



StarHopper Telescope

INSTRUCTION MANUAL

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INTRODUCTION

Congratulations and welcome to the **Celestron** world of astronomy. If you're a newcomer to the hobby of astronomy, some of the terms and telescope components described in this instruction manual may be new to you. To assist you in assembling and operating your telescope, the next few pages will explain some commonly used terms and show diagrams of your new telescope and its components. If you're already well-versed in the language of astronomy and telescopes, you might want to review these sections, then move on to unpacking and assembling your new **Celestron** telescope.

This manual is designed to instruct you in the proper use of your Celestron telescope. You'll also find this instruction manual contains a wealth of useful information on celestial observing, commonly used terms in astronomy, instruction on the care of your telescope, and optional accessories to enhance your viewing experience. There are five major sections to the manual. The first section covers the proper procedure for setting up your **Celestron Star Hopper®** telescope. This includes unpacking and assembling the telescope and mount, attaching the telescope to the mount and installing the finderscope.

The second section deals with the proper procedure for collimating the telescope. Daytime and nighttime collimation techniques are included to insure that your telescope images are their sharpest. The third section discusses the basics of operating your telescope. Topics include focusing and pointing the telescope as well as calculating the eyepiece magnification and field of view. In the fourth section, visual observing of both solar system and deep sky objects is covered, along with the techniques for finding these objects. Finally, the fifth sections covers cleaning and care of the telescope's optics.

In addition to the major sections mentioned previously, there is a list of optional accessories for your **Celestron Star Hopper®** telescope that include a brief description of its purpose. This is the section to consult when you've mastered the basics and ready for new, more challenging observations. The final part of this manual contains the technical specifications for each of the **Star Hoppers®**.

CAUTION: READ THIS SECTION BEFORE USING YOUR TELESCOPE

Your **Celestron Star Hopper®** telescope is designed to give you hours of fun and rewarding observations. However, there are a few things to be aware of before using your telescope that will ensure your safety and protect your equipment.

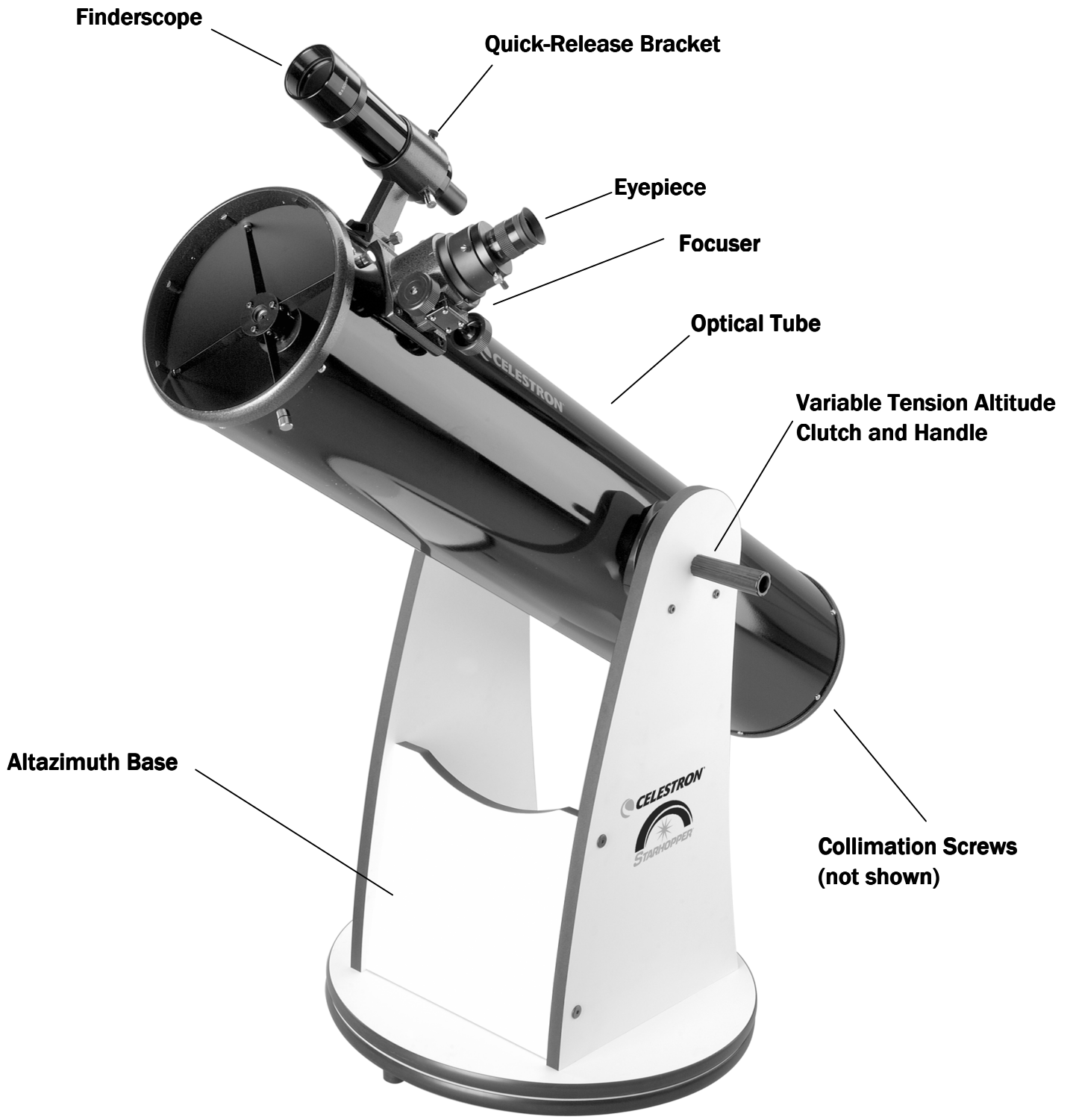
NEVER LOOK DIRECTLY AT THE SUN WITH THE NAKED EYE OR WITH A TELESCOPE. NEVER POINT YOUR TELESCOPE AT THE SUN UNLESS YOU ARE USING THE PROPER SOLAR FILTER. PERMANENT AND IRREVERSIBLE EYE DAMAGE MAY RESULT.

NEVER USE YOUR TELESCOPE TO PROJECT AN IMAGE OF THE SUN ONTO ANY SURFACE. INTERNAL HEAT BUILD-UP CAN DAMAGE THE TELESCOPE AND/OR ANY ACCESSORIES THAT MAY BE ATTACHED TO IT.

NEVER LEAVE YOUR TELESCOPE UNSUPERVISED, ESPECIALLY WHEN CHILDREN ARE PRESENT. THIS ALSO HOLDS TRUE FOR ADULTS WHO MAY NOT BE FAMILIAR WITH THE CORRECT OPERATING PROCEDURES FOR YOUR TELESCOPE.

NEVER USE AN EYEPIECE SOLAR FILTER OR A HERSHEY WEDGE. INTERNAL HEAT BUILD-UP WITHIN THE TELESCOPE CAN CAUSE THESE DEVICES TO CRACK, BREAK OR DAMAGE YOUR TELESCOPE. ANY SOLAR FILTER USED SHOULD BE A FILTER FOR THE PRIMARY LENS.

ALWAYS COVER A FINDERSCOPE (IF INSTALLED) WHEN USING YOUR TELESCOPE WITH THE CORRECT SOLAR FILTER. ALTHOUGH SMALL IN APERTURE, THIS INSTRUMENT HAS ENOUGH LIGHT GATHERING POWER TO CAUSE PERMANENT AND IRREVERSIBLE EYE DAMAGE. THE IMAGE PROJECTED BY THE FINDERSCOPE IS HOT ENOUGH TO BURN SKIN OR CLOTHING.



StarHopper[®] Telescope

(StarHopper 8" Shown)

GLOSSARY

Altazimuth mount - the simplest type of mount, with two motions: altitude (up and down) and azimuth (side-to-side). "Mount" refers to the parts of the telescope supporting the tube, which carries all the telescope's optics. The mount is made up of the ground plate, or base, and the rocker box.

Altitude bearings - used on the **Star Hopper**[®] to provide an axis of rotation for altitude adjustments.

Aperture - the diameter of the main optical element of the telescope; either the primary mirror or objective lens. The larger the aperture, the more light the telescope collects. More light creates a brighter, sharper image.

