Astronomy 301 LAB 3 ---- Resolving power and astronomical seeing Fall 2017

In this lab we will observe binary stars to further explore the capabilities of our binoculars and telescopes, and the limitations imposed by the Earth’s atmosphere. For this lab, we will make use of the “automated” star finding capabilities of the telescopes; Tirion atlases will be used to help confirm the pointings. These observations will provide a foundation for a detailed analysis of the “resolving power” of an optical instrument and (even more important as we will find out) the phenomenon known as astronomical “seeing.” The Earth’s atmosphere makes everything blurry—at a level that can’t be discerned with the unaided eye but becomes very noticeable when using telescopes. The “seeing” can vary from site to site and from night to night at a given location. It affects the amount of fine detail that can be discerned and is an important effect to understand and be able to quantify whenever you are engaging in astronomical studies.

Materials

* list of double stars; Tirion Atlases; Golden Guides

In-class preparations

(1) Construct a list of potentially interesting double stars to observe during the lab period tonight. Start from the list of double and binary stars provided. Which stars will be up during the lab period (and after dusk)? Choose only stars with separations in the range of 3 – 8 arcseconds. Avoid stars that will be close the horizon (e.g., altitude less than about 15-20 degrees).

(2) In your log book, make a table of the binary stars that you identified as possible targets. Be sure to include γ And and ε Lyr. List them all in order of angular separation, and include the following quantities in your table:

(i) Bayer or Flamsteed name
(ii) angular separation in the year 2000, in arcseconds
(iii) magnitude of each star and difference in magnitude between the two
(iv) R.A. in hms format (you will need to convert decimal minutes to minutes and seconds of time)
(v) Dec. in degrees/arcminutes/arcseconds format
(vi) Orbital period, if listed on handout

(3) Time permitting, locate each of these double stars in the Tirion Atlas. If short of time, just find ε Lyr.

In the Observatory

Please note: Throughout the lab, take care to always make note of which telescope you used for a particular observation, and which eyepiece (i.e., its focal length). For the lab report you will need to compute the magnification, referring to the handout with telescope focal lengths.

(1) Align both your finders on a bright star

(2) Align your telescope for automated star finding

Ask your instructor for assistance learning how to align your telescope so that you can find stars by name and/or by their R.A. and Dec.
(3) A reasonably wide binary: Gamma Andromedae

Our first binary star will be $\gamma$ And, with a separation of 9.7". You will use this system to check that your telescope is pointing well and to get a feeling for what sort of magnification you are going to need to have a chance to resolve the binaries in this lab. Start with a 40-50 mm eyepiece, then try a ~20-30 mm eyepiece, then a ~5-12 mm eyepiece. Pay particular attention to whether the increased magnification each time helped you see the binary better or not. Make a sketch with whatever eyepiece shows the binary best, and be sure to record what telescope and eyepiece you are using.

(4) Binaries in 3-8 arcsec range

Pick a binary in each of the following ranges of separation. Start with the widest and move to closer and closer binaries. Remember to use 40 mm eyepiece when locating the object, then switch eyepiece for higher magnification.

(i) 6-8 arcsec
(ii) 4-6 arcsec
(iii) 3-4 arcsec

(5) A very close quadruple star (“double double”): epsilon Lyrae

This will be our toughest test of the seeing tonight. This “double double” star has one pair separated by about 2.6" and the other separated by about 2.3". Take your time to observe them carefully, and be sure you have enough magnification!

(i) To be sure you are on the right object, look at $\epsilon$ Lyr through the finder. What do you see? The two pairs are separated by 208" (about 3.5 arcmin) so should be easily separated in the finder. Those with very sharp eyes may be able to separate them with unaided eyes! Record the view through the finder in your log book.

(ii) Now look with the telescope. Experiment with different eyepiece to see if you can resolve them (it's somewhat rare, but not impossible, in the SFSU observatory)! Use the “clock” idea to confer with your lab partners about whether you are all seeing the same thing. Remember to make sketches and take good notes!

NOTE: For this lab we may rotate between different telescopes, to see how views compare through the different ones. Don’t forget to take good notes on what you saw, including the telescope and eyepiece you used, and to make a sketch. Was the binary easily resolved (split into two), not resolved at all, or only resolved with difficulty? Could you see any colors?

Lab Report: Be ready to discuss your results in class. Lab reports are typically due one week following our final discussion of the results.