# Lab 9: The Moon, Revisited

You and your classmates have been observing the Moon over the past several weeks and have recorded some of these observations in detail. In this lab, we will assemble and interpret these observations to learn more about the many interesting phenomena associated with the Moon.

## Part I: Interpreting our Observations of the Moon

Start by pulling out your own observations of the Moon and answer the following questions. If you're working with a small group or a partner, include their observations in questions 1-4.

1. What lunar phases did you succeed in observing? (list them all)

2. What was the range of lunar altitudes you (or your group partners) recorded? Was the Moon ever at the zenith?

3. Were you able to estimate the direction to the Moon? In what range of directions did you (or your lab partners) see the Moon?

4. Did you find that you could cover the Moon with the tip of your finger? Did the result depend on what phase the Moon was in, or how high in the sky it was?

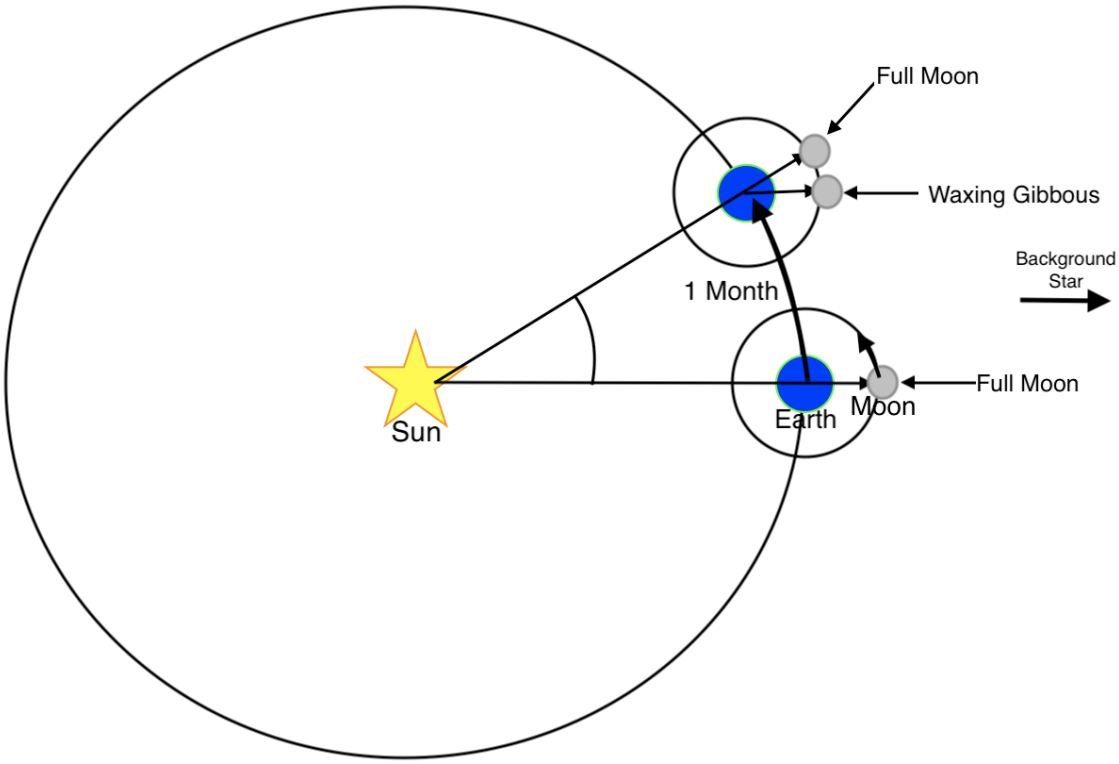
Now let's take a look at the full set of observations collected by the class. You can find all of your classmates observations on the iLearn Moon Observations forum. In the left column of the table name all of the lunar phases in order starting with New Moon. In the second column state the range of dates that you and your classmates observed that moon phase. If there was more than one range of dates for a given phase, include both!

| lunar phase | range of dates observed |
|---|---|
| NEW | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

