

EXPLORE[®] SCIENTIFIC

134mm Equatorial Newtonian Instruction Manual



#ES-ON13449EQ3



WARNING:

SUN HAZARD – Never look directly at the sun with this device.
CHOKING HAZARD – Small parts. Not for children under 3 years.
The lens contains lead that may be harmful. Wash hands after touching.



CA WARNING:

This product can expose you to chemicals including lead, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

IMPORTANT SAFETY INSTRUCTIONS

READ AND FOLLOW THE INSTRUCTIONS BEFORE USE.
KEEP THESE INSTRUCTIONS FOR LATER USE.



• **SUN WARNING: WARNING – NEVER ATTEMPT TO OBSERVE THE SUN WITH THIS DEVICE! OBSERVING THE SUN – EVEN FOR A MOMENT – WILL CAUSE INSTANT AND IRREVERSIBLE DAMAGE TO YOUR EYE OR EVEN BLINDNESS.** EYE DAMAGE IS OFTEN PAINLESS, SO THERE IS NO WARNING TO THE OBSERVER THAT THE DAMAGE HAS OCCURRED UNTIL IT IS TOO LATE. DO NOT POINT THE DEVICE AT OR NEAR THE SUN. DO NOT LOOK THROUGH THE DEVICE AS IT IS MOVING. CHILDREN SHOULD ALWAYS HAVE ADULT SUPERVISION WHILE OBSERVING.

• **RESPECT PRIVACY:** WHEN USING THIS DEVICE, RESPECT THE PRIVACY OF OTHER PEOPLE. FOR EXAMPLE, DO NOT USE IT TO LOOK INTO PEOPLE'S HOMES.



• **CHOKING HAZARD:** CHILDREN SHOULD ONLY USE DEVICE UNDER ADULT SUPERVISION. KEEP PACKAGING MATERIALS LIKE PLASTIC BAGS AND RUBBER BANDS OUT OF THE REACH OF CHILDREN AS THESE MATERIALS POSE A CHOKING HAZARD.

• **RISK OF BLINDNESS:** NEVER USE THIS DEVICE TO LOOK DIRECTLY AT THE SUN OR IN THE DIRECT PROXIMITY OF THE SUN. DOING SO MAY RESULT IN A PERMANENT LOSS OF VISION.

• **RISK OF FIRE:** DO NOT PLACE DEVICE, PARTICULARLY THE LENSES, IN DIRECT SUNLIGHT. THE CONCENTRATION OF LIGHT RAYS COULD CAUSE A FIRE.

• **DO NOT DISASSEMBLE THIS DEVICE:** IN THE EVENT OF A DEFECT, PLEASE CONTACT YOUR DEALER. THE DEALER WILL CONTACT THE CUSTOMER SERVICE DEPARTMENT AND CAN SEND THE DEVICE IN TO BE REPAIRED IF NECESSARY.

• **DO NOT SUBJECT THE DEVICE TO TEMPERATURES EXCEEDING 60 °C (140 °F).**



• **DISPOSAL:** KEEP PACKAGING MATERIALS, LIKE PLASTIC BAGS AND RUBBER BANDS, AWAY FROM CHILDREN AS THEY POSE A RISK OF SUFFOCATION. DISPOSE OF PACKAGING MATERIALS AS LEGALLY REQUIRED. CONSULT THE LOCAL AUTHORITY ON THE MATTER IF NECESSARY AND RECYCLE MATERIALS WHEN POSSIBLE.



• THE WEEE SYMBOL IF PRESENT INDICATES THAT THIS ITEM CONTAINS ELECTRICAL OR ELECTRONIC COMPONENTS WHICH MUST BE COLLECTED AND DISPOSED OF SEPARATELY.

• NEVER DISPOSE OF ELECTRICAL OR ELECTRONIC WASTE IN GENERAL MUNICIPAL WASTE. COLLECT AND DISPOSE OF SUCH WASTE SEPARATELY.

