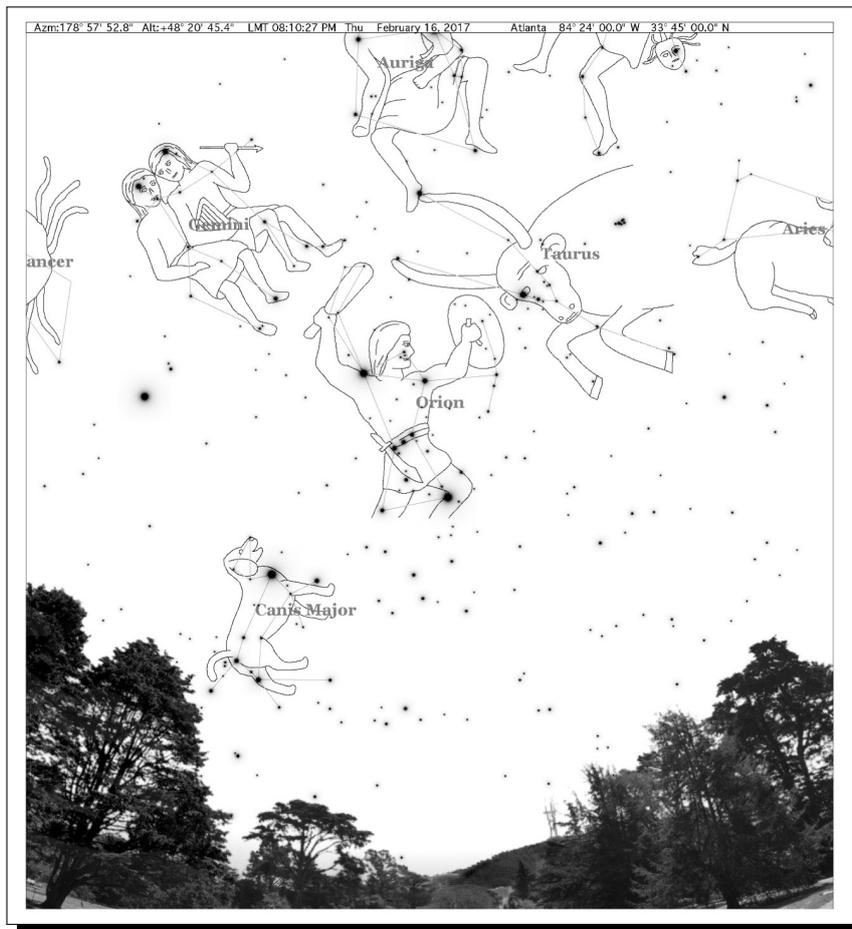NAME: ——————————————— DATE: ———————————————

Observing Lab: The Orion Constellation

In this observing lab, you will photograph the Orion Constellation and create a time lapse, star trails, image.

Contents

Procedures for Photographing the Night Sky

1. Photographing the Constellation of Orion

Dr. Segrè 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 SkySafari planetarium phone app.

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 30 seconds and take a single bright image of the Orion. You should able to see in the photograph most, if not all, of the stars that make up the constellation.

2. 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.

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 Orion constellation, as well as to construct a star trail image from the sequential photos of Orion.

Orion Constellation Photograph: From your photograph of Orion above you are to label on the names of the major stars in the constellation, as well as to draw in the constellation lines as they appear in the SkySafari phone app. 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 SkySafari app, find Orion and, by comparing side by side your photo and the image in SkySafari, 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) Label, using a textbox, the names of the brightest stars listed in Table 1 on your photograph.

    (c) Put your names and the constellation name on the 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. Open the image in any photoviewer and try adjusting the brightness/contrast to improve the image quality

6. Insert the star trails image of the Orion constellation onto the third powerpoint slide and rescale the image to fill the entire slide.

7. Put your correct name, date, and title on the slide.

8. Finally, save the Powerpoint file containing your 2 slides, and change the names of the file to include your names, 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 have talked about this in class and from your photos 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 SkySafari app, 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 the SkySafari app, and then then using the Info panel page. 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	Visual Magnitude m	Distance d (pc)	Absolute Magnitude M	Luminosity (*Suns Visual*)	Temperature (^{0}K)	Spectrum OBAFGKM	Main Sequence *or* Giant
Betelgeuse							
Bellatrix							
Saiph							
Rigel							
Tabit							
belt-Alnitak							
belt-Alnilam							
belt-Mintaka							

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 SkySafari?

$$d = 10^{1+0.2(m-M)}$$

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.