Astronomy 50 Spring 2016

Astronomy 50 Lab

**Lab: Telescopic Observations of the Moon and Outer Planets**

**Introduction**

Using a less powerful telescope than you will get to use, Galileo, in the early 1600s, made a number of significant discoveries that disproved the Ptolemeic model of the Universe (which was the model taught by the Catholic church), in which the Earth was located at the center and all other bodies in the heavens orbited the Earth, and all bodies in the heavens were perfect spheres and moved endlessly in circles, while the Earth is flawed with its mountains and valleys and objects moved in straight lines and naturally came to a stop.

Some of Galileo’s most significant discoveries you will reproduce here. These are the following.

1. The Moon is not a perfect sphere.

2. There are moons orbiting about Jupiter revealing .that there are bodies that do not orbit the Earth – which provided evidence against the geocentric model.

3. Saturn is not a perfect sphere. It appeared to have ears. We now know these are the rings of Saturn.

(His other discoveries included phases of Venus that required that it is sometimes further from Earth than the Sun and the concept of friction which explained why objects on the Earth naturally came to a stop.)

In the 1800’s, the Italian astronomer Giovanni Schiaparelli made telescope observations of Mars and reported that it appeared to have dark lines across its surface, which he speculated might be channels. This was mistranslated to English to be ‘canals’, which implied planet-wide artificial structures and hence a highly advanced civilization. In the early 1900’s, then, many people believed, and feared, that there existed superior beings just one planet away from us, which might come and invade the Earth. (This is one reason that the 1938 radio broadcast of “War of the Worlds” caused mass panic.) Also visible in telescopic views of Mars are its polar ice caps, which we now know contain both ices of both H2O and CO2.

**A. Get Familiar with Telescope:**

1. While in a warm, well-lit room, get familiar with your telescope:

a. The front of the telescope is the end by the eyepiece holder. There should be a dust cover on the front that easily pops off. Be sure not to lose this cover, or any dust cover (such as those on the finder scope).

b. Attach the mount to the telescope by opening the two large metal rings on the mount, inserting the telescope, and closing the rings. Slide the nuts with knobs into the slots and tighten gently; you will find that you first have to loosen the nuts to get the screws into the slots.

c. Note that the telescope can now swing about two different axes. (If not, you may have the locks on—ask your instructor for help.) These correspond to the two celestial coordinates (RA and DEC – these are like lines of latitude and longitude in the sky).

d. Locks and fine-adjustment knobs. Each of the two axes has black lock handles which you can use to fix the telescope in position. It should be obvious to you when you turn the handles when they are locked. To unlock, you only need to turn these handles a 1/2 turn counterclockwise. There are also large black knobs attached to cables which enable you to turn the telescope on these axes more slowly and with more control. These are the fine-adjust knobs. They are used when you have the telescope close to, but not at, the position you want it to be. These knobs are used, for example, to help center an object in the field of view (either in the telescope or the finder scope).

e. Finder scope. The miniature telescope attached to the big telescope is known as the finder scope and is used for getting the celestial object of interest into the field of view of the telescope. The finder scope, with its low magnification, has a much larger field of view than the main telescope. So, it is much easier to line up the telescope to get a particular object into the field of view of the finder scope than it is to get into the field of view of the telescope.

f. Eyepiece holder and focus knob. The telescope will not already have an eyepiece. The holder for the eyepiece should be obvious. Notice that it has a little set screw to lock onto the eyepiece. On the eyepiece holder is the focus knob. Every time you put in a new eyepiece you will need to re-focus.

g. Remove the telescope from the mount. Carefully turn the mount over and note the bottom--you will mount the telescopes onto metal piers at the Niskayuna Soccer Fields. You should see two screws facing each other. These will grab a metal peg of the top of the pier, once correctly placed.

2. With one partner carefully carrying the telescope and the other carrying the mount, find a way (using backpack or pockets) to also carefully carry the pair of eyepieces provided, a flashlight, and your lab instructions to the van.

**B. Set-up at the Park:**

3. Choose your pier, noting that they have different heights (tall, medium, and short). Verify that your chosen pier is not open at the top, but has a metal top with a screw hole in the middle and a vertical metal peg. Insert the mounting screw into the pier and place the telescope mount onto the pier. You probably have to loosen the two screws at the base of the telescope mount in order for the mount to settle into place. The screw from the top of the pier should go through the bottom of the mount first, and only afterwards will you tighten the two matching screws around the peg. This is your only sure method to avoid it falling off, so double-check it is well-adjusted, but do not force it!

4. Rough Polar alignment. Check that the axis of the telescope mount is at least roughly aimed at the N. Pole star. If it is off, use the pair of screws (mentioned in #3) at the base of the mount and that touch the peg of the pier to move in azimuth (loosening one screw and then tightening the other). The polar alignment for this lab is not crucial.

5. Install the telescope into the mount, rotated so that the eyepiece and finder scope are easily accessible.

6. Insert the eyepiece. Insert a long-focal length eyepiece into the eyepiece holder and lock it down.

7. Check the balance of the telescope by locking one axis and seeing how easily it swings in either direction on the other axis. If it seems significantly unbalanced on either axis, adjust either how it sits in the rings and or the position of the counter weight until it is balanced. Be sure to check the balance with respect to both axes.