• MAKE USE OF THE RETURN AND COLLECTION SYSTEMS AVAILABLE TO YOU, OR YOUR LOCAL RECYCLING PROGRAM. CONTACT YOUR LOCAL AUTHORITY OR PLACE OF PURCHASE TO FIND OUT WHAT SCHEMES ARE AVAILABLE.

• ELECTRICAL AND ELECTRONIC EQUIPMENT CONTAINS HAZARDOUS SUBSTANCES WHICH, WHEN DISPOSED OF INCORRECTLY, MAY LEAK INTO THE GROUND. THIS CAN CONTRIBUTE TO SOIL AND WATER POLLUTION WHICH IS HAZARDOUS TO HUMAN HEALTH, AND ENDANGER WILDLIFE.

• IT IS ESSENTIAL THAT CONSUMERS LOOK TO RE-USE OR RECYCLE ELECTRICAL OR ELECTRONIC WASTE TO AVOID IT GOING TO LANDFILL SITES OR INCINERATION WITHOUT TREATMENT.

Need Customer Support?

Our customer service experts will answer any question. Call us toll free **866.252.3811**.

Monday – Friday; 8am – 5pm Central Time

Or visit our online Customer Service Center at

www.explorescientific.supportsync.com

We know you'll enjoy your new Explore Scientific telescope for years to come.

Please familiarize yourself with the directions before starting assembly.

When you unpack the box, we suggest you keep the box and packing materials, so you can store it safely, or easily ship it.

If you are new to amateur astronomy, we suggest you learn the constellations that are in the night sky this time of year. The constellations are like states in a country, and the things you want to look at are like counties and cities. While pointing the telescope is not hard, pointing it at a specific celestial target is a skill you need to learn. That comes from patience and practice.

It's also important to remember, because of light pollution around cities, the farther away you are from the city lights the more things you will see.

Table of Contents

1. Unpacking	pg. 4
2. Assembly	pg. 6
3. Inserting an Eyepiece	pg. 10
4. Attach and Align the Finderscope	pg. 10
5. Focus the Telescope	pg. 12
6. How an Equatorial Mount Works/Polar Alignment	pg. 13
7. Balancing the Telescope	pg. 15
8. Pointing the Telescope	pg. 16
9. Slow-Motion Controls	pg. 17
10. Determining Magnification	pg. 18
11. Collimating the Optics	pg. 20
12. Care and Maintenance	pg. 25
13. Telescope Basics	pg. 26
14. Specifications	pg. 32



WARNING:

DO NOT USE THIS TELESCOPE OR ANY ACCOMPANYING FINDER SCOPE TO LOOK AT OR NEAR THE SUN UNLESS YOU ARE USING A SPECIAL SOLAR FILTER! EVEN MOMENTARY VISUAL CONTACT WITH THE SUN'S LIGHT RAYS CAN INSTANTLY CAUSE IRREVERSIBLE DAMAGE TO YOUR EYE(S). EYE DAMAGE CAN BE PAINLESS, SO THERE IS NO WARNING TO THE OBSERVER THAT DAMAGE HAS OCCURRED UNTIL IT IS TOO LATE. TAKE EXTRA CARE WHEN USING THE TELESCOPE OR A FINDER SCOPE DURING DAYLIGHT HOURS, AND DO NOT POINT EITHER AT OR NEAR THE SUN. DO NOT LOOK THROUGH EITHER WHEN YOU ARE MOVING THE INSTRUMENTS DURING THE DAYTIME. NEVER ALLOW ANYONE TO USE THE TELESCOPE OR A FINDER SCOPE DURING THE DAYTIME WITHOUT WARNING THEM OF THE HAZARDS OF AIMING EITHER AT OR NEAR THE SUN. MAKE SURE THAT THEY ARE ADEQUATELY TRAINED ON THE USE OF THESE INSTRUMENTS BEFORE ALLOWING THEM TO START OBSERVING. CHILDREN SHOULD ALWAYS HAVE INFORMED AND TRAINED ADULT SUPERVISION WHILE OBSERVING.

1. Unpacking

Carefully remove all items from the boxes and spread the parts out on a flat surface.

