

29:50 Laboratory Exercise
Stars, Galaxies, and the Universe
Telescopes

Name.....

Date.....

I. Introduction

The most basic astronomical instrument is the telescope. A telescope collects light from and magnifies an astronomical object. Until the end of the 19th century, all observational work in astronomy was based on observations made at the eyepiece of a telescope. Nowadays, even though astronomical research relies on much more sophisticated types of measurements, an introductory course in astronomy should develop familiarity with small telescopes and their use in observing the objects discussed in lecture.

We will learn to set up and use small telescopes owned by the University. A total of 6 telescopes will be made available. Four of the telescopes are refractors, which use lenses to collect light and form an image. Two of the telescopes are examples of the other major class of telescope, the reflector, which uses a mirror. Two of the refractors to be used have lenses with diameters of 100 and 120 mm, respectively. The other two refractors are Rich Field Telescopes with lenses 80mm in diameter and a short focal length. More details are given in the table below.

The main point of this lab will be to familiarize students with setting up and using a small telescope. Each pair of students will be assigned to one type of telescope, an Orion ShortTube refractor, a larger Orion refractor, or a Celestron C8 Cassegrain reflector. After this exercise, students should be able to set up these telescopes during field trips and make observations of objects discussed in class.

The activities to be carried out in this project consist of the following. Students will set up a telescope on the roof of Van Allen Hall and prepare it for observation. Eyepieces of different focal length will be used as the telescopes observe distant objects in Iowa City and its surroundings. The different magnification will be noted (see further discussion of magnification below). The setting circles of the telescope will be adjusted, and used to point the telescope towards the Moon or the planet Venus, which may be visible during the daytime.

The last part of the exercise will be to return to the roof at night (in the Clear Sky Patrol) during a 3 week period, properly adjust the setting circles, and find an astronomical object for which the telescope is well suited, such as the globular star cluster M13, the Chi-h double star cluster in Perseus, or the double star Beta Cygni.

An important concept in this project is that of the magnification of a telescope. It is expressed as a number greater than one, and indicates how much a bigger an

astronomical object looks through the telescope than it would if viewed with the naked eye alone. Alternatively, the object looks like you are closer to it by a factor equal to the magnification. If your telescope has a magnification of 100X, the object looks like it would with the unaided eye if you were 1/100 of your actual distance. This is the way a telescope allows us to see an object “up close”.

The magnification is determined by the focal length of the telescope (the distance between the lens or mirror and the point where the light rays come to a point) F_1 , and the focal length of the eyepiece F_2 . The magnification of the telescope is then given by $M=F_1/F_2$.

The characteristics of the telescopes which will be used in this exercise are given in the table below.

Telescope	Aperture Diameter (mm)	Focal Length (mm)
Orion ShortTube 80	80	400
Orion SkyView Pro 100	100	600
Orion SkyView Pro 120	120	1000
Celestron C8	203.2	2000

II. Setting Up the Telescope

Once you and your lab partner have been assigned a telescope, get it to the roof and set it up. The teaching assistant will help you with this. All of the telescopes have the following features in common: (a) a tripod on which the telescope is mounted, (b) a “wedge” or other type of mount which orients the telescope in the Celestial Coordinate System, and (c) the telescope proper. In setting up the telescope, be sure the mount is polar aligned, which means that its axis is pointing towards the north celestial pole. In the daytime, this can only be done very roughly.

III. Changes in Magnification

The teaching assistant will point out a remote object, such as the tops of the smoke stacks on the university power plant, or the dome on City High School. Pick an eyepiece with a fairly long focal length, at least 25mm, put it in the telescope, point the telescope at the remote object, and focus. Use the data table below to record your observations.

Telescope	Eyepiece Focal Length(mm)	Magnification

Next, put an eyepiece with a short focal length, 10mm or less in the telescope and refocus. Make corresponding notes in the table above. Note the difference in the appearance of the distant object as you change eyepieces.

Go to at least one other telescope, preferably one quite different from the one you have been using, and check out the distant object through it. Note the magnification that your fellow students have calculated for that telescope, and compare the appearance of the object with the observations you made with your own telescope.

IV. Adjusting the Setting Circles

Most astronomical telescopes have a pair of dials called setting circles. These tell the Right Ascension and Declination at which the telescope is pointing. Setting circles can be extremely useful in finding astronomical objects which otherwise are hard to locate in the sky.

If the telescope is set up properly, the declination setting circle will give an accurate reading. However, the Right Ascension setting circle must be adjusted or calibrated for each observing session.

The way this is done is to point the telescope at an obvious object (for example, the star Vega) of known coordinates, then adjust the Right Ascension setting circle to equal that of the object. Once the setting circles are set, the observer can point the telescope to any pair of celestial coordinates.

During the nighttime observing session (see part V below), we will carry out the procedure described above. However, in the daytime session on the roof, we will do an approximate calibration of the setting circles.

Point your telescope due south. A good way to do this is to use the theodolites to establish the direction south, find an object to point at, then point at the same object with your telescope.

Next, return to the lab room, where your teaching assistant will give you the value of the *Local Sidereal Time*. The Local Sidereal Time is defined to be the Right Ascension of an object on the meridian at that moment. Obviously, sidereal time changes in the same way that standard time does.

Return to the roof and “dial in” the sidereal time on the Right Ascension setting circle of your telescope. Your setting circles are now calibrated.

Now the teaching assistant will give you the coordinates of an object which is up in the sky. The object of choice is one which would really be visible in the daylight, such as the Moon, the planet Venus, or (for the larger telescopes), the planet Jupiter. Move your telescope to the coordinates and see if you can find the object in the daylight.

If it is cloudy during your session, do the calibration and pointing procedure anyway, since it will familiarize you with the mechanics of this operation. Record your observations in the space indicated below.

Object.....
Right Ascension.....
Declination.....
Result of
Observation.....
.....

V. Nighttime Observations with Telescopes

Following the regular lab session, you will come to the Clear Sky Patrol session in the period October 2 – October 18. You will sign in on an attendance sheet. One of the telescopes in the table above will be set up on the roof. You will be given an object, such as the star Vega, with which to calibrate the setting circles, and then an object to find and observe with the telescope. The observing form for this exercise is given on the next page. Complete it during your session, have the on-duty teaching assistant sign it, then hand it in to your regular teaching assistant at the next class meeting.

Warning! Autumn nights in Iowa are usually cloudy. Make these observations as soon as possible, rather than putting it off to Thursday, October 18, only to discover that it is cloudy that night.

Telescopic Observing Sheet

Student.....

Date.....

Teaching Assistant.....

Telescope Used.....

Eyepiece used.....

Standard Star (+ RA and Dec).....

Object Observed.....

RA and Dec.....

Make Drawing or Give Description of the Object in the Space Below