Telescope Field of View

MOON LAB – ONE NIGHT

Purpose: This lab has four primary purposes:

1. To familiarize yourself with the appearance of the Moon through a telescope.
2. To learn to interpret geologic features that you see in terms of the history of the object.
3. To become aware of the Moon and its history.
4. To measure the sizes of some of the geological features on the Moon.

Introduction

After many years of debate, it now seems clear that the Moon formed after a large object (1/2 the size of Earth, i.e. a Mars-sized object) [called an "impactor"] collided with the Earth early in its formation (within the first few hundred million years). The impactor, like the other terrestrial planets, probably had a core, mantle, and crust. After the collision, most, if not all of the dense core material (i.e. iron and nickel) stayed on the Earth, while some of the crust and mantle material went into Earth orbit and eventually coalesced into the Moon. (Some of that material may still be orbiting the Sun someplace.) During the intervening 4+ billion years, the Earth and Moon have had similar histories.

Both bodies were heavily bombarded by large meteoroids after they formed. This bombardment probably took place even before the objects solidified and cooled. Some of the meteoroids were hundreds of miles across, traveling at about 20 miles per second (72,000 mph)! These fast impacts left huge craters on both the Earth and the Moon and liquefied much of the Moon's near side for a while.

Plate tectonics and erosion have nearly completely erased the crater evidence on Earth. However, the Moon has almost no erosion or tectonic processes, so its scars remain to this day. Many craters and other results of impacts are visible with the naked eye.

The cratering barrage slowed down significantly about 3.1 billion years ago. During those 3 billion years, the Moon's crust solidified and the Moon synchronized its rotation so that it kept the same face towards the Earth at all times. Meanwhile, the Moon continued to cool and the denser, then-molten mantle "sank" closer to Earth. This means that the Moon's crust (which is less dense than the average Moon material) was thinner on the near side than the far side. This allowed the magma from the interior to reach the surface of the near side through cracks in the crust that had formed from large impacts. All of the large impact basins on the near side were thus flooded with basalt-like lava that cooled and solidified. Since the crust is thicker on the far side, there are very few such filled basins on the far side.

Basalt is darker than the rest of the crust and can be seen on the nearside as "maria" or "seas" of dark material. You can see them anytime you look up at the Moon. For some people, the pattern of these maria form a smiley face, for others, they form a rabbit.

Some of the craters that were in the floors of the impact basins were only partially flooded and can still be seen protruding through the giant frozen sea of basalt. Other craters are just below the surface, and can be seen only faintly as "ghost craters" when the Sun shines low on them, because the Sun casts long shadows, making the contrast visible to the eye. Some craters were half flooded and appear as "bays" along the coastline. Sinus Iridium is a good example.

Mountain ranges still exist on the Moon that were created from the early, huge impacts. The Haemus Mts. and the Caucasus Mts. that border the impact basin that is now Mare Serenitatis, and the Apennines that border Mare Imbrium are excellent examples. Some ranges are half buried in the solidified basalt, such as the Straight Range, and some ranges are almost entirely buried, with only the highest peaks still visible above the Mare surface, such as Mt. Piton and Mt. Pico. Note that mountain ranges on the Moon are not the result of plates colliding, as they are on Earth. Lunar mountains are results and by-products of impacts.

Impact craters still formed after the maria solidified, but they were much less frequent and smaller. When a crater is made today, it excavates the material below the immediate surface, and the newly exposed material appears very bright, especially when the Sun is high in the lunar sky. As millions of years wear on, the particles from the solar wind slowly darken this excavated material (called "ejecta") and the crater slowly fades to match its surroundings. Thus, the most recent craters are the brightest spots on the Moon. Excellent examples of recent impacts are Aristarchus (the brightest spot on the Moon), Tycho (whose ejecta "rays" can be seen for thousands of miles across the surface), Copernicus, and Kepler.

There are other geologic features on the Moon, including faults (such as the Straight Wall), rilles, and rift valleys (such as Alpine Valley) due to crust motion or ancient volcanic activity.

