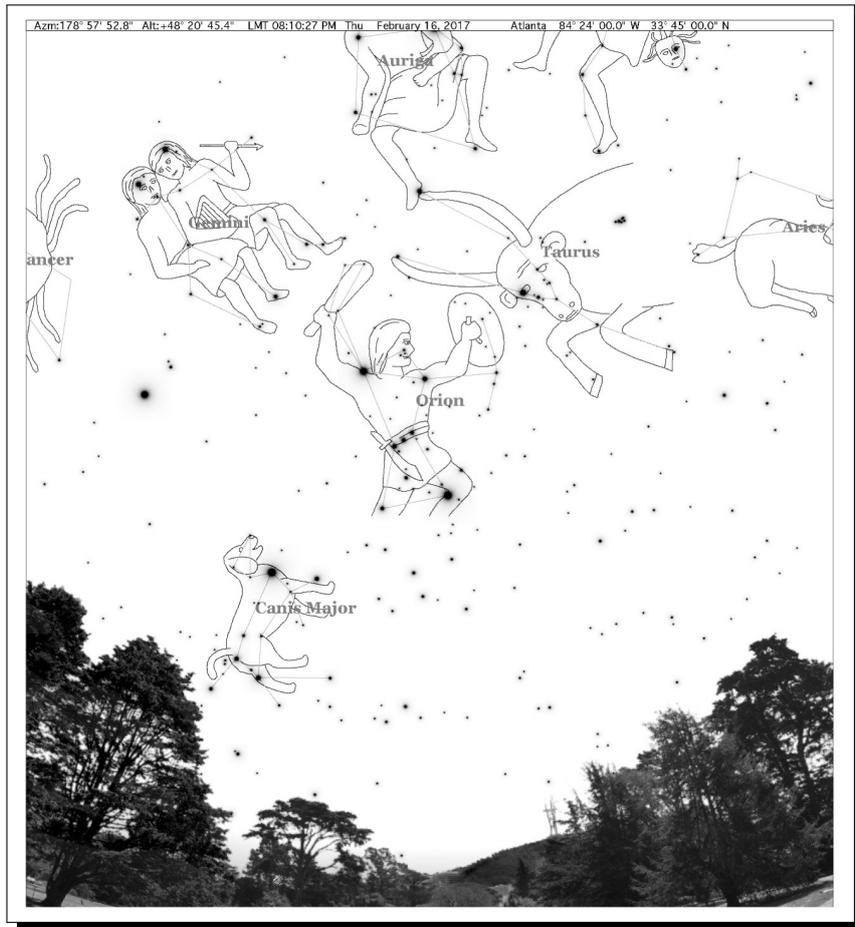


NAME: _____

DATE: _____

Observing Lab: The Orion Constellation

In this observing lab, you will photograph 2 different constellations and create a time lapse, star trails, image.



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Procedures for Photographing the Night Sky

1. Photographing the Constellation of Orion

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 SouthEast and locate the constellation Orion by eye. Look for Orion's belt, the three bright stars in a line located in the middle of the constellation. Dr. Segre can help with this, and you can also use the Skygazer planetarium program.
2. Once you have found Orion, point the camera in its direction and take a series of test photographs with a 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 10-20 seconds and take a single bright image of the Orion. You should be able to see in the photograph most, if not all, of the stars that make up the constellation.

2. Photographing a Second Constellation

Your next task is to photograph another constellation of your choosing. Listed below are constellations that should all be visible in the night sky. Begin by consulting the Skygazer program, or the SkySafari app on your phone, to find what exactly the constellations look like, and where they are in the sky. Each of these constellations will fit in the field of view of the camera.

South - Orion, Auriga

East - Gemini

North - Cassiopeia, Ursa Minor (the little dipper)

West - Perseus

1. Use the same procedure that you used above for the Orion constellation to capture a single 10-20 second long exposure of your chosen constellation.

3. Making a Star Trails Image

You will now make a star trails image (see the cover image for an example) of your chosen constellation. A star trail image is created by taking a series of photographs over several minutes of the same region of the sky (i.e. the camera never moves). Over time, as the Earth rotates, the stars will move slightly across the camera image. After you obtain the images, you will use a software program, StarStax, to 'stack' all of the photographs on top of each other and create a single star trails image.

Star trail images are a great way of demonstrating the rotation of the night sky over time. It's important to note that the actual appearance of star trails will vary according to where you're looking. The cover photograph shows an example of one looking North, and the North star Polaris is in the center of the 'spiral'. A circular type pattern will also occur if looking South, although the center of the 'spiral' is below the horizon. If you look East or West, the trails should look more vertical as stars rise upwards or set downwards.

