

# GETTING STARTED WITH YOUR NEW TELESCOPE

by

William J. Busler

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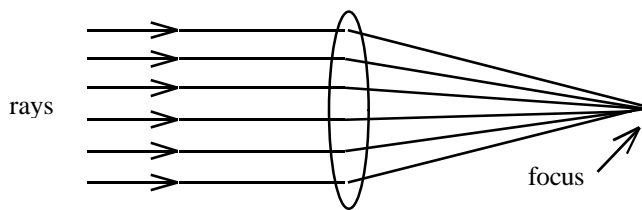
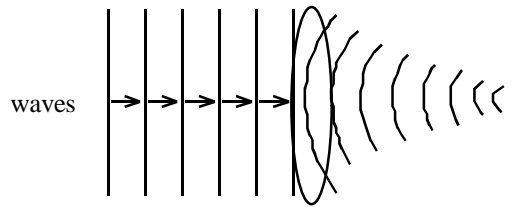
So you got a new telescope for Christmas or your birthday, or maybe you just went out and bought one for yourself. If you're like most beginners (myself included, back in 1957!), it can be pretty intimidating to set up a telescope for the first time, much less use it to find things in the sky. We hope this article will ease your transition from rank beginner to knowledgeable amateur.

Note: Most of the information below can be found in more detail in our booklet entitled *A Short Course in Astronomy*, published by the Memphis Astronomical Society and available at meetings for \$5.00.

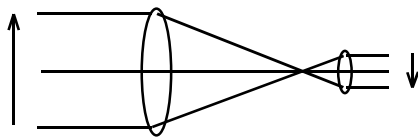
## Types of Telescopes

You probably already know what type of telescope you have, but you might want to read this section anyway to see how your scope works, and how it differs from other types.

**A. Refractor Telescope:** Based on the principle that light is *refracted* (bent) as it passes through a lens. This is due to the slowing down of the light waves from 186,000 mi/sec in a vacuum or air to about  $\frac{1}{2}$  to  $\frac{2}{3}$  of that value, depending on the type of glass. As the waves pass through a *convex* lens, they are slowed more in the center than at the edges of the lens. This causes the waves to converge to a focus. An *image* (of the distant object) is formed at the focal point; it may be projected onto a screen, a piece of film, or a retina, if the lens was the eye's own lens.



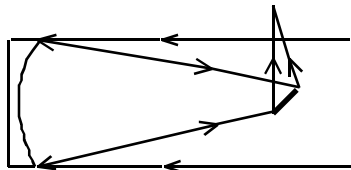
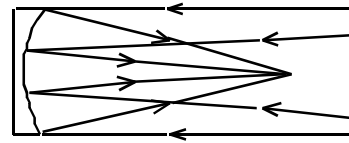
The image may not be viewed directly, since the rays passing through the focal point will diverge; rays must be nearly parallel to be focused by the eye.



The light rays are made parallel by allowing them to focus and then using a convex lens (in an eyepiece) to straighten them. This gives an *inverted* image, which is usually not a problem.

Relative merits: No alignment (usually), high power, limited to small diameter. Relatively high cost. Best for *small, bright* objects, such as the Moon, planets, and double stars.

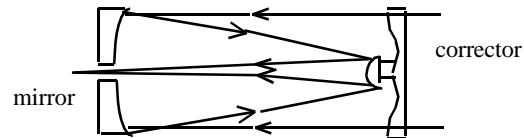
**B. Reflector Telescope:** A concave mirror reflects incoming parallel rays back to a focus. There is no chromatic aberration, since all colors are reflected together. The mirror must be *parabolic* in cross-section (nearly spherical). It is easy to make large mirrors: there is only one surface to figure, there is no need for transparency, and a mirror can be supported from the back.



Small reflectors need a *diagonal* mirror to divert light out to the side, so the observer's head won't block incoming light (*Newtonian* design). An eyepiece is used, as with a refractor. A finder scope is needed, preferably a small refractor of straight-through design. A variation on the reflector design is the *Cassegrain*, which has a hole in the objective mirror through which the light is focused.

