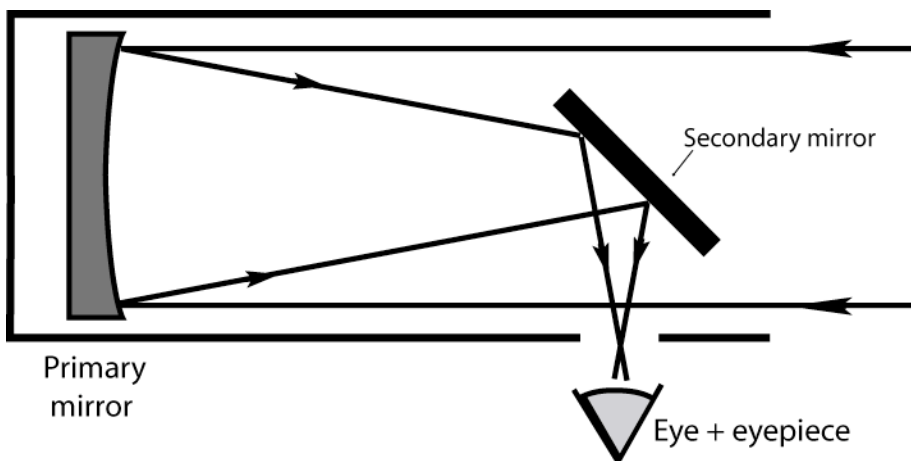


# Introduction to the Dobsonian Telescopes

One type of telescope that students in the astronomy class frequently use is a 10 - inch Dobsonian telescope. These telescopes are medium-size, as amateur telescopes go (the amateur range would be 4 to 20 inches in diameter); they are mechanically simplified for low price and ease of use.

As almost all modern astronomical telescopes, they are *reflectors*; the main optics is a concave mirror located in the bottom of the tube. Light enters the tube from a distant star on to the main mirror at the bottom of the tube. From the main mirror, the light is then reflected to a secondary mirror, and then sideways out of the tube, on to the lens of an attached eyepiece where the image is seen. (See the picture). This system of a concave primary mirror and a plain secondary is called the “Newtonian” system.



The image formed by this system is viewed through an eyepiece. The magnification,  $M$ , of the telescope is calculated as follows  $M = f_{\text{objective}} / f_{\text{eyepiece}}$ , where  $f_{\text{objective}}$  is the focal length of the telescope, and  $f_{\text{eyepiece}}$  is the focal length of the eyepiece. You can use various eyepieces of your choice.

Aiming the telescope at an object needs some care. Due to magnification, the size of the field you see in the eyepiece is little (not much more than the size of the Moon would fit in the telescope), so you need to use an aiming device. Such a device, called a TELRAD, is mounted on the side of the telescope. You'll need to get your star exactly in the middle of the “bull's eye”, and then the star will show up in the eyepiece (you may want to dim the bull's eye so much that it does not overwhelm the light of the star you are watching).

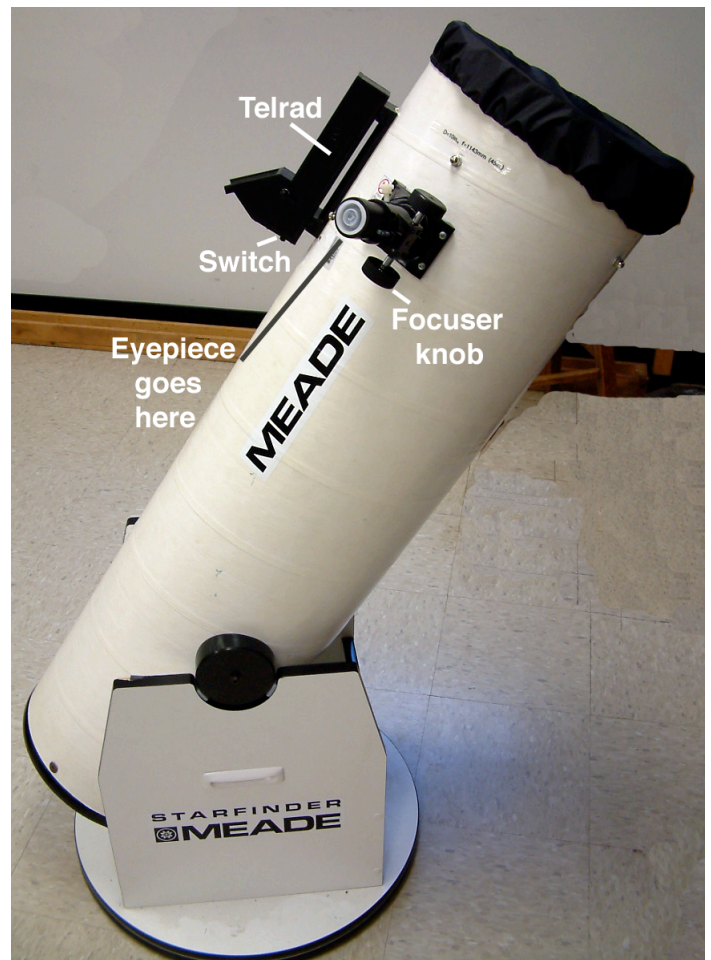
Once you aim your telescope at a star, you'll notice that it is moving and it quickly leaves the field. Earth's rotation causes the sky turn (apparently), and the telescope magnifies this motion. It takes only a minute or two for the star to move out of the field. As the stars “move” on a circle around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

These particular telescopes are mounted such that they can turn around a vertical axis and a horizontal axis. Such a mount is called an *altazimuthal mount*. When these telescopes are used, the stars need to be tracked 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*. When focusing, you move the eyepiece closer or farther from the main mirror, making the image as sharp as possible.) If you were glasses you should remove them and adjust the focus to your suit your vision (in order to place your eyes as close to the eyepiece as possible). Turn the focusing knob until the star appears to be 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 if other people use your telescope they will be adjusting the focus as well.

