



ASTROMASTER[®]

EQ TELESCOPE



INSTRUCTION MANUAL

Models #21062, 21064, 31035, 31042, 31045, 31051
(70EQ, 90EQ, 76EQ, 114EQ, 130EQ, 130EQ-MD)

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SOLAR WARNING

- Never look directly at the Sun with the naked eye or with a telescope unless you have 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 any accessories attached to it.
- Never use an eyepiece solar filter or a Herschel wedge. Internal heat build-up inside the telescope can cause these devices to crack or break, allowing unfiltered sunlight to pass through to the eye.
- Do not leave the telescope unsupervised, either when children are present or adults unfamiliar with the correct operating procedures of your telescope are present.

WHAT'S IN THE BOX

We recommend saving your telescope box so it can be used to store the telescope when it is not in use. Unpack the box carefully as some parts are small. Use the parts list below to verify that all parts and accessories are present.

PARTS LIST



1. Objective Lens
2. Telescope Tube
3. DEC Setting Circle
4. RA Setting Circle
5. RA Slow Motion Knob
6. Counterweight
7. Counterweight Bar
8. Tripod
9. Accessory Tray
10. Dovetail Mounting bracket
11. StarPointer Finderscope
12. Eyepiece
13. Erect Image Diagonal
14. Focus Knob
15. DEC Slow Motion Knob
16. Equatorial Mount
17. Latitude Adjustment Screw



1. StarPointer Finderscope
2. Eyepiece
3. Focus Knob
4. Telescope Tube
5. Tube Rings
6. DEC Setting Circle
7. RA Setting Circle
8. Counterweights
9. Counterweight Bar
10. RA Slow Motion Knob
11. Primary Mirror
12. DEC Slow Motion Knob
13. Latitude Adjustment Screw
14. Tripod
15. Accessory Tray

ASSEMBLING YOUR TELESCOPE

THE TRIPOD AND EQUATORIAL MOUNT

This section covers the assembly instructions for your AstroMaster EQ telescope. Your telescope should be set up indoors the first time so that it is easy to identify the various parts and familiarize yourself with the correct assembly procedure before attempting it outdoors.

To assemble tripod:

1. Remove the tripod and mount from the box.
2. Loosen the hand knobs at the bottom of each leg and extend the inner section of the leg to the desired length. Tighten the knobs to secure the legs, being careful not to over tighten.
3. Stand the tripod upright and pull the tripod legs apart until the center brace snaps into place.
4. Place the accessory tray on top of the center brace lined up the keyed hole in the center. Rotate the tray until the tabs at the three points of the tray snap into the holders on each arm of the tripod's center brace.



The equatorial mount allows you to tilt the telescope's axis of rotation so that you can track celestial targets as they move across the sky.

1. Remove the equatorial mount from the box.
2. Set the protrusion base of the equatorial mount into the indentation on the top of the tripod head.
3. Use the large hand knob under the tripod head to secure the mount to the tripod. Thread until snug, but do not overtighten.
4. Thread the latitude adjustment screw into the threaded hole on the back of the mount. You only need to thread this in a short way as you will adjust this screw later.



COUNTERWEIGHT BAR AND COUNTERWEIGHTS

In order to properly balance your telescope tube, the mount comes with a counterweight bar and counterweights.

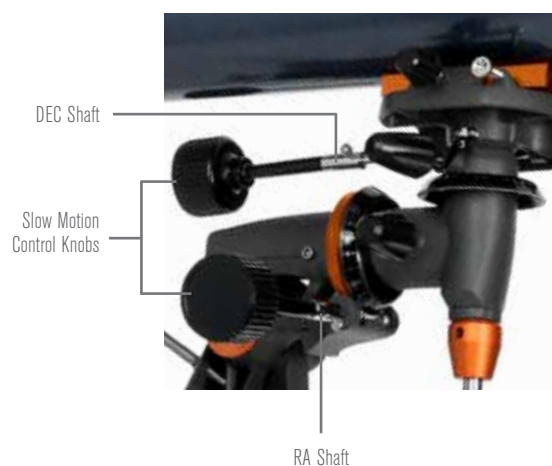
1. Remove the counterweight bar from the box and screw it into the threaded hole on the bottom of the declination axis of the mount.
2. Remove the orange counterweight safety screw from the bottom end of the counterweight bar.
3. Loosen the large black locking knob on the side of the counterweight. Make sure the hole through the counterweight is unobstructed.
4. Slide the counterweight onto the counterweight shaft about half way, then tighten the locking knob to hold the counterweight in place. If your telescope comes with more than one counterweight, add the second weight in the same manner as the first.
5. Replace the orange counterweight safety screw onto the bottom of the counterweight shaft. This will prevent the counterweight from falling off the shaft if it accidentally comes loose.



SLOW MOTION CONTROLS

The AstroMaster mount comes with two slow motion control knobs that allow you to make fine pointing adjustments to the telescope in both Right Ascension and Declination axes, also referred to as RA and DEC. To install the knobs:

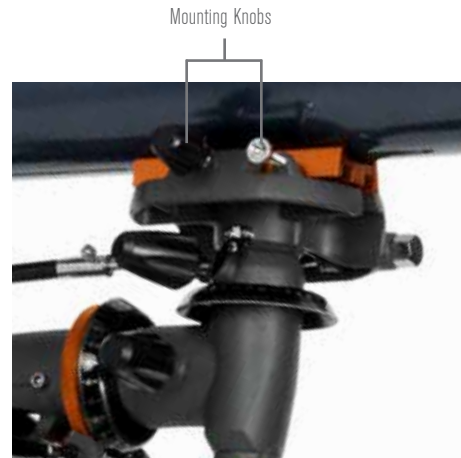
1. Locate the two knobs in the box. Both knobs are identical so it does not matter which one you use on each axis.
2. Loosen the set screw on the end of one of the two knobs.
3. Slide it onto the end of the RA gear shaft as far as it will go and tighten the setscrew to secure it in place. The RA knob can be used on either the left or right side of the mount, based on your preference.
4. Slide the other knob onto the DEC gear shaft and tighten the set screw to secure it.



THE TELESCOPE TUBE

The telescope tube attaches to the equatorial mount using a quick release dovetail system. For all of the refractor telescopes and the 76 mm Newtonian, the dovetail is attached directly to the telescope tube. For the 114 mm and 130 mm Newtonian telescopes, the dovetail attaches to tube rings that hold the telescope tube.

1. Loosen the two mounting knobs located on the side of the dovetail mounting bracket on the top of the equatorial mount. Make sure they are backed out far enough for the dovetail bar to slide into the mounting bracket.
2. Slide the dovetail bar on the telescope tube into the mounting bracket, making sure the dovetail is fully seated inside the bracket.
3. Tighten both mounting knobs to hold the telescope in place.



THE ERECT IMAGE DIAGONAL (Refracting telescopes only)

The erect image diagonal attaches to the back of a refracting telescope and contains a small prism that reflects light at a 90° angle, providing a more comfortable viewing position. Most astronomical telescopes will give a view that is either inverted or reversed left-to-right. The erect image diagonal corrects the image so that you will have a 100% correctly oriented image, making your telescope perfect for daytime terrestrial observing.

To insert the diagonal on the AstroMaster 70EQ and 90EQ refractors:

1. Remove the caps from both sides of the diagonal.
2. Loosen the setscrews on the back of the focuser and pull out the small dust cap.
3. Insert the smaller tube on the diagonal into the back of the focuser and secure it by tightening the setscrews. You can adjust the angle of the star diagonal to any desired direction before tightening the screws.



NOTE: An erect image diagonal is not able to reach focus on a Newtonian telescope. The image will always appear upside-down. The Newtonian telescopes come with one special 20 mm erecting eyepiece that has an erecting prism built-in for terrestrial use.

THE EYEPIECE

Your telescope comes with two eyepieces. The 20 mm which will give low magnification with a moderately wide field of view. The 10 mm will give you higher magnification, but a narrower field of view. Additional eyepieces can be purchased to increase or decrease the magnification to your desired level. When first locating an object, it is best to use the 20 mm eyepiece, then, once the object is centered, change to the 10 mm eyepiece to “zoom in” on it.

To install the eyepiece on the the AstroMaster 70EQ and 90EQ refractors:

1. Loosen the setscrews on the open end of the star diagonal.
2. Insert the silver barrel of the 20 mm eyepiece into the star diagonal.
3. Tighten the setscrews to secure the eyepiece in place.
4. To see the sharpest image possible, focus by looking through the eyepiece and slowly turning the focusing knobs until the image comes into sharp focus.



To install the eyepiece on the AstroMaster 76EQ, 114EQ and 130EQ Newtonian telescopes:

1. Loosen the setscrew on the end of the focuser and remove the dust cap.
2. Insert the silver barrel of the 20 mm eyepiece directly into the focuser.
3. Tighten the setscrew to secure the eyepiece in place.
4. To see the sharpest image possible, focus by looking through the eyepiece and slowly turning the focusing knobs until the image comes into sharp focus.

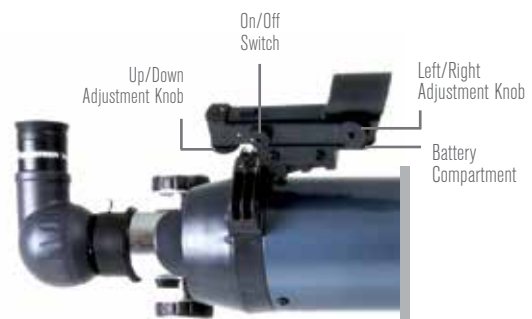


THE STARPOINTER FINDERSCOPE

Your telescope comes with a StarPointer red-dot finderscope that you will use as a sighting tool when aiming the telescope at a target.

To install the finderscope:

1. Loosen the two Philips-head screws on the side of the finderscope and slide the clamp over the dovetail bracket near the telescope focuser. The large window on the finder should be facing the front of the telescope.
2. Secure the finderscope in place by tightening the two Philips-head screws. Do not over tighten these screws. Just make the connection snug.
3. Remove the small plastic tab under the battery cover. This is installed to prevent the battery from accidentally discharging during transportation.



CHANGING THE FINDERSCOPE BATTERY

To replace the StarPointer battery, remove the finder from the scope and turn it over. The battery compartment is located directly under the large lens assembly. Using a small screwdriver or your fingernail, gently lift straight up on the cover to remove it. The battery is held in place by a spring contact. Gently lift this contact and turn the finder on its side. The battery should slip right out. Replace the battery with a 3-Volt CR2032 button cell battery. Slide the new battery under the contact, making sure that the positive terminal of the battery (the side marked with a "+") is pointing upward, toward the spring contact. The battery should snap in place. Replace the cover by lining up the pins on the cover with the holes in the finderscope and pressing it down. Be sure to dispose of the old battery according to your local laws.



MOVING THE TELESCOPE

The AstroMaster equatorial mount was designed to move in two directions based on the celestial coordinate system. The Right Ascension, or RA, axis moves the telescope in the East/West direction). The Declination, or DEC, axis moves the telescope in the North/South direction. By moving the scope in RA and DEC, you will be able to point your telescope to any point in the sky.

To move the telescope over long distances:

1. Loosen the RA and DEC clutch knobs located on the side of the mount by turning them counter-clockwise. This will allow the scope to spin freely in each direction.
2. Move the scope by hand in RA and DEC until you are close to your desired position.
3. Tighten the two clutch knobs clockwise to secure the mount in place.

To make fine adjustments to the pointing of the telescope:

1. Make sure both clutches are locked.
2. Turn the RA or DEC slow motion knob as required to center an object in your eyepiece view.

NOTE: If the clutches are unlocked, the slow motion knobs will not work.



ALIGNING THE FINDERSCOPE

The StarPointer finderscope is a reflex sight that uses a red LED to project a red dot onto the round glass window. When you look through the window, you see the red dot superimposed on your target. The first time you assemble your telescope, you'll need to align the finderscope with the main optics of the telescope. Although this step can be done at night, it is significantly easier to do during the day. Once you have completed the finderscope alignment, you should not have to repeat this step unless the finderscope is bumped or dropped.

To install the StarPointer finderscope:

1. Take the telescope outside during the day. Using your naked eye, find an easily recognizable object, such as a streetlight, car license plate, or tall tree. The object should be as far away as possible, but at least a quarter mile away.
2. Remove the main dust cover from the telescope and make sure your 20 mm eyepiece is installed.
3. Move the telescope left and right or up and down so that it is roughly pointing toward the object you chose in step 1.
4. Look through the telescope's eyepiece and manually move the telescope until the object you chose lies in the center of the view. If the image is blurry, gently turn the focus knobs until it comes into sharp focus.
5. Once the object is centered in your 20 mm eyepiece, turn on the finderscope by turning the power/brightness switch knob on the side of the unit as far as it will go.
6. With your head positioned about a foot behind the finder, look through the round window and locate the red dot. It will probably be close to, but not on top of, the object you see when you are looking through the 20 mm eyepiece.
7. Without moving the telescope, use the two adjustment knobs on the side and underneath the finderscope. One controls the left-right motion of the reticle, while the other controls the up-down motion. Adjust both until the red dot appears over the same object you are observing in the 20 mm eyepiece.

Now choose some other distant targets to practice aiming your telescope. Look through the StarPointer finderscope window and place the red dot over the target you are trying to view and verify that it appears in the 20 mm eyepiece of the scope.

NOTE: Be sure to turn off the StarPointer finderscope when not in use to conserve battery power.

BALANCING THE TELESCOPE

To eliminate undue stress on the mount and gears, the telescope should be properly balanced on the mount.

To balance the mount in the RA axis:

1. Make sure the telescope is properly attached to the mount with the dovetail mounting knobs tightly secured.
2. Release the RA clutch knob to allow the scope to spin freely in the RA axis.
3. Rotate the telescope in the RA axis so that the telescope tube is on the side of the mount and the counterweight bar is parallel to the ground.
4. Slowly release your grip on the telescope and see what side is heavier – the side with the telescope tube or the side with the counterweight.
5. If the counterweight side is heavier, loosen the counterweight locking knob and slide the counterweight up the shaft (toward the telescope tube) a small amount, lock the counterweight down in its new position and try the test again.
6. If the telescope tube side is heavier, loosen the counterweight locking knob and slide the counterweight down the shaft (away from the telescope tube) a small amount, lock the counterweight down in its new position and try the test again.
7. Keep adjusting the position of the weight until you can let the telescope go and it does not move up or down.

To balance the scope in the DEC axis:

1. Place the telescope in the same position as listed for the RA balance test above with the telescope tube on one side of the mount and the counterweight bar parallel to the ground. Lock the RA clutch knob to hold the mount in place.
2. Holding the telescope tube securely with one hand, loosen the DEC clutch knob and rotate the telescope so that it is parallel to the ground.
3. Slowly let go of the telescope tube and see if the telescope starts to rotate upward or downward, then lock the DEC clutch knob to secure the tube in place.
4. If the nose of the telescope pointed upward, the tube is back-heavy and the balance point will need to change. Loosen the telescope tube dovetail mounting screws and slide the dovetail forward slightly. Tighten the two dovetail mounting screws and try the test again.
5. If the nose of the telescope pointed downward, the tube is front-heavy and the balance point will need to change. Loosen the telescope tube dovetail mounting screws and slide the dovetail back slightly. Tighten the two dovetail mounting screws and try the test again.
6. Keep adjusting the position of the dovetail bar until you can let the telescope go and it does not rotate up or down.

NOTE: For the 114mm and 130mm Newtonian telescopes, you can adjust the balance point of the telescope without moving the dovetail bar. Simply loosen the silver screws found on the two tube rings that surround the telescope tube. You can then slide the telescope tube forward or backward within the rings. When the balance point is reached, tighten the tube ring screws to lock it in place. You can also rotate the tube within the tube rings using this same method to place the eyepiece at a comfortable angle for viewing.



RA Axis



DEC Axis

POLAR ALIGNMENT

Your equatorial mount has the ability to easily track celestial targets by turning the RA slow motion knob or by using an optional motor drive that will turn it for you. In order for the mount to do this accurately, your mount will need to be “polar aligned” or setup so the RA axis of rotation is parallel to Earth’s rotational axis. This sounds more complicated than it is and after you have done it a few times, it will be second nature. The first step of polar aligning is to set your mount at the proper latitude setting for your observing site.

To set the latitude on your mount:

1. Adjust the height of all three tripod legs so that your mount is level. Eyeballing this is sufficient.
2. Determine your latitude on Earth. If you have GPS enabled device, such as a tablet or smartphone, you should be able to read your latitude directly from your device. If not, you can find this information online.
3. Locate the latitude scale, found on the side of the equatorial mount near the base.
4. Use the sliding handle to loosen the latitude adjustment locking knob by rotating it counter-clockwise.
5. Adjust the latitude adjustment screw on the back of the mount by rotating it clockwise or counter-clockwise until the pointer above the altitude scale points at your latitude on Earth.

Example: *In Los Angeles, California, our latitude is 33 degrees.*

6. Once you have set your latitude correctly, tighten the latitude adjustment locking knob by rotating it clockwise.

NOTE: This latitude setting generally only needs to be done once if you setup the scope in the same location every time you observe. The only time you would need to change this is if you travel with the telescope far enough North or South to change a degree of latitude. This is approximately 70 miles. Small changes such as moving the scope from your front yard to your back yard, or even to different locations within a city, will not require you to change this setting.

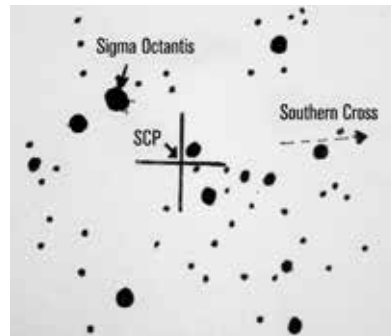
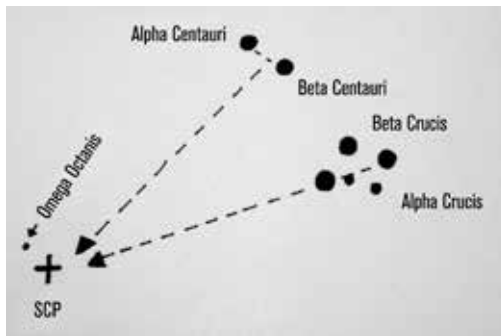
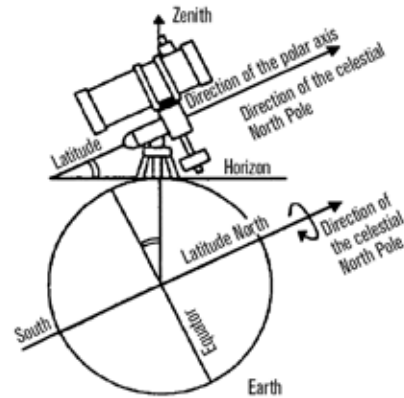
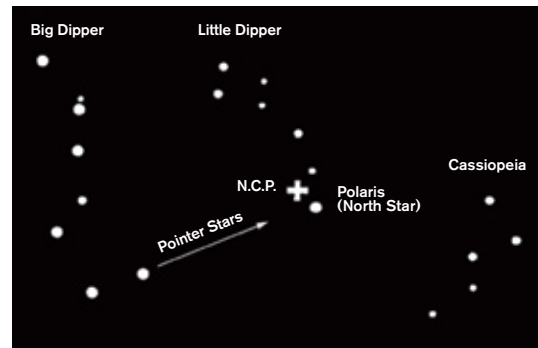


With your tripod level and your latitude set, the only thing left is to rotate the mount so that the polar axis (the RA axis of rotation) points north. To do this:

1. Setup the telescope so that the telescope tube is directly above the equatorial mount and the front of the telescope tube points directly over the counterweight bar. Lock down the RA and DEC clutch knobs to hold the mount in this position.
2. Locate the direction of north. There are two ways of doing this:
 - a. Use a magnetic compass or a smart device app to find magnetic north. This is the easiest method but unfortunately is not very accurate. Magnetic north can vary by as much as 15 degrees from true north. This is still a good method to get up and operating quickly since some compass apps for smart devices can compensate for magnetic variations and show true north.

- b. If you have more time and a little knowledge of the night sky, you can actually find true north by looking for the Big Dipper and/or the constellation Cassiopeia. The star Polaris, the North Star, lies about 0.8 degrees away from true celestial north and is bright enough to find with the naked eye from suburban skies. Look for the two stars that form the end of the bowl of the dipper and draw a straight line through them and it will take you directly to Polaris. Using Polaris as true north will get you plenty close to an accurate polar alignment.
3. Slightly loosen the knob between the three tripod legs that holds the EQ mount to the tripod head. Loosen this just enough to rotate the mount inside the tripod head.
4. Grab the equatorial mount and rotate it until the optical tube is pointing in the same direction indicated by the compass needle. If you used the Polaris method, turn the mount until you sight down the length of the tube and see Polaris.
5. Once the mount is aligned to north, tighten the knob connecting the mount to the tripod to secure it in place.

NOTE: If you are in the Southern Hemisphere, you will use a compass to locate the south celestial pole. Turn the mount until the telescope points south when using a compass needle. Instead of Polaris, you can use the star Sigma Octantis. The Southern Cross is a good guide to finding this star.



With your mount polar aligned, you should find it very easy to track objects as they slowly drift across the sky as Earth rotates underneath them. You can also locate objects using the setting circles found on your mount. For more details on the use of setting circles, please see the section at the end of the manual titled "A Word on Setting Circles".

YOUR FIRST ASTRONOMICAL OBSERVING SESSION

THE MOON

Now you are ready to take your telescope out at night and do some real observing!

Let's start with the Moon. The Moon takes about one month to go through a complete phase cycle, from new Moon to full Moon and back again. Try observing it at different points during this cycle.

While you can observe the Moon any time it is visible in the sky, the best time to view it is from two days after a new Moon up to a few days before a full Moon. During this period, you will be able to see the most detail in craters and lunar mountain ranges. Consult a calendar to find out when the next new Moon will be.

1. With a clear view of the Moon, set up your telescope with the 20 mm eyepiece.
2. Turn on the finderscope and look through it to find the red dot.
3. Move the telescope until you can see the Moon through the finderscope's window and the red dot is centered on the Moon.
4. Look through the 20 mm eyepiece. Gently turn the focus knobs to adjust the sharpness of the image.

CONGRATULATIONS! YOU HAVE NOW OBSERVED YOUR FIRST CELESTIAL OBJECT!

You can view many other celestial objects, such as planets, star clusters and nebulae using this same basic technique.

CELESTIAL OBSERVING TIPS

This section covers visual observing hints for both solar system and deep-sky objects as well as general observing conditions which will affect your ability to observe.

MAGNIFICATION

You can change the magnification of your telescope by simply changing eyepieces. Both telescopes and eyepieces have focal lengths that are measured in millimeters. To calculate the magnification of a given telescope and eyepiece combination, take the focal length of the telescope and divide it by the focal length of the eyepiece. The resulting number is the magnification factor.

For example, the AstroMaster 90EQ has a focal length of 1000 mm. Using the 20 mm eyepiece:

$$\text{Magnification} = \frac{\text{Focal length of Telescope}}{\text{Focal length of Eyepiece}} = \frac{1000 \text{ mm}}{20 \text{ mm}} = 50x$$

FIELD OF VIEW

Determining the field of view is important if you want to get an idea of the angular size of the object 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 it gives you in the scope you are using.

Using the example in the previous section, we can determine the field of view using the same telescope and 20 mm eyepiece. The 20 mm eyepiece has an apparent field of view of 40°.

$$\text{Actual Field Of View} = \frac{\text{Apparent Field of View of Eyepiece}}{\text{Magnification}} = \frac{40^\circ}{50} = 0.8 \text{ degrees of arc}$$

The 20 mm eyepiece has an apparent field of view of 40°. Divide the 40° by the magnification, which is 50 power. This yields an actual field of view of 0.8 degrees or 48 minutes of arc.

THE PLANETS

In addition to the Moon, your telescope is capable of observing the 5 brightest planets. Since planets change their positions against the background stars, you will need to consult sources on the web or use a planetarium app on a smart device to help you locate where these are.

Here are some things to look for:

- **Mercury and Venus-** Just like the Moon, the two inner planets will go through phases ranging from thin crescents to gibbous phases.
- **Mars-** When it is near opposition (the point in its orbit where it is closest to Earth) you should be able to discern the polar cap and possibly some larger surface features that appear as dark markings on the surface.
- **Jupiter-** Look for the darker methane cloud bands that circle the planet just above and below the equator. If the Great Red Spot is facing the Earth, you may be able to catch a glimpse of it. You will also see the four brightest moons of Jupiter – Io, Europa, Ganymede, and Callisto. These moons are fun to watch because they can move appreciably over just a couple of hours. Occasionally they will travel behind Jupiter or into its shadow and disappear for periods of time. They can also cross the face of Jupiter and you may even see a shadow of the moon crossing with it. There are some useful apps for smart device that will help you predict when the Great Red Spot can be seen as well as when any interesting events are going to occur with Jupiter's moons.
- **Saturn-** The rings! Saturn is arguably one of the most beautiful objects to look at in a telescope. If seeing conditions are stable enough, you may even catch the shadow of the rings on the planet and the shadow of the planet on the rings. You should be able to see Titan, the brightest moon of Saturn.

DEEP-SKY OBJECTS

Deep-sky objects are all of those celestial objects that are outside of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars and other galaxies outside our own Milky Way. Objects such as nebulae and galaxies can be quite large, but they are also very faint. In order to get the best view, you will need to make sure you are in the darkest skies possible. The farther you are away from city lights, the better you will see these objects in the eyepiece. In photographs of nebulae and galaxies, you will see vivid reds and blues. These colors are not visible when you look through the eyepiece. The colorful images were very long exposure images taken over 15 – 60 minutes or more, where your eye only records data on an instant by instant basis. Digital sensors are much more sensitive to reds and blues than the human eye is which is most sensitive in the green part of the spectrum. Still, you will be able to see the soft glow of the Andromeda galaxy and the expanse of the Orion Nebula.

SKY CONDITIONS

Sky conditions can significantly affect the performance of your telescope in three ways.

- **Steadiness of the Air-** On windy days, images of the Moon and planets will appear to wave or jump around in the eyepiece; as if you are looking at them through moving water. Nights where winds are calm will offer the best higher magnification views of the planets and the Moon. The best way to judge the stability of the atmosphere is to look at bright stars with the naked eye. If they are “twinkling” or rapidly changing colors, the air is unstable and you are better off using lower powers and looking for deep sky objects. If the stars are sharp and not twinkling, the air is stable and should offer great high magnification planetary views.
- **Transparency-** How clear is the air you are looking through? If there is a high amount of humidity in the air, the faint light from galaxies and nebulae can be scattered and diffused before reaching your telescope, causing a loss of brightness in your image. Debris in the air from local forest fires or even distant volcanic eruptions can contribute to large loss of brightness. Sometimes this humidity or debris can help stabilize the air, making for good planetary and lunar images, but the loss of light would make it difficult to see fainter deep-sky objects.
- **Sky Brightness-** The amount of ambient light in the atmosphere can also effect deep-sky observing. How dark the sky is can depend on your local surroundings. In the middle of a city, sky-glow caused by city lights being reflected back to earth from the sky can overpower the faint light from distant galaxies. Getting away from the bright lights of a major city can make the difference between seeing a faint deep-sky object and missing it altogether. Planets and the moon are plenty bright enough on their own so the effect on observing them is minimal.

SELECTING AN OBSERVING SITE

If you are going to be observing deep-sky objects, such as galaxies and nebulae, you should consider traveling to a dark sky site that is reasonably accessible. It should be away from city lights, a relatively unobstructed view of the horizon, and upwind of any major source of air pollution. Always choose as high an elevation as possible as this can lower the effects of atmospheric instability and can ensure that you are above any ground fog. While it can be desirable to take your telescope to a dark sky site, it is not always necessary. If you plan to view the planets, the Moon or even some of the brighter deep-sky objects, you can do this from any location, such as your own backyard. Try to setup the scope in a location that is out of the direct path of streetlights or house lights to help protect your night vision. Try to avoid observing anything that lies within 5 to 10 degrees over the roof of a building. Rooftops absorb heat during the day and radiate this heat out at night. This can cause a layer of turbulent air directly over the building that can degrade your image. It is best if you set your telescope up directly on a dirt or grassy surface. Setting up on any raised platform such as a wooden deck or a hard surface like concrete or a sidewalk should be avoided as they transmit vibrations easily that can be transferred to the telescope.

Observing through a window is not recommended because the window glass will distort images considerably. And an open window can be even worse, because warmer indoor air will escape out the window, causing turbulence which also affects images. Astronomy is an outdoor activity.

CHOOSING THE BEST TIME TO OBSERVE

Try not to view immediately after sunset. After the sun goes down, the Earth is still cooling, causing air turbulence. As the night goes on, not only will seeing improve, but air pollution and ground lights will often diminish. Some of the best observing time is often in the early morning hours before dawn. Objects are best observed as they cross the meridian, the imaginary line that runs from north to south through a point directly over your head. This is the point at which objects reach their highest points in the sky and your telescope is looking through the least amount of atmosphere possible. Objects that are rising or setting near the horizon will suffer more atmospheric turbulence since you are looking through a much longer column of air. It is not always necessary to have cloud-free skies if you are looking at planets or the moon. Often broken cloud conditions provide excellent seeing.

COOLING THE TELESCOPE

Telescopes require at least 10 minutes to cool down to outside air temperature. This may take longer if there is a big difference between the temperature of the telescope and the outside air. This minimizes heat wave distortion inside the telescope tube (tube currents).

ADAPTING YOUR EYES

If you are planning to observe deep sky objects at a dark sky site, it is best if you allow your eyes to fully adapt to the dark by avoiding exposure to white light sources such as flashlights, car headlights, streetlights, etc. It will take your pupils about 30 minutes to expand to their maximum diameter and build up the levels of optical pigments to help your eyes see the faint light from a distant target. If you need light to help setup your telescope in the dark, try using a red LED flashlight at as low a brightness setting as possible and avoid looking straight at the light source. This will give you the best chance of capturing those faint deep sky objects.

When observing, it is important to observe with both eyes open. This avoids eye fatigue at the eyepiece. If you find this too distracting, cover the unused eye with your hand or an eye patch. The center of your eye works well in bright daylight, but is the least sensitive part of the eye when trying to see subtle detail at low light levels. When looking in the eyepiece for a faint target, don't look directly at it. Instead look toward the edge of the field of view and the object will appear brighter.

ASTROIMAGING

One of the first questions most people have about their new telescope is "How can I take images with it?". Your telescope is capable of imaging the Moon and planets, but deep-sky objects would require a more advanced telescope and mount with finely geared motorized tracking. There are a few different methods for using your telescope for imaging:

- **Smart Devices or Point-and-Shoot Cameras-** This is the easiest and most straight forward method and works well for images of the Moon and planets. Simply hold your device's camera up to the eyepiece and take the image. While you can use this with any eyepiece, it is generally easier to get an image using a lower power (longer focal length) eyepiece. You will need a steady hand to hold the phone to the eyepiece but you can get good results.
- **DSLR-** Celestron offers adapters that will allow you to attach a Canon or Nikon DSLR body to the telescope in place of the eyepiece. You would be effectively using your telescope as a telephoto lens. This will require a T-adapter for the telescope and a T-ring for the camera body.
- **CMOS Planetary Imagers-** These are specialized cameras that replace the eyepiece in your telescope. It would connect to your laptop via a USB port. The camera records video of the planet, then the included software breaks up the video file into individual still frames. The software then combines the individual frames into a single image that contains more detail than was visible in any single frame. This method will provide you the best possible lunar and planetary images, but does require that you have a laptop at the scope.

DEEP-SKY OBSERVING EQUIPMENT

There are some tools that will be indispensable to you for identifying and locating deep-sky objects:

- **Red Flashlight-** This is an essential tool for deep-sky astronomy for reading finder charts or star atlases. In order to see the faint light coming from distant objects like nebulae or galaxies, your eyes must be fully dark adapted with your irises open to the fullest extent to let the most light from your telescope into them. White light from a standard flashlight will cause your eye's irises to close down and it can take up to a half-hour for your eyes to return to full dark adaptation. Red lights do not have the same effect. We recommend any red LED flashlight that has adjustable brightness output, because even red light, if excessively bright can affect your night vision. These are available through most telescope retailers but can also be found in camping and hardware stores.
- **Planisphere-** A planisphere is a special circular star map that will show you the rough placement of constellations over your head, so you can navigate your way across the sky. Unlike charts you can print online, planispheres are good for any time of year, not just the date or month you printed it for. The planisphere consists of two round disks joined at the center. The bottom disk has a map of the constellations while the top disk has a window cut into it out showing a portion of the sky map. By turning the inner and outer disks to match your specific date and time, the map will display only those constellations visible to you at that time. This is handy for finding rough locations of bright stars and constellations. Planispheres are available through book stores and are available for a number of geographical latitudes in the Northern or Southern Hemispheres. Be sure to pick one that is designed for your location. To get more detailed information on where deep-sky objects reside within constellations you will need a Star Atlas.
- **Star Atlas-** Star atlases are the roadmaps of the sky. Once you have located a constellation with your planisphere, the Star Atlas will show you a detailed, close-up view of that region of sky showing the stars and deep-sky objects that reside in it. These are available through many telescope retailers or bookstores.
- **Apps and Programs-** There are many applications available for a smartphone or tablet that can take the place of the planisphere and star maps. These will give digital representations of the night sky on your device, allowing you to go from a wide view to a zoomed-in view with a touch of the screen. These can be downloaded or purchased from your application store, depending on your platform. There are also some great astronomical sky simulation programs available for your computer that will show you very detailed star maps on screen and can help you plan an observing session before you get outside with printable star maps customized for your date, location and time.

STAR HOPPING

The easiest way to find your way around the sky is by a technique called star hopping. The first thing you will need to do is measure the field of view of your finderscope. Look in the sky and locate a constellation with bright stars. You can use your planisphere or astronomy app to help identify it. Now find the map in your star atlas that shows this constellation. Center your finderscope on any bright star that you can recognize on the star map. Hold your head 12 inches behind the reflective window of your StarPointer finderscope and move the telescope so that the bright star is at the edge of the field of view of the window (it does not matter which direction you pick). Without moving the telescope, look through the finderscope window and locate another star near the opposite edge of the field of view. Locate this second star on the chart. Measure the distance between these two stars on the chart using a ruler. This distance represents one finderscope field of view on your atlas. You can now use this measurement to locate celestial objects.

CARE AND CLEANING OF THE TELESCOPE

While your telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best. Occasionally, dust and/or moisture may build up on the objective lens. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the optics, follow these steps, in order, to clean your scope:

1. Use a camel hair brush to gently remove the larger particles.
2. Use a photographer's squeeze bulb to blow away any loose debris. You can also use a can of compressed air, such as those sold for cleaning computer keyboards, but you need to be careful. Avoid using cans that are almost empty and be sure to hold the air can vertically. Failure to do this can result in the can spitting propellant out onto the optics. Hold the optical surface at an angle to the spray from the can for approximately two to four seconds.
3. Use an optical cleaning solution of over-the-counter isopropyl alcohol and distilled water in a 50/50 mixture. Apply this solution to a white unscented tissue, then apply the tissue paper to the optics. Low pressure strokes should go from the center of the lens (or mirror) to the outer portion in straight lines like spokes on a wheel. **Do not rub in circles!**

You may experience dew build-up on the optics of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer (on low setting) or by pointing the telescope at the ground until the dew has evaporated. If moisture condenses on the inside of the optics, remove the accessories from the telescope. Place the telescope in a dust-free environment and point it downward until the moisture evaporates.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the telescope tubes are not sealed, the covers should be placed over the openings when not in use. This will prevent contaminants from entering the tubes.

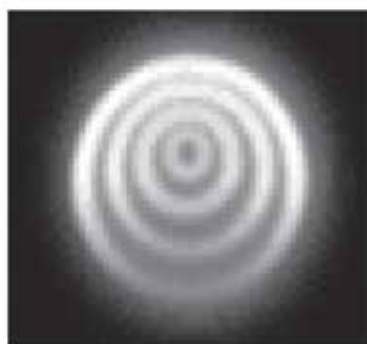
Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

COLLIMATION OF A NEWTONIAN TELESCOPE

While your telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best. Collimation is the process of aligning the mirrors of your telescope so that they work in concert with each other to deliver properly focused light to your eyepiece. By observing out-of-focus star images, you can test whether your telescope's optics are aligned. Place a star in the center of the field of view and move the focuser so that the image is slightly out of focus. If the seeing conditions are good, you will see a central circle of light (the Airy disc) surrounded by a number of diffraction rings. If the rings are symmetrical about the Airy disc, the telescope's optics are correctly collimated.



Correctly Aligned

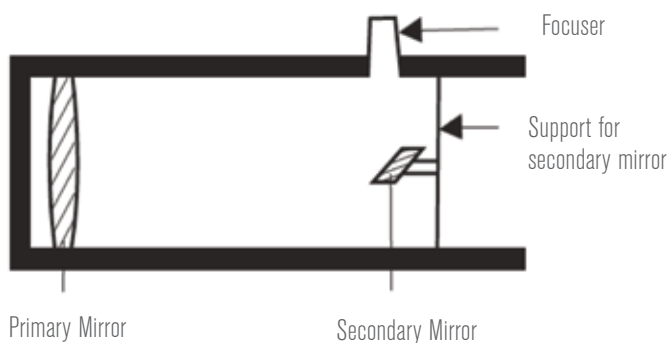


Needs Collimation

Collimation is a painless process and works like this:

Pull off the lens cap which covers the front of the telescope and look down the optical tube. At the bottom you will see the primary mirror held in place by three clips 120° apart, and at the top the small oval secondary mirror held in a support and tilted 45° toward the focuser outside the tube wall.

The secondary mirror is aligned by adjusting the three smaller screws surrounding the central bolt. The primary mirror is adjusted by the three adjusting screws at the back of your scope. The three locking screws beside them serve to hold the mirror in place after collimation.



ALIGNING THE SECONDARY MIRROR

Point the telescope at a lit wall look into the focuser without the eyepiece installed. You may have to twist the focus knob a few turns until the reflected image of the focuser is out of your view. Keep your eye against the back of and centered in the focus tube. Look for the three clips holding the primary mirror in place. If you can't see them, it means that you will have to adjust the three bolts on the top of the secondary mirror holder, with possibly an Allen wrench or Phillip's screwdriver. You will have to alternately loosen one and then compensate for the slack by tightening the other two. Stop when you see all three mirror clips. Make sure that all three small alignment screws are tightened to secure the secondary mirror in place.



ALIGNING THE PRIMARY MIRROR

There are 3 large bolts and 3 small screws at the back of your telescope. The large bolts are the adjusting screws and the small screws are the locking screws. Loosen the large bolts by a few turns. Now run your hand around the front of your telescope keeping your eye to the focuser, you will see the reflected image of your hand. The idea here being to see which way the primary mirror is deflected, you do this by stopping at the point where the reflected image of the secondary mirror is closest to the primary mirrors' edge.

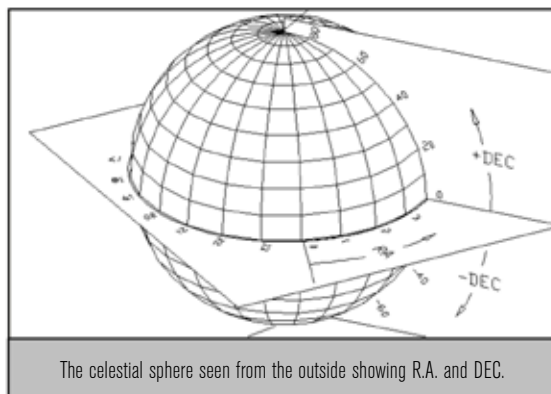
When you get to that point, stop and keep your hand there while looking at the back end of your telescope, is there an adjusting screw there? If there is you will want to loosen it (turn the screw to the left) to bring the mirror away from that point. If there isn't an adjusting screw there, then go across to the other side and tighten the adjusting screw on the other side. This will gradually bring the mirror into alignment. (It helps to have a friend to help for primary mirror collimation. Have your partner adjust the adjusting screws according to your directions while you look in the focuser).

After dark, go out and point your telescope at Polaris, the North Star. With an eyepiece in the focuser, take the image out of focus. You will see the same image only now, it will be illuminated by starlight. If necessary, repeat the collimating process only keep the star centered while tweaking the mirror.



A WORD ON SETTING CIRCLES

The celestial coordinate system is much like the latitude and longitude system that we use to map the Earth. Just like cities on a map have specific longitude and latitude coordinates, stars and deep-sky objects all have Right Ascension (RA) and Declination (DEC) coordinates on the Celestial Sphere. Your telescopes comes with two setting circles, one on the RA axis and one on the DEC axis. The setting circles are 3-inch diameter disks with graduated markings on them that can help you locate objects in the night sky by their celestial coordinates.



The Declination axis of the Celestial Sphere are broken down into degrees, minutes and seconds of arc. At the Celestial equator, the Dec coordinate is 0 degrees, with +90 degrees being the North Celestial Pole and -90 degrees being the South Celestial Pole. The Dec coordinate tells you how far north or south to go to find your target.

Before you can use the setting circles to find objects in the sky you need to align the setting circles first. When you polar align the mount, you are actually aligning the DEC setting circle as well, so there is nothing more required for this one. The RA setting circle requires some additional information.

On the RA setting circle there are two sets of numbers on the dial – one for the northern hemisphere (bottom) and one for the southern hemisphere (top). In order to align the RA setting circle, you will need to be able to identify some of the brighter stars in the sky. You can use a star atlas or astronomy app to help you with this.

To align the RA setting circle:

1. Locate a bright star near the celestial equator. The farther you are from the celestial pole the better your reading on the RA setting circle will be.
2. Use your star atlas or you astronomy app to lookup the coordinates of the star you selected.
3. Center the star in the telescope's eyepiece.
4. Without moving the telescope, rotate the RA setting circle until the RA indicator points at the RA coordinate of the star you selected.

NOTE: The RA setting circle does **NOT** move as the telescope moves in RA, the setting circle must be aligned each time you want to use it to find an object. However, you do not need to use a star each time. Instead, you can use the coordinates of the object you are currently observing.

Once the circles are aligned you can use them to find any object with known coordinates. The accuracy of your setting circles is directly related to the accuracy of your polar alignment.

To find objects using the setting circles:

- 1.** Select an object to observe. Use a planisphere, star atlas, or astronomy app or program to make sure the object you chose is above the horizon. As you become more familiar with the night sky, this will no longer be necessary.
- 2.** Look up the coordinates of your target.
- 3.** Hold the telescope and release the DEC lock knob.
- 4.** Move the telescope in declination until the indicator is pointing at the correct declination coordinate.
- 5.** Lock the DEC lock knob to prevent the telescope from moving.
- 6.** Hold the telescope and release the RA lock knob.
- 7.** Move the telescope in RA until the indicator points to the correct coordinate.
- 8.** Lock the RA lock knob to prevent the telescope from slipping in RA.

Due to errors in polar alignment and the accuracy of the setting circles on this equatorial mount, it is unlikely that you will see the object in your telescope's eyepiece. You will need to use the slow motion controls and perform a slow circular search until the object falls into the field of view.

Please note that the use of setting circles is more complicated than the simple method described in the "Star Hopping" section above. It is recommended to start with Star Hopping, but with a little patience and some practice, setting circles can be a viable way to locate objects in the night sky. Try practicing on bright stars or even planets as they are relatively easy to see in your finderscope until you get the hang of it.