Barlow lens - these lenses are optional accessories that double the magnifying power of your eyepieces by increasing their effective focal length. For example, an 18mm eyepiece mounted on a 2x Barlow lens would have the magnifying power of a 9mm eyepiece. It's like having two eyepieces in one - an economical way to increase your range of magnifications without buying new eyepieces.

Collimation - the proper alignment of the optical elements in a telescope, which is critical to achieving optimum results. Poor collimation results in visual aberrations and distorted images. For a full description of how to collimate your telescope see the Collimation section of this manual.

Deep-sky objects - celestial objects outside the boundaries of our solar system.

Extended objects - large celestial objects, other than stars, such as nebulae and galaxies.

Field of view - the size, in degrees, of the area you can see through the eyepiece of your telescope.

Finderscope - a low power telescope with cross hairs mounted to the side of a higher powered telescope, used to locate objects more easily.

Focal length - the distance from the optical center of the lens to the point where the incoming light rays converge, creating a clear, focused image.

Newtonian reflecting telescope - generally use a concave parabolic primary mirror to collect and focus incoming light into a flat secondary mirror, which reflects the image into the eyepiece.

Primary mirror - gathers incoming light and forms a sharply focused image of the object being viewed.

Secondary mirror - reflects light from the primary mirror to the eyepiece. It's also know as a diagonal mirror because it is at 45° with respect to the optical axis.

"Seeing" or "seeing conditions" - refer to the stability of the atmosphere, transparency and sky illumination. See the section of the manual entitled "Seeing Conditions".

Thermal turbulence - turbulence caused by temperature variations. Some sources of turbulence are differences in temperature between the telescope tube and the air within it, or viewing near a heat source, such as a roof top or parking lot releasing stored daytime heat.

UNPACKING THE TELESCOPE / BASE

The **Star Hopper®** telescope comes in two boxes, one containing the telescope tube and accessories, the other containing the unassembled mount with hardware.

	Star Hopper® 6 #10600	Star Hopper® 8 #10800	Star Hopper® 10 #10110	Star Hopper® 12 #10112
Eyepieces	25mm Plossl - 1¼"	25mm Plossl - 1¼"	32mm e-lux - 2"	32mm e-lux - 2"
Finderscope	6x30	9x50	9x50	9x50
Focuser	1.25"	2"	2"	2"
Cooling	N/A	N/A	Fan w/ battery pack	Fan w/ battery pack
Mirror Cell	3-point	3-point	9-point	9-point
Handle	Base	Base	Base	Base
Other Accessories	Eyepiece Tray	Eyepiece Tray	Eyepiece Tray	Eyepiece Tray
	Collimation Cap	Collimation Cap	Collimation Cap	Collimation Cap

Before the telescope can be used the mount must be assembled. The box with the mount contains the parts necessary for assembly, including:

- Two side panels
- Front panel
- Base plate (with the four pre-drilled holes)
- Ground plate
- Azimuth Roller Bearing
- Two Azimuth Bearing Plates
- Azimuth tension bolt
- Metal sleeve
- Tension spring washer
- Two altitude tension handles w/ washers and bearing
- Four nylon altitude cylinders w/ four 1¼" Allen head bolts
- Carrying Handle w/ two 1¼" Allen head bolts
- Eyepieces Accessory Tray w/ two ½" wood screws
- Eight 2" Allen head wood screws
- Three rubber feet w/ 1" wood screws
- Plastic screw head caps

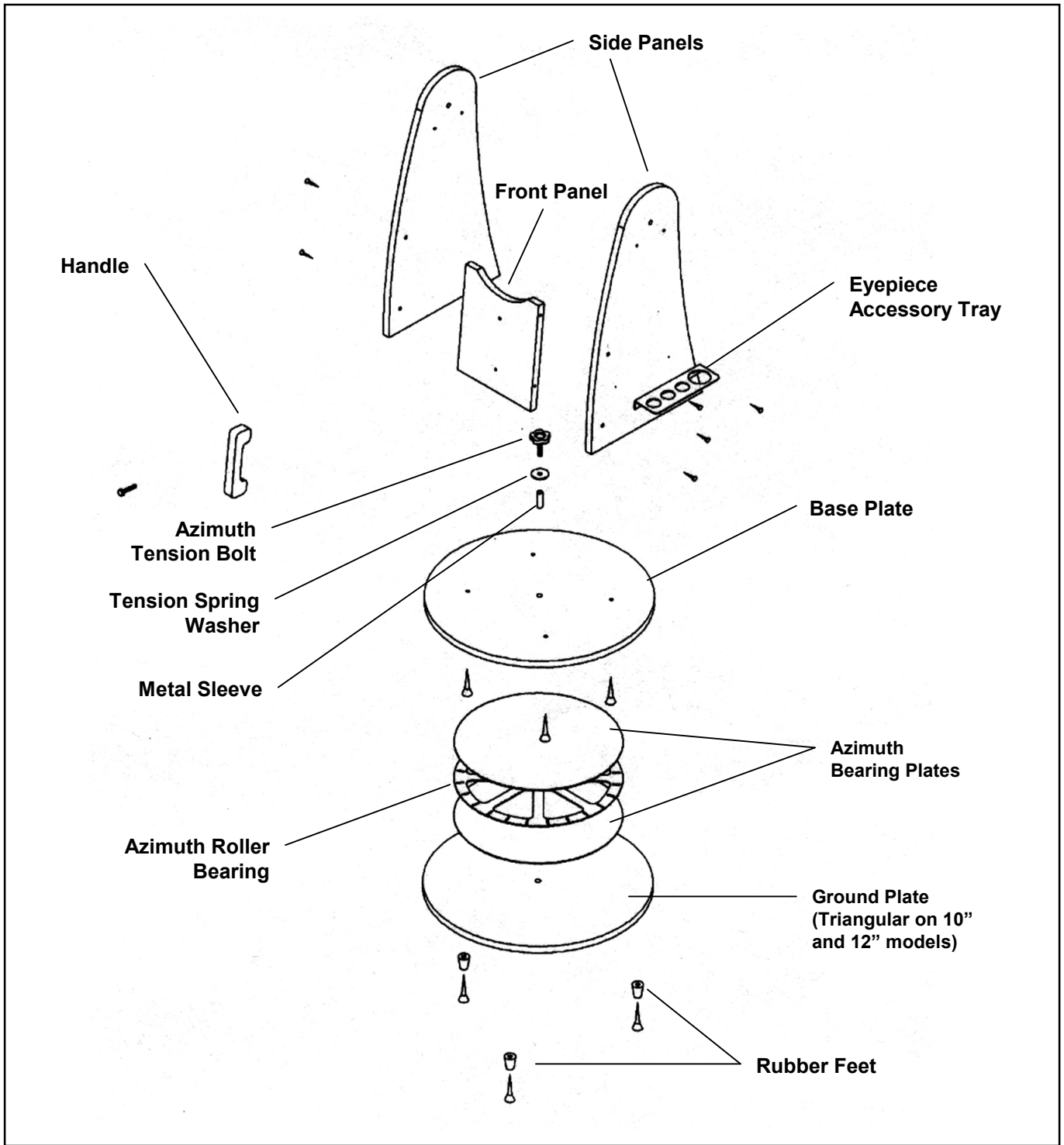


Figure 1 – Assembling the Base

Assembling The Base For The StarHopper

1. Locate the front panel and the two side panels of the base (refer to Figure 1 to identify all the parts referred to in these instructions).
2. Align the predrilled holes of the side panels with the holes on the edge of the front panel and attach using four of the 2" Allen head wood screws. (The **StarHopper**[®] logo should be facing the outside of the base).
3. Lay the base plate/side panel assembly on its side and align the predrilled holes on the base plate with the holes on the bottom of the side panels.
4. Use the remaining 2" wood screws to fasten the base plate to the side panels by inserting the screws through the holes and tightening until the head of the screw is below the surface of the base plate.
5. Locate the ground plate. Use the three 1" wood screws to attach the rubber feet into the bottom of the ground plate.
6. Place the azimuth roller bearing with one bearing plate on either side on top of the ground plate so that the center holes line up.
7. Insert the metal sleeve through the holes in the plates, bearing and ground plate.
8. Gently place the base plate assembly over the metal sleeve and on to the ground plate.
9. Place the azimuth tension washer over the center hole of the base plate (with the curved side facing down), and insert the azimuth tension bolt through the top of the base plate and the metal sleeve.
10. Thread the azimuth tension bolt into the T-nut at the bottom of the ground plate and tighten. (Note: If the center bolt is over-tightened it will make the base difficult to rotate in azimuth).