Verify that you have all the parts listed in Figure 1.1 and Figure 1.2. If something is missing, double-check the shipping boxes. If the item still cannot be found, contact Explore Scientific Customer Service at 866.252.3811. Leave a detailed message including your name, address, phone number, and email address.

Parts List:

- A – Optical Tube Assembly with Cradle Rings
- B – Dust Cover
- C – Tripod
- D – Equatorial Mount
- E – Accessory Tray
- F – Slow-Motion Controls
- G – Counterweight Shaft
- H – 25mm Plossl Eyepiece, 1.25-inch diameter
- I – 10mm Plossl Eyepiece, 1.25-inch diameter
- J – 6x30 Finderscope
- K – Counterweight

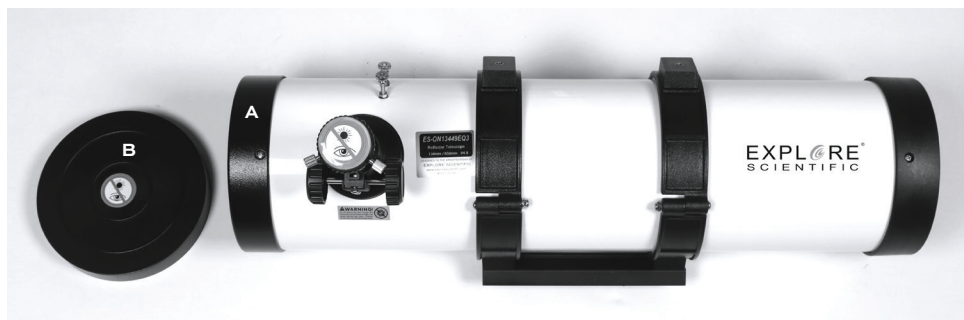


Figure 1.1

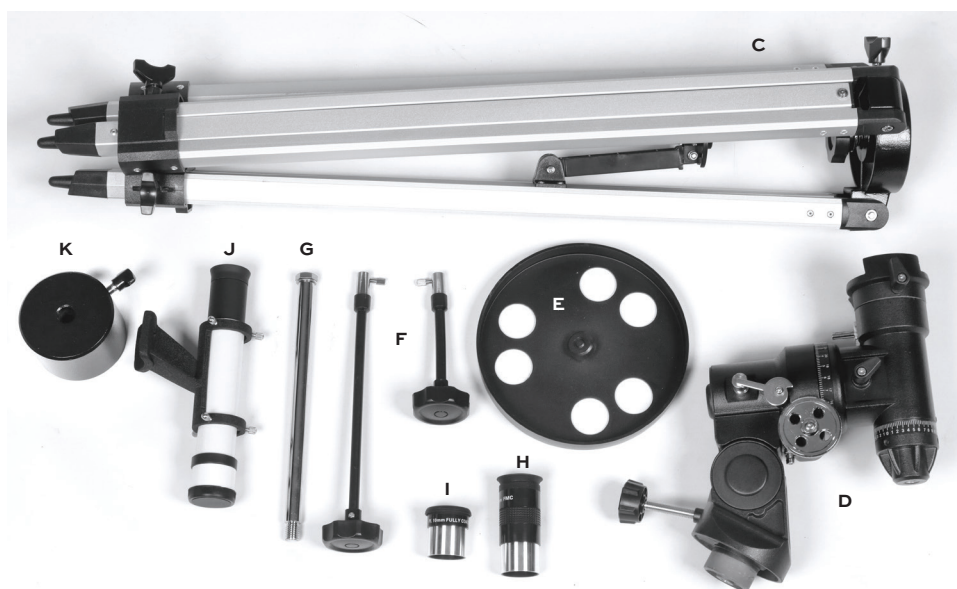


Figure 1.2

2. Assembly

1. Open the legs of the tripod and stand it on the three feet (Figure 2.1).
2. The legs can be extended to raise the height. Loosen a leg lock knob, extend the leg, then tighten the lock knob. Do this for each leg. You should extend them so that the top of the tripod remains level.
3. Locate the accessory tray lock knob in the center of the leg braces. Unscrew it. Place the tray (Item E) so the center hole fits over the center of the leg brace. Screw the tray lock knob back into place (Figure 2.2).

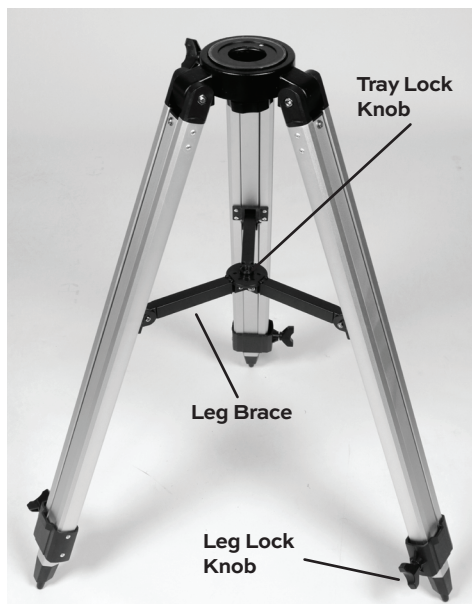


Figure 2.1

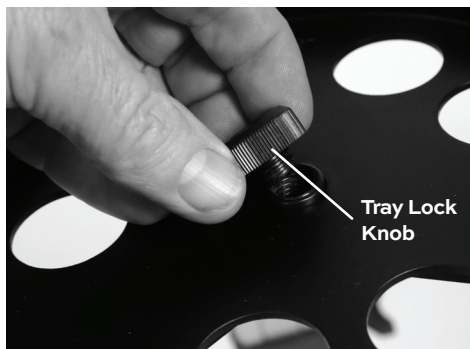


Figure 2.2

4. Locate the attachment knob that is under the top of the tripod. Grab the equatorial head (Item D), then place the bottom into the top of the tripod (Figure 2.3). Reach under the top of the tripod and tighten the attachment knob until it holds the mount in place (Figure 2.4).



Figure 2.3

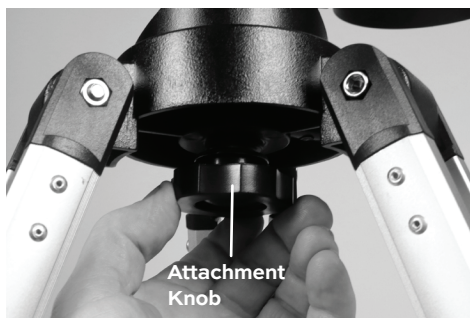


Figure 2.4

5. Locate the counterweight shaft (Item G) and screw it into the mount (Figure 2.5A). Remove the bolt and washer from the end of the counterweight shaft (Figure 2.5B).
6. Locate the counterweight (Item K) and loosen the counterweight lock knob, then slide it onto the counterweight shaft (Figure 2.6A). Tighten the counterweight lock knob. Put the bolt and washer back into the end of the counterweight shaft (Figure 2.6B).

Figure 2.5B

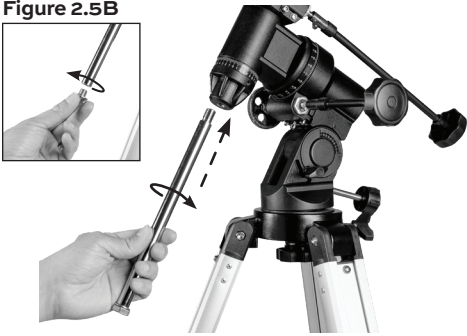


Figure 2.5A

Figure 2.6B



Figure 2.6A

7. Locate the slow-motion controls (Item F) and loosen the thumb screws – being careful not to remove them. On the mount head are shafts, onto which you will attach these controls. The shafts have a flat side. Orient the controls so the thumbscrews are on top of the flat part of the shafts (Figure 2.7). Tighten the thumbscrews. The longer control attaches to the declination shaft (near the top of the mount), while the shorter one attaches to the right-ascension shaft (Figure 2.8).

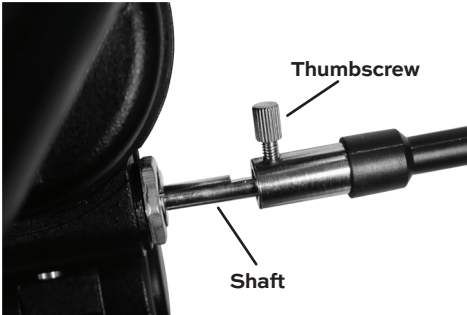


Figure 2.7

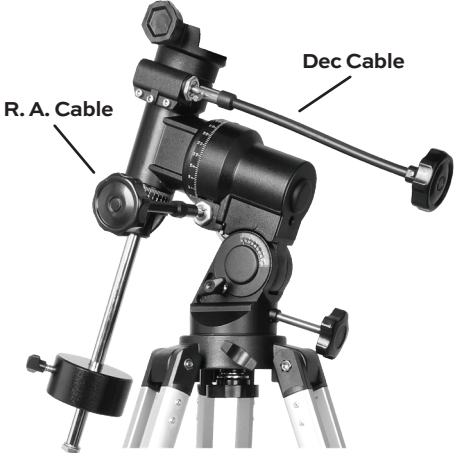
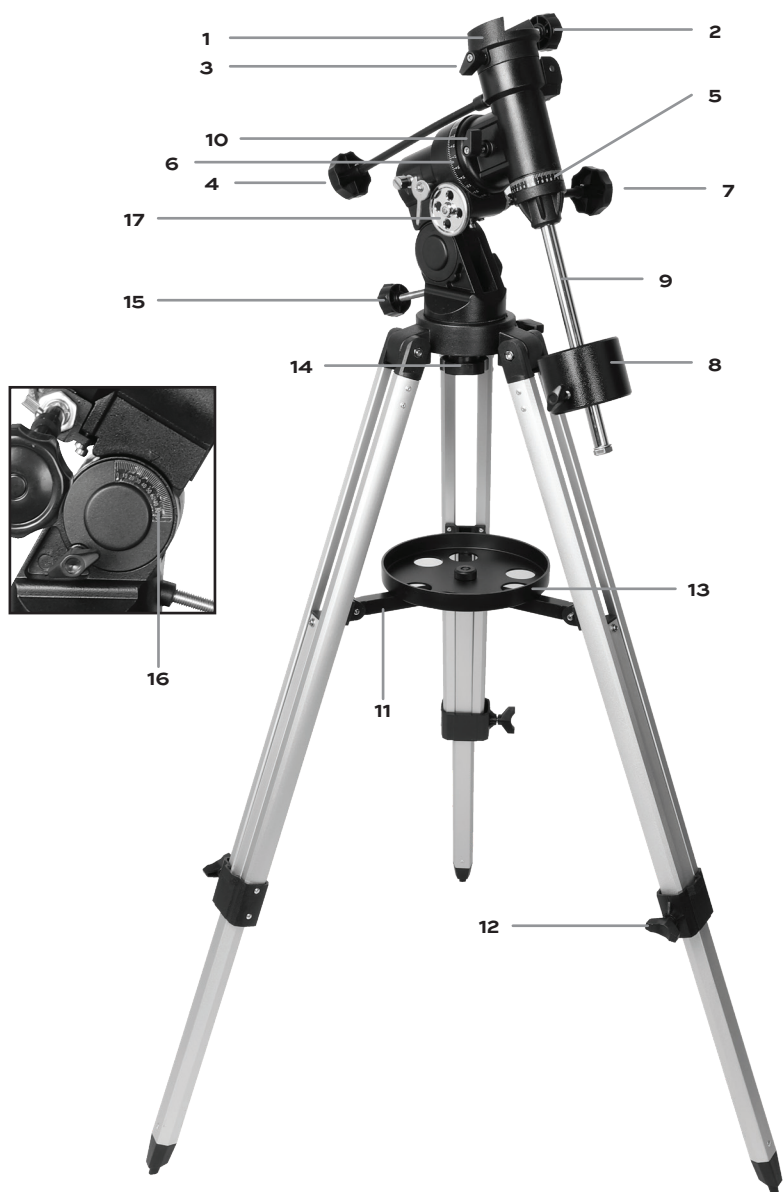


Figure 2.8

You have now assembled the equatorial mount and attached it to the tripod (Figure 2.8).

The next step is attaching the telescope to the mount.

Figure 2.9 Features of the equatorial mount and tripod.



- | | | |
|-------------------------|-------------------------|------------------------------|
| 1. Saddle | 7. RA Slow-Motion Cable | 13. Accessory Tray |
| 2. Saddle Lock Knob | 8. Counterweight | 14. Azimuth Lock Knob |
| 3. Dec Lock Knob | 9. Counterweight Shaft | 15. Latitude Adjustment Knob |
| 4. Dec Slow-Motion Knob | 10. Latitude Lock Knob | 16. Latitude Scale |
| 5. Dec Setting Circle | 11. Leg Brace | 17. For Optional Motor Drive |
| 6. RA Setting Circle | 12. Leg Lock Knob | |

8. Ensure the locks for the right ascension axis and declination axis are locked (Figure 2.10). Do this to ensure the RA and Dec do not turn when you attach the tube.



Figure 2.10

9. Grab the telescope with the tube rings (Item A). Make sure the rings that hold the telescope are secured and cannot move. You can tighten the rings by turning the clamp knobs (Figure 2.11). Do not overtighten.

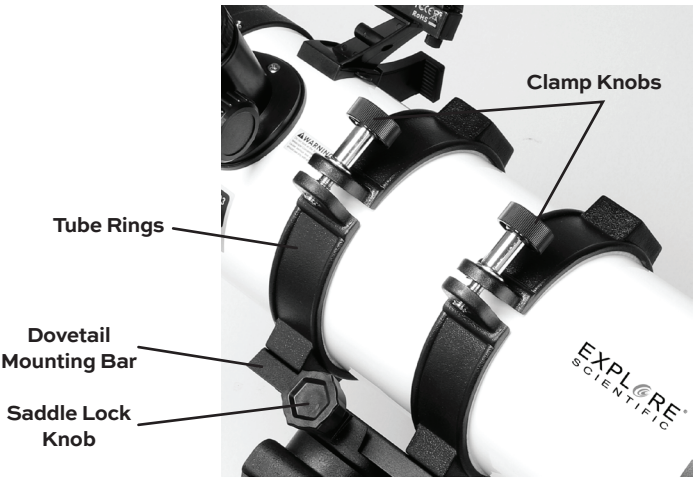


Figure 2.11

10. On top of the mount is the saddle plate, where the telescope goes. The rings that hold the telescope are connected to a Vixen-style dovetail that perfectly fits into the saddle plate. Loosen the saddle lock knob on the side of the saddle plate.

11. Slide the dovetail into the saddle plate, then tighten the saddle lock knob so the telescope will not move.

Congratulation! You have fully assembled the tripod and telescope. But it's not ready to use quite yet. You need to put an eyepiece into the telescope, then align the red dot.

3. Inserting an Eyepiece

Your telescope package arrived with two 1.25-inch Plossl eyepieces (Items H & I) – one with a focal length of 25 mm, the other with 10 mm. Information about magnification can be found later in this manual.

Remove the eyepiece from the protective case and remove the plastic bag. On the end of the focuser, you'll find a silver thumbscrew. Loosen the thumbscrew and remove the protective cap. Insert the silver barrel of the eyepiece into the focuser, being sure to fully seat the eyepiece. Lightly tighten the thumbscrew to secure it.

Adjusting Focuser Orientation

The orientation of the focuser can be changed to achieve a comfortable viewing position.

Loosen the clamp knobs on the tube rings (Figure 2.11) until you can rotate the telescope tube by gripping it on both ends. When the focuser is in the position you want, tighten the clamp knobs. Do not overtighten.

