The Care and Feeding of Your Observing Notebook

Materials: One spiral-bound notebook

Your observing journal is your primary record of your astronomical observations, analysis, and in-class work. A log of observations is important to remind yourself of what you did and for use in interpretation of your observations at a later date. Maintaining an accurate log is very important. You will need this information for your analysis, and you can certainly guarantee that you won't remember the details of each observation in a few weeks time.

In Class Work

On cloudy nights (hopefully not too many), we will be working with various methods of astronomical analysis using the AIP4WIN V2 program. The program is available on the class website. The syllabus gives a list of the required assignments for 469 and 669. Record your work and answers to questions in your observing notebook. You are expected to complete the assignments outside of class. ***You will not receive credit if completed handouts (including answers to ALL QUESTIONS) are not included!!!***

CLEA Virtual Observatory:

Many people think of an astronomer as someone who gathers data through the eyepiece of a telescope. This is no longer true. Most observations are actually completed remotely. The CLEA Virtual Observatory gives the opportunity to experience remote observing. You are responsible for completing the HR Diagrms of Star Clusters and the Classification of Stellar Spectra assignments. Record your answers in your observing notebook.

Observations

An observing template can be found at the class website (If your observations require different filters, please use the observing template for filters.) Begin your observing session by using this template to record:

1. **the date**
2. **your location**.
3. Record notes about the **sky conditions** by
    1. estimating the limiting visual magnitude by noting which stars you can see with your naked eye
    2. recording how much cloud cover
    3. what is the phase of the moon,
    4. weather conditions (is it foggy?).

Your journal will contain records of your observations during this class. It will contain two types of observations. One type is your observations using your astrolabe. The second type records observations you make visually and at the telescopes.

High-tech Astronomy – Telescope Observations

24 inch telescope observations

For each individual observation with the 24 inch telescope, record the following in your observing template:

1. **the date of the observation**
2. **the time of the observation**
3. **the observer's name**
4. **the weather conditions**
5. **the type of telescope**
6. **the focal length of the telescope (2438 mm for the 24 inch)**
7. **the object's name**
8. its **right ascension and declination**
9. its **magnitude**
10. **a description** of the object in the Notes section.
11. Be sure to complete the **sky conditions section** of the observing template.

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No further information is required for 24 inch observations. Coordinates (right ascension and declination) can be retrieved from the ECU computer screen, or various planetarium programs.

Other telescopes

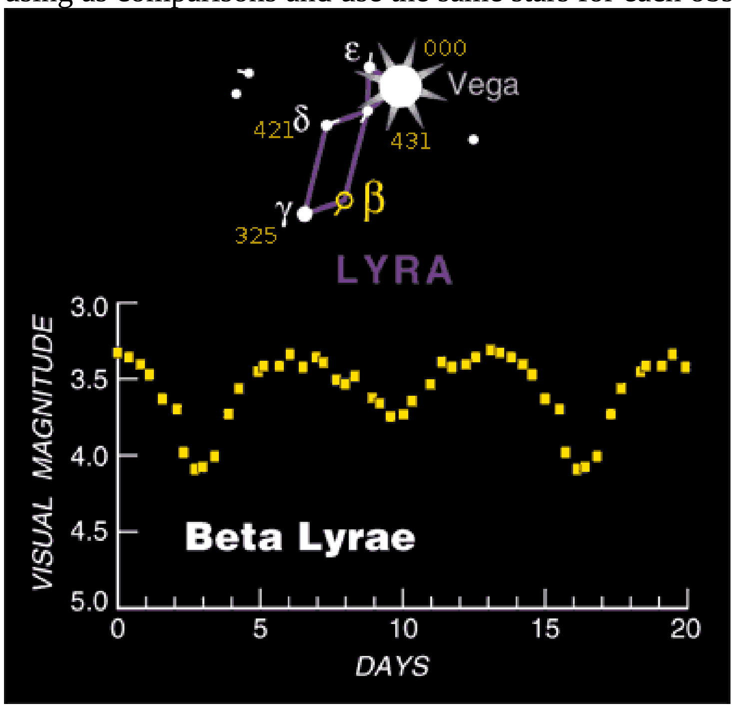
You will also use the observing templates for observations with the 4 inch refractor or the 10 inch or 11 inch portable catadioptric telescopes. During clear nights, we will have multiple telescopes available simultaneously. You are responsible for learning to set up and use each telescope and obtaining the required observations with each telescope. **Use a separate observation template for each observation from each telescope.** You should use the multiple drawing template for an object observed with multiple filters at the same telescope. Fill out the following sections in the observing template:

