At-Home Activity: Virtual Planetarium

To do this assignment, we will be using a virtual planetarium (sky simulation) called *Stellarium*. *Stellarium* is free, open-source, community-developed, and community-supported software. Go to the *Stellarium* website and download and install the version of *Stellarium* that is appropriate for your operating system:

https://stellarium.org

Setting up *Stellarium*

STEP 1: Open *Stellarium*. First, let's familiarize ourselves with the interface.

To look around in the sky, you can click anywhere on the sky and drag your mouse around.

Using the mouse wheel, or swiping to scroll up/down, or using the Page Down/Page Up keys, you can zoom in and out.

Move the mouse to the bottom of the window and you should see a button bar pop up. You can use these buttons to turn on/off certain types of information and visualization.

Move the mouse to the left edge of the window and you should see another button bar pop up. This one contains most of the settings for the application.

Click on a sky object to get more information about that object. Press the spacebar to center your view on that object. Once you've centered an object, you can zoom in and out on it easily.

STEP 2: Using the pop-up button bar at the bottom of the window, turn the following things ON:

- Constellation lines
- Constellation labels
- Ground
- Cardinal Points
- Planet Labels

And turn the following things OFF for now (feel free to play with these later if you like):

- Constellation art
- Equatorial grid
- Azimuthal grid
- Atmosphere
- Deep-sky Objects

STEP 3: In the bottom button bar, click the Play/Pause button until the Pause icon is showing. This stops the time from elapsing in the simulation.

STEP 4: In the lefthand button bar, click the top icon called “Location”. In the dialog that pops up, search for Austin and then click on Austin, TX to set your location. Then close the dialog.

In the lefthand button bar, click the second icon from top, called “Date/Time”. In the dialog that pops up, set the date to be December 1 of this year at 9pm (21:00). Then close the dialog.

The simulation is now showing you what the night sky would look like if viewed from Austin, TX at 9pm on December 1 of this year.

STEP 5: Let’s ask *Stellarium* to show more information on the screen. To adjust what Stellarium shows you, use the third icon from the top on the lefthand button bar, which is titled “Sky and viewing options”.

With the dialog open, make sure you are on the tab called “Sky”. On the right is a panel for Stars. Ensure that the check box next to “Stars” is checked. Then, beneath Stars, find the control titled “Labels and Markers”. Ensure the check box next to it is checked, and then slide the slider until it is roughly in the center of its track. This should adjust the number of stars that are labeled in the virtual sky. Then close the dialog.

Part 1: Winter Sky

STEP 1: Find the North Star (**Polaris**) in the simulated night sky. You can use the compass directions to help you find it. Click on Polaris and press space to center your view on it.

Polaris lies at the tip of what constellation (also known as the Little Dipper)?

STEP 2: With your view still centered on Polaris, go to the bottom button bar and un-pause the simulation. The simulation will start ticking off one second at a time, in real time. But we can accelerate this process (or even run it in reverse) however we like.

To increase the speed of time, use the double-right-arrow on the button bar (or press the “L” key). Click on it 3 or 4 times until you can clearly see the motion of the stars in the sky.

What do you notice about the motions of the stars relative to Polaris? Does this agree with something we learned earlier this semester?

STEP 3: Return the simulation to normal speed by clicking on the Play/Pause button. Reset the date and time back to Dec 1 at 21:00 (9 pm).

Turn the Constellation Art on (using the bottom tool bar, or by pressing “R”).

Use the Search feature (the magnifying glass icon on the lefthand menu) to find the constellation **Orion**. At this time and date, is Orion above, below, or on the horizon? You may need to turn the Ground (use the button on the bottom tool bar, or press "G") off and on to find out.

There are two supergiant stars in the Orion constellation, one that is red and one that is blue. They are on opposite corners of Orion: one is in his armpit and the other is his heel. What are the names of these two stars?

By the way, the name "Betelgeuse" comes from the Arabic for "giant's armpit"!

Use the search feature to find the **Big Dipper** (also called Ursa Major for "big bear"). At this time and date, is the Big Dipper above, below, or on the horizon? You may need to turn the Ground (use the button on the bottom tool bar, or press "G") off and on to find out.

STEP 4: Turn OFF the Constellation Art.

Now use the search feature to find the **Andromeda galaxy** (you will need to specify "galaxy" in your search because there are multiple night sky objects named Andromeda). Click on it, press space to center on it, and then zoom in until you can see a faint fuzzy patch in the sky. This is how the galaxy would appear to the naked eye or in a backyard telescope. Zoom in some more and you can see the disk shape of the galaxy.

Messier Catalog

The Messier catalog is a list of 110 sky objects that is named for the astronomer – Charles Messier – who first compiled and published his catalog of sky objects in the 1770's and 1780's. Objects in the Messier catalog are denoted by Messier (or just "M") followed by a number.

The Andromeda galaxy is a part of Messier's catalog and so it is sometimes called "Messier 31" or M31 because it is the thirty-first object in Messier's catalog.

Historical Note: The scientists of Messier's time (the late 1800's) didn't know that M31 was a galaxy. In fact, the real nature of M31 wasn't settled until 1925 (less than 100 years ago!) when the work of Edwin Hubble (for whom the space telescope is named) showed that M31 was actually a completely separate galaxy far beyond our own. Before that time, it was thought

that our galaxy might be the only one. Originally, these other galaxies were nicknamed “island universes”.