Advantages and Disadvantages: Frequently needs alignment (easy), and eventual resurfacing. Low cost per inch; large diameters are practical. Best for large dim objects, such as nebulae, galaxies, and faint star clusters.

**C. Hybrid (Schmidt-Cassegrain) Telescope:** Popularized by Celestron and Meade. Large diameter *and* long effective focal length due to convex secondary mirror; high power, bright images. Good for all types of observing. Main drawback: quite expensive! Many commercial types are rather poorly figured. Corrector plate "dews up" easily on humid Memphis nights.

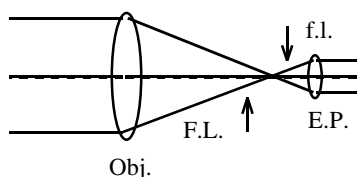


## Useful Information About Telescopes

(Applies to all kinds of telescopes)

**A. Magnification (Power):** This is overrated, especially in advertisements for inexpensive telescopes.

$$\text{Power} = \frac{\text{F.L. objective}}{\text{f.l. eyepiece}}$$



Power is adjusted by changing eyepieces. The shorter the focal length (f.l.) of the eyepiece (E.P.), the higher the power (×).

Example: A telescope has a 48" focal length mirror and is used with a  $\frac{1}{2}$ " eyepiece.

$$\text{Power} = \frac{48''}{0.50''} = 96\times.$$

Although magnification is theoretically unlimited, the practical limit is about 50× per inch of diameter (lens or mirror). Example: A  $2\frac{1}{4}$ " refractor gives a *maximum* useful power of 113×. Most of the time, **lower magnification is more useful than high power.**

**B. Limiting Magnitude:** Tells how faint an object can be seen through your telescope. The brightest stars are known as *first-magnitude*; the faintest you can see with the unaided eye are *sixth-magnitude*. Since the telescope gathers more light than your eye, you can see fainter objects through it. Here's the equation which gives you the limiting magnitude:

$$\text{Mag.}_{\text{lim.}} = 9.0 + 5 \log \text{Diameter (in.)}$$

Example: For a 4" telescope,  $\text{Mag.}_{\text{lim.}} = 9.0 + 5 \log (4) = 9.0 + 5 (0.602) = 9.0 + 3.0 = 12.0$ .

## Types of Mountings

**Altazimuth:** Allows for up-and-down or back-and-forth motions. Simple, but not recommended for astronomical use, since tracking an object across the sky requires two simultaneous motions. Also, it is sometimes more difficult to find an object in the first place. However, many amateurs get used to these limitations and become quite proficient at using an altazimuth mounting.

**Equatorial:** An equatorial mounting consists of two axes at right angles to each other. The polar axle is aligned with the Earth's axis; as the stars move westward across the sky due to the Earth's rotation, they can be followed by turning the telescope on its polar axis, i.e., with only one type of motion. The other axle (the declination axis) allows the telescope to be moved north or south, so that any object in the sky can be located.

# Setting Up Your Telescope

## A. Preliminary

Set up the tripod or pedestal first, and make sure that all the screws and wing nuts are tight. The mounting must be wobble-free when you are attempting to use your telescope.

If you have an equatorial mounting, attach the counterweight to the declination axle (see below).

Place the telescope on its mounting, and secure it with the straps, bolts, or clamps provided.

If necessary (and if possible), extend the tripod legs to a convenient length. Realize, however, that the farther they are extended, the less stable the mounting will be.

## B(1). Altazimuth Mounting

With an altazimuth mounting, few adjustments are necessary, or even possible. Try to adjust the locking or tension knobs on each axis so that the telescope can be aimed freely in any direction, but stays put when you let go of it.

## B(2). Equatorial Mounting

First, the polar axis must be adjusted so that it is parallel with the Earth's axis. At the latitude of Memphis,  $35^\circ$ , the polar axis must be aimed  $35^\circ$  up from the horizontal. This is easy to do if there is a calibrated latitude scale for this purpose on the mounting. If not, take the mounting outdoors at night, place it on a reasonably level surface, and aim the polar axis northward, and raise or lower the latitude adjustment until the polar axis is pointed at the North Star (Polaris). This can be done with the telescope on or off the mounting, as you prefer. Tighten the latitude adjustment securely.

