

## Laboratory 1: Using skycharts & planetarium software

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Experiments are to be completed on the provided laboratory sheets below; any supporting material (eg. graphs) should be attached. Make sure your name and your partners name(s) are clearly indicated on the front page of your lab. **Neatness and clarity count!** Use complete sentences in answering all questions, explain your answers when asked clearly, and if you use an equation to do a calculation, *write the equation down* first, then put in numbers and solve. **Show all your work!**

**Labs must be written *in pen* and are due a week after the lab.**

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### APPARATUS

Skychart, ruler, calculator, *Starry Night* or *SkySafari* or other equivalent planetarium software.

### OBJECTIVE

1. To learn to use a *skychart*.
2. To learn to use *planetarium software*.
3. To learn about *angular measurement* and the *angular size* of objects in the sky.

### THEORY

1). Skycharts (such as those available via the ASTR 111 website) are a *projection* of the three-dimensional sky onto paper, showing the position of stars, planets, and other objects on the sky. The skychart is arranged so that the center of the chart (marked with a +) is the *zenith*, the point directly overhead on the sky while the edges represent the horizon. The cardinal directions (N, S, etc.) are indicated along the horizon. Brighter or more major stars are indicated by larger dots.

*(Example)* What would we see in the SW sky? Turn the skychart so that SW appears “rightside up”. Near the horizon is the star Antares (the ‘Rival of Mars’) and the constellation of Scorpius. About half way up in the sky are the globular star clusters M10 and M12 in the constellation Ophiuchus, and near the zenith (the small ‘+’) is the constellation Cygnus.

2). *Angular measurement* is common when working with skycharts. The *zenith* (point directly overhead) is exactly  $90^\circ$  from the horizon. An imaginary line running from horizon to horizon through the *zenith* spans  $180^\circ$ , i.e. tracing out a line north to south passing through the zenith.

*(Example)* The star Antares in Scorpius is about  $10^\circ$  above the horizon; M10 is about  $1/2$  way up or about  $40\text{-}45^\circ$  above the horizon; and Albireo in Cygnus is roughly  $3/4$  of the way to the zenith.

3). The *angular size* of objects in the sky is also important. How big an object looks depends on how big it is and how far away it is; the relationship between the *diameter* of the object,  $d_o$ , the distance to the object,  $d$ , and the *angular size* of the object (in degrees),  $\theta$ , is given by

$$\theta = 57.3 \times \frac{d_o}{d} \quad (1)$$

*(Example)* The Sun is 149,598,000 km away and has a diameter of 1,392,000 km. The angular size of the Sun in our sky is:

$$\theta = 57.3 \times \frac{d_o}{d} = 57.3 \times \frac{1,392,000}{149,598,000} = 0.53^\circ$$

*This is pretty small - about half the width of your thumb at arms length. Surprised?*

4). *Starry Night* and *SkySafari* are two examples of computer programs that simulate the night sky and as a result are sometimes referred to as ‘planetarium’ software. *Starry Night* is bundled with some versions of the class textbook and is also installed on the computers in the lab located in B315-113 while *SkySafari* is available for purchase online for phones, tablets and Mac computers. A basic PDF tutorial and video on using these programs is available on the ASTR 111 website under the ‘Info & Handouts’ page. **You should work through these short tutorials PRIOR to attempting this lab. NOTE: a VIU computer account is required to log onto the computers in the lab; see <http://www.viu.ca/technology/> for further details.** Other planetarium programs such as *Stellarium* may also be used but please note that they are not supported with supplementary material in ASTR 111.

*(Example)* You should know how to do the following tasks in a planetarium program: set your location, adjust date & time, search for objects, zoom in/out, obtain astronomical information about a selected object, adjust the portion of the sky being viewed, display constellation names and boundaries, display a field-of-view indicator, display a grid/zenith/nadir/ecliptic, etc.

