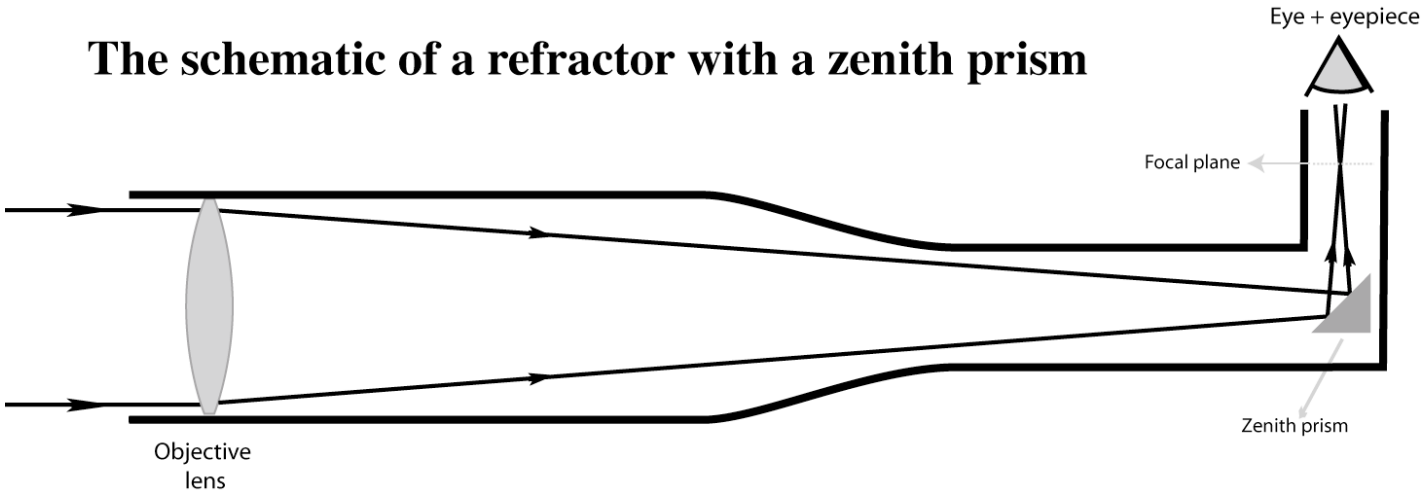
Lab #52a: How to use a telescope? (Refractor)

In this laboratory you will learn how to set up and use the 12-cm (5-inch) refractors. They are small-size as amateur telescopes go. The amateur rage would be 4 to 20 inches in diameter.
Most modern astronomical telescopes are *reflectors*; in those the main optics is a concave mirror located in the bottom of the tube. The ones you will be using in this lab are *refractors*, which use a lens in the front as main optics. The objective forms image at the back of the telescope (The zenith prism turns the viewing by 90°, which is very convenient when you are looking at a star high up. Zenith is the point straight up – hence the name.)

The image formed by this system is viewed through an eyepiece. The magnification of the telescope is calculated as $M = f_{objective} / f_{eyepiece}$, and you can use various eyepieces of your choice. A good starting point is an $f = 26\ mm$ eyepiece. What will the magnification be with this eyepiece? What would be the magnification with an $f = 9\ mm$ eyepiece? Enter your answers in the lab report.

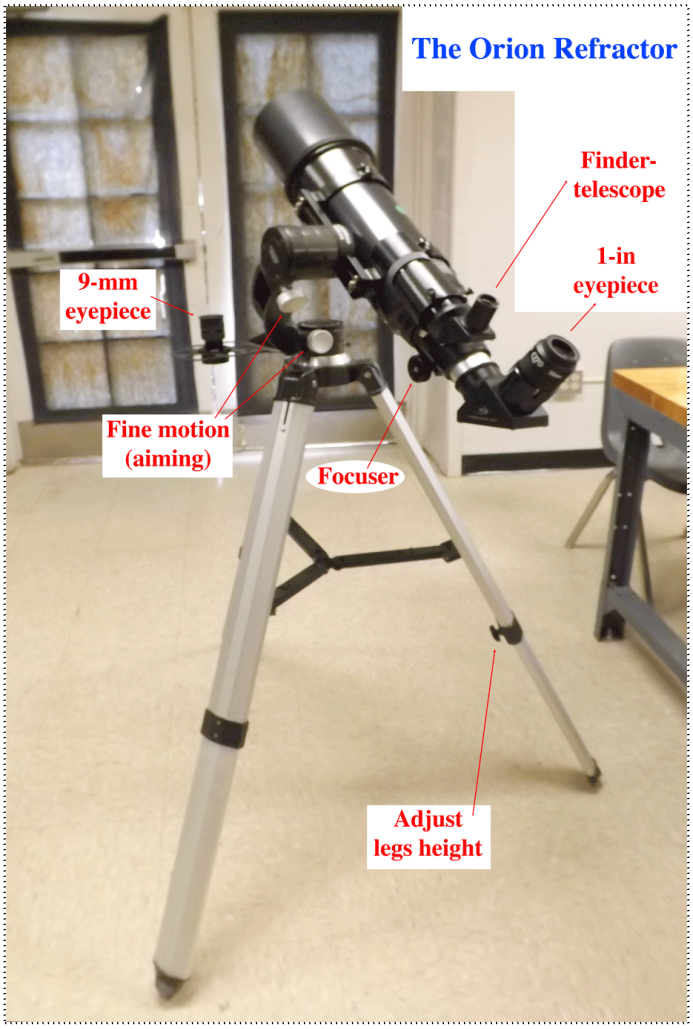


Aiming the telescope at an object needs some care. Due to magnification, the size of the field you see in the eyepiece is little (nothing much larger than the size of the Moon would fit in the telescope), so you need to use an aiming device. For this purpose, a small telescope called the *findertelescope* is attached, and it always points at the same star. In order to aim at an object in the sky, you'll need to turn the scope so that the object shows up in the finder first. You'll need to get your star exactly in the middle of the *crosshair*, and then the star will show up in the eyepiece. For precise aiming you'll be using the fine adjustment knobs. (You should not pull the telescope tube for adjustment!)

Once you aim your telescope at a star, you'll notice that it is moving and it quickly leaves the field. Earth's rotation causes the sky turn (apparently), and the telescope magnifies this motion. It takes only a minute or two for the star to move out of the field. As the stars "move" on a circle around the axis of Earth (which points at the North Star), once in 24 hours, the telescope has to be turned around this same axis.

The telescopes we are using in this laboratory exercise have a rudimentary mount. It can turn around a vertical axis and a horizontal axis. Such a mount is called an *altazimuthal mount*. You will need to keep tracking the stars manually by turning the telescope around both axes simultaneously.

Once you have a star in the field, you have to *focus* the telescope. (Do not confuse *focusing* with *aiming*. Focusing means moving the eyepiece closer or farther from the main lens, making the image as sharp as possible.) Take off your glasses if you have any, and place your eyes as close to the eyepiece as you can. Grab the focuser knob and turn it this way and that until the star is as small of a dot as you can make it. Every time you look in the telescope you'll need to focus it, because your eye changes all the time, and other people's eyes are different from yours.



Notice that you want the stars to be as tiny dots as you can make them. As you move the eyepiece far from focus in either direction, the star looks like a large disk with a black hole in the middle. That is not the star's image; you need to turn the focuser knob to make the star little again. All stars look like dots in a telescope; their disks are so tiny that even the largest telescopes cannot ever resolve them.

Telescopes are precise and sensitive devices. Handle them as you would hande an eggshell. In particular, never use force for anything: if it does not move easily, you are doing it wrong, and you should ask your instructor for help.

Occasionally some parts of the telescope may become loose, or the finder may not stay parallel to the main scope. If that happens, ask your instructor to tighten the loose parts, or parallelize the finder with the scope. Don't try to do this yourself.

PROCEDURE AND LAB REPORT

Date:_____ Your name: _____Partner's name: _____ Section: ___/___

Maximum two students may work together as partners!

This laboratory is in a large part done outdoors. For this reason, the report must be printed out and the paper copy must be used.

1. ***Form groups*** *of two students;* ***listen*** *to the introduction by your instructor.*

2. ***Read the introduction and answer the questions.*** Your telescope has a focal length of *f* = _____ *mm*; with a 26 mm eyepiece its magnification would be, M = ___×. With a 9-mm eyepiece, M = ___×.

3. ***Examine the Orion refractor.*** It might be difficult to learn how to do this in the dark, so do this **in the well-lit laboratory**.

-- Insert an *f = 26 mm* eyepiece into the telescope, and find the *focuser knob* and turn it.

-- Push the telescope around both axes to see how it moves. After that, try out both *fine motion* knobs.

-- Find the findertelescope, and identify the leg adjustment bolts. Make sure they are tight.

-- Take off the two lens caps and put them in the 'collection box' in the laboratory. Lens caps are notoriously easy to loose in the dark when taken outside.

4. ***Take the telescope outside.***

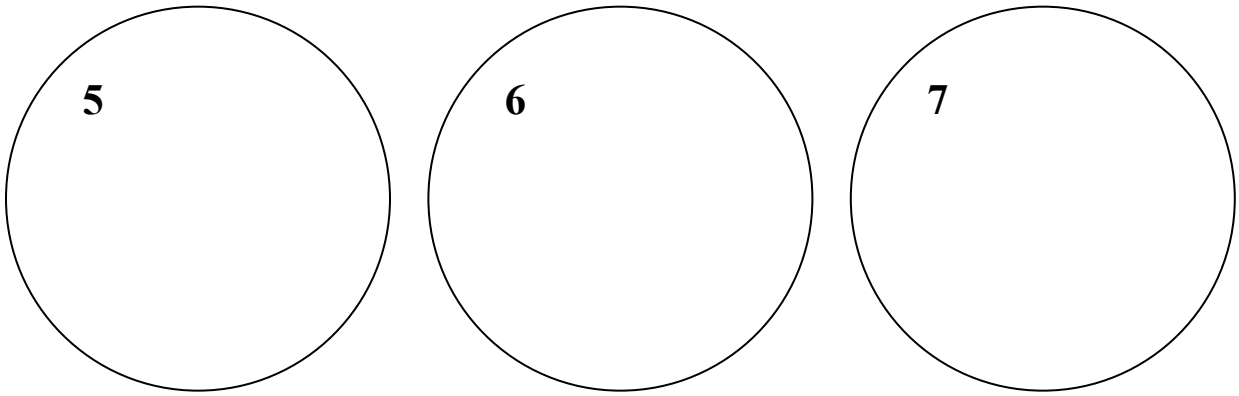
-- Hold the scope by the tripod and don't try to list it by the telescope tube. Your instructor should demonstrate how to grab it safely. When outside, make sure your telescope is stable enough and does not tip over.

-- Aim the telescope at any bright star. It should show up int the finder first. Use the two fine motion tubes to center the star in the finder, then look into the larger scope.

-- Focus the image with the focuser knob. How little did you manage to make the star's image? Describe it in a few words: _____.

-- Observing the star you will see that it is moving out of the field. Using your watch, estimate how many minutes (or seconds) it takes for the star to move from the center of the field to the edge. _____ (It is advisable to do this with a star close to the equator; otherwise it will move too slowly.) The name of the star you looked at is: _____

Star name	Official name	Description
Castor	α Geminorum	The northern one of the two stars of the Twins.
Alcor and Mizar	ζ Ursae Maioris	The middle star of the handle of the Big Dipper.
Albireo	β Cygni	The head of the Swan.
-	γ Andromedae	-



5. ***Aim at a double star in the sky***. Your instructor will tell you which one to choose from the four listed ones below. Ask him/her which one is high up tonight.

-- Turn the focusing knob
this way and that until the star appears to be as tiny a dot as possible.

-- Make a drawing of what you see in the field.
The circles represent the field of view in the telescope.

6. ***Turn the focusing knob*** so that the eyepiece moves out of the telescope a few millimeters. Make a drawing of what you see in the field now.

7. ***Turn the focusing knob*** back and beyond correct focus, so that the eyepiece moves into the telescope a few millimeters. Make a drawing of what you see in the field now.

8. ***Which one*** of the above situations is a correctly focused telescope? _____

9. ***Center your double star and replace the eyepiece*** with a *10 mm* eyepiece; refocus. The image of the stars will appear blurred and magnified. Do you think what you see is really the disk of the star, yes or no? _____. If no, what do you think is causing the star look like a blurred disk at high magnification? _____.

10. ***Take the telescope back inside.*** Make sure of the following:

a. The two lens caps are replaced.
b. The scope points straight up.
c. The large (26-mm) eyepiece is in the scope, the 9-mm one on the tray, upside up.
d. The telescope's legs are all pulled in short.
e. The scope is put in a place where it is not blocking the way.