Now that the base is fully assembled you can attach the eyepiece accessory tray, handle and altitude nylon bearing cylinders:

- Align the **eyepiece accessory tray** with the holes in the side panel and attach with two ½” wood screws.



Figure 2

- Align the **base handle** with the thread holes in the front panel. Insert a bolt through the handle and thread into the front panel.



Figure 3

- Align each **altitude nylon cylinder** with the holes on the inside of the side panels of the base. From the outside of the side panels, insert a 1 ¼” Allen head bolt through the hole and thread it into each nylon cylinder.

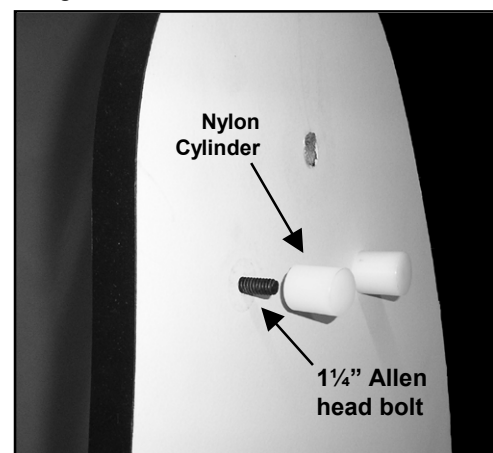


Figure 4

The Optical Tube

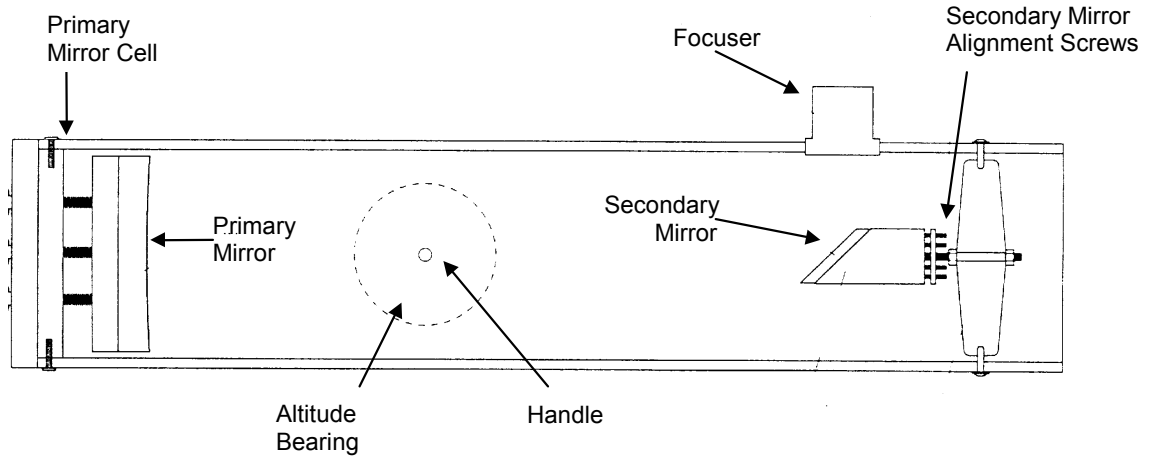


Figure 5 – The Optical Tube Assembly

Installing the Variable Tension Handles

The **Star Hopper**[®] comes with convenient side handles that attach to the altitude bearings on either side of the mount. These handles will not only assist you in moving the telescope in azimuth when observing but also include a tension system allowing you to compensate for imbalance.

1. Place the optical tube into the base so that the altitude bearings are resting on the nylon altitude cylinders.
2. Insert the handle containing the roller bearing (see Figure 6) through the side panel of the base and into the hole of the altitude bearing located on the same side as the focuser. Turn clockwise to tighten.
3. Place a washer over the remaining handle and thread the handle into the altitude bearing opposite the focuser.

Now that the handles are attached, tighten the focuser side handle to the desired amount of tension to properly balance the optical tube.

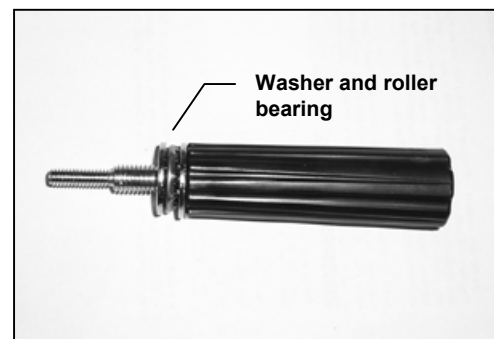


Figure 6 – Handle with bearing attaches to focuser side of base

The Finderscope

The finderscope is used to find and center objects in the main eyepiece of the telescope. The finder is attached using two alignment screws and a spring loaded pivot.

Attaching the finderscope to the finder bracket

To install the finderscope onto the telescope you must first mount the finderscope through the finder bracket and then attach it to the telescope. Toward the front of the telescope tube, near the focusing assembly, there is a small bracket with a set screw in it. This is where the finderscope bracket will be mounted. To install the finderscope:

1. Slide the rubber O-ring over the eyepiece end of the finderscope and roll it 2/3 of the way up the finderscope.
2. Insert the eyepiece end of the finderscope through the bracket until the O-ring presses tightly between the finder and the inside of the bracket.
3. Tighten the adjustment screws until they make contact with the finderscope body.

Attaching the finderscope bracket to the telescope tube

1. Locate the mounting bracket near the front (open) end of the telescope.
2. Loosen the set screw on the mounting bracket on the telescope.
3. Slide the finder bracket (attached to the finderscope) into the mounting bracket on the telescope.
4. The finderscope bracket will slide in from the back. The finderscope should be oriented so that the objective lens is toward the front (open) end of the telescope.
5. Tighten the set screw on the mounting bracket to hold the finderscope in place.

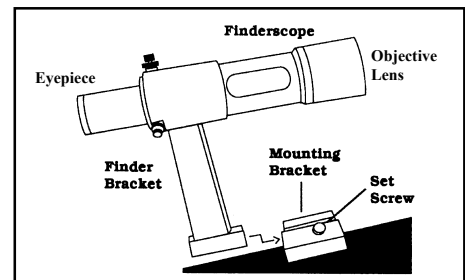


Figure 7 – The finderscope and quick-release bracket.

Aligning the Finderscope

To make things a little easier, you should align the finder during the day when it is easier to locate objects. To align the finder:

1. Choose a conspicuous object that is over 500 yards away. This will eliminate any possible parallax effect.
2. Point your telescope at the target and center it in the eyepiece of the telescope.
3. Check the finder to see where the object is located in the field of view.
4. Adjust the two screws on the finder bracket, until the cross hairs are centered on the target object.

Accurate alignment of the finder will make it much easier to find objects in the main optical tube. Remember that the finderscope is a simple refracting telescope and therefore will always give an inverted (upside-down and backwards) view. Because of this, it may take a few minutes to familiarize yourself with the directional change each screw has on the finder.

Installing the Eyepieces

The eyepiece, or ocular as it is also called, is an optical element that magnifies the image focused by the telescope. Without the eyepiece it would be impossible to use the telescope visually. The eyepiece fits directly into the eyepiece holder. To attach the eyepiece:

1. Loosen the set screw on the eyepiece holder so that it does not obstruct the inner diameter of the eyepiece holder.
2. Slide the chrome portion of the eyepiece into the eyepiece holder.
3. Tighten the set screw to hold the eyepiece in place.

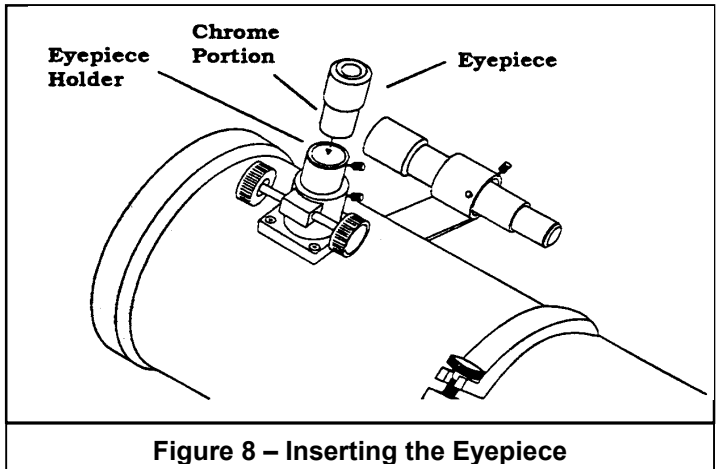


Figure 8 – Inserting the Eyepiece

To remove the eyepiece, loosen the set screw on the eyepiece holder and slide the eyepiece out. You can replace it with another ocular.

Eyepieces are commonly referred to by focal length which is printed on the eyepiece barrel. The longer the focal length (i.e., the larger the number) the lower the eyepiece power and the shorter the focal length (i.e., the smaller the number) the higher the magnification. Generally, you will use low-to-moderate power when viewing.

The StarHopper 8", 10" and 12" can use eyepieces with both an 1-1/4" barrel diameter and 2" barrel diameter. To use a 2" barrel eyepiece, the 1 1/4" eyepiece adapter must first be removed. To do this, simply loosen the two chrome thumbscrews located around the focuser barrel and remove the 1 1/4" adapter. Once removed, a 2" eyepiece can be inserted directly into the focuser barrel and secured with the two thumb screws.

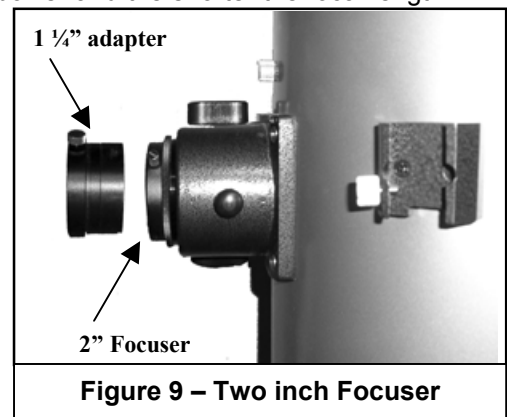


Figure 9 – Two inch Focuser

Using The Cooling Fans (Starhopper 10" and 12" Only)

The StarHopper 10" and 12" telescopes come with a built-in cooling fan located on the rear cell of the optical tube. This fan greatly reduces the damaging tube currents inside the tube as well as shortening the time it takes for the optics to reach thermal equilibration. For more information on the affects of tube currents and "seeing" refer to the *Celestial Observing* section later in this manual.

The cooling fan comes with its own battery pack using 8 user supplied AA batteries. To power the fan simply plug the power pack into the power outlet located on the fan.

Note: The cooling fans are used to help the telescope reach thermal equilibration and should not be used while observing through the telescope. It is best to let the fan run prior to uses while the tube is cooling down.

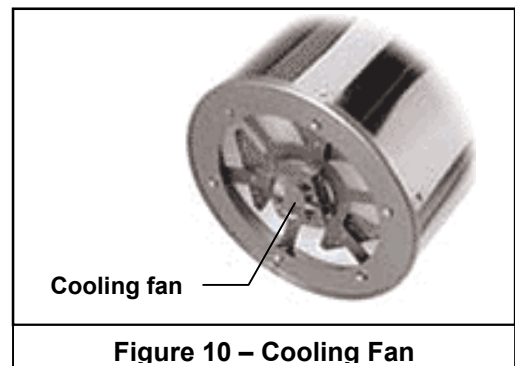


Figure 10 – Cooling Fan

Collimation

The optical performance of most Newtonian reflecting telescopes can be optimized by collimating (aligning) the telescope's optics, as needed. Poor collimation will result in optical aberrations and distortions.

Before collimating your telescope, take time to familiarize yourself with all its components, using the diagram in Figure 5. The primary mirror is the large mirror at the back end of the telescope tube. This mirror is adjusted by loosening and tightening the three screws (A), located 120 degrees apart, on the rear cell of the telescope tube (See Figure 12). The rear cell also has three mirror support screws (B), that are finger tightened to hold the mirror in one place when transporting the telescope. The support screws need to be loosened before adjusting the collimation screws.

The secondary mirror (the small, elliptical mirror under the focuser) also has adjustment screws. To check the collimation of your telescope, point the front of the tube toward a bright wall or blue sky (never point your telescope at or near the sun) and follow the directions below.

Aligning the Secondary Mirror

If you have an eyepiece in the focuser, remove it. Rack in the focuser tub completely, using the focusing knobs, until the draw tube is no longer visible. You will be looking through the focuser at a reflection of the secondary mirror, projected from the primary mirror. During this step, ignore the silhouetted reflection from the primary mirror. Insert the collimating cap into the focuser and look through it. With the focuser pulled in all the way, you should be able to see the entire primary mirror reflected in the secondary mirror. If the primary mirror is not centered in the secondary mirror, adjust the secondary mirror screws by alternately tightening and loosening them until the periphery of the primary mirror is centered in your view. DO NOT loosen or tighten the center screw in the secondary mirror support, because it maintains proper mirror position.

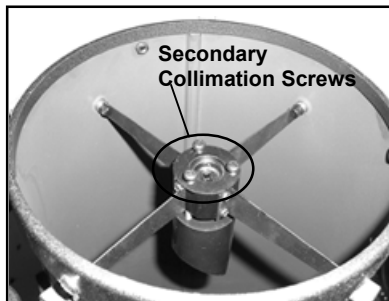


Figure 11 – Secondary Collimation Screws

Aligning the Primary Mirror

Now adjust the primary mirror screws to re-center the reflection of the small secondary mirror, so it is silhouetted against the view of the primary. As you look into the focuser, silhouettes of the mirrors should look concentric. Repeat steps one and two until the mirror reflections appear concentric.

Remove the collimating cap and look into the focuser, you should see the reflection of your eye in the secondary mirror.

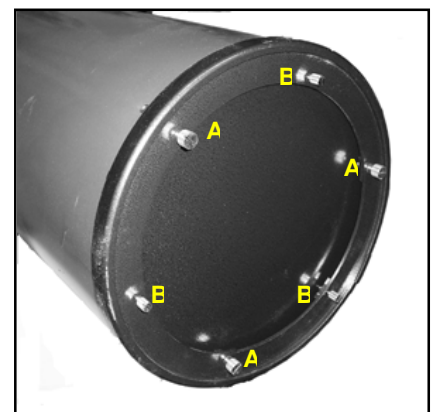


Figure 12 - (A) Collimation screws
(B) Mirror Support Screws

Newtonian collimation views as seen through the focuser.

Figure A: If you cannot see the entire primary mirror reflected in the secondary mirror, the secondary mirror will need adjustment. To do this, adjust the secondary collimation screws by alternately tightening and loosening them until the outer edge of the primary mirror is reflected in the secondary mirror.

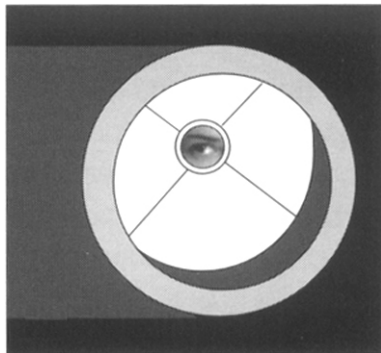
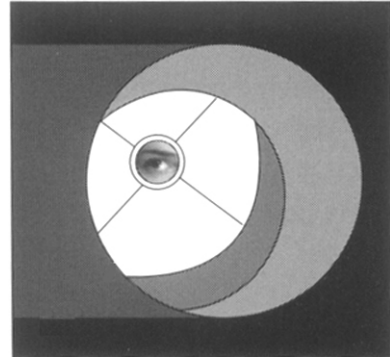
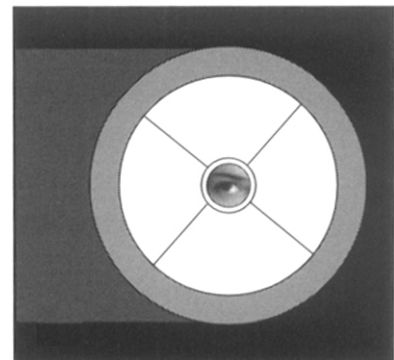


Figure B: Now that you can see the entire primary mirror reflected in the secondary mirror, you will notice that the secondary mirror is not perfectly centered in the primary mirror. To correct this, you must adjust the primary collimation screws located at the bottom of the primary mirror cell (see Figure 12).

Figure C: With both mirrors aligned you should see the silhouette of the secondary mirror positioned in the center of the primary mirror. You should see your eye reflecting back at you from the center of both mirrors. Collimation is now completed.



Night Time Star Collimation

After successfully completing daytime collimation, night time star collimation can be done by closely adjusting the primary mirror while the telescope tube is on its mount and pointing at a bright star. The telescope should be set up at night and a star's image should be studied at medium to high power (30-50 power per inch of aperture). If a non-symmetrical out-of-focus pattern is present (see figure 13), then it may be possible to correct this by re-collimating only the primary mirror.

Procedure

(Please read this section completely before beginning)

To star collimate in the Northern Hemisphere, point at a stationary star like the North Star (Polaris). It can be found in the north sky, at a distance above the horizon equal to your latitude. It's also the end star in the handle of the Little Dipper (Ursa Minor). Polaris is not the brightest star in the sky and may even appear dim, depending upon your sky conditions. Observers in the southern hemisphere should aim the telescope at a bright star near the celestial pole.

Prior to re-collimating the primary mirror, locate the collimation screws on the bottom of the primary mirror cell at the end of the telescope tube. These three screws are to be adjusted one at a time. Normally, motions on the order of an $\frac{1}{8}$ turn will make a difference, with approximately a $\frac{1}{2}$ to $\frac{3}{4}$ turn being the maximum required. This method of collimation is particularly sensitive to atmospheric and heat turbulence, so it is best to let the optics cool to thermal equilibrium for at least an hour after sunset for best results.

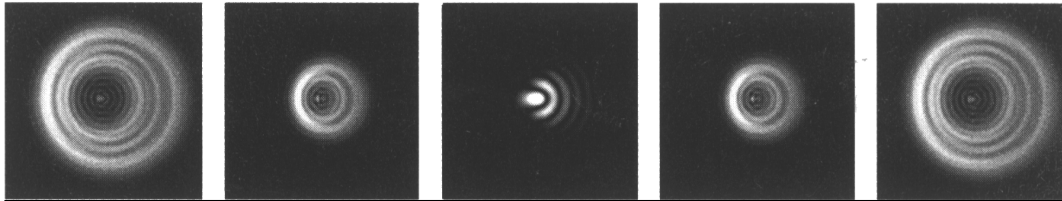


Figure 13 - Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

With Polaris or a bright star centered within the field of view, focus with either the standard eyepiece or your highest power eyepiece, i.e. the shortest focal length in mm, such as a 6mm or 4mm. Another option is to use a longer focal length ocular with a Barlow lens. When a star is in focus it should look like a sharp pinpoint of light. If, when focusing on the star, it is irregular in shape or appears to have a flare of light at its edge, this means your mirrors aren't in alignment. If you notice the appearance of a flare of light from the star that remains stable in location, just as you go in and out of exact focus, then re-collimation will help sharpen the image.

Take note of the direction the light appears to flare. For example, if it appears to flare toward the three o'clock position in the field of view, then you must move whichever screw or combination of collimation screws necessary to move the star's image toward the direction of the flaring. In this example, you would want to move the image of the star in your eyepiece, by adjusting the collimation screws, toward the three o'clock position in the field of view. It may only be necessary to adjust a screw enough to move the star's image from the center of the field of view to about halfway, or less, toward the field's edge (when using a high power ocular).

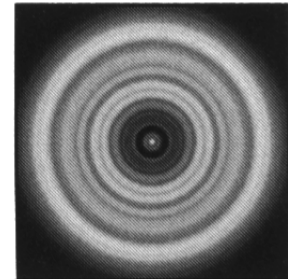


Figure 14
A collimated telescope should appear as a symmetrical ring pattern similar to the diffraction disk seen here.

Collimation adjustments are best made while viewing the star's position in the field of view and turning the adjustment screws simultaneously. This way, you can see exactly which way the movement occurs. It may be helpful to have two people working together: one viewing and instructing which screws to turn and by how much, and the other performing the adjustments.

IMPORTANT: After making the first, or each adjustment, it may be necessary to re-aim the telescope tube to re-center the star again in the center of the field of view. The star image can then be judged for symmetry by going just inside and outside of exact focus and noting the star's pattern. Improvement should be seen if the proper adjustments are made. Since three screws are present, it may be necessary to move at least two of them to achieve the necessary mirror movement.

TELESCOPE BASICS

Focusing the Telescope

The **Star Hopper**[®] telescope is equipped with a rack and pinion focuser. Focusing is accomplished by rotating the focuser knobs until a sharp focus is reached. To focus your telescope, begin by putting the eyepiece in the eyepiece holder of the focuser. When doing astronomical viewing, you'll find that out of focus star images are very diffuse and difficult to see. Therefore, choose a bright object, like the moon or a planet for your first astronomical target. This way, the image will be visible even when out of focus. If you're focusing on a star, its image should, as closely as possible, resemble a pinpoint. If you're focusing on the moon or a planet, rotate the focuser barrel until the image is sharp.

Calculating Magnification

You can change the viewing power of your **Celestron Star Hopper**[®] telescope just by changing the eyepiece. There are various optional eyepieces shown in the Optional Accessories section of this manual. To determine the magnification of your telescope, simply divide the focal length of the telescope by the focal length of the eyepiece being used. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

To determine the magnification using the standard 25mm eyepiece, simply divide the focal length of your **Star Hopper**[®] telescope by the focal length of the eyepiece (25mm). For example, dividing the focal length of the **Star Hopper**[®] 8" (1200mm) by 25mm yields a magnification of 48 power. Although the power is variable, each telescope, used under average skies, has a limit to its highest useful magnification. The general rule is that 60 power is the maximum that can be used for every inch of aperture, although seeing condition rarely allow this. For example, the **Star Hopper**[®] 10 is 10" in diameter. Multiplying 10 by 60 gives a maximum useful magnification of 600 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture, which is 200 to 350 for the **Star Hopper**[®] 10.

Determining Field of View

Determining the field of view is important if you want to get an idea of the angular size of the object that you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Field} = \frac{\text{Apparent Field of Eyepiece}}{\text{Magnification}}$$

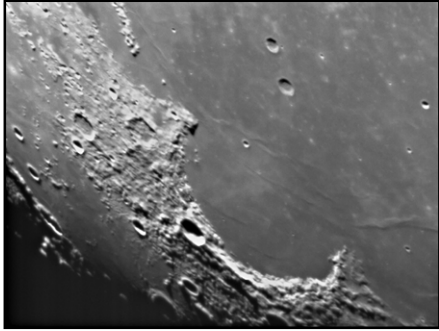
As you can see, before determining the field of view, you must calculate the magnification. Using the example above, we can determine the field of view using the same 25mm eyepiece. The 25mm eyepiece has an apparent field of view of 52°. Divide the 52° by the magnification, which is 48 power for the **Star Hopper**[®] 8. This yields an actual field of 1.08°, or a little over a degree. The apparent field of each eyepiece that **Celestron** manufactures is found in the **Celestron** Accessory Catalog (#93685).

CELESTIAL OBSERVING

Now that your telescope is set up, you're ready to use it for observing. This section covers visual observing for both solar system and deep-sky objects.

Observing the Moon

In the night sky, the moon is a prime target for your first look because it is extremely bright and easy to find. Although the beauty of the full moon may make it seem a perfect viewing object, in fact, the light reflected from its fully illuminated face can be overpowering. In addition, little or no contrast can be seen during this phase.



One of the best times to observe the moon is during its partial phases, such as a crescent or quarter moon. At these times, long shadows reveal a great amount of detail on the lunar surface. At low power, with the standard eyepiece, you'll be able to see the whole lunar disk at one time. Change to higher power (magnification) with an optional eyepiece to focus in on a smaller

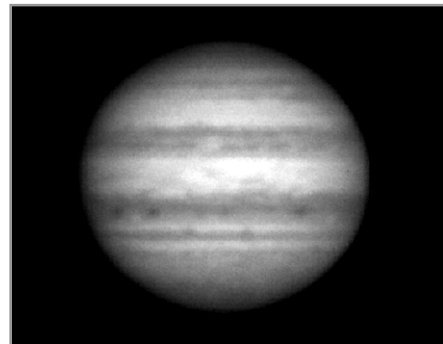
area. Keep in mind that the rotation of the earth will cause the moon to drift out of your field of view. You'll have to manually adjust the telescope to keep the moon centered. This effect is more noticeable at higher power. Consult a current astronomy magazine or your local newspaper to find out the current phase of the moon.

