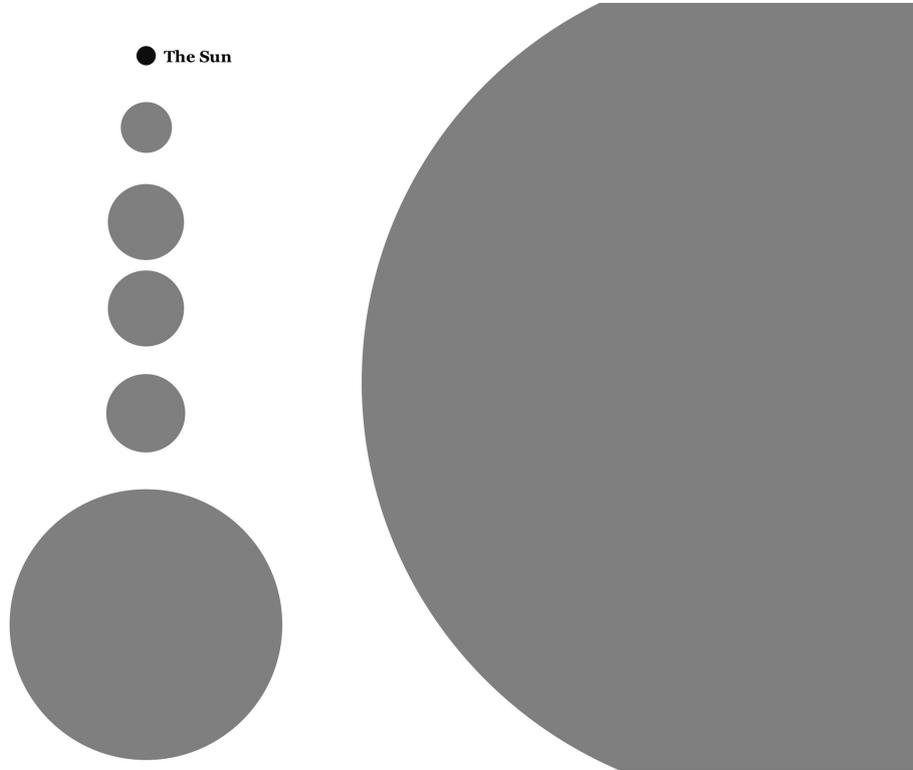
Star	Distance	Radius (Sun=1)	Temperature	Luminosity (Sun=1)
Caph				
Shedar				
Navi				
Ruchbah				
Segin				
50 Cassiopeia				

Table 2: Calculating the Luminosity of Stars in the Constellation of Cassiopeia

Star	r/r_{Sun}	T/T_{Sun}	Luminosity $L = \left(\frac{r}{r_{Sun}}\right)^2 \times \left(\frac{T}{T_{Sun}}\right)^4$
Caph			
Shedar			
Navi			
Ruchbah			
Segin			
50 Cassiopeia			

1. Fill in data Table 1 using information found in Skygazer/Voyager for the main stars in Cassiopeia.
2. Fill in data Table 2 by (a) writing in the values for r/r_{sun} from Table 1, (b) Calculating T/T_{Sun} using the value $T_{Sun} = 5800K$, and (c) calculate the star luminosities L from the first two columns. Do your calculated values for L agree with the values from Skygazer/Voyager listed in Table 1?

3. 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.



4. Compare the relative brightness 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?
5. Look at your star trails image. Are all of the line segments the same color? Explain what you see in terms of the star temperatures.

6. 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 in Table 3 using data from Skygazer/Voyager. Do the same things for 2 very cold stars, with temperatures less than 6,000K.

Table 3: Star Colors and Temperatures

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