Next, aim the whole mounting so that the polar axis points toward the North Star. (It already is, if you just set the latitude adjustment by sighting on Polaris, as in the previous paragraph.)

Turn the telescope so that the declination axis and the telescope tube are horizontal; lock the polar axle and loosen the declination tension knob. If possible, position the tube in its mounting so that the tube is balanced and doesn't try to turn on the declination axis. Secure the tube.

Next, tighten the declination knob and loosen the polar axle knob. Adjust the position of the counterweight until it exactly balances the weight of the tube assembly. Fasten the counterweight securely.

Finally, try to adjust the tension knobs on each axis so that the telescope can be aimed freely in any direction, but stays put when you let go of it. Then, tighten the declination (north-south) knob a little more, so that it's easier to turn the telescope on its polar axis than on the declination axis. This makes it easier to track objects across the sky, but still lets you move easily from one object to another.

### C. Aligning the Finder Scope

The finder scope is used to aim the main telescope, in much the same way as a sighting scope on a rifle. The finder must be collimated (aligned) with the telescope if it is to be of any use.

It is best to carry out most of this procedure during the daytime, finishing up with the final adjustments at night.

Insert the lowest-power eyepiece into the telescope. It will be the one with the longest focal length, usually about 1 inch (25 mm).

Aim the telescope at some easily-recognizable object at least 100 feet away, such as a chimney top, church spire, street light, etc. Center the object in the eyepiece, and lock the telescope's axes.

While looking through the finder, turn the adjustment screws until the object is centered on the crosshairs. This is easy if there are two sets of screws: keep the front set fairly tight, and aim the finder by tightening and loosening individual screws in the rear set. Finish up by tightening **all** the screws. Make sure the object is still centered in the main scope and in the finder.

If your finder has only one set of screws (usually towards the rear of the finder), there must be some way of securing the front end to prevent wobbling. It really isn't possible to have the same three screws aim the finder and at the same time hold it securely. Unfortunately, this fundamental design principle is frequently overlooked. Sometimes, a wobbly finder can be made usable by forcing something tight yet flexible into the front part of the finder bracket: an "O"-ring, a heavy rubber band, a piece of rolled-up paper towel. If you can wiggle the finder (while looking through it) after the adjusting screws are tight, you're not finished yet. Every minute spent now in making the finder useful will save hours of frustration later!

Repeat the alignment using a more distant object. It should not be necessary to loosen the front screws once the finder is approximately aligned in the previous step.

Finish up by repeating the alignment at night, using a bright star as a target. Then do it again, using a higher-power (shorter) eyepiece. This is tedious, but will save much time and effort later. I can say without a doubt that more frustration and time-wasting at observing sessions is caused by misaligned finders than by any other single factor.

By the way, if your finder is of the right-angle type rather than a straight-through model, replace it as soon as possible. What good is it if your neck is comfortable if you can't find anything?

**If you have trouble with (or questions about) anything up to this point, please don't hesitate to call one of our members for assistance!**

## Using a Sky Map

Even if your telescope is ready to go, **you** aren't! What are you going to look at? Sometimes the Moon or a couple of planets might be up. Then what? Chances are, if you're a beginner, you've never even heard of many of the celestial objects that will become your favorites in years to come.

A good way to begin is to use a low-detail sky map to learn the major constellations for this time of year. Sky maps are available individually from the M.A.S.; they are also included in our booklet, *An Amateur's Guide to the Messier Objects* (for details, see our Web site).

The circle around the edge of the sky map represents the horizon; the four main compass directions are indicated. The center of the map represents the zenith, or overhead point. Constellation names are in capital letters; star names are in lower case.

Whichever direction you are facing, hold the map in front of you with that edge of the map down. For example, if you are facing south, hold the map with the south edge down. Then, the stars and constellations above the southern horizon on the map will correspond to those in the part of the actual sky you are facing.

Learn the major constellations first, then fill in the lesser ones. Know where the most interesting objects are located in each constellation. If you can't point your *finger* at a certain celestial object, don't expect to be able to point your *telescope* at it!