Lunar Observing Hint

To increase contrast and bring out visible detail on the lunar surface, try using different filters (available through your local **Celestron** dealer). A yellow filter works well for improving contrast.

Observing the Planets

Other easy targets include the five "naked eye" planets of our solar system, so called because they can be spotted in the night sky by the unaided eye. You can see **Venus** go through its lunar-like phases. **Mars** can reveal a host of surface detail and one, if not both, of its polar caps. You'll be able to see the cloud belts of **Jupiter**, perhaps even the great Red Spot. In addition, you'll be able to see the moons of Jupiter as they orbit the giant planet. **Saturn**, with its beautiful rings, is easily visible at moderate power, as is **Mercury**. All you need to know is where to look. Most astronomy publications indicate where the planets are in the sky each month.



Observing Deep-Sky Objects

Deep-sky objects are simply those objects outside the boundaries of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars and other galaxies outside our own Milky Way. Unlike the sun, moon and our five major planets, most deep-sky objects are not visible to the naked eye. Finding them requires a method called star hopping, described below. **Celestron** Sky Maps (#93722) can help you locate the brightest deep-sky objects.

Most deep-sky objects have a large angular size. Therefore, a low-to-moderate power eyepiece is all you need to see them. Visually, they are too faint to reveal any of the color seen in long exposure photographs. Instead, they appear black and white. Because of their low surface brightness, they should be observed from a "dark-sky" location. Light pollution around large urban areas washes out most nebulae making them difficult, if not impossible, to observe.

Star Hopping

One way to find deep-sky objects is by star hopping and a finderscope is very helpful. Star hopping is done by using bright stars to "guide" you to an object. For successful star hopping, it is helpful to know the field of view of your telescope. If you're using the standard **Celestron** 25mm eyepiece with the **Star Hopper**[®] 8, your field of view is approximately 1°. If you know an object is 3° away from your present location, then you just need to move 3 fields of view. If you're using another eyepiece, then consult the section on determining field of view. Listed below are directions for locating two popular objects.

The Andromeda Galaxy, also known as M31, is an easy target. To find M31:

1. Locate the constellation of Pegasus, a large square visible in the fall (in the eastern sky, moving toward the point overhead) and winter months (overhead, moving toward the west).
2. Start at the star in the northeast corner—Alpha (α) Andromedae.
3. Move northeast approximately 7°. There you will find two stars of equal brightness—Delta (δ) and Pi (π) Andromeda—about 3° apart.
4. Continue in the same direction another 8°. There you will find two stars—Beta (β) and Mu (μ) Andromedae—also about 3° apart.
5. Move 3° northwest—the same distance between the two stars—to the Andromeda galaxy.

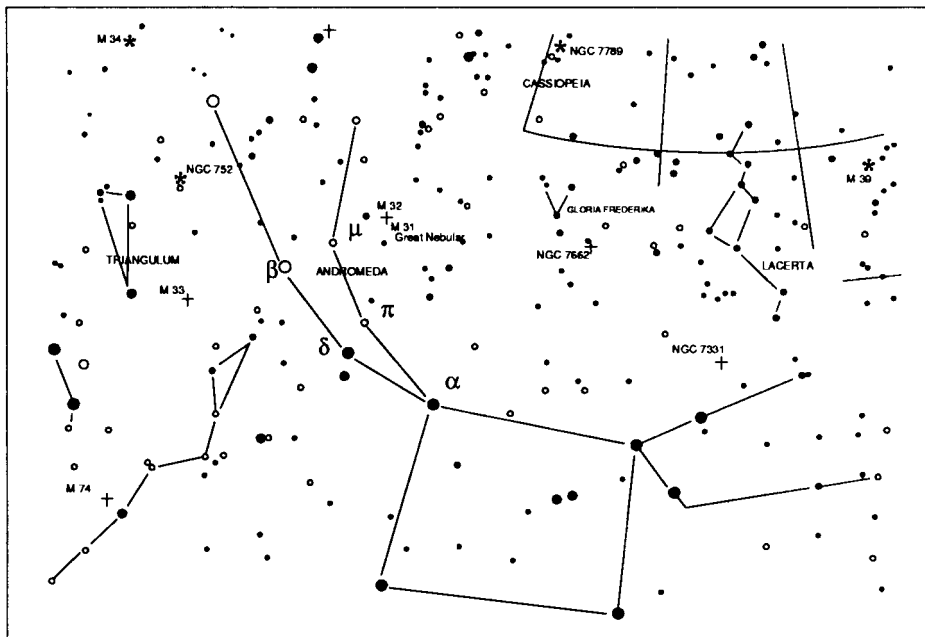


Figure 15

Star hopping to the Andromeda Galaxy (M31) is a snap, since all the stars needed to do so are visible to the naked eye.

Star hopping may take some getting used to since you can see more stars through a finderscope than you can see with the naked eye. Also, some objects are not visible in a finderscope. One such object is M57, the famed Ring Nebula. Here's how to find it:

1. Find the constellation of Lyra, a small parallelogram visible in the summer and fall months. Lyra is easy to pick out because it contains the bright star Vega.
2. Start at the star Vega—Alpha (α) Lyrae—and move a few degrees southeast to find the parallelogram. The four stars that make up this geometric shape are all similar in brightness, making them easy to see.
3. Locate the two southernmost stars that make up the parallelogram—Beta (β) and Gamma (γ) Lyra.
4. Point the finderscope halfway between these two stars.
5. Move about $\frac{1}{2}^\circ$ toward Beta (β) Lyra, while remaining on a line connecting the two stars.
6. Look through the telescope and the Ring Nebula should be in your field of view. The Ring Nebula's angular size is quite small and, therefore, not visible in the finderscope.
7. Because the Ring Nebula is rather faint, you may need to use "averted vision" to see it. "Averted vision" is a technique of looking slightly away from the object you're observing. So, if you are observing the Ring Nebula, center it in your field of view and then look off toward the side. This causes light from the object viewed to fall on the black and white sensitive rods of your eyes, rather than your eyes color sensitive cones. (Remember that when observing faint objects, it's important to try to observe from a dark location, away from street and city lights. The average eye takes about 20 minutes to fully adapt to the darkness. So always use a red-filtered flashlight to preserve your dark-adapted night vision).

These two examples should give you an idea of how to star hop to deep-sky objects. To use this method on other objects, consult a star atlas, then star hop to the object of your choice using "naked eye" stars.

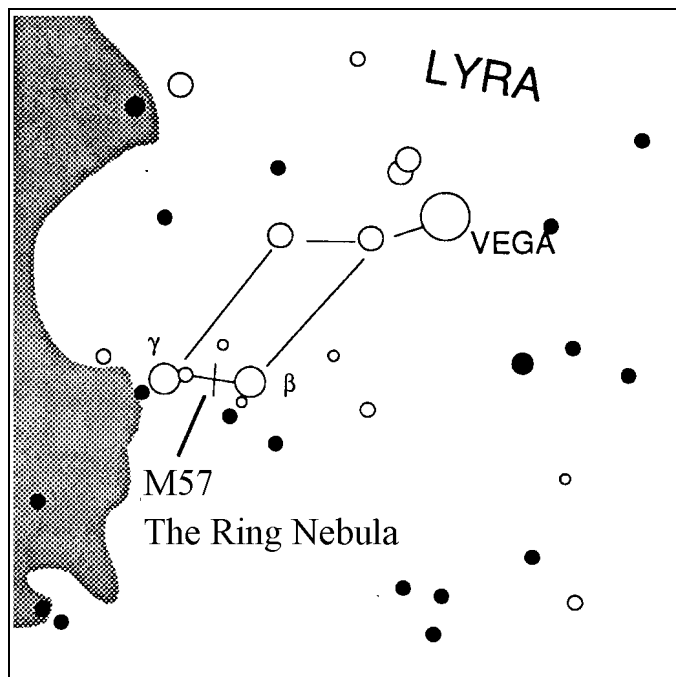


Figure 16

Although the Ring Nebula lies between two “naked eye” stars, it may take a little time to locate because it isn’t visible in a finderscope. Note that the scale for this star chart is different from that of the chart on the previous page, which shows several constellations, including Pegasus, Triangulum and Andromeda.