Mark this lab:  individually  
 as a group

NAME:  
PARTNER:

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1. **Print off the lab & September skychart for the Northern Hemisphere** from the website.
2. Start up the *planetarium* software (see the appropriate tutorials available on the website). **Set the date & time to Thurs, Sept 12, 2024 at 9pm PDT in Nanaimo. Press the time ‘stop’ button (■) or the equivalent in other programs to keep the time set to 9pm.**
3. For *Starry Night*, **turn on Stick figures (Astronomical) & Labels** under Constellations under the Options (sub)menu. For *SkySafari* do the same using **Settings → Constellations** (use As Traditional Lines; you may also wish to Show Asterisms and Show Names as necessary.)
4. For *Starry Night* use the Options submenu **display the Zenith/Nadir (Poles)** under Alt-Az Guides & **display the Ecliptic** under Celestial Guides. For *SkySafari* do the same using **Settings → Grid & Reference**.
5. [2 marks] **Are the skychart and planetarium software views of the sky exactly equivalent? Describe specific differences. Which is more accurate for Nanaimo? Why?**
  
6. [2 marks] On the skychart the *ecliptic* is shown as a dashed line that runs through the southern sky; the programs show it as a coloured line (when displayed). Using the textbook, class notes or other source **define the ecliptic**. Using the skychart and/or the programs, **list all planets visible at this time from Nanaimo. What ‘trend’ do you notice about the planets’ locations in the sky? Explain why this makes sense given the definition of the ecliptic.**

7. [**1 mark**] In the planetarium software **display both constellation boundaries and names/labels**. **Record the names of the (visible) constellations that the ecliptic passes through** (the names should be familiar!). **These constellations are collectively referred to as the...?**

8. [**2 marks**] The *Milky Way* passes through several constellations, including *Cassiopeia*, *Cygnus* and *Sagittarius*. In the planetarium software display the Milky Way and turn its brightness all the way up. **Using compass directions, describe the horizon-to-horizon orientation of the Milky Way on the skychart. What *is* the Milky Way? How does the Milky Way's appearance change in the region near *Sagittarius*? Why does it appear different there?**

9. [**3 marks**] Many constellations are located using a particular pattern of stars ('asterisms') that may not always resemble what the constellation is "*supposed*" to represent! **Give the location (compass direction & approximate height above horizon) of these asterisms: Great Square, The Teapot, The Keystone. In which *constellation* is each located? What are each of these *constellations* supposed to represent? Hint: use both the skychart & the planetarium software search feature, adjusting constellation settings to display and label asterisms.**

10. [**1 mark**] In the planetarium software, turn to face south and zoom out until the field-of-view (FOV) is about  $100^\circ$ . Access the time controls and continuously ‘step’ ahead a minute at a time until roughly an hour has passed (reset time to 9pm when you are done). **Overall, how do the stars appear to move over time? Why do the stars appear to move in this way?**

11. [**1 mark**] On the skychart, use a ruler to measure the (linear) distance between the horizon and zenith (center of skychart): \_\_\_\_\_ cm; this ‘length’ corresponds to an angle of  $90^\circ$ . **Using these two values, calculate the (vertical) scale of the skychart (horizon-to-zenith) in degrees-per-cm.** Show your work fully.

12. [**3 marks**] From the skychart, *estimate* the compass direction & height (in degrees) of *M13* in the constellation of Hercules: \_\_\_\_\_ . **Then, use a ruler to measure the distance from the horizon to *M13*: \_\_\_\_\_ cm** (measure along the radial line connecting the horizon, *M13*, and the zenith). **Use this measured distance & your (vertical) scale from Question 11 to *convert* the distance from cm to degrees above the horizon.** **Comment on the agreement with your estimate for the height of *M13*.**

13. [1 mark] Using Equation (1) from the Theory section, **calculate the angular size of the Moon on the sky** in degrees, given the Moon's diameter is 3476 km & its distance from the Earth is 384,400 km. Show all of your work, including all equations used, steps, units, etc.

14. [1 mark] Describe the location of the *Andromeda Galaxy* (M31) on the skychart.

15. [3 marks] Find & center M31 in your planetarium program. In *Starry Night* use the FOV Indicators submenu item to display a red, circular  $5^\circ$  field-of-view on the sky; in *SkySafari* use **Observe** → **Scope Display** and enable both  $5^\circ$  Custom Field of View and Show Even if Not Connected to Telescope settings. Zoom in so the  $5^\circ$  field-of-view circle fills the screen. **Estimate the angular size of M31 using the  $5^\circ$  field-of-view as a guide: \_\_\_\_\_ $^\circ$ . Now, calculate the angular size of M31, given a diameter of 140,000 ly and a distance of 2.5 million ly from Earth. Watch your units! Divide the angular size of M31 by the previously calculated angular size of the Moon to compare them, i.e. to give M31's size in terms of the size of the Full Moon. Given the result (which should be fairly surprising!) why isn't M31 more obvious to our eyes when we look in the sky?**