How to use the Moon Map

To find a crater, look at the names and numbers along the sides of the map. On the back of the map, the numbers have their approximate moon latitude and longitude listed. Note that you should make sure you recognize exactly where the crater is, since you will be observing it again during the second half of this lab. If you are unsure of which crater you are looking at, either pick another crater or pay careful attention to where you are looking and draw a detailed sketch of the surroundings.
NOTE: There is a typo on the map – the Apenines are labeled “b” on the map (instead of being correctly labeled “d”), near crater #97. The Apenines may not be visible during 1st quarter.

Requirements: For first quarter OR full phases:

1. A good sketch of the entire Moon as seen through the telescope. [3 pts]
2. Identify and label the features indicated below, doubly underlined. [4 pts]
3. Determine north, south, east, and west (on the sky) on this sketch [1/2 pt]
4. Compute the time it takes the Moon drift across its diameter [1 pt, do it 3 times]

Note: this sketch should take about 20-30 minutes. On this sketch, you should label the visible objects listed below:

Mare (seas) – label all of: crisium (crisis), fecunditatis (fertilitiy), nectaris (nectar), tranquillitatis (tranquility), serenitatis (serenity), vaporum (vapors), frigoris (cold), imbrium (rains), and nubium (clouds). If you see the Oceanus Procellarum (Ocean of Storms), label it too.

Craters (pick 3 craters during 1st quarter, and 5 craters during full phase including the same 3 from 1st quarter): Tycho, Plato, Aristarchus, Copernicus, Eratosthenes, Gassendi, Posidonius, Ptolemaeus, Fracastorius, Kepler, Plinius, Theophilus.

During the first quarter Moon, you should see the underlined craters and perhaps 1-2 more, not counting what you see near the terminator.

Mountain ranges (all 3): Haemus, Caucasus, Apennines.

5. [1 pt per object] Detailed (high power) sketches of the features listed below (i.e. ABCD). Each detailed sketch should take 5-10 minutes. Note: you will pick the same exact object for both phases, so record the name of the object you choose and label it on your first drawing. (Yes, the map has its directions labeled incorrectly from the Earth’s perspective, but correctly from the Moon’s perspective. West is the direction that the Sun moves, even on the Moon.)
   A. A small mare
   B. A recent impact crater (drift time the rays, if visible, instead of timing the crater)
   C. A mountain range
   D. A partially submerged crater
6. Measure the drift time of each of the objects you sketched for #5 [1/2 pt per object]
7. Answers to the questions below.

Directions:

1. Set up a telescope and roughly align it with the north celestial pole.
2. Find the Moon and begin getting your eyes adapted to it at low power.
3. Sketch the important features on the Moon.
   DON'T LABEL YOUR DRAWING UNTIL FINISHING ALL OF YOUR SKETCHES!
4. Locate a feature that you want to sketch in detail and label it on your drawing.
5. Move the feature to the center of the eyepiece.
6. Switch to high power and focus.
7. Make a detailed sketch of the feature.
8. Go back to low power, and back to step 4 and repeat.

Questions:

1. [2 pt] How do you know if a surface is younger or older than another one on a planet/moon? There are at least two answers, one given in the introduction. A hint about the other: think how the maria look compared to the other, older parts of the Moon)?
2. [1 pt] What do recent impact craters look like? List at least 2 features that distinguish new craters from old craters.
3. [1/2 pt] Why were you not instructed to find a totally submerged crater? [Be specific.]
4. [1.5 pts] During which phase are you looking when lunar shadows are longest? Is the Sun high in the sky or low in the sky when shadows are long?
5. [1 pt] What time of lunar day is it on the 1st quarter terminator? (Hint: getting lighter or darker? Waxing or waning?)

Fact: the speed of light is 300,000 km/sec, and that radio light and visible light signals from the Moon take about 1.3 seconds to reach Earth. You will find useful information on pages **Error! Bookmark not defined.** through **Error! Bookmark not defined.**.

6. [6 pts] Compute A) the angular size of the Moon based on your drift timing, B) the distance to the Moon C) the actual size of the Moon using the formula we have used many times, D) the ratio of the Moon's diameter to the Earth's diameter, and E) [2 pts] the physical size of each of your 4 objects based on your drift times for those objects.

Normally, this is a 2-week lab, once during a full-phase and once during 1st quarter. However, you are fortunate enough to have a **lunar eclipse during one of our classes**. We will be hosting an event for the public on that night, in lieu of performing a lab.