“Seeing” Conditions

Viewing conditions affect what you can see through your telescope during an observing session. Conditions include transparency, sky illumination and “seeing”. Understanding viewing conditions and the affect they have on observing will help you get the most out of your telescope.

Transparency

Transparency refers to the clarity of the atmosphere and is affected by clouds, moisture, dust and other airborne particles. Thick cumulus clouds are completely opaque, while cirrus clouds can be thin, allowing light from the brightest stars through. Hazy skies absorb more light than clear skies, making fainter objects hard to see and reducing contrast on brighter objects. Dust particles and gases ejected into the upper atmosphere from volcanic eruptions also affect transparency. Ideal conditions are when the night sky is inky black.

Sky Illumination

General sky brightening caused by the moon, aurorae, natural airglow and light pollution greatly affect transparency. While not a problem when viewing brighter stars and planets, bright skies reduce the contrast of extended nebulae, making them difficult, if not impossible, to see. To maximize your observing, limit deep-sky viewing to moonless nights, far from the light polluted skies found around major urban areas. Light Pollution Reduction (LPR) filters enhance deep-sky viewing from light polluted areas by blocking unwanted light, while transmitting light from certain deep-sky objects. Planets and stars can still be observed from light polluted areas or when the moon is out.

"Seeing"

The terms "seeing conditions" or "seeing" refer to the stability of the atmosphere, which directly effects the amount of fine detail seen in extended objects. Essentially, extended objects are objects other than stars, of some size, such as nebulae and galaxies.

The air in our atmosphere acts as a lens, which bends and distorts incoming light rays. The amount of bending depends on air density. Varying temperature layers have different densities and, therefore, bend light differently. Light rays from the same object arrive slightly displaced, creating an imperfect or smeared image. These atmospheric disturbances vary from time-to-time and place-to-place. Another form of turbulence that effects seeing conditions is referred to as "air parcels". These air parcels are the smaller turbulence patterns in the air, within your immediate environment. The size of the air parcels, compared to the aperture of your telescope, also determines seeing quality. Under good seeing conditions, fine detail is visible on the brighter planets like Jupiter and Mars, and stars are pinpoint images. Under poor seeing conditions, images are blurred and star images are diffuse. Seeing conditions are rated on a five-point scale with one being the worst condition and five the best. Seeing conditions can be classified in one of three categories. The definitions of these categories are based on the causes of the different seeing conditions.

Type 1 seeing conditions are characterized by rapid changes in the image seen through the telescope. Extended objects, like the moon, appear to shimmer while point sources (stars) appear double. Type 1 seeing is caused by air currents within, or very close to, the telescope tube. These currents are caused by a telescope that has not reached thermal equilibrium with the outdoor surroundings or heat waves from people standing near the telescope. To avoid the problems associated with Type 1 seeing, allow your telescope approximately 30 minutes outdoors to reach thermal equilibrium with the environment. If observing with others, make sure no one stands in front of or directly below the telescope tube. The StarHopper 10" and 12" telescopes come with a built-in fan behind the primary mirror that shortens the time it takes to reach thermal equilibrium and eliminates tube currents.

The images produced by **Type 2** seeing conditions don't move as quickly as those produced by Type 1 conditions, but the images are quite blurry. Fine detail is lost and contrast is low for extended objects. Stars appear spread out and lack sharpness. Type 2 seeing conditions are produced in the lower atmosphere, most likely by heat waves from the ground or buildings. To avoid the problems associated with Type 2 seeing, select a good observing site. Look for broad hilltops or open grassy fields. Stable thermal conditions found near lakes and atmospheric inversions tend to produce good seeing. Avoid sites that overlook asphalt parking lots, plowed fields, valleys or shorelines. If you can't get a better location, wait until the early morning hours when the surroundings are uniformly cool and seeing is generally better.

Type 3 seeing conditions are characterized by fast ripples that create shimmer in the visual field, affecting otherwise sharp images. For extended objects, fine details are visible, but images shift around the field. Stars are crisp points, but they rapidly shift small distances within the field of view. The cause of Type 3 seeing is turbulence in the upper atmosphere, which means the observer has no control over it. However, the effects of Type 3 seeing are generally less pronounced than those of Type 1 and 2 conditions. Type 3 seeing conditions can't really be avoided, so your best bet is to wait for moments of atmospheric steadiness. If seeing conditions are extremely bad, you might consider waiting for a better night.

The conditions described here apply to both visual and photographic observations.



Figure 17

Seeing conditions directly affect image quality. These drawings represent a point source (i.e., star) under bad seeing conditions (left) to excellent conditions (right). Most often, seeing conditions produce images that lie somewhere between these two extremes.

CLEANING THE OPTICS

While your **Star Hopper**[®] telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs optimally.

Care and Cleaning of the Optics

Occasionally, dust may build up on the primary mirror of your **Star Hopper**[®] telescope. Special care should be taken when cleaning any telescope so as to avoid damaging its optics. You shouldn't need to clean your optics more than twice a year at the most. Generally, it's better to leave dust on the mirror, should a small amount accumulate there. A small amount of dust will have little affect on the image, but cleaning the optics too often can damage the mirror's reflective coatings. Also, take precautions to keep dust out of your telescope.

If cleaning is necessary, remove the primary mirror from the tube. To remove dust from the primary mirror, use a brush (made of camels hair) or a can of pressurized air. When using pressurized air, spray at an angle to the mirror for approximately two to four seconds. Then, use an optical cleaning solution and white, unscented (Kleenex type) tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the mirror. Low pressure strokes should go from the center of the mirror to the outer edge. DO NOT rub in circles or apply pressure.

You can use a commercially made lens cleaner (available at most camera stores) or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

TECHNICAL SPECIFICATIONS

	Star Hopper® 6 #10600	Star Hopper® 8 #10800	Star Hopper® 10 #10110	Star Hopper® 12 #10112
Aperture	6"	8"	10"	12"
Focal Length	48" (1219mm)	48" (1219mm)	50" (1270mm)	60" (1500mm)
f/#	f/8	f/6	f/5	f/5
Eyepieces	25mm - 1.25"	25mm - 1.25"	32mm - 2"	32mm - 2"
Magnification	49x	49x	40x	47x
Secondary Size	1.5 "	1.95"	2.5"	2.75"
Obstruction	25% by diameter 6.3% by area	24% by diameter 5.9% by area	25% by diameter 6.3% by area	23% by diameter 5.3% by area
Primary Mirror	BK7	BK7	BK7	BK7
Cooling	N/A	N/A	Fan	Fan
Mirror Cell	3-point	3-point	9-point	9-point
Azimuth Bearing	Roller track	Roller track	Roller track	Roller track
Altitude Bearing	Nylon Bearing	Nylon Bearing	Nylon Bearing	Nylon Bearing
Tension System	Variable friction clutch	Variable friction clutch	Variable friction clutch	Variable friction clutch
Highest useful power	359x	480x	600x	721x
Lowest useful power	22x	29x	36x	44x
Resolution: Rayleigh Criterion Dawes Criterion	.91 arcsec .76 arcsec	.68 arcsec .57 arcsec	.54 arcsec .46 arcsec	.45 arcsec .38 arcsec
Field of view with standard eyepiece	1.03°	1.03°	1°	.83°
Exit pupil with standard eyepiece	3.1mm	4.2mm	5mm	5.1mm
Light gathering power (times the unaided eye)	472	843	1317	1898
Limiting visual magnitude	13.4	14	14.5	14.9
Optical tube length	45"	45"	48"	58"

OPTIONAL ACCESSORIES

You will find that additional accessories enhance your viewing pleasure and expand the usefulness of your telescope. For ease of reference, all the accessories are listed in alphabetical order.

Barlow Lens - A Barlow lens is a negative lens that increases the focal length of a telescope. Used with any eyepiece, it doubles the magnification of that eyepiece. Celestron offers two Barlow lens in the 1-1/4" size. The 2x Ultima Barlow (#93506) is a compact triplet design that is fully multicoated for maximum light transmission and parfocal when used with the Ultima eyepieces. The OMNI Barlow (#93326) is a compact achromatic Barlow lens that is under three inches long and weighs only 4 oz. It works very well with all Celestron eyepieces.

