Spring 2023

Astronomy 102 Lab: The Celestial Sphere and Coordinates

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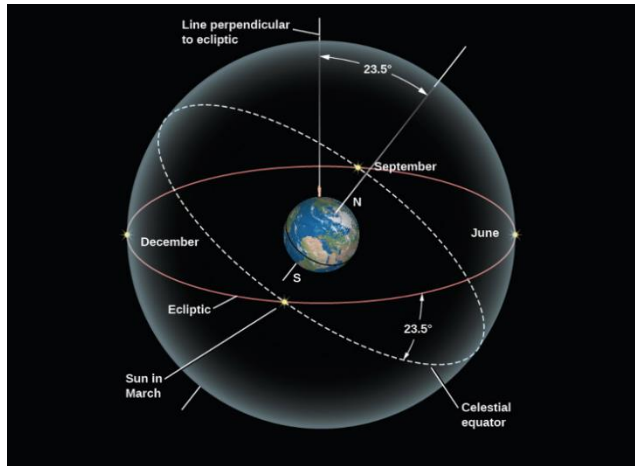
Astronomy 102 Lab: The Celestial Sphere and Coordinates

Introduction: The idea of a celestial sphere has been around for centuries. In the 4th century BC, Aristotle, a Greek philosopher and astronomer, believed that the celestial sphere was a kind of map for tracking the motions of astronomical objects. At that time, many astronomers believed that the stars were fixed points on a sphere that revolved around the stationary Earth. Although many of the ideas and models of Aristotle and other ancient astronomers are incorrect compared to our modern knowledge, the idea of a celestial sphere is still useful to consider in some sense. In this lab, you will explore ideas related to the celestial sphere by making your own observations on Stellarium.



Pre-Lab: Answer the following questions before starting the lab

a. **Why could the concept of stars being fixed on a celestial sphere be useful to consider in modern astronomy?**

b. **Do you think that the stars remain in constant positions in our sky? For example, do you think that in five years, the sky will look how it does today?**

Procedure: Open Stellarium. You can take the program out of full screen by pressing F11 (you may need to also hold down the fn button). Make sure that the location is set to Champaign. Change the date and time to the following:

Date: September 30th (09-30) of the current year
Time: 9 PM (21:00:00)

Open the Configuration window and select the Information tab. Uncheck every box for the "Displayed fields" except for the following: Name, Azimuth/Altitude. Make sure to keep the field of view (FOV) at 60˚. Move the sky so that you are facing to the east.

1A. What happens to the stars after pressing the speed up button (shortcut "L") three or four times? Describe the motion of the stars.

1B. Repeat part A facing the western sky. How does the motion of the stars change? Describe.

1C. Repeat part A facing the northern sky. How does the motion of the stars change? Describe.

1D. Repeat part A facing the southern sky. How does the motion of the stars change? Describe.

2. From what you have observed in question 1, do the stars remained in fixed positions to

one another (moving in the same direction and maintaining the same spacing between stars) or do they moved independently (moving different directions and changing location in respect to other stars)?

3. Why do you think the motion of the stars change depending on where you look in the sky?

4. Do you think that people would see the same motions you observed in each direction of the sky no matter their location on Earth? Explain.

Go into the Date and Time and make sure it is reset to these conditions:

Date: September 30th (09-30)
Time: 9 PM (21:00:00)

Now having observed stars from our time, you will look at the sky in the past. Set the year to -55,000.

5. What does the Big Dipper look like? Does it look like what we see today? If you are having trouble finding it, type in "Alkaid" in the Stellarium's search feature. Alkaid is the star at the end of the handle of the Big Dipper.

For the following question, change the year to 500.

6. What does the Big Dipper look like? Does it look like what we see today? Does it look different from what it looked like earlier in the past (question 4)?

7. Based on your observations, do you think the sky will look different thousands of years in the future or the same? Explain.

8. Based on your observations, do you think the sky will look different 100 years in the future or the same? Explain.

9. Based on your observations, why do you think that the celestial sphere could still be useful in astronomy?

Barnard's star is a useful star to look at to better understand the motion of the stars. Find it by using the search function.

This time we will travel to the future. Open the Date and Time window again. Click on the year so that your cursor is there. Now hold the page up button on your keyboard. You should see the year quickly increasing.

10. What do you notice about the motion of Barnard's star? Does it stay in a consistent place compared to other stars? Explain your observations.

The motion of Barnard's star is an example of *proper motion*. Proper motion is a transverse motion, meaning a movement across the celestial sphere as opposed to a movement towards or away from us.

The location of a star with a high proper motion, like Barnard's star, changes position on the celestial sphere relative to other stars.

Reset the Date and Time back to September 30th at 9 PM (21:00:00).

Azimuth is a celestial coordinate that is based on the cardinal directions. Azimuth increases in the clockwise direction, the azimuth being 0° in the north, 90° in the east, 180° in the south, and 270° to the west. There is a total of 360°, though no astronomical object has the azimuth of 360° because at that point that object the northern direction, which is 0°. Azimuth is abbreviated as Az.

Altitude is a celestial coordinate that is based on the angle to the horizon. At the horizon, the altitude is 0°. At the top of the sky, the zenith, the altitude would be 90°. Objects that are below the horizon have a negative value, which can go as low as -90°. Altitude is abbreviated as Alt.

Now you will make some observations regarding azimuth and altitude.

11A. What bright object is close to 180° azimuth?

11B. Note the azimuth and altitude for this object.

Open the Location window and search for Belize City. Stellarium has a map next to the Location search feature with an arrow pointing towards your current location.

12A. What do you notice about the location of Belize City on the map compared to Champaign?

12B. At Belize City, note the azimuth and altitude of the object from question 11.

12C. What has changed in the azimuth and altitude? Why do you think the location of this bright object in the sky changed in this way?

Open the Location window and return to Champaign. Now search for Denver and move your location there.

13A. What do you notice about the location of Denver on the map compared to Champaign?

13B. At Denver, note the azimuth and altitude of the object from question 11.

13C. What has changed in the azimuth and altitude? Why do you think the location of this bright object in the sky changed in this way?

14. Why do you think astronomers use azimuth and altitude? Explain.

15. How do you think azimuth and altitude applies to the celestial sphere?