STEP 5: Use the bottom tool bar to turn on Deep Sky Objects (DSO) (or press “D”).

Notice that the Andromeda galaxy actually has two satellite galaxies near it. What are these galaxies named? Note: They are named using the Messier catalog system, so each of their names will be “M” followed by a number.

These two galaxies are smaller galaxies that orbit around the much larger Andromeda galaxy. One contains roughly 3 billion stars, and the other about 9 billion stars, as compared to Andromeda which contains about 1.2 *trillion* stars.

Our Milky Way galaxy also has some satellite galaxies. Two of the best known are called the **Small Magellanic Cloud** (SMC) and **Large Magellanic Cloud** (LMC).

STEP 6: Turn off the Deep Sky Objects to remove some clutter from the screen, then use the search function to find the “Small Magellanic Cloud” and “Large Magellanic Cloud”. They should both appear as faint smudges in the sky. You can see why they were initially labeled “clouds”, but they are in fact galaxies. Using Stellarium, you can zoom in on them until you see that they are made of stars.

The SMC and LMC both orbit around our Milky Way galaxy. The SMC contains several hundred million stars and the LMC contains about 10 billion stars, as compared to the Milky Way which contains 100-500 billion stars.

STEP 7: Let’s look at one more deep sky object. Use the search feature and search for **M13**. Press the forward slash (“/”, the one that shares a key with “?”) to zoom in on the object. Describe its appearance below. What is this type of object called (look at the information presented by *Stellarium* on the top left) by astronomers?

M13 also goes by the name **Hercules Cluster**.

Part 2: Summer Sky

Let's now take a look at the sky as it will look next summer.

STEP 1: Keep your location in Austin, TX but change the date and time to July 1 of next year at 11pm (23:00).

Find the **Summer Triangle**, an asterism which consists of the stars Altair, Deneb, and Vega.

Altair, Deneb, and Vega are each the brightest star in their respective constellations. What constellations are these stars in?

Altair:

Deneb:

Vega:

STEP 2: At this date and time (July 1 of next year at 23:00), is the Big Dipper (Ursa Major) above or below the horizon?

STEP 3: Is Orion above or below the horizon at this time of year? Does this match your expectation based on what we saw with the in-class model of Earth's orbit that included the constellations taped to the walls?

Part 3: Future Sky

In 2024 there will be a total solar eclipse that is visible right here in Austin. Let's fast-forward to 2024 in our simulation and see if we can see the eclipse.

STEP 1: Keep your location at Austin, TX. Set your date and time to be April 8, 2024 at 10am (10:00).

STEP 2: Find the Sun, click on it, and press spacebar to center your view on it.

For a slightly more realistic view, you can turn ON the atmosphere (bottom tool bar, or press "A") so that the sky looks blue, as it really would at 10am.

Since this is a solar eclipse, what must the Moon phase be right now? And therefore, should the Moon be easy to see (mostly lit, from our perspective) or difficult to see (mostly dark, from our perspective)?

If it's difficult to see the Moon, turn the atmosphere OFF so that you can clearly see both the Sun and Moon.

STEP 3: Use the time controls to speed up time so that you can see the Moon approaching the Sun.

Pause the simulation right as the total eclipse occurs. The Moon will completely block out the Sun and you will see a "halo" of sunlight around the Moon. This is called **totality**.

At what time does totality happen? Write down the hour and minute below.

STEP 4: With the simulation still paused, let's move to a different city and see what the eclipse looks like. Change your location to Houston, TX.

Try running the time forward and backward a bit to watch the solar eclipse from Houston. Does the eclipse ever reach totality, as seen from Houston? Why do you think this is?

Part 4: Past Sky

In 1878 a solar eclipse happened that could be seen from Texas. Let's take a look at this eclipse.

STEP 1: Set your location to Austin. Set your date and time to July 29, 1878 at about 1pm (13:00).

STEP 2: Find the Sun, click on it, and press spacebar to center your view on it. Zoom in until you can see the Sun and Moon, turning off the atmosphere visualization if desired.

STEP 3: Use the time controls to watch the eclipse in fast-forward. Does the eclipse ever reach totality (where the Moon completely blocks the Sun and a halo of sunlight appears around the Moon) as seen from Austin, TX?

STEP 4: Change your location to Dallas, TX. Use the controls to rewind and fast-forward the eclipse. Does the eclipse ever reach totality as seen from Dallas, TX?

An eclipse occurs when a nearer object passes between us (Earth) and a distant object (for instance, the Moon passing between Earth and the Sun). Do you think Venus might ever potentially pass between Earth and the Sun? The answer is yes! However, since Venus doesn't substantially block out the Sun's light, we call this a **transit** instead of an eclipse.

Venus last transited the Sun in 2012. The next transit won't occur until the year 2117! Let's take a look at the transit that happened in 2012.

STEP 5: Set your time and date to June 5, 2012 17:00 and your location to Austin, TX.

Turn the ground off. Click on the Sun to select it and then press the spacebar to center on it.

Zoom in until the Sun is quite large. You should also see Venus, which will appear very near to the Sun.

STEP 6: Fast-forward time to watch Venus transit the Sun. What time did the transit start and finish? Write down the hour and minute of the start and finish times.

Start: Finish: