

# INSTRUCTION MANUAL

## Orion® SpaceProbe™ 130mm EQ

Equatorial Newtonian Reflector Telescope #9007



 **ORION**®  
TELESCOPES & BINOCULARS  
AN EMPLOYEE-OWNED COMPANY

Corporate Offices: 89 Hangar Way, Watsonville CA 95076 - USA

Toll Free USA & Canada: (800) 447-1001

International: +1(831) 763-7000

Customer Support: [support@telescope.com](mailto:support@telescope.com)

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*Congratulations on your purchase of a quality Orion telescope. Your new SpaceProbe 130ST EQ is designed for high-resolution viewing of astronomical objects. With its precision optics and equatorial mount, you'll be able to locate and enjoy hundreds of fascinating celestial denizens, including the planets, Moon, and a variety of deep-sky galaxies, nebulas, and star clusters.*

If you have never owned a telescope before, we would like to welcome you to amateur astronomy. Take some time to familiarize yourself with the night sky. Learn to recognize the patterns of stars in the major constellations. With a little practice, a little patience, and a reasonably dark sky away from city lights, you'll find your telescope to be a never-ending source of wonder, exploration, and relaxation.

These instructions will help you set up, properly use and care for your telescope. Please read them over thoroughly before getting started.

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**Figure 1.** The included parts

## I. Unpacking

The entire telescope system will arrive in one box. Be careful unpacking the box. We recommend keeping the original shipping container. In the event that the telescope needs to be shipped to another location, or returned to Orion for warranty repair, having the proper shipping container will help ensure that your telescope will survive the journey intact. Make sure all the parts in the Parts List are present. Be sure to check boxes carefully, as some parts are small. If anything appears to be missing or broken, immediately call Orion Customer Support (800-447-1001) for assistance

## II. Parts List

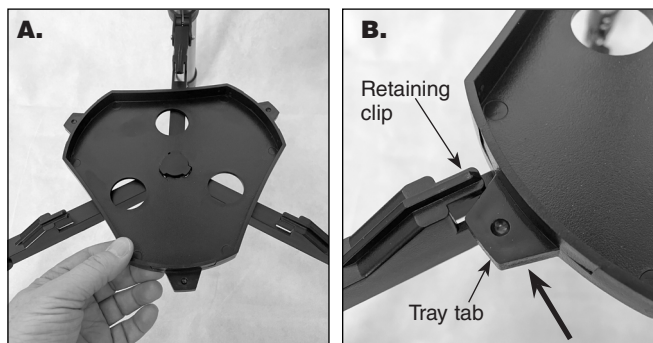
Part	Qty
A – Tripod	1
B – Equatorial Head	1
C – Optical Tube Assembly	1
D – Tube rings	2
E – Slow motion cables	2
F – Counterweight shaft	1
G – Latitude Adjustment t-bolts	2
H – Counterweight	1
I – Collimation cap	1
J – 25mm Plossl eyepiece, 1.25"	1
K – 10mm Plossl eyepiece, 1.25"	1
L – 1.25" Visual back (eyepiece adapter)	1
M – EZ Finder II reflex sight	1
N – Smartphone camera adapter	1
O – Accessory tray	1
P – DeepMap 600	1
Q – MoonMap 260	1

## III. Assembly

Assembling the telescope for the first time should take about 30 minutes. No tools are needed other than the ones provided. All screws should be tightened securely to eliminate flexing and wobbling, but be careful not to over-tighten or the threads may strip.

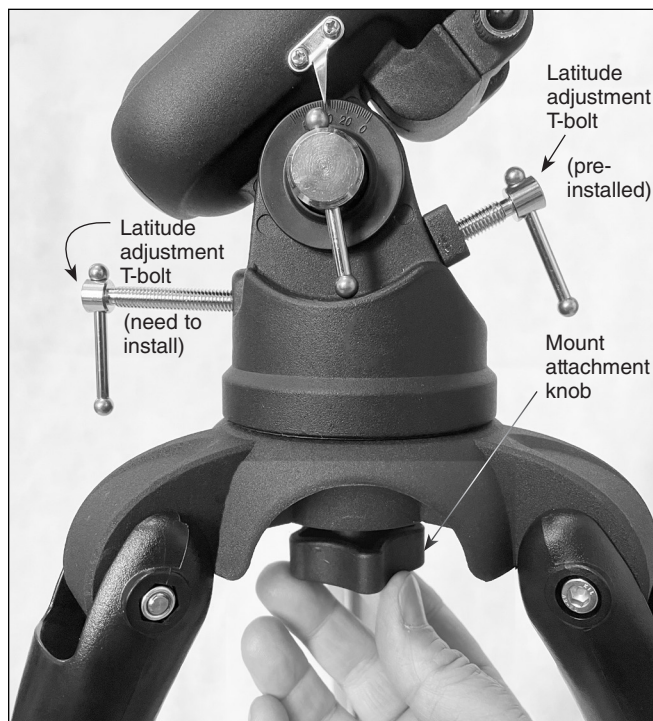
During assembly (and anytime, for that matter), DO NOT touch the surfaces of the telescope mirrors or the lenses of the finderscopes or eyepieces with your fingers. The optical surfaces have delicate coatings on them that can easily be damaged if touched inappropriately. NEVER remove any lens assembly from its housing for any reason, or the product warranty and return policy will be voided

**WARNING:** Do NOT look at the Sun without a professionally made solar filter on the telescope; serious eye damage may result if you look at the Sun with any unfiltered optical instrument. Do not leave the telescope unsupervised around children. Always cover the lenses when leaving the telescope in direct sunlight.

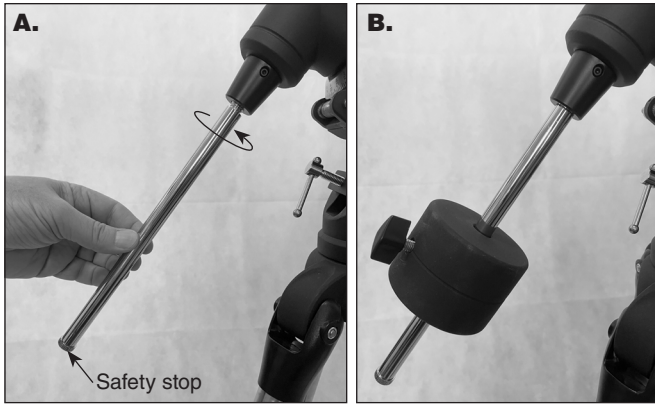


**Figure 2.** **A)** Place center of accessory tray over the center of the leg brace assembly. **B)** Press down and twist tray until the tabs click under retaining clips.

1. Spread the tripod legs apart and stand the tripod on the ground. You can extend the legs to the desired height later using the leg lock knobs. For now just keep them fully retracted
2. Attach the accessory tray by registering its center cutout over the center of the tripod leg brace assembly (**Figure 2A**). Press the tray down and twist it until the tray tabs click in place under the three retaining clips on the brace (**2B**).
3. Now you will attach the equatorial mount (**B**) to the tripod. Place the base of the mount onto the tripod's mounting platform, and then simply thread the captive mount attachment knob under the tripod clockwise up into the mount until it is tight (**Figure 3**)..
4. Next, thread the second latitude adjustment T-bolt (D) into the hole in the mount base. (One T-bolt comes pre-installed;



**Figure 3.** Secure the EQ mount to the tripod with the mount attachment knob.



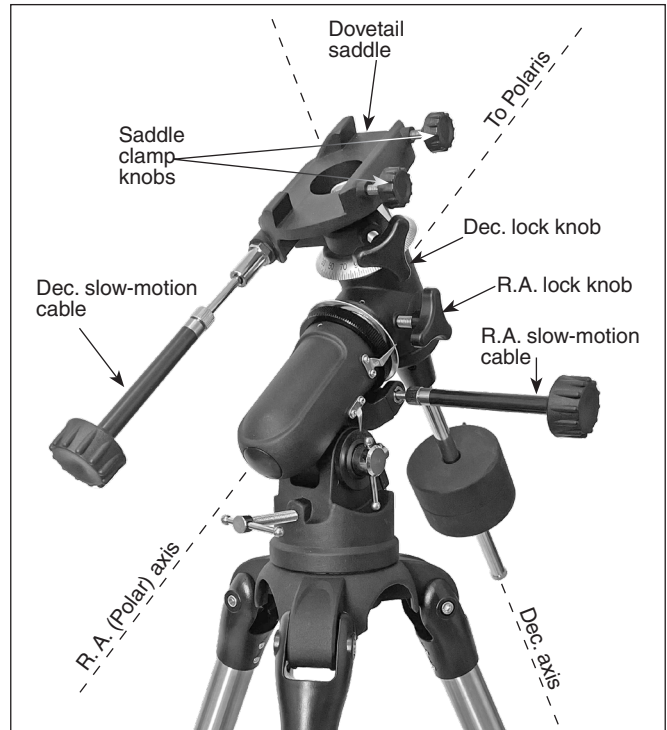
**Figure 4.** **A)** Thread the counterweight shaft onto the mount. **B)** After removing the safety stop, slide the counterweight onto the shaft.

the other one you must install yourself.) **Figure 3** shows the two installed latitude adjustment T-bolts.

5. Install the counterweight shaft by threading it into the counterweight shaft collar. (**Figure 4A**).
6. Now remove the safety stop at the end of the shaft and slide the counterweight onto the shaft (**Figure 4B**). You may have to loosen the counterweight lock knob to allow the weight to slide onto the shaft. Once the counterweight is on the shaft, replace the safety stop.
7. Attach the two slow-motion cables to the RA and Dec gear shafts by threading the collar on the gear shaft onto the cable until tight (**Figure 5**).



**Figure 5.** Attach the two slow-motion cables to the mount.



**Figure 6.** The assembled EQ-13 mount looks like this.

The EQ mount is now fully assembled. To install the optical tube on the mount, proceed through the following steps.

8. Ensure that the right ascension and declination lock knobs (**Figure 6**) are tightened so that the mount won't swivel accidentally when you're attaching the tube rings or the optical tube. And of course make sure the counterweight is installed on the counterweight shaft.
9. Back out the two saddle clamp knobs enough to allow the dovetail bar to seat properly. Then lift the optical tube and set the dovetail mounting bar into the mount's saddle.
10. When the dovetail bar is seated in the saddle, tighten the saddle clamp knobs until tight.
11. One of the two tube rings has a piggyback camera adapter on top (the knurled silver ring and thread); it can be used to mount a camera for "piggyback" astrophotography.

Final assembly includes attaching the eyepieces and finder-scope

12. The 1.25" visual back should be threaded onto the end of the focuser drawtube (**Figure 7**).
13. Eyepieces can then slip into this visual back and are secured by gently tightening down the eyepiece setscrew on the side of the visual back. See the section at the end of this manual for eyepiece selection.
14. Attach the finderscope to the dovetail beside the focuser (**Figure 8**).



**Figure 7.** The Visual Back (eyepiece adapter) threads onto the focuser drawtube.

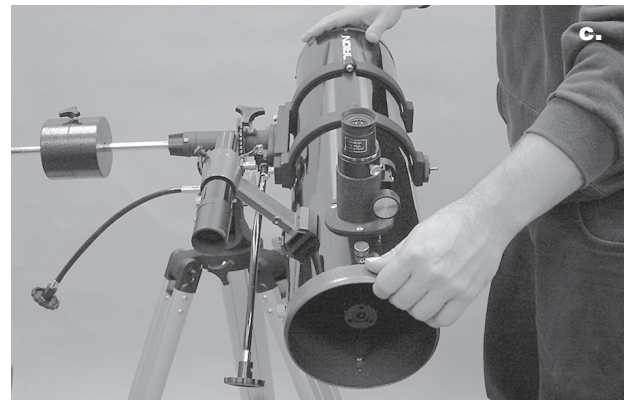
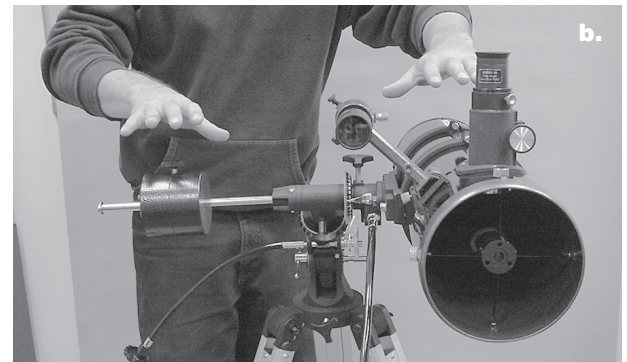
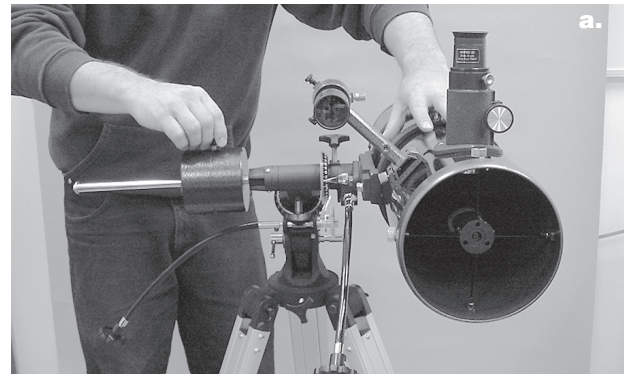
## IV. Balancing the Telescope

To ensure smooth movement of the telescope on both axes of the equatorial mount, it is imperative that the optical tube be properly balanced. First we'll balance the telescope with respect to the R.A. axis, then the Dec. axis.

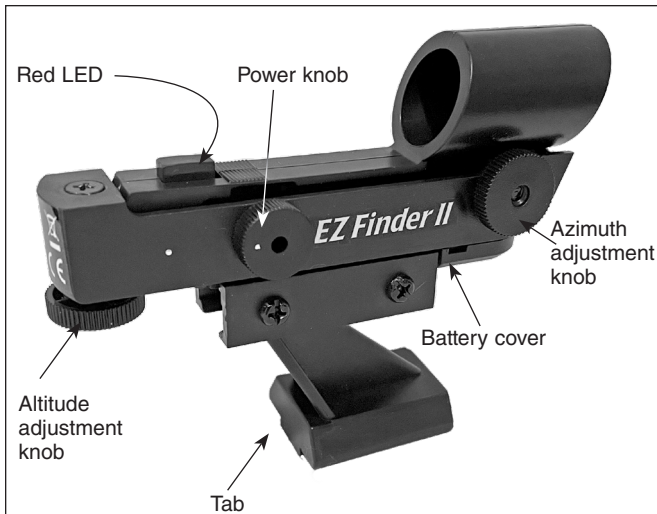
1. Keeping one hand on the telescope optical tube, loosen the R.A. lock knob (see **Figure 9**). Make sure the Dec. lock knob is locked, for now. The telescope should now be able to rotate freely about the R.A. axis. Rotate it until the counterweight shaft is parallel to the ground (i.e., horizontal), as in **Figure 9A**.
2. Now loosen the counterweight lock knob and slide the weight along the shaft (**Figure 9A**) until it exactly counterbalances the telescope. That's the point at which the shaft remains horizontal even when you let go of the telescope with both hands (**Figure 9B**).
3. Retighten the counterweight lock knob. The telescope is now balanced on the R.A. axis.



**Figure 8.** Slide the EZ Finder II into the telescope's finder scope base as shown.



**Figure 9.** Proper operation of the equatorial mount requires that the telescope tube be balanced on both the R.A. and Dec. axes. (a) With the R.A. lock knob released, slide the counterweight along the counterweight shaft until it just counterbalances the tube. (b) When you let go with both hands, the tube should not drift up or down. (c) With the Dec. lock knob released, loosen the tube ring lock clamps a few turns and slide the telescope forward or back in the tube rings. (d) When the tube is balanced about the Dec. axis, it will not move when you let go.



**Figure 10.** Features of the EZ Finder II.

4. To balance the telescope on the Dec. axis, first tighten the R.A. lock knob, with the counterweight shaft still in the horizontal position.
5. With one hand on the telescope optical tube, loosen the Dec. lock knob (see **Figure 6**). The telescope should now be able to rotate freely about the Dec. axis. If the front of the telescope swings downward on its own (**Figure 9C**), that means you need to move it back in the mount's saddle. If the front of the telescope swings upward, then you need to shift the telescope forward in the saddle. To move the telescope in the saddle, while holding the optical tube securely in one hand, loosen the saddle lock knobs just a little – so the dovetail bar doesn't accidentally pop out of the saddle. Position the telescope so it remains horizontal when you carefully let go with both hands (**Figure 9D**). This is the balance point. The tube can also be moving forward and backward in the rings themselves instead of sliding the dovetail bar forward and back.
6. Retighten the saddle clamp knobs, and/or tube rings if necessary.

The telescope is now balanced in both axes. Now when you loosen the lock knob on one or both axes and manually point the telescope, it should move without resistance and should not drift from where you point it.



**Figure 12.** Adjusting tripod legs

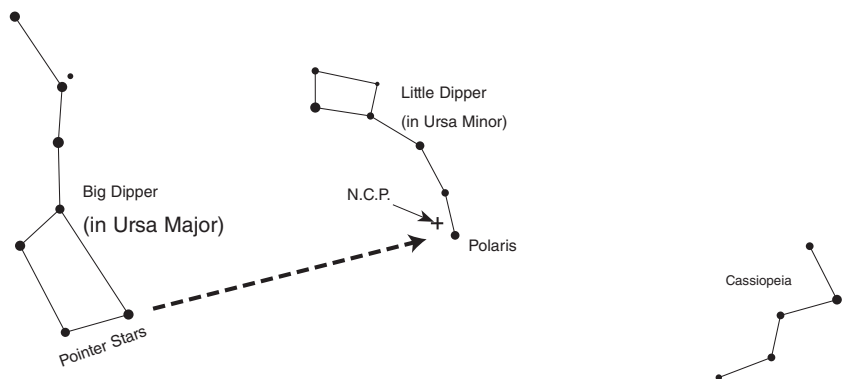
## V. Using the EZ Finder II finder scope

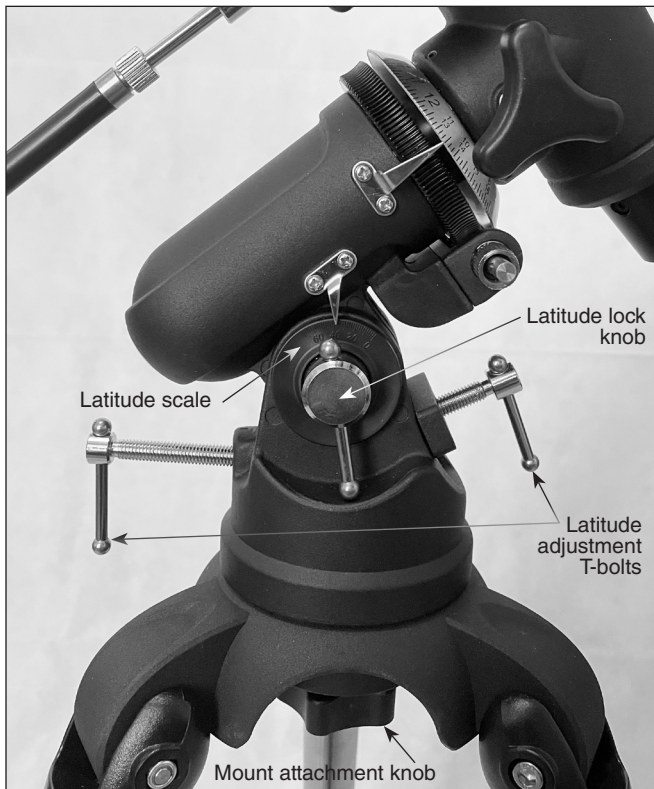
### Operation

The EZ Finder II works by projecting a tiny red dot (it's not a laser beam) onto a lens mounted in the front of the unit. When you look through the EZ Finder II, the red dot will appear to float in space, helping you locate even the faintest of deep space objects. The red dot is produced by a light-emitting diode (LED) near the rear of the sight. A 3-volt lithium battery provides the power for the diode.

Turn the power knob (see **Figure 10**) clockwise until you hear the "click" indicating that power has been turned on. Look through the back of the reflex sight with both eyes open to see the red dot. Position your eye at a comfortable distance from

**Figure 11.** To find Polaris in the night sky, look north and find the Big-Dipper. Extend an imaginary line from the two "Pointer Stars" in the bowl of the Big Dipper. Go about five times the distance between those stars and you'll reach Polaris, which lies within 1° of the north celestial pole (NCP).





**Figure 13.** Loosen the latitude lock knob, then use the two latitude adjustment T-bolts to set the latitude scale pointer to your location's latitude.

the back of the sight. In daylight you may need to cover the front of the sight with your hand to be able to see the dot, which is purposefully quite dim. The intensity of the dot is adjusted by turning the power knob. For best results when stargazing, use the dimmest possible setting that allows you to see the dot without difficulty. Typically a dimmer setting is used under dark skies and a bright setting is used under light-polluted skies or daylight.

At the end of your observing session, be sure to turn the power knob counterclockwise until it clicks off. When the two white dots on the EZ Finder II's rail and power knob are lined up, the EZ Finder II is turned off.

### Aligning the EZ Finder II

When the EZ Finder II is properly aligned with the telescope, an object that is centered on the EZ Finder II's red dot should also appear in the center of the field of view of the telescope's eyepiece. Alignment of the EZ Finder II is easiest during daylight, before observing at night. Aim the telescope at a distant object such as a telephone pole or roof chimney and center it in the telescope's eyepiece. The object should be at least 1/2 mile away. Now, with the EZ Finder turned on, look through the EZ Finder II. The object will appear in the field of view near the red dot.

Without moving the main telescope, use the EZ Finder II's azimuth (left/right) and altitude (up/down) adjustment knobs (see **Figure 10**) to position the red dot on the object in the eyepiece.

When the red dot is centered on the distant object, check to make sure that the object is still centered in the telescope's

field of view. If not, recenter it and adjust the EZ Finder II's alignment again. When the object is centered in the eyepiece and on the EZ Finder's red dot, the EZ Finder II is properly aligned with the telescope.

### Replacing the Battery

Should the battery ever die, replacement 3-volt lithium batteries are available from many retail outlets. Remove the old battery by inserting a small flat-head screwdriver into the slot on the battery casing (**Figure 10**) and gently prying open the case. Then carefully pull back on the retaining clip and remove the old battery. Do not overbend the retaining clip. Then slide the new battery under the battery lead with the positive (+) end facing the retaining clip (outward) and replace the battery casing.

Once aligned, EZ Finder II will usually hold its alignment even after being removed and remounted. Otherwise, only minimal realignment will be needed.

## VI. Polar Alignment

When you look at the night sky, you no doubt have noticed the stars appear to move slowly from east to west over time. That apparent motion is caused by the Earth's rotation (from west to east). An equatorial mount is designed to compensate for that motion, allowing you to easily "track" the movement of astronomical objects, thereby keeping them from drifting out of the telescope's field of view while you're observing.

This is accomplished by slowly rotating the telescope on its right ascension (R.A.) axis, using only the R.A. slow-motion cable. But first the R.A. axis of the mount must be aligned with the Earth's rotational (polar) axis—a process called polar alignment.

For Northern Hemisphere observers, approximate polar alignment is achieved by pointing the mount's right ascension axis at the North Star, also known as Polaris (see **Figure 11**). It lies within 1° of the north celestial pole (NCP), which is an extension of the Earth's rotational axis out into space. Stars in the Northern Hemisphere appear to revolve around the NCP.

To find Polaris in the sky, look north and locate the pattern of the Big Dipper (**Figure 11**). The two stars at the end of the "bowl" of the Big Dipper point approximately to Polaris.

Observers in the Southern Hemisphere aren't so fortunate to have a bright star so near the south celestial pole (SCP). The star Sigma Octantis lies about 1° from the SCP, but it is barely visible with the naked eye (magnitude 5.5).

### To polar align the equatorial mount:

1. Roughly level the mount by adjusting the length of the three tripod legs as needed (**Figure 12**).
2. Loosen the latitude lock knob a half turn or so (**Figure 13**).
3. Using the two latitude adjustment T-bolts, set the latitude so that the pointer on the latitude scale indicates the latitude of your observing location. (Loosen one latitude adjustment T-bolt before tightening the other.) If you don't know your location's latitude, you can look it up on the internet. For example, if your latitude is 35° North, set the pointer to 35. Then retighten the latitude lock knob. The latitude setting



**Figure 14.** The R.A. and Dec. setting circles allow you to locate an object by its R.A. and Dec. coordinates.

should not have to be adjusted again unless you move to a different viewing location some distance away.

4. Next, loosen the mount attachment knob (see **Figure 6**) just enough to allow you to rotate the mount in azimuth. Then rotate the mount by hand so the R.A. axis points roughly at Polaris (**Figure 6**). If you cannot see Polaris directly from your observing site, consult a compass and rotate the mount so the telescope points North. Then retighten the mount attachment knob.

The equatorial mount is now (roughly) polar aligned. From this point on in your observing session, you should not make any further adjustments to the azimuth or the latitude of the mount, nor should you move the tripod. Doing so will ruin the polar alignment. The telescope should henceforth be moved only about its R.A. and Dec. axes.

## VII. Using the R.A. and Dec. Slow-Motion Control Cables

The R.A. and Dec. slow-motion control cables (see **Figure 6**) allow fine adjustment of the mount's position to center objects within the telescope's field of view. Before using the cables, manually "slew" the mount to point the telescope in the vicinity of the desired target. Do this by loosening the R.A. and Dec. lock knobs and moving the telescope about the mount's R.A. and Dec. axes. Once the telescope is pointed somewhere close to the object to be viewed, retighten the mount's R.A. and Dec. lock knobs.

The object should now be visible somewhere in the field of view of the EZ Finder II. If it isn't, use the slow-motion controls to scan the surrounding area of sky. Note: when using the slow motion cables, the R.A. and Dec lock knobs should be tightened, not loose. When the object is visible in the finder scope, use the slow-motion controls to center it. Now, look in the telescope's eyepiece (start with the low power 25mm eyepiece) and use the slow-motion controls to center it in the eyepiece.

The R.A. slow motion cable can turn the mount's R.A. axis a full 360 degrees. However, the Dec. slow-motion cable has a limited range of about 25 degrees. If you reach the end of the range of motion – and you cannot turn the knob further – you should reverse direction by 10 degrees or so, then release the Dec. lock knob and move the telescope by hand back to about where it was pointed before the slow-motion cable stopped turning. Now you should be able to use the slow motion cable again for fine pointing in either direction.

## VIII. Tracking Celestial Objects

When you observe a celestial object through the telescope, you'll see it drift slowly across the field of view. To keep it in the field, assuming the equatorial mount is polar aligned, just turn the R.A. slow-motion control cable counterclockwise to track. The Dec. slow-motion control cable is not needed for tracking. Objects will appear to move faster at higher magnifications, because the field of view is narrower.

### Optional Electronic Drive for Automatic Tracking

An optional DC electronic drive is available for the SpaceProbe 130mm reflector. This battery-operated drive provides automated, hands-free tracking. Objects will then remain stationary in the field of view without any manual adjustment of the R.A. slow-motion control cable.

### Understanding the Setting Circles

The two setting circles on an equatorial mount enable you to locate celestial objects by their "celestial coordinates." Every object resides in a specific location on the "celestial sphere." That location is denoted by two numbers: its right ascension (R.A.) and declination (Dec.). In the same way, every location on Earth can be described by its longitude and latitude. R.A. is similar to longitude on Earth, and Dec. is similar to latitude. The R.A. and Dec. values for celestial objects can be found in any star atlas or online planetarium app.

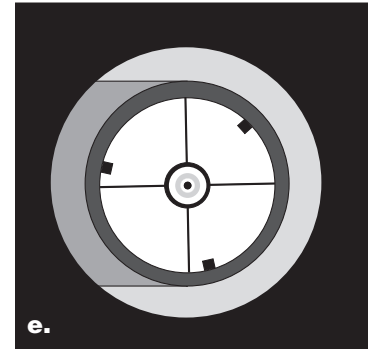
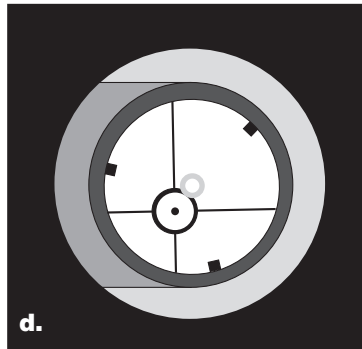
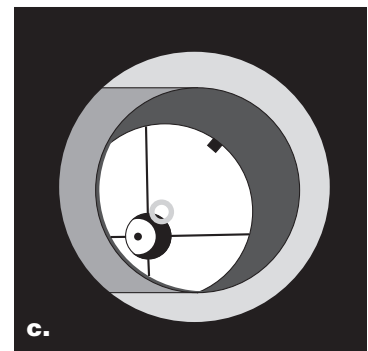
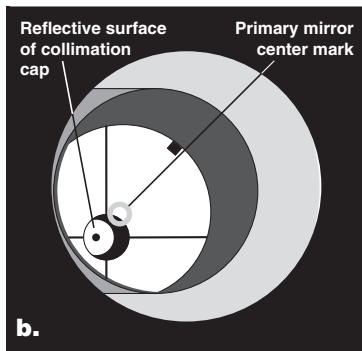
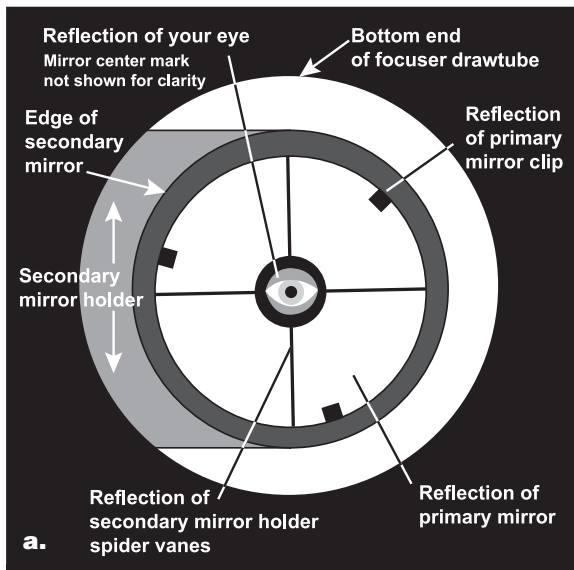
On the SpaceProbe 130mm, the R.A. setting circle is scaled in hours, from 1 through 24, with small marks in between representing 10-minute increments (**Figure 14**). The numbers at the base of the setting circle scale apply to the Northern Hemisphere while the numbers above them apply to viewing in the Southern Hemisphere.

The Dec. setting circle is denoted in degrees, with each main mark representing 10° increments (**Figure 14**). Values of Dec. coordinates range from +90° to -90°. The 0° mark indicates the celestial equator. For this mount, the number scale goes to 90 on either side of 0 – there are no (+) or (-) signs. When the telescope is pointed north of the equator, actual values of Dec. are negative.

For example, the coordinates for the Orion Nebula (M42) are:

R.A. 5 hr 35.4 min, Dec. -5° 27'

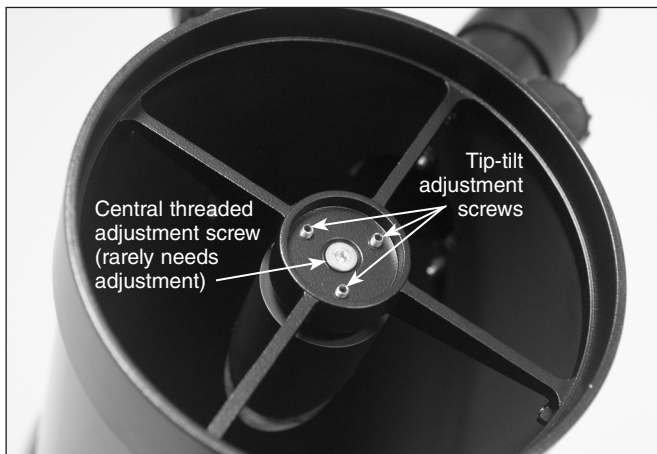




**Figure 15.** Collimating the optics. **(a)** When the mirrors are properly aligned, the view down the focuser drawtube should look like this **(b)** With the collimation cap in place, if the optics are out of alignment, the view might look something like this. **(c)** Here, the secondary mirror is centered under the focuser, but it needs to be adjusted (tilted) so that the entire primary mirror is visible. **(d)** The secondary mirror is correctly aligned, but the primary mirror still needs adjustment. When the primary mirror is correctly aligned, the “dot” will be centered, as in **(e)**.

That’s 5 hours and 35.4 minutes in right ascension, and -5 degrees and 27 arc-minutes in declination (there are 60 arc-minutes in 1 degree of declination).

Before you can use the setting circles to locate objects, the mount must be polar aligned, and the setting circles must be calibrated. The easiest way to calibrate the setting circles is to point the telescope at an identifiable bright star, center it in the eyepiece, then set the setting circles to the star’s published coordinates, which you can find in a star atlas or astronomical software program, or perhaps on the internet.



**Figure 16.** Secondary mirror collimation screws.

### Calibrating the Setting Circles

Using a star atlas or astronomy planetarium program, identify a bright star visible in your sky. Some smartphone astronomy apps allow you to hold your phone up to the sky and the app will identify the stars and constellations visible in the direction you’re pointing to. Note the right ascension and declination coordinates of the star.

Let’s take as an example Altair, in the constellation Aquila. Its coordinates are:

R.A. 19 hr 51 min, Dec 8° 52'

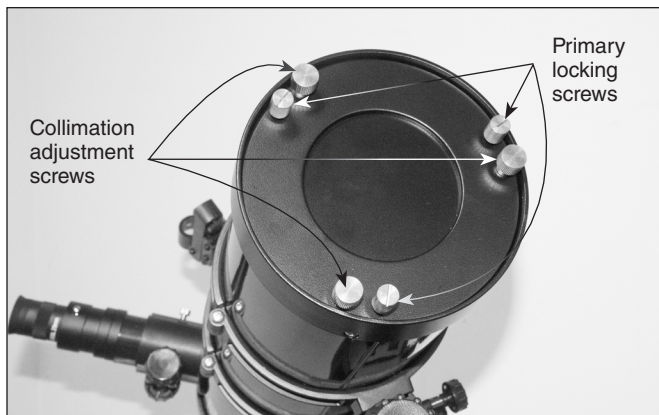
1. Loosen the R.A. and Dec. lock knobs on the equatorial mount, so the telescope optical tube can move freely.
2. Point the telescope at Altair. Lock the R.A. and Dec. lock knobs. Center the star in the eyepiece with the slow-motion control cables.
3. Rotate the R.A. setting circle until the metal arrow indicates 19 hr 51 min.
4. Then rotate the Dec. setting circle until the metal arrow indicates +8° 52'

Note that the setting circles may be a little hard to rotate. But just grab it firmly around the edge and twist it and it will rotate.

### Finding Objects with the Setting Circles

Now that both setting circles are calibrated, look up the coordinates of an object you wish to view.

1. Loosen the R.A. lock knob and rotate the telescope until the R.A. value from the star atlas matches the reading on the R.A. setting circle. Remember to use the lower set of



**Figure 17.** Primary mirror collimation screws.

numbers on the R.A. setting circle if you're in the Northern hemisphere. Retighten the lock knob.

- Loosen the Dec. lock knob and rotate the telescope until the Dec. value from the star atlas matches the reading on the Dec. setting circle. Remember that values of the Dec. setting circle are positive when the telescope is pointing north of the celestial equator (Dec. = 0°), and negative when the telescope is pointing south of the celestial equator. Retighten the lock knob.

Most setting circles are not accurate enough to put an object dead-center in the telescope's eyepiece, but they should place the object somewhere within or near the field of view of the finder scope, assuming the equatorial mount is accurately polar aligned. Use the slow-motion controls to center the object in the finder scope, and it should appear in the telescope's field of view.

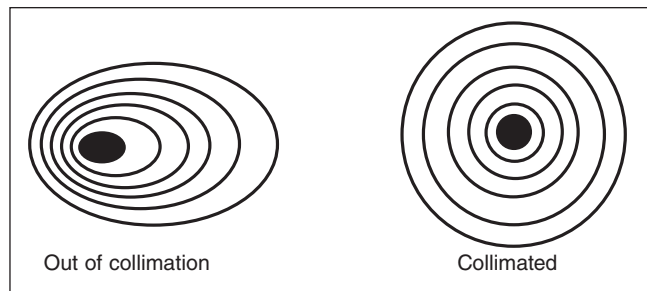
The R.A. setting circle must be re-calibrated every time you wish to locate a new object. Do so by calibrating the setting circle for the centered object before moving on to the next one.

### Confused About Pointing the Telescope?

Beginners occasionally experience some confusion about how to point the telescope overhead or in other directions. One thing you DO NOT do is make any adjustment to the mount's latitude setting or to its azimuth position. That will throw off the mount's polar alignment. Once the mount is polar aligned, the telescope should be moved only about the R.A. and Dec. axes. This is done by loosening one or both of the R.A. and Dec. lock knobs and moving the telescope by hand, or keeping the knobs tightened and moving the telescope using the slow-motion cables.

## IX. Collimating the Optics (Aligning the Mirrors)

Collimating is the process of adjusting the mirrors so they are aligned with one another. Your telescope's optics were aligned at the factory, and should not need much adjustment unless the telescope is handled roughly. Accurate mirror alignment is important to ensure the peak performance of your telescope, so it should be checked regularly. Collimating is relatively easy to do and can be done in daylight.



**Figure 18.** A star test will determine if a telescope's optics are properly collimated. An unfocused view of a bright star through the eyepiece should appear as illustrated on right if optics are perfectly collimated. If circle is unsymmetrical, as in illustration on left, scope needs collimation.

To check collimation, remove the eyepiece and look down the focuser drawtube. You should see the secondary mirror centered in the drawtube, as well as the reflection of the primary mirror centered in the secondary mirror, and the reflection of the secondary mirror (and your eye) centered in the reflection of the primary mirror, as in **Figure 15a**. If anything is off-center, proceed with the following collimating procedure.

### The Collimation Cap and Mirror Center Mark

Your SpaceProbe 130ST EQ comes with a collimation cap. This is a simple cap that fits on the focuser drawtube like a dust cap, but has a hole in the center and a silver bottom. This helps center your eye so that collimating is easy to perform.

**Figures 15b** through **15e** assume you have the collimation cap in place. In addition to providing the collimation cap, you'll notice a tiny ring (sticker) in the exact center of the primary mirror. This "center mark" allows you to achieve a very precise collimation of the primary mirror; you don't have to guess where the center of the mirror is. You simply adjust the mirror position (described below) until the reflection of the hole in the collimation cap is centered inside the ring. NOTE: The center ring sticker need not ever be removed from the primary mirror. Because it lies directly in the shadow of the secondary mirror, its presence in no way adversely affects the optical performance of the telescope or the image quality. That might seem counterintuitive, but it's true!

### Aligning the Secondary Mirror

With the collimation cap in place, look through the hole in the cap at the secondary (diagonal) mirror. Ignore the reflections for the time being. The secondary mirror itself should be centered in the focuser drawtube, in the direction parallel to the length of the telescope. If it isn't, as in **Figure 15b**, it must be adjusted. Typically, this adjustment will rarely, if ever, need to be done. It helps to adjust the secondary mirror in a brightly lit room with the telescope pointed toward a bright surface, such as white paper or wall. Placing a piece of white paper in the telescope tube opposite the focuser (i.e., on the other side of the secondary mirror) will also be helpful in collimating the secondary mirror. Using an Allen wrench, loosen the three small alignment setscrews in the center hub of the 3-vaned spider several turns. Now hold the mirror holder stationary (be careful not to touch the surface of the mirrors), while turning the center larger Allen setscrew (**Figure 16**). Turning the screw clockwise

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will move the secondary mirror toward the front opening of the optical tube, while turning the screw counter-clockwise will move the secondary mirror toward the primary mirror.

When the secondary mirror is centered in the focuser draw-tube, rotate the secondary mirror holder until the reflection of the primary mirror is as centered in the secondary mirror as possible. It may not be perfectly centered, but that is OK. Now tighten the three small alignment set screws equally to secure the secondary mirror in that position.

If the entire primary mirror reflection is not visible in the secondary mirror, as in **Figure 15c**, you will need to adjust the tilt of the secondary mirror. This is done by alternately loosening one of the three alignment setscrews while tightening the other two an equal amount. The goal is to center the primary mirror reflection in the secondary mirror, as in **Figure 15d**. Don't worry that the reflection of the secondary mirror (the smallest circle, with the collimation cap "dot" in the center) is off-center. You will fix that in the next step. Be sure that the final adjustment of the secondary tilt adjustment screws is to TIGHTEN the screw. You cannot leave any of the screw loose, otherwise the secondary mirror will not be secure and will wobble out of alignment.

### **Aligning the Primary Mirror**

The final adjustment is made to the primary mirror. It will need adjustment if, as in **Figure 15d**, the secondary mirror is centered under the focuser and the reflection of the primary mirror is centered in the secondary mirror, but the small reflection of the secondary mirror (with the "dot" of the collimation cap) is off-center.

The tilt of the mirror is adjusted with three pairs of collimation screws (**Figure 17**). The collimation screws can be turned by hand without the need of a tool.

Each pair of collimation screws work together to adjust the tilt of the primary mirror. The knob with the flat head screwdriver slot cut into it is the locking screw, and the larger thumb knob is the actual adjustment screw. First, back off all three locking screws a turn or two (do not completely remove these screws). Then try tightening or loosening one of the adjustment screws one half to one turn. Look into the focuser and see if the secondary mirror reflection has moved closer to the center of the primary. You can tell this easily with the collimation cap and mirror center mark by simply watching to see if the "dot" of the collimation cap is moving closer or farther away from the ring on the center of the primary mirror. Repeat this process on the other two collimation adjustment screws, if necessary. It will take a little trial and error to get a feel for how to adjust the mirror to center the "dot" of the collimation cap in the ring of the mirror mark.

When you have the dot centered as much as possible in the ring, your primary mirror is collimated. The view through the collimation cap should resemble **Figure 15e**. Make sure to then re-tighten all the primary collimation locking screws (but do not overtighten), to secure the mirror tilt.

A simple star test will tell you whether the optics are accurately collimated.

### **Star-Testing the Telescope**

When it is dark, point the telescope at a bright star and accurately center it in the eyepiece's field of view. Slowly de-focus the image with the focusing knob. If the telescope is correctly collimated, the expanding disk should be a perfect circle (**Figure 18**). If the image is unsymmetrical, the scope is out of collimation. The dark shadow cast by the secondary mirror should appear in the very center of the out-of-focus circle, like the hole in a donut. If the "hole" appears off-center, the telescope is out of collimation.

If you try the star test and the bright star you have selected is not accurately centered in the eyepiece, the optics will always appear out of collimation, even though they may be perfectly aligned. It is critical to keep the star centered, so over time you will need to make slight corrections to the telescope's position in order to account for the sky's apparent motion.

## **X. Using Your Telescope— Astronomical Observing**

### **Choosing an Observing Site**

When selecting a location for observing, get as far away as possible from direct artificial light such as street lights, porch lights, and automobile headlights. The glare from these lights will greatly impair your dark-adapted night vision. Set up on a grass or dirt surface, not asphalt, because asphalt radiates more heat. Heat disturbs the surrounding air and degrades the images seen through the telescope. Avoid viewing over rooftops and chimneys, as they often have warm air currents rising from them. Similarly, avoid observing from indoors through an open (or closed) window, because the temperature difference between the indoor and outdoor air will cause image blurring and distortion.

If at all possible, escape the light-polluted city sky and head for darker country skies. You'll be amazed at how many more stars and deep-sky objects are visible in a dark sky!

### **"Seeing" and Transparency**

Atmospheric conditions vary significantly from night to night. "Seeing" refers to the steadiness of the Earth's atmosphere at a given time. In conditions of poor seeing, atmospheric turbulence causes objects viewed through the telescope to "boil". If, when you look up at the sky with just your eyes, the stars are twinkling noticeably, the seeing is bad and you will be limited to viewing with low powers (bad seeing affects images at high powers more severely). Planetary observing may also be poor.

In conditions of good seeing, star twinkling is minimal and images appear steady in the eyepiece. Seeing is best overhead, worst at the horizon. Also, seeing generally gets better after midnight, when much of the heat absorbed by the Earth during the day has radiated off into space.

Especially important for observing faint objects is good "transparency"—air free of moisture, smoke, and dust. All tend to scatter light, which reduces an object's brightness. Transparency is judged by the magnitude of the faintest stars you can see with the unaided eye (6th magnitude or fainter is desirable).

## Cooling the Telescope

All optical instruments need time to reach “thermal equilibrium.” The bigger the instrument and the larger the temperature change, the more time is needed. Allow at least 30 minutes for your telescope to cool to the temperature outdoors. In very cold climates (below freezing), it is essential to store the telescope as cold as possible. If it has to adjust to more than a 40° temperature change, allow at least one hour.

## Let Your Eyes Dark-Adapt

Don't expect to go from a lighted house into the darkness of the outdoors at night and immediately see faint nebulas, galaxies, and star clusters—or even very many stars, for that matter. Your eyes take about 30 minutes to reach perhaps 80% of their full dark-adapted sensitivity. As your eyes become dark-adapted, more stars will glimmer into view and you'll be able to see fainter details in objects you view in your telescope.

To see what you're doing in the darkness, use a red-filtered flashlight rather than a white light. Red light does not spoil your eyes' dark adaptation like white light does. A flashlight with a red LED light is ideal, or you can cover the front of a regular incandescent flashlight with red cellophane or paper. Beware, too, that nearby porch and streetlights and car headlights will ruin your night vision.

## Eyepiece Selection

By using eyepieces of varying focal lengths, it is possible to attain many magnifications with the SpaceProbe 130ST EQ. The telescope comes with two high-quality Plössl eyepieces: a 25mm, which gives a magnification of 26x, and a 10mm, which gives a magnification of 65x. Other eyepieces can be used to achieve higher or lower powers. It is quite common for an observer to own five or more eyepieces to access a wide range of magnifications. This allows the observer to choose the best eyepiece to use depending on the object being viewed.

To calculate the magnification, or power, of a telescope and eyepiece combination, simply divide the focal length of the telescope by the focal length of the eyepiece:

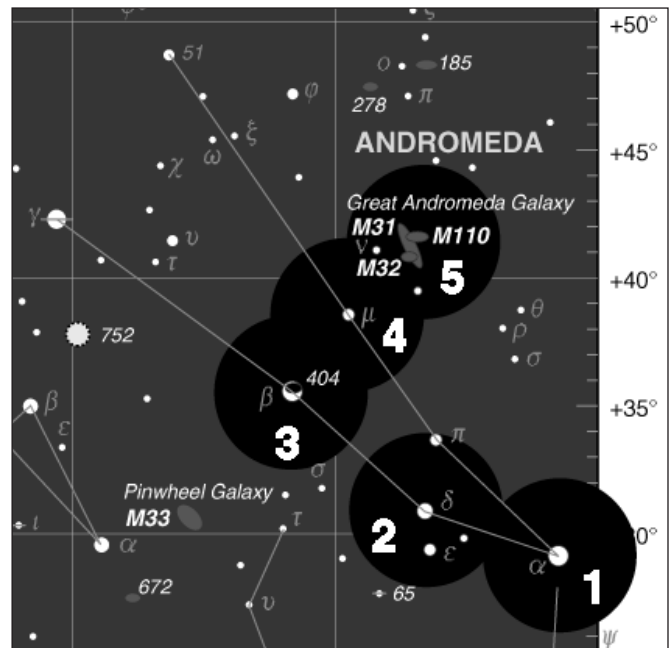
$$\text{Magnification} = \frac{\text{focal length of telescope}}{\text{focal length of eyepiece}}$$

For example, the SpaceProbe 130ST EQ, which has a focal length of 650mm, used in combination with the 25mm eyepiece, yields a magnification of

$$\frac{650\text{mm}}{25\text{mm}} = 26\text{x}$$

Every telescope has a useful limit of magnification of about 2x per millimeter of aperture. Which comes to about 260x for the SpaceProbe 130ST. Claims of higher power by some telescope manufacturers are a misleading advertising gimmick and should be dismissed. Keep in mind that at higher powers, an image will always be dimmer and less sharp (this is a fundamental law of optics). The steadiness of the air (the “seeing”) can also limit how much magnification an image can tolerate.

Whatever you choose to view, always start by inserting your lowest-power (longest focal length) eyepiece to locate and center the object. Low magnification yields a wide field of view, which shows a larger area of sky in the eyepiece. This makes acquiring and centering an object much easier. If you try to



**Figure 19.** Star hopping is a good way to locate hard-to-find objects. Refer to a star chart to map a route to the object that uses bright stars as guideposts. Center the first star you've chosen in the finder scope and telescope eyepiece (1). Now move the scope carefully in the direction of the next bright star (2), until it is centered. Repeat (3 and 4). The last hop (5) should place the desired object in the eyepiece.

find and center objects with high power (narrow field of view), it's like trying to find a needle in a haystack!

Once you've centered the object in the eyepiece, you can switch to higher magnification (shorter focal length eyepiece), if you wish. This is especially recommended for small and bright objects, like planets and double stars. The Moon also takes higher magnifications well.

Deep-sky objects, however, typically look better at medium or low magnifications. This is because many of them are quite faint, yet have some extent (apparent width). Deep-sky objects will often disappear at higher magnifications, since greater magnification inherently yields dimmer images. This is not the case for all deep-sky objects, however. Many galaxies are quite small, yet are somewhat bright, so higher power may show more detail.

The best rule of thumb with eyepiece selection is to start with a low power, wide field, and then work your way up in magnification. If the object looks better, try an even higher magnification. If the object looks worse, then back off the magnification a little by using a lower-power eyepiece.

## Objects to Observe

Now that you are all set up and ready to go, one critical decision must be made: what to look at?

### A. The Moon

With its rocky surface, the Moon is one of the easiest and most interesting targets to view with your telescope. Lunar craters, maria, and even mountain ranges can all be clearly seen from a distance of 238,000 miles away! With its ever-changing

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phases, you'll get a new view of the Moon every night. The best time to observe our one and only natural satellite is during a partial phase, that is, when the Moon is NOT full. During partial phases, shadows are cast on the surface, which reveal more detail, especially right along the border between the dark and light portions of the disk (called the "terminator"). A full Moon is too bright and devoid of surface shadows to yield a pleasing view. Make sure to observe the Moon when it is well above the horizon to get the sharpest images.

Use an optional Moon filter to dim the Moon when it is very bright. It simply threads onto the bottom of the eyepieces (you must first remove the eyepiece from the focuser to attach a filter). You'll find that the Moon filter improves viewing comfort, and also helps to bring out subtle features on the lunar surface.

### **B. The Sun**

You can change your nighttime telescope into a daytime Sun viewer by installing an optional full-aperture solar filter over the front opening of the SpaceProbe 130ST EQ. The primary attraction is sunspots, which change shape, appearance, and location daily. Sunspots are directly related to magnetic activity in the Sun. Many observers like to make drawings of sunspots to monitor how the Sun is changing from day to day.

**Important Note: Do not look at the Sun with any optical instrument without a professionally made solar filter, or permanent eye damage could result. Leave the covercaps on the finder scope, or, better yet, remove the finder scope from the telescope when solar viewing.**

### **C. The Planets**

The planets don't stay put like the stars, so to find them you should refer to Sky Calendar at our website, [www.telescope.com](http://www.telescope.com), or to charts published monthly in *Astronomy*, *Sky & Telescope*, or other astronomy magazines. Venus, Mars, Jupiter, and Saturn are the brightest objects in the sky after the Sun and the Moon. Your SpaceProbe 130ST EQ is capable of showing you these planets in some detail. Other planets may be visible but will likely appear star-like. Because planets are quite small in apparent size, optional higher-power eyepieces are recommended and often needed for detailed observations. Not all the planets are generally visible at any one time.

**JUPITER** The largest planet, Jupiter, is a great subject for observation. You can see the disk of the giant planet and watch the ever-changing positions of its four largest moons—Io, Callisto, Europa, and Ganymede. Higher-power eyepieces should bring out the cloud bands on the planet's disk.

**SATURN** The ringed planet is a breathtaking sight when it is well positioned. The tilt angle of the rings varies over a period of many years; sometimes they are seen edge-on, while at other times they are broadside and look like giant "ears" on each side of Saturn's disk. A steady atmosphere (good seeing) is necessary for a good view. You will probably see a bright "star" close by, which is Saturn's brightest moon, Titan.

**VENUS** At its brightest, Venus is the most luminous object in the sky, excluding the Sun and the Moon. It is so bright that sometimes it is visible to the naked eye during full daylight! Ironically, Venus appears as a thin crescent, not a full disk, when at its peak brightness. Because it is so close to the Sun, it never wanders too far from the morning or evening horizon.

No surface markings can be seen on Venus, which is always shrouded in dense clouds.

**MARS** The Red Planet makes its closest approach to Earth every two years. During close approaches you'll see a red disk, and may be able to see the polar ice cap. To see surface detail on Mars, you will need a high-power eyepiece and very steady air!

### **D. The Stars**

Stars will appear like twinkling points of light. Even powerful telescopes cannot magnify stars to appear as more than a point of light. You can, however, enjoy the different colors of the stars and locate many pretty double and multiple stars. The famous "Double-Double" in the constellation Lyra and the gorgeous two-color double star Albireo in Cygnus are favorites. Defocusing a star slightly can help bring out its color.

### **E. Deep-Sky Objects**

Under dark skies, you can observe a wealth of fascinating deep-sky objects, including gaseous nebulas, open and globular star clusters, and a variety of different types of galaxies. Most deep-sky objects are very faint, so it is important that you find an observing site well away from light pollution. Take plenty of time to let your eyes adjust to the darkness. Do not expect these subjects to appear like the photographs you see in books and magazines; most will look like dim gray smudges. Our eyes are not sensitive enough to see color in deep-sky objects except in a few of the brightest ones. But as you become more experienced and your observing skills get sharper, you will be able to ferret out more and more subtle details and structure.

### **How to Find Deep-Sky Objects: Star Hopping**

Star hopping, as it is called by astronomers, is perhaps the simplest way to hunt down deep-sky objects to view in the night sky. It entails first pointing the telescope at a bright star close to the object you wish to observe, and then progressing to other stars closer and closer to the object until it is in the field of view of the eyepiece. It is a very intuitive technique that has been employed for hundreds of years by professional and amateur astronomers alike. Keep in mind, as with any new task, that star hopping may seem challenging at first, but will become easier over time and with practice.

To star hop, only a minimal amount of additional equipment is necessary. A star chart or atlas that shows stars to at least magnitude 5 is required. Select one that shows the positions of many deep-sky objects, so you will have a lot of options to choose from. If you do not know the positions of the constellations in the night sky, you will need a planisphere to identify them.

Start by choosing bright objects to view. The brightness of an object is measured by its visual magnitude; the brighter an object, the lower its magnitude. Choose an object with a visual magnitude of 9 or lower. Many beginners start with the Messier objects, which represent some of the best and brightest deep-sky objects, first catalogued about 200 years ago by the French astronomer Charles Messier.

Determine in which constellation the object lies. Now, find the constellation in the sky. If you do not recognize the constella-

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tions on sight, consult a planisphere. The planisphere gives an all-sky view and shows which constellations are visible on a given night at a given time.

Now, look at your star chart and find the brightest star in the constellation that is near the object you are trying to find. Using the finder scope, point the telescope at this star and center it on the crosshairs. Next, look again at the star chart and find another suitably bright star near the bright star currently centered in the finder. Keep in mind that the field of view of the finder scope is about  $7^\circ$ , so you should choose another star that is no more than  $7^\circ$  from the first star, if possible. Move the telescope slightly, until the telescope is centered on the new star.

Continue using stars as guideposts in this way until you are at the approximate position of the object you are trying to find (**Figure 19**). Look in the telescope's eyepiece, and the object should be somewhere within the field of view. If it's not, sweep the telescope carefully around the immediate vicinity until the object is found.

If you have trouble finding the object, start the star hop again from the brightest star near the object you wish to view. This time, be sure the stars indicated on the star chart are in fact the stars you are centering in the eyepiece. Remember, the finder scope (and main telescope eyepiece, for that matter) gives an inverted image, so you must keep this in mind when star hopping from star to star.

## **XI. Care and Maintenance**

If you give your telescope reasonable care, it will last a lifetime. Store it in a clean, dry, dust-free place, safe from rapid changes in temperature and humidity. Do not store the telescope outdoors, although storage in a garage or shed is OK. Small components like eyepieces and other accessories should be kept in a protective box or storage case. Keep the caps on the front of the telescope and on the focuser drawtube when it is not in use.

Your SpaceProbe 130ST EQ telescope requires very little mechanical maintenance. The optical tube is steel and has a smooth painted finish that is fairly scratch-resistant. If a scratch does appear on the tube, it will not harm the telescope. If you wish, you may apply some auto touch-up paint to the scratch. Smudges on the tube can be wiped off with a soft cloth and a household cleaner.

### **Cleaning Lenses**

Any quality optical lens cleaning tissue and optical lens cleaning fluid specifically designed for multi-coated optics can be used to clean the exposed lenses of your eyepieces or finder scope. Never use regular glass cleaner or cleaning fluid designed for eyeglasses. Before cleaning with fluid and tissue, however, blow any loose particles off the lens with a blower bulb or compressed air. Then apply some cleaning fluid to a tissue, never directly on the optics. Wipe the lens gently in a

circular motion, then remove any excess fluid with a fresh lens tissue. Oily fingerprints and smudges may be removed using this method. Use caution; rubbing too hard may scratch the lens. On larger lenses, clean only a small area at a time, using a fresh lens tissue on each area. Never reuse tissues.

### **Cleaning Mirrors**

You should not have to clean your telescope's mirrors very often; normally once every year or so. Covering your telescope when it is not in use will prevent dust from accumulating on the mirrors. Improper cleaning can scratch mirror coatings, so the fewer times you have to clean the mirrors, the better. Small specks of dust or flecks of paint have virtually no effect on the visual performance of the telescope.

The large primary mirror and the elliptical secondary mirror of your telescope are front-surface aluminized and over-coated with hard silicon dioxide, which prevents the aluminum from oxidizing. These coatings normally last through many, many years of use before requiring re-coating (which is easily done).

To clean the secondary mirror, remove the mirror in its holder from the 4-vaned spider in the tube. Do this by grasping the secondary mirror holder with your fingertips while turning the central bolt on the spider's central hub counterclockwise. Handle the mirror holder only; do not touch the mirror surface. Then follow the same procedure described below for cleaning the primary mirror. The secondary mirror is glued into its holder, and should not be removed from the holder for cleaning.

To clean the primary mirror, carefully remove the mirror cell from the telescope. Do this by first removing the four screws that connect the mirror cell to the tube. These screws are located on the outside of the tube, just above the mirror cell casting. Next, remove the primary mirror from the mirror cell; you will need to remove the three mirror clips to do this. Completely unthread the two Phillips head screws on each clip, and carefully lift the mirror from its cell. Be careful not to touch the front surface of the mirror with your fingers. Set the mirror with the aluminized face up on a clean, soft towel. Fill a clean sink, free of abrasive cleanser, with room-temperature water, a few drops of liquid dishwashing detergent, and if possible, a cap-full of rubbing alcohol. Submerge the mirror (aluminized face up) in the water and let it soak for several minutes (or hours if it's a very dirty mirror). Wipe the mirror under water with clean cotton balls, using extremely light pressure and stroking in straight lines across the surface. Use one ball for each wipe across the mirror. Then rinse the mirror under a stream of lukewarm water. Any particles on the surface can be swabbed gently with a series of clean cotton balls, each used just one time. Dry the mirror in a stream of air (a "blower bulb" works great), or remove any stray drops of water with the corner of a paper towel. Water will run off a clean surface. Cover the mirror surface with tissue, and leave the entire assembly in a warm area until it is completely dry before reassembling the telescope.

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## **XII. Specifications**

Optical tube: Steel

Primary mirror diameter: 130mm

Primary mirror coating: Aluminum with silicon dioxide (SiO<sub>2</sub>) overcoat

Primary mirror figure: Parabolic

Secondary mirror minor axis: 37mm

Focal length: 650mm

Focal ratio: f/5

Focuser: Rack and pinion, accepts 1.25" eyepieces

Eyepieces: 25mm and 10mm Plössl, fully coated with multi-coatings, 1.25"

Magnification: 26x (with 25mm), 65x (with 10mm)

Finder scope: EZ Finder red dot finder scope

Mount: German-type equatorial

Tripod: Steel

Motor drives: Optional

Weight: 28.4lbs. (tube 6.9lbs., mount 21.5lbs.)

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## One-Year Limited Warranty

This Orion product is warranted against defects in materials or workmanship for a period of one year from the date of purchase. This warranty is for the benefit of the original retail purchaser only. During this warranty period Orion Telescopes & Binoculars will repair or replace, at Orion's option, any warranted instrument that proves to be defective, provided it is returned postage paid. Proof of purchase (such as a copy of the original receipt) is required. This warranty is only valid in the country of purchase.

This warranty does not apply if, in Orion's judgment, the instrument has been abused, mishandled, or modified, nor does it apply to normal wear and tear. This warranty gives you specific legal rights. It is not intended to remove or restrict your other legal rights under applicable local consumer law; your state or national statutory consumer rights governing the sale of consumer goods remain fully applicable.

For further warranty information, please visit [www.OrionTelescopes.com/warranty](http://www.OrionTelescopes.com/warranty).



**Corporate Offices:** 89 Hangar Way, Watsonville CA 95076 - USA  
**Toll Free USA & Canada:** (800) 447-1001  
**International:** +1(831) 763-7000  
**Customer Support:** [support@telescope.com](mailto:support@telescope.com)

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