8. Check the alignment of the finder scope. THIS IS A VERY IMPORTANT STEP. The alignment of the finder scope with the telescope is ***very*** important. If the finder scope is not well aligned, you will find it very difficult to find any object. However, once the finder scope is aligned it will probably stay aligned for a long time. You might find that the finder scope IS already aligned and so this step will be only a check. But, you should always take the few minutes necessary to check. You’ll save yourself a lot of agony if you discover the finder scope is misaligned before you try to use it to center an object. Find a distant, bright, and easy to see object (such as the water tower to the East, or the Moon) and move the telescope so that the object is in the center of the field of view of the telescope’s eyepiece (you'll probably need to focus) and lock the axes. Then, check the finder scope. If the object is not exactly in the center of the cross hairs of the finder scope then you need to adjust the finder scope. To do so, use the two or three set screws on the finder scope, loosening one or two and then tightening another. If using the Moon, make sure that it is the same part of the Moon at the center of the finder scope and in the telescope.

9. Move to the desired object. With the lock handles unlocked, swing the telescope using both axes to the correct direction. Then, lock the axes with the lock knobs, look through the finder scope, and use the fine-adjust knobs to center the object in the finder scope. You might find it helpful to use the “double-eye method” as explained by your instructor. Center the object in the field of view of the telescope’s long focal-length eyepiece. Long focal-length means that it has low magnification, and therefore a large field of view. You will find it very hard to get an object in the center of the field of view using the highest power eyepiece, so you should always start with a long-focal length eyepiece.

10. Once you have the object in the center of the field of view of the lower power eyepiece, then you can put in the higher power eyepiece.

11. Since the telescope mount does not have a motor, the object will drift out of the field and so you will need to frequently turn the fine-adjust knobs to re-center it. If the mount is well-aligned, you should only need to use the right ascension knob.

**C. Exercises**

Examine the following bodies through your telescope and answer the questions.

1. The Moon

 a. Do you see the craters and is it clear from this view that the Moon’s surface is not smooth? Comment on whether this was an obvious discovery for Galileo, and whether it should have been easy to prove to others that the Moon was not a perfect sphere simply by asking them to look in the telescope. Part of Galileo’s difficulties was that the others refused to look into the telescope for fear of seeing what they did not want to see. Do you know of modern examples of this “ostrich” behavior?

b. The craters are doing collisions with space rocks. Why do you think the Moon is so heavily cratered, while on Earth there are only a few meteor craters of note?

 c. The darker areas (the spots that make up the eyes and mouth of the face of the “Man in the Moon”). These areas were called “maria” by Galileo. Maria means “seas” (in Italian). We now know that they are not seas. Based on your view of them, why do you suppose Galileo called them seas?

 d. The differences between the dark areas and light areas. Describe the ways that the dark areas (the maria) are different from the light areas, which are called “the highlands”? Why do you suppose the lighter areas are called “highlands”? Why do you suppose these regions have different shades of gray? Can you explain why the regions that appear like “seas” are also not the “highlands”? Give a scenario for how these two different types of areas were created.

 e. The shadows. Where are the shadows the longest? Can you explain this? Consider now if we were to observe a full moon with the telescope; what then would our view of the shadows look like? In fact, as you can see the three-dimensionality of the first quarter moon jumps out at you, whereas a full moon looks kind of flat. Explain why that is.

2. Jupiter

a. Do you see moons of Jupiter? How many? Draw a sketch of Jupiter and its moons to scale. How obvious would it have been to someone in Galileo’s day to see these moons simply by looking through Galileo’s telescope?

b. Do you see stripes? What colors are they? These are called the “zones and bands” of Jupiter. They are due to Jupiter’s gaseous composition, rapid rotation, and weather.

c. Do you see the red spot? Is it easy to see, difficult? How red is it? (There is a 50% probability that it is hidden on the backside at the time that you’re looking.)

3. Mars

 a. Draw a sketch of what you see.

b. Do you see a polar cap? Do you see one or two caps? If only one, explain why. What does this tell you about seasons on Mars?

c. Do you see markings that could have been what Schiaparelli saw? We now know that these are due to dust storms on Mars’ surface. How large are these features—are these storms as large, or larger than storms on the Earth?

4. Saturn

 a. Sketch what you see.

 b. Do you see the rings? Was it obvious to Galileo that Saturn was not a simple sphere?

c. Are the rings tilted? Do you see a gap (known as the Cassini division) in the rings?

 e. Do you see at least one moon of Saturn? Considering that Saturn is almost twice as far as Jupiter, and that the light we see from these bodies come from the Sun and reflected back toward Earth, what might you conclude about Saturn’s brightest moon?

Summarize your observing experience. Discuss the effect of using a telescope to study the bodies in our Solar System and how this changes our appreciation and understanding of the Universe we live in. Extrapolate this concept to consider the invention of new instruments, in general, and the advancement of humanity’s understanding of nature.

**D. Dismantling**

1. Remove the eyepiece and puts its lens cover(s) on. Be sure you still have two eyepieces.

2. Put covers back on: the front of the telescope, both ends of the finder scope, and on the eyepiece holder.

3. Take the telescope off the mount by opening the two large mounting circles.

4. Remove the mount from the pier by loosening the two screws that clamp onto the peg, and loosening the bolt under the mount at the top of the pier, if applicable.

5. Carry all the parts back to the van and then to the storage room and help put them away.

**Lab Report**: Describe (in separate paragraphs) your answers to the questions in the “Exercises.” Include diagrams where appropriate.