ASTRO 1050 -
Observing the Moon

ABSTRACT

In this lab we will create a model of the Earth-Moon-Sun system. This will allow us to explain the Moon's rotation, why the Moon has phases, and understand why eclipses take place.

1. Create a Model of the Earth-Moon-Sun System

The scientific method relies heavily on the use of models to make sense of the universe around us. After making observations, a model can be used to synthesize the data, construct a hypothesis and finally to make predictions. Models can take many different forms (structures smaller or larger than the original, conceptual analogies, mathematical equations or computer simulations), but all serve similar purposes to help us conceptualize a phenomenon otherwise difficult to grasp. In this lab you will be given a tennis ball, golf ball and flashlight, representing the Earth, Moon, and Sun, respectively, and asked to construct a model of the Earth-Moon-Sun system that accurately represents the data given to you.

1.1. Lunar Phases

Using your tennis ball, golf ball, and flashlight construct a model that matches the following data:

(1) The lunar synodic month (the time it takes to complete one cycle of phases), which is about 29.5 days
(2) The lunar sidereal period (the time it takes for the Moon to orbit the Earth once as viewed by you looking down on the system), which is 27.3 days.
(3) The direction of rotation for both the Earth and Moon. They rotate according to the right hand rule (with your thumb pointing North, they rotate the direction your fingers are pointing)

Remember that the Moon does not produce its own light. Also, the phases of the Moon as viewed from the Earth are in the following order:

1a: Describe your model. Draw a picture that depicts the moon's orbit.

We name the lunar phases according to what proportion of the disk of the Moon is lit. Thus, we call it a Full Moon when the entire disk is lit and a New Moon when none of it is. The intermediary phases are categorized as Crescent (less than half of the disk lit), Quarter (half the disk lit), and Gibbous (more than half the disk lit but not completely). The Crescent and Gibbous phases are split into groups, Waxing and Waning. Waxing means that the portion of the disk of the Moon that is lit is in the process of increasing, and Waning means that it is in the process of decreasing (i.e., you can have a Waxing Gibbous and a Waning Gibbous as well as a Waxing Crescent and Waning Crescent).

1b: Label the Phases of the Moon on the images given to you as well as on your own schematic.

1c: Based on your model, what direction does the Moon orbit the Earth?

1d: How is the Earth-Moon-Sun system aligned during a New Moon? Draw a picture!

1e: What about a Third Quarter Moon? Draw a picture!

1f: What time of day is it when a First Quarter Moon is highest in the sky or "crossing the meridian"? (The time of day is defined as the position of the Sun in the sky - so it's noon when the Sun is on the meridian, sunset is at about 6 pm and sunrise is at about 6 am, etc)

1g: What time does a Full Moon rise?

1h: How much of the total surface of the Moon is lit by the Sun when it is at Third Quarter?

1i: How much of the total surface of the Moon is visible from Earth when the Moon is at Third Quarter?

1j: Are any phases of the Moon visible during the day? If so, which ones? *For Full Moon and New Moon, provide answers for just before (say 5 minutes before) and just after (say 5 minutes after) these phases (the fact that our Sun is not a point source, combined with refraction of light by the Earth's atmosphere, causes the day to be 6-7 minutes longer than you might expect).*

2. Understand Eclipses Based on the Model

Next you want to use your model (and adjust it if necessary) to account for eclipses. We have a series of time-lapse pictures of a lunar eclipse as observed from the Earth.

We also have a series of time-lapse pictures of a solar eclipse as viewed from the Earth. The bright disk at the beginning and end of the series is the Sun. The central picture is enhanced to show the extended corona of the Sun.

2a: How is the Earth-Moon-Sun system aligned during a lunar eclipse?

2b: What phase is the Moon during a lunar eclipse?

2c: How is the Earth-Moon-Sun system aligned during a solar eclipse?

2d: What phase is the Moon during a solar eclipse?

2e: Based on your model, come up with a definition for what an eclipse is. Be very general!

2f: <u>According to your current model</u>, how often should lunar eclipses happen? And solar eclipses?

3. Understanding the Timing of Eclipses Based on Your Model

Finally, refine your model one more time to account for the fact that eclipses happen approximately every 6 months (and not every month). Also account for the fact that the orientation of the Moon's orbit relative to the Earth remains constant throughout the course of the Earth's orbit.

3a: Describe your model and any additions you have made.

3b: Why don't we see a lunar and a solar eclipse every month?