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 – and the black hole in the middle is simply the shadow of the secondary mirror.

All stars look like dots in a telescope; their disks are so tiny that even the largest telescopes cannot ever resolve them.



# General Telescope Information

How we see images – lens in the eye bends to a point called the “focus”.  
The distance from lens to the focus is the focal length.

Angular separation is how big an angle you can still perceive two separate stars as separate.  
The Human eye can only see  $1/60^{\text{th}}$  degree (1 arc minute)  
Also, the human eye transmits signal continuously to brain, so it cannot see very dim objects well.

Telescopes – with them we can see much smaller angles and magnify the sky.

Cameras – with them we can collect more light before saving the image, allowing us to see dimmer images.

In its essence, a telescope is an instrument that makes a far away object look closer. To do this, a telescope has a device that collects light from a distant object (objective lens or primary mirror) and brings that light (image) to a focus where a second device (eyepiece lens) magnifies the image and brings it to your eye.

**There are 2 types of Telescopes:**

- **Refracting** (Uses Lenses)

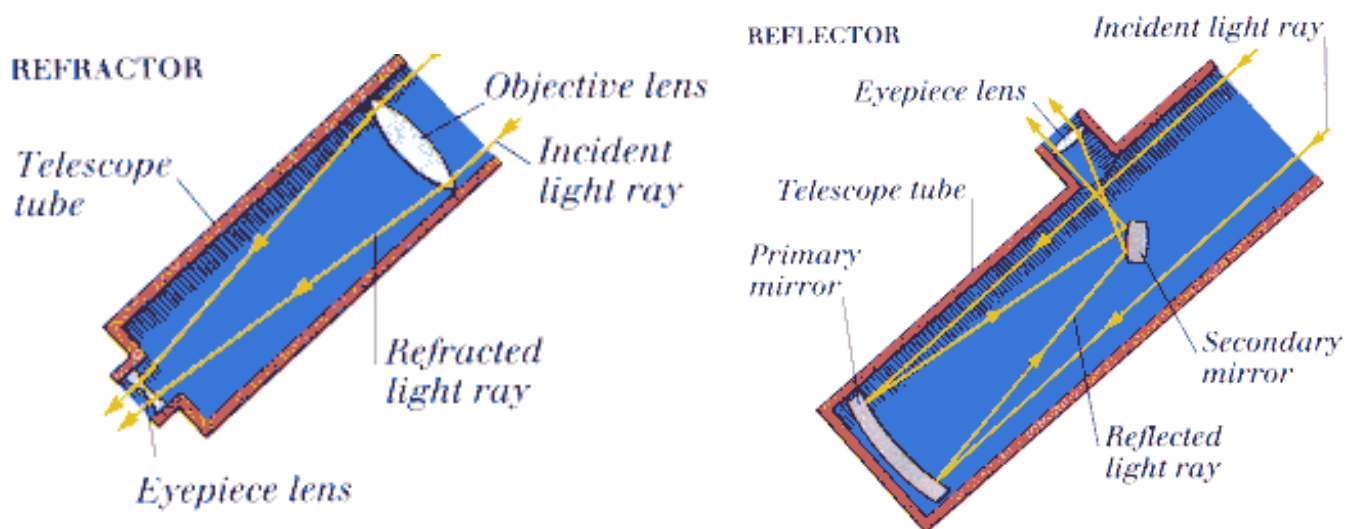
Example: 2 lenses -> 1 objective + 1 eyepiece

Works like eye with a focus from the front lens that meets the focus from the eyepiece.

- **Reflecting** (Uses Mirrors)

Example: 1 main mirror + 1 diagonal mirror + 1 eyepiece

Has concave mirror at back that reflects light to another mirror that reflects into the eyepiece.



How does the size of a telescope help see more? It can collect more light and give more angular resolution.

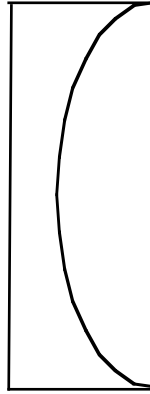
Telescopes sizes are referred to by the diameter of their primary mirror or lens. (i.e. 1 meter, 12 in)

# Basic Telescope Terms

**Diverging** - Lens or mirror that causes light to spread out.

**Converging** - Lens or mirror that causes light to come together to a focal point.

**Concave** - Curved in. In a lens it causes light to diverge, but in mirror it causes light to converge to a focal point.



**Convex** - Curved out. In a mirror it causes light to diverge, but in lens it causes light to converge to a focal point.



**Field of View** - area of the sky that can be seen through the telescope with a given eyepiece.

**Focal Length** - distance required by a lens or mirror to bring the light to a focus.

**Focal Point or Focus** - point at which light from a lens or mirror comes together.

**Magnification (power)** - telescope's focal length divided by the eyepiece's focal length.

**Resolution** - how close two objects can be and yet still be detected as separate objects, usually measured in arc-seconds (this is important for revealing fine details of an object, and is related to the telescope's aperture).