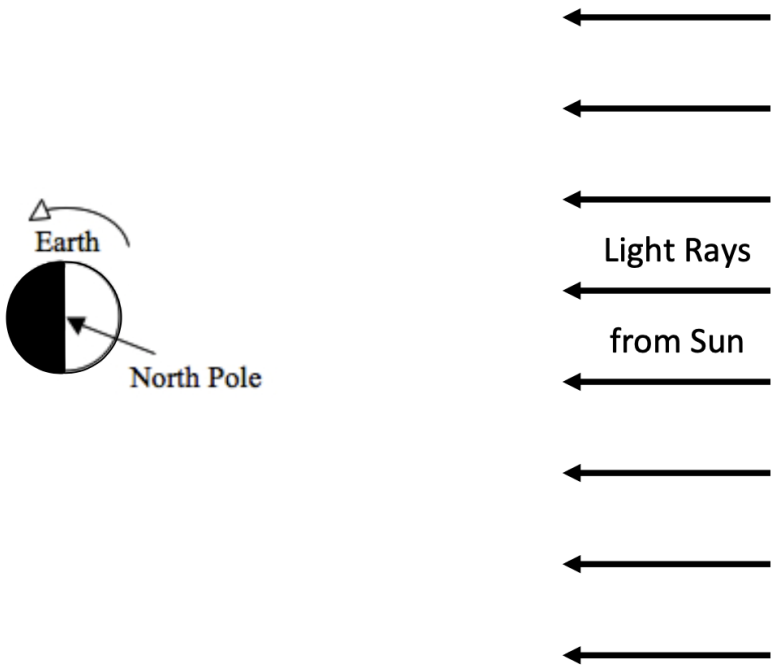
## Sidereal vs Synodic Month

As the Earth goes around the Sun and as the Moon goes around the Earth, there are two different Moon cycles that we call a Sidereal Month and a Synodic Month. A **sidereal month** is the amount of time the Moon takes to complete one full revolution around the Earth with respect to the background stars, or in other words, for it to go 360° around its orbit. A sidereal month is about 27.3 days

A **synodic month** is the time it takes for the Moon to go back to the same phase. Because the Earth is going around the Sun, the same phase doesn't happen until it goes more than one full revolution around the Earth. The diagram below shows the difference between the Moon's position after a sidereal month and synodic month as the Earth goes around the Sun. You can see that it takes a little bit of extra time for the Moon to go further around its orbit to reach another Full Moon.



5. **Sketch** in a circle to represent the moon at locations corresponding to each of the four principal phases and label them. (Principal phases are those that occur on a single day in a lunar cycle!). Then work with the other members of your lab group to make your best estimate of the date on which each of these phases occurred. **Write the dates** next to the corresponding positions in orbit. If the observations cover more than one lunar cycle, some phases may be labeled with two dates.




6. Now, from your sketch above, make an estimate of the Moons synodic period (i.e., the number of days it takes for the cycle of phases to repeat itself). There is more than one way to do this! Explain in words how you made your estimate.

7. A synodic month is 29.5 days. How accurate was your estimate of the synodic period? Justify your answer.

If you feel you need more help with the Earth-Moon system, watch the following video: `https://youtu.be/mQwvHn_qkBA`

# Part II: The Clockwork Moon

You may have noticed as you've been observing the Moon over the past few weeks that you can't always see it at the same time, or in the same place. Let's take a closer look at how this works.

Our goal is to predict at about what time the Moon should rise and set, and at about what time it crosses the meridian (i.e. be due south, and highest in the sky). Let's go back to the Earth-Moon simulator that we used in Lab 2: `https://pbslm-contrib.s3.amazonaws.com/WGBH/buac19/buac19-int-earthsunmoon35model/index.html`

Assume that the answer will always be one of the following:

**"about noon"** **"about 6pm"** **"about midnight"** **"about 6am"**

1. Using the simulator, enter your predictions in Table 9.2 and 9.3.

**Table 9.2: Rise, set, and meridian-crossing times of the Moon**

| phase | rise time | highest in sky | set time |
|---|---|---|---|
| new | | | |
| first quarter | | | |
| full | | | |
| third quarter | | | |

2. Considering the table entries above, can you guess in what range of times the other four phases of the moon can be seen?

To keep this simple, assume that the answer will always be one of the following:
**"about 3pm"** **"about 9pm"** **"about 3am"** **"about 9am"**

**Table 9.3: Rise, set, and meridian-crossing times of the Moon continued**

| phase | rise time | highest in sky | set time |
|---|---|---|---|
| waxing crescent | | | |
| waxing gibbous | | | |
| waning gibbous | | | |
| waning crescent | | | |

3. Now compare your predictions to the observations that you and your classmates have made. Do the times you saw the different phases make sense? What about the directions? Give some specific examples.

4. Suppose you see a waning crescent moon near the horizon in the west. About what time is it?

# Part III: Kinesthetic Moon Explorations

Now let's return to one of the phenomena associated with the Moon that we began exploring in Lab 1. The starting point for all of these explorations is that the Moon is tidally locked to the Earth. This means that the same side of the Moon always faces the Earth (nearly). Using this fact, we will explore the following questions. Use the Earth-Moon simulator to help you visualize the system and answer the following questions. *(Hint: notice how the one side of the Moon always faces the Earth)*

1. Does the Moon spin? (If you are standing on the Moon, will you see the stars rise and set?)

2. How long is the lunar day? (How long between successive sunrises?)

3. Is there a dark side of the Moon (a part of the Moon that is never lit up by the Sun)?

4. If you are standing on the Moon, will you see the Earth go through phases?

5. If you are standing on the Moon and see the Earth in a gibbous phase, what is the phase of the Moon as viewed from Earth?

6. If you are standing on the Moon, will you see the Earth rise and set?

7. Which is longer, a synodic month (the time between successive full Moons) or a sidereal month (the time it takes the Moon to complete one spin on its axis, as measured relative to the distant stars)? Why? By how much?