Collimation Eyepiece (#94182) – The Celestron Cheshire eyepiece is ideal for precise collimation of Newtonian telescopes. This special eyepiece fits into any 1 ¼" focuser. Alignment is easy using the small opening on one end and thin crosshairs at the other end. The collimation eyepiece provides more accuracy than the simple collimation tool.

Exotherm (#93504)- Perfect for chilly evenings outdoors camping, stargazing, or at sporting events, the Exotherm hand warmer is convenient, reusable and made from nontoxic materials. Heat lasts up to 1 hour.

Eyepieces - Like telescopes, eyepieces come in a variety of designs. Each design has its own advantages and disadvantages. For the 1-1/4" barrel diameter there are four different eyepiece designs available.



- **OMNI Plössl** - Plössl eyepieces have a 4-element lens designed for low-to-high power observing. The Plössls offer razor sharp views across the entire field, even at the edges! In the 1-1/4" barrel diameter, they are available in the following focal lengths: 4mm, 6mm, 9mm, 12.5mm, 15mm, 20mm, 25mm, 32mm and 40mm.
- **X-Cel** - This 6 element design allows each X-Cel Eyepiece to have 20mm of eye relief, 55° field of view and more than 25mm of lens aperture (even with the 2.3mm). In order to maintain razor sharp, color corrected images across its 55° field of view, extra-low dispersion glass is used for the most highly curved optical elements. The excellent refractive properties of these high grade optical elements, make the X-Cel line especially well suited for high magnification planetary viewing where sharp, color-free views are most appreciated. X-Cel eyepiece come in the following focal lengths: 2.3mm, 5mm, 8mm, 10mm, 12.5mm, 18mm, 21mm, 25mm.
- **Ultima** - Ultima is our 5-element, wide field eyepiece design. In the 1-1/4" barrel diameter, they are available in the following focal lengths: 5mm, 7.5mm, 10mm, 12.5mm, 18mm, 30mm, 35mm, and 42mm. These eyepieces are all parfocal.
- **Axiom** – As an extension of the Ultima line, a new wide angle series is offered – called the Axiom series. All units are seven element designs and feature a 70° extra wide field of view (except the 50mm). All are fully multicoated and contain all the features of the Ultimas.



Filters Sets, Eyepiece - Celestron offers four convenient filter sets, which contain four different filters per set. Not only are these highly useful filter combinations, but they also offer an economical way to add versatility to your filter collection.

Series 1 – #94119-10

Orange, Light Blue, ND13%T, Polarizing (#s 21, 80A, #15, Polarizing)

Series 2 – #94119-20

Deep Yellow, Red, Light Green, ND25% T (#s 12, 25, 56, 96ND-25)

Series 3 – #94119-30
Light Red, Blue, Green, ND50% T (#s 23A, 38A, 58, 96ND-50)

Series 4 – #94119-40
Yellow, Deep Yellow, Violet, Pale Blue (#s 8, 47, 82A, 96ND-13)

Flashlight, Night Vision - (#93588) - Celestron's premium model for astronomy, using two red LED's to preserve night vision better than red filters or other devices. Brightness is adjustable. Operates on a single 9 volt battery (included).

Light Pollution Reduction (LPR) Filters (#94126A) - These filters are designed to enhance your views of deep sky astronomical objects when viewed from urban areas. LPR Filters selectively reduce the transmission of certain wavelengths of light, specifically those produced by artificial lights. This includes mercury and high and low pressure sodium vapor lights. In addition, they also block unwanted natural light (sky glow) caused by neutral oxygen emission in our atmosphere.

Moon Filter (#94119-A) - Celestron's Moon Filter is an economical eyepiece filter for reducing the brightness of the moon and improving contrast, so greater detail can be observed on the lunar surface. The clear aperture is 21mm and the transmission is about 18%.

Peterson First Guides® - Astronomy (#93728)

A simplified field guide to the stars, the planets and the universe featuring full color maps showing the positions of the stars throughout the year. This useful guide also includes beautiful constellation paintings, photographs, and clear, concise descriptions of stars, the planets, the sun, the moon, comets, black holes, galaxies and more.

Polarizing Filter Set (#93608) - The polarizing filter set limits the transmission of light to a specific plane, thus increasing contrast between various objects. This is used primarily for terrestrial, lunar and planetary observing.

Sky Maps (#93722) - Celestron Sky Maps are the ideal teaching guide for learning the night sky. You wouldn't set off on a road trip without a road map, and you don't need to try to navigate the night sky without a map either. Even if you already know your way around the major constellations, these maps can help you locate all kinds of fascinating objects.

Star Pointer (#51630)

This electronic finderscope can be used on any telescope by itself, or as a complement to other finderscopes for easily locating objects. It's used with both eyes open and features variable brightness control for comfortable viewing. It works by projecting a red dot on the image of the object to be viewed in the sky, which the telescope is then lined up with. This finderscope is compact and lightweight, it weighs just 1.5 oz. and is only 4.5" in length, and is easily mounted using the adhesive strip on its base.

"The Sky - Level 1 from Celestron" CD-ROM (#93700) presented by Celestron and Software Bisque, is the most comprehensive CD-ROM on the market for all levels of astronomers. It features a 10,000 object database, 75 full color enhanced images, 360° screen rotation, zoom from 4° to 235°, realistic sky display showing stellar brightness and contrast and more. Comet Hale-Bopp and Hyakutake coordinates included. This CD-ROM is easy to load, requiring only a 4MB system to run. Windows and Windows 95 compatible.

A full description of all Celestron accessories can be found in the Celestron Accessory Catalog (#93685)

CELESTRON TWO YEAR WARRANTY

- A. Celestron warrants this telescope to be free from defects in materials and workmanship for two years. Celestron will repair or replace such product or part thereof which, upon inspection by Celestron, is found to be defective in materials or workmanship. As a condition to the obligation of Celestron to repair or replace such product, the product must be returned to Celestron together with proof-of-purchase satisfactory to Celestron.
- B. The Proper Return Authorization Number must be obtained from Celestron in advance of return. Call Celestron at (310) 328-9560 to receive the number to be displayed on the outside of your shipping container.

All returns must be accompanied by a written statement setting forth the name, address, and daytime telephone number of the owner, together with a brief description of any claimed defects. Parts or product for which replacement is made shall become the property of Celestron.

The customer shall be responsible for all costs of transportation and insurance, both to and from the factory of Celestron, and shall be required to prepay such costs.

Celestron shall use reasonable efforts to repair or replace any telescope covered by this warranty within thirty days of receipt. In the event repair or replacement shall require more than thirty days, Celestron shall notify the customer accordingly. Celestron reserves the right to replace any product which has been discontinued from its product line with a new product of comparable value and function.

This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or subjected to abuse, misuse, mishandling or unauthorized repair. Further, product malfunction or deterioration due to normal wear is not covered by this warranty.

CELESTRON DISCLAIMS ANY WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR USE, EXCEPT AS EXPRESSLY SET FORTH HEREIN.

THE SOLE OBLIGATION OF CELESTRON UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE COVERED PRODUCT, IN ACCORDANCE WITH THE TERMS SET FORTH HEREIN. CELESTRON EXPRESSLY DISCLAIMS ANY LOST PROFITS, GENERAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM BREACH OF ANY WARRANTY, OR ARISING OUT OF THE USE OR INABILITY TO USE ANY CELESTRON PRODUCT. ANY WARRANTIES WHICH ARE IMPLIED AND WHICH CANNOT BE DISCLAIMED SHALL BE LIMITED IN DURATION TO A TERM OF TWO YEARS FROM THE DATE OF ORIGINAL RETAIL PURCHASE.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitation on how long an implied warranty lasts, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Celestron reserves the right to modify or discontinue, without prior notice to you, any model or style telescope.

If warranty problems arise, or if you need assistance in using your telescope contact:

Celestron
Customer Service Department
2835 Columbia Street
Torrance, CA 90503 U.S.A.
Tel. (310) 328-9560
Fax. (310) 212-5835
Monday-Friday 8AM-4PM PST

All authorized returns should be shipped to :
Celestron
1380 Charles Willard St
Carson, CA 90747

This warranty supersedes all other product warranties.

NOTE: This warranty is valid to U.S.A. and Canadian customers who have purchased this product from an Authorized Celestron Dealer in the U.S.A. or Canada. Warranty outside the U.S.A. and Canada is valid only to customers who purchased from a Celestron Distributor or Authorized Celestron Dealer in the specific country and please contact them for any warranty service.



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