1. **the date**
2. **the time**
3. **the observer's name**
4. **the weather conditions**
5. **the type of telescope**
6. **the focal length of the telescope (2800mm for 11 inch telescope, 1200 mm for the 10 inch, and 1828 mm for the 4 inch refractor)**
7. **the focal length of the eyepiece**
8. **the magnification (focal length of telescope divided by the focal length of the eyepiece)**
9. **any filters used (multiple filters for the same object should use the multiple drawing template)**
10. **the object's name**
11. **the object's magnitude**
12. **a drawing(s)** of the object
13. **a description** of the object in the Notes section
14. Be sure to complete the **sky conditions section** of the observing template.

Take some time with the drawings. I don't expect photographic quality, but I do expect some realism. Include notes about what you are seeing in the eyepiece. Part of the purpose of this exercise is to learn to pay attention to the details. ***OBSERVATIONS WILL NOT BE GRADED IF THE OBSERVING TEMPLATE IS NOT COMPLETE. FOR DRAWINGS: A squiggle surrounded by random dots will not be graded.***

Visual Observations of Beta Lyra

Beta Lyra is an eclipsing binary of an interesting type. Many binaries appear nearly constant between eclipses because the brighter star of the pair is approximately spherical. But Beta Lyrae's components are so close together that they are distorted into ellipsoids by each other's gravity. As the system revolves in its 12.94-day orbital period, we see continuous change at all phases of its light curve. The magnitude range is cataloged as 3.3 to 4.4. We will monitor Beta Lyra's brightness as compared to the surrounding stars three times a night. Record which stars you are using as comparisons and use the same stars for each observation.



Astrolabe Observations

Measuring the Motion of Objects in Altitude
Targets for Fall 2021: 1)Vega, 2) Deneb, 3) Altair, 4) a star in Pegasus, 5) star in the Big Dipper, 6) a star in Cassiopeia, 7) Polaris (North Star), 8) Saturn, 9) Jupiter, 10) the Moon:

Measure the altitude above the horizon of each object at three different times during the same night/day (for example, 8:00 pm, 9:30 pm and 10:30 pm.. To improve your accuracy, take ***three measurements at each time and compute their average.*** Include the standard deviation for your measurements. If the moon is not above the horizon, record that information. If it is visible, record its shape/phase. Repeat this sequence for every clear night we have during class and during the week you are working on your take home exam.

An astrolabe template is available on the class website. Your journal should contain entries that look like the following (this is an example of astrolabe measurements for one night)

January 23, 2055, Mt. Cuba Observatory.

Sky conditions: clear with thin clouds to the west. Stars in the Little Dipper are easily visible.

		#	Time			Phase/Shape of moon
Object	Instr		7:00 pm	8:30 pm	10:00 pm	
Polaris	Astrolabe	1	42	38	43	
		2	46	42	41	
		3	38	40	37	
Average (+ err)			42±1.6	40±1.2	40.3±1.2	
Altair	Astrolabe	1	56	65	70	
		2	58	63	68	
		3	57	57	69	
Average (+ err)			57±1.2	61.7±1.2	69±1.2	
Saturn	Astrolabe	1	23	35	46	
		2	21	35	44	
		3	25	35	48	
Average (+ err)			23±1.4	35	46±1.4	

It is important to understand how accurate your observations are. You can calculate the basic "standard deviation" of your observations of your observations. The mathematical formula is:

Standard deviation = $\sqrt{(1/(N-1) \times (\sum(o_i - o_{av})^2)}$
N is the total number of observations.

So for the 7:00 pm observations of the Altair, N is 3. The average is 57. So I subtract 56 –57, square it (get 1), 58-57, square it (get 1) and 57-57, square it (get zero). The sum of that is 1+1+0=3. Now I multiply by 1/(N-1) which is 1/(3-1) = ½, or 0.5. 3*0.5 is 1.5. Now the standard deviation is the square root of 1.5 = 1.2.

This just means that, while your average is 57, any number between 55.8 and 58.2 can be considered equally correct, too. No observation is ever perfectly exact. There is always "noise", and the standard deviation gives an indication of the importance of the noise.

<u>You will not receive full credit if you do not include the graphs!!!!</u>

1) Generate a set of plots of the altitude of each object as a function of time**.** For each object, plot the average of observations you took on each day (**include error bars)**. Time will be the x axis, and altitude will be the y axis. For example, if your first observations are January 13 at 7:00, 8:00 and 9:30 pm and your second is Jan 14 at 7:00, 8:00 and 9:30 pm, then you choose Jan 13 as T=0, and Jan 14 is T=24 hours

(or 86400 seconds, or 1 day, whichever you prefer as long as you are consistent). You will end up with one graph for each object with all your average observations for each day.

2) Generate a second set of plots of the altitude of each object as a function of time of day. For example, let's say you have 8 Polaris observations at 7:00, 5 at 8:00 and 6 at 9:30. The x-axis will be time (7:00, 8:00, and 9:30). The y axis will be altitude. Plot all of your 7:00 observations at 7:00 location on the x-axis. Repeat for 8:00 and 9:30.
3) Search the internet (or use the included chart) to find the magnitudes of the stars surrounding Beta Lyra. Use your comparisons to estimate the brightness of Beta Lyra during Fall 2019. Plot your results (time is the x axis, magnitude (or brightness) is the y axis).

Answer the following questions and include them in your journal:

<u>You will not receive full credit if you do not include these answers in your journal!</u>

1) Examine your astrolabe measurements for individual nights of observations of Vega, Altair, Deneb, your star in Cassiopeia, Arcturus, and your Big Dipper star. By how many degrees does the altitude of each change from hour to hour (calculate the average change during each night). Show your calculations. How should the altitude of your targets change during a 24 hr period? How closely do your observed results agree with your calculations? How can you account for any differences you find?

2) How does the altitude of Vega, Deneb, Altair, your Cassiopeia star, Arcturus, and your Big Dipper star, change from day to day? Look at your measurements for the same time each night (the second set of plots), and calculate any change. How do you account for any change you find?

3) Examine your plots for Polaris. How does the altitude of Polaris change in an hour (calculate the average change during each night and how your calculations)? How would the altitude of Polaris change during a 24 hr period?

4) Examine your plots for the Moon. By how many degrees does the moon's altitude change from hour to hour?

5) Examine your plots for the Moon at the same time each night. Does the Moon's altitude increase or decrease when looking at the same time from night to night?

6) What is the maximum change (in degrees) you observed for the change in the moon's altitude from hour to hour?

7) What do your answers to 5, 6, and 7 mean for the motion of the moon through the sky?

8) Repeat questions 5-7 for Saturn.

9) Repeat questions 5-7 for Jupiter.

10) Astronomers try to explain their observations with theories – explanations of the physical phenomena causing the observed behavior. What differences do you observe between the behavior of your stars and planets? What physical processes do you think is responsible for your observations?

11) Imagine that you are Christopher Columbus' navigator. You only have your astrolabe and your measurements to explain to the King and Queen that you will not fall off the edge of the earth if you sail west. What arguments would you use to justify this claim?

12) Do you think your astrolabe is an accurate measurement tool? Explain.

13) Do your results say that Beta Lyra is a constant brightness, or does it change over time? What kind of object is Beta Lyra?