## Finding Objects With Your Telescope

Locating objects in a telescope can be unexpectedly difficult for the beginner; discouragement in this area is probably the main reason so many telescopes are stored in attics! Seasoned observers will develop their own methods; the following hints are intended to reduce exasperation for beginners.

**A. Preparation:** Give yourself a fighting chance!

1. Collimate the telescope optics. If *everything* looks like a planetary nebula, you won't be able to pick out the *real* one!
2. Align the finder scope with the main telescope. This will save you more time and frustration than anything else.
3. Point the polar axis at Polaris. Why pay for an equatorial mount if the axes aren't parallel with the celestial coordinates?
4. Align the finder crosshairs with the celestial coordinates. This makes the crosshairs line up with the permitted motions of the equatorial mount. Aim the telescope at a star near the celestial equator – Orion's belt, Virgo, etc. Move the telescope back and forth slightly around the polar axis while looking through the finder. The star should follow a crosshair from one edge of the finder field to the other, not cross it diagonally. If necessary, slightly loosen the finder adjustment screws, and rotate the finder until the star *does* follow the crosshair. Of course, when the scope is moved on the declination axis, the star should follow the other crosshair. Finish up by making sure the finder is still aligned correctly, as described previously.

## **B. Finding the Sun:**

This is harder than you might think, due to the potential danger. **Cover the finder!** Minimize the shadow of the tube on the ground until you see light coming out of the eyepiece. Project the solar image onto a screen. To observe the Sun directly, use a solar screen over the **front** of the telescope. **NEVER use a solar filter in the eyepiece!**

## **C. Finding the Moon:**

Minimize the shadow of the tube on the ground, as for the Sun, or use the following procedure (D).

## **D. Naked-eye stars, planets, etc.:**

Insert your lowest-power (longest) eyepiece into the telescope. Leave both eyes open; look through the finder with your “better” eye while looking directly at the sky with the other. This takes some practice. Move the telescope so that the desired object as seen with your naked eye moves towards the finder. (Of course, it’s the other way around, but it helps to think this way.) Keep moving the object towards the center of the finder. Note that things will be moving *backwards* through the finder field. Eventually, you will see the object enter the finder field – from the “wrong” side! Move slowly and carefully until the image seen through the finder converges with the object as seen with your naked eye. When this happens, the object should be close to the intersection of the crosshairs. Center the object precisely. Look through the eyepiece; if you carried out step A (above) properly, the object should be near the center of the eyepiece field. Center it and lock the declination axle. If desired, carefully switch to a higher-power eyepiece.

## **E. Naked-eye Messier objects, etc.:**

Find the object on a low-detail sky map, so you’ll know where to look in the sky. Locate the object with the naked eye; use binoculars, if necessary. Then use procedure D.

Examples: M42 (Orion), M8 (Sagittarius), M13 (Hercules), M45 (Taurus), M44 (Cancer), M31 (Andromeda),  $\omega$  Centauri. Others: Double Cluster in Perseus, M35 (Gemini), M6 and M7 (Scorpius).

## **F. Object which is invisible to the naked eye, but lies between a close pair of bright or well-known stars:**

Find in *Sky & Telescope* or *Norton’s Star Atlas* (or other good star atlas); use procedure D to find (and center) the *stars* in the finder; then look through the telescope at the *object*. (Use low power, then higher if desired.) Examples: M57 (Lyra), M13 (Hercules), if not visible to the naked eye.

## **G. Object which is directly north, south, east, or west of a well-known star:**

Use *Norton’s* or *An Amateur’s Guide to the Messier Objects* (published by the Memphis Astronomical Society); find the “guide star” using procedure D. While looking through a low-power eyepiece, turn the telescope along the appropriate equatorial axis in the proper direction until the object appears in the eyepiece. For long distances (from the well-known “guide star”), the mount must be aligned well with the North Celestial Pole.

Examples: M41 (Canis Major), M4 (Scorpius),  $\omega$  Centauri, M27 (Vulpecula).

The techniques described above should keep you busy for several months. When you are ready to move on to more difficult objects, those procedures can be found in the *Short Course* manual or *An Amateur’s Guide to the Messier Objects* (mentioned previously).