1. You should use the same constellation that you used in part 2 above to make a star trails image. Use the same camera settings that you used in part 2 to capture the images. The procedure is to take consecutive images, without moving the camera, for a period of about 12 minutes. For example, if you find that you get a good single image with an exposure time of 20 seconds, then take 36 consecutive images, one after another, for 12 minutes total. Later on, back in the lab, you will take those 36 images and create a star trails image using StarStax.

Analysis Back in the Lab

To complete this observational lab, you will need to identify the brightest stars that make up the 2 constellations, Ursa Major and Orion, as well as to construct a star trail image from the sequential photos of Orion.

Constellation Photographs: You should have 2 photographs from parts 1 and 2 above - one of the Orion constellation, and one from Ursa Major. You are to label on the figures the names of the major stars in the constellations, as well as to draw in the constellation lines as they appear in the Skygazer program. To do this you will need to be able to write text and draw lines on the jpg's, and this can be easily done in Powerpoint.

1. The procedures are the same for both photos. Begin by opening the Powerpoint template file for this lab which can be downloaded from our class webpage at www.philsegre.com. Insert onto the first slide a photograph of the Orion constellation and rescale the image to fill the entire slide. To properly label the stars in your photo, open the Skygazer program, scroll over to Orion and, by comparing side by side your photo and the image in Skygazer, you should be able to identify the constellation stars.
 - (a) Draw the outline of the constellation with white lines connecting between the constellation stars.
 - (b) Write, using a textbox, the names of the brightest stars seen on your constellation slide.
 - (c) Repeat this procedure for one of the photos of Ursa Major.
 - (d) Put your name and the constellation name somewhere on each slide.

Star Trails Image: You can make a star trails image from your collection of sequential photos using the software program **StarStax**.

1. Begin by opening the program, choose **File** ⇒ **Open Images** and select all of the images of the Orion constellation. You should see them all listed on the left panel of the StarStax program.
2. 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.
3. Click on **Edit** ⇒ **Start Processing**. You should now see the star trails image on the screen.
4. Click on **File** ⇒ **Save As** to save your image.
5. Insert the star trails image of the Orion constellation onto the third powerpoint slide and rescale the image to fill the entire slide.
6. Put your correct name, date, and title on the slide.

7. Finally, save the Powerpoint file containing your 3 slides, and change the names of the file to include your name, like **Smith-Orion.ppt**, and email it to me.

Star Colors, Distances, and Temperatures

You might have noticed that the stars, and the stars trails, display a variety of colors. We will talk about this much more when we talk about stars later in the semester but for now, you can examine whether there is any correlation between the colors of stars and their temperatures.

Examine your image of the constellation Orion, open up the Skygazer program, and set the time and date to that of the photo and locate the constellation Orion. You can find the surface temperature of any star by clicking on it in Skygazer, and then on the popup Info panel, click on the Physical tab. You will see listed the Temperature of that star. Examine the brightest stars on your photo, and fill in the table below.

Table 1: Stars in the Constellation of Orion

Star	<i>m</i>	<i>d</i> (pc)	<i>M</i>	<i>L/L_{Sun}</i>	Temperature	Spectral Type	MS/Giant
Betelgeuse							
Bellatrix							
Saiph							
Rigel							
Tabit							
<i>belt-Alnitak</i>							
<i>belt-Alnilam</i>							
<i>belt-Mintaka</i>							

1. Looking at the table, which stars in the Orion constellation are the brightest and dimmest *as seen from Earth*?
2. If all of the stars in Orion were moved so that they are all *exactly the same distance away from us*, which star would be the brightest, and which the dimmest?
3. Use the listed values for the apparent and absolute magnitudes m and M for Betelgeuse to calculate its distance d using the magnitude distance relationship. Show all work. How does your calculated distance compare to the value listed in Skygazer?
4. If our Sun was moved out to the same distance as Betelgeuse is, would it appear to be brighter or dimmer than Betelgeuse? Explain how you can determine this using the data in Table 1.
5. Now calculate how bright our Sun would appear if it were moved out to the same distance d as Betelgeuse. To do that, we can rearrange the magnitude distance relationship so solve for the apparent magnitude m as a function of the Sun's absolute magnitude M and distance d ,

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

6. Given the value of the apparent magnitude m for our Sun at the distance of Betelgeuse, do you think it would be visible in the photograph that you took? Explain your reasoning.

7. 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 and give an example of two stars with different colors and temperatures.