Physics 10293 Lab #3:
Starry Night –
Observations of the Sun and Moon

Introduction

Today, we are going to use the Starry Night software to learn about motion of the stars, sun and moon on the celestial sphere. At each step along the way, I will ask you a few simple questions to check your understanding of what you are seeing.

First, start up the program and make sure your location is set to Fort Worth for today's date and time. Turn your view toward the West, then we will make a few changes to what you are seeing so that it more closely resembles one of the celestial sphere models we worked with during the first week.

Step 1

Click the "Options" sidebar (not the top options menu). The tab for the options sidebar is on the left side of the Starry Night viewscreen just beneath the top choice "Find". Once that is open, do the following...

- Make sure the Guides window is open on top of this sidebar
- Click on the + sign to expand Alt-Az guides
  Check the Local Equator (Horizon) option

- Click on the + sign to expand Celestial guides
  Check the Equator option
  Check the Grid option
  Check the Poles option

- Click on the + sign to expand Ecliptic guides
  Check the Ecliptic option

- Click the + sign to expand the Local View window
  Uncheck the Daylight option
  Uncheck the Local Horizon (lake) option

- Click the + sign to expand the Solar System window
  Uncheck the Asteroids option
  Uncheck the Comets option
  Uncheck the Satellites option
  Uncheck the Space Missions option

- Click the + sign to expand the Constellations window
  Check the Boundaries option
  Check the Labels option

Your screen should now resemble what you would see if you could stand on the tiny Earth inside one of the transparent celestial sphere models. Zoom out and back in to see the whole sphere. Now scroll around the screen and find some information about various objects you see in order to answer the questions below.

In what constellation is the Sun today? ______________________

What time does the Sun set today? ________________

How long is the day today, to the nearest hour? ___________ hrs

What constellation will the Sun move to next as it travels along the ecliptic? _______________________

Find the North Celestial Pole (NCP) on the sky. What constellation is the NCP in? ____________________

What is the name of the bright star found very near the NCP on the sky? ____________________

Find the South Celestial Pole (SCP) on the sky? What constellation is the SCP in? ____________________

Since there is no star close to the SCP, navigators long ago used the constellation Crux, also known as the Southern Cross, to help find the location of the SCP and thus the direction true South.

Find the constellation Crux and within it, the star Acrux. How far is Acrux from Earth? ____________ ly

The “ly” units stand for “light years”. The nearest star to us, besides the Sun, is Alpha Centauri, about 4 light years away.

Step 2

Next, we will study the motion of the Moon. First, use the find sidebar to find the moon. Just enter "Moon" in the search box, and the program should find and center the Moon for you. Within the Find window, the Moon has two checkboxes to the left of its name (both checked) and two checkboxes to the right (both unchecked). If you hover the mouse over each checkbox, it will tell you what the checkbox is for. Check the box to label the Moon's orbit.

You should now see the Sun's apparent annual orbital path in the sky (the Ecliptic) and the Moon's apparent monthly orbital path in the sky both as green lines. We know that we can only get lunar or solar eclipses during "eclipse seasons" when the Moon's orbital path and the Sun's orbital path cross every six months.

It will help if we now find and center on the Sun so that we can keep the Sun in the center of our screen as we move time forward. Use the find sidebar to find the Sun. Type "sun" into the search box and then below that, double-click on the Sun from the list of possible objects. The program should now smoothly scroll around the sky until your view is centered on the Sun.

Take note of which constellations you can find the intersection of the Moon and Sun orbits. The intersection points are called "nodes". You may need to zoom in to see the intersection clearly in some cases. Answer the associated questions below.

In which two constellations do the orbital paths of the Sun and Moon intersect this year?

_________________, ___________________

What days of the year (this year) does the Sun cross the Moon's orbital path? You may need to run time forward/backwards to see this. These are the dates around which lunar and solar eclipses are possible.

Earlier crossing on __________________________

Later crossing on _________________________

Minimize Starry Night for the time being and open up a browser window. Visit the web site http://eclipse.gsfc.nasa.gov and find out the dates closest to the two dates above (should be within a month) on which we see solar eclipses somewhere on Earth.

________________________ and _________________________

Access Starry Night again and set time forward to January, three years from this year. During the new year you have set, find the crossing dates:

Earlier crossing on ___________________________

Late crossing on ___________________________

Again, using NASA's eclipse web page, find the two dates closest to the above dates on which we will see solar eclipses. You can find this using the Decade Solar Eclipse Tables under the large heading Eclipses of the Sun.

_________________________ and _________________________

Step 3

The motion of this intersection (the node) through the sky is due to the fact that the Moon's orbit wobbles. Each year, the Moon's orbital plane, which is tilted 5° with respect to the Ecliptic, wobbles. This causes the nodes to shift positions on the sky by about 20 degrees in Celestial Longitude (Right Ascension). So each year, the eclipse time table moves by about 20 days forward. In Step 2, your dates for eclipses three years from now should be about 60 days later than the dates for this year.

It takes approximately 18 years for the nodes to return to their original location. This time period is called a Saros Cycle. Ancient astronomers recognized this motion of the Moon and Sun and could thus predict eclipses with some accuracy by measuring the precise location of the Full Moon as it would set along the horizon.

Let's do an example together. Use the find and info functions of Starry Night to gather data on the positions of the Sun and Moon on certain days of the year. To begin, find the first full moon of this calendar year. Now look to the Western horizon and set the time to sunrise on that day (there is a button just below the time display to do this). You should see the full moon near the horizon. Adjust the time minute-by-minute until the full moon sets (when the top bit of the moon is just dipping below the horizon).

There are a couple of different ways to get the information about the azimuth of an object. One is to use the find tab to find and center on the object. Once the screen is centered on the object you are trying to find, the object's azimuth (and altitude) will appear on the "Gaze" window on the upper right of your screen. The other way is to right-click on the object and go to the bottom of that menu to "Show Info". Then the azimuth will appear on the left in the info sidebar.

Now start filling in your data table on the last page of the lab. Note the date and the azimuth of the full moon (info tab on the sidebar) at moonset (which is near sunrise but not exactly at sunrise most of the time). Now switch the time to sunset. Your screen should now show the Sun dipping below the Western horizon. Click on the Sun (it may take some zooming and/or precise clicking to do this) to get the Sun's positional information to appear in the info sidebar. Record the Sun's azimuth at this time.

Now repeat for each of the 12 or 13 full moons that will occur during this calendar year. Each full moon date should be separated by about 29-30 days. Note that the moon is technically full sometimes on two different days, and it doesn't matter which of those two you choose for our purposes.

Step 4

There is a good possibility of eclipse when the Sun, Earth and Moon are precisely lined up, so how can you tell when they are lined up? You may notice from your observations that when the Full Moon sets North of West, the sun tends to set South of West and vice versa.

Suppose the full moon sets 20 degrees South of West. We are likely to get an eclipse of the sun sets equally far (20 degrees) North of West. So on this table, I've included some columns for you to do simple calculations. For each line of recorded data, fill in the relative azimuths of the Sun and Moon, where West is 270 degrees.

For example, if the Moon sets at an azimuth of 293 degrees, that is (293-270 =) +23 or 23 degrees North of West.

On the same day, if the Sun sets at an azimuth of 242 degrees, that is (242-270 =) -28 or 28 degrees South of West.

Since these numbers aren't the same, there is no chance of an eclipse.

On a different day, if you get -11 for the Full Moon set and +11 for the sunset, then an eclipse is likely. Even if the numbers are only different by 1 (or 2 at the most), an eclipse is likely since there is some margin for error.

Step 5

Based on your table, during which months of this year are we likely to get eclipses? Write down this answer below and then go online to http://eclipse.gsfc.nasa.gov and find out during which months of the year lunar or solar eclipses are actually occurring.

Based on your table in step 4, during which months are eclipses likely?

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Compare your answer to the published eclipse dates listed above in step 2 for this year. They should be pretty close (within a month or two for sure).

Date	Azimuth of Full Moon Set (near sunrise)	Azimuth of Sun Set	Moon Azimuth - 270	Sun Azimuth - 270