4. Attach and Align the 6x30 Finderscope

A 6x30 finderscope (6x magnification, 30 mm in diameter) comes with your 134 mm Newtonian telescope.

The finderscope (Item J) is a small, low-power telescope that provides a wide view of the sky, allowing you to accurately center objects so they appear in the higher-power field of view of your main telescope.

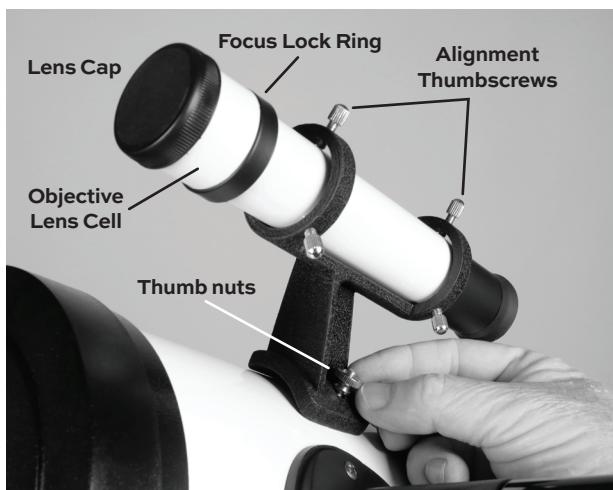


Figure 4.1

To attach the finderscope:

Remove the two thumb nuts located near the focuser. Do not remove the small nuts underneath—only the thumb nuts. Place the base of the finderscope over the bolts, then reinstall and tighten the thumb nuts (Figure 4.1).

Focusing the Finderscope

The 6x30 finderscope has a built-in focus adjustment.

Point the finderscope at an object far away. If the image appears blurry: Loosen the focus lock ring, located just behind the objective lens cell on the body of the finderscope (Figure 4.1). Rotate the ring a few turns.

While looking through the finderscope, slowly rotate the front lens cell. If the focus worsens, turn it in the opposite direction. Adjust until the image is sharp for your eye. Once focused, tighten the lock ring against the front lens cell to secure the setting.

Now it's time to align the finderscope with the telescope.

The finderscope is held in place by two rings, each with three small silver alignment thumbscrews (Figure 4.1). These thumbscrews adjust where the finderscope points. To use them, you must loosen at least one while tightening another. You may also loosen two and tighten one. It takes a bit of practice, but don't adjust them yet—follow the directions below.

Steps to Align the Finderscope:

1. Point the telescope at an object at least $\frac{1}{4}$ mile away (farther is better). Suitable targets include the top of a flagpole, a radio tower, or a utility pole.

To move the telescope, loosen the RA and Dec locks (Figure 2.9), swing the telescope until the target appears in the eyepiece, then tighten the locks.

2. Use the slow-motion controls to center the target in the eyepiece — for example, the tip of the flagpole.

3. Look through the finderscope. If the target is not visible, slightly loosen two alignment thumbscrews (Figure 4.1) on the front ring and tighten another. Did the finderscope move toward the target? If yes, continue adjusting. If not, try loosening a different thumbscrew while tightening the others. This process adjusts the direction of the finderscope. The same method can be applied to the rear ring if needed.

4. Once the object is visible in the finderscope, make fine adjustments with the thumbscrews until the target is centered.

5. Check the eyepiece again to confirm the telescope is still centered on the target (it may have shifted during adjustment). If both the eyepiece and finderscope are centered on the same object, you are finished. If not, use the slow-motion controls to re-center the telescope, then continue adjusting the finderscope until both are aligned.

5. Focus The Telescope

Insert the 25mm Plossl eyepiece into the focuser, being sure to lightly tighten the locking screws that holds it in place (Figure 5.1).

On each side of the focuser is large knob. These knobs turn a shaft that causes the drawtube to move in and out. Look through the eyepiece at something at least a half mile away, slowly turn the focus knobs until the target comes into focus. To ensure it's in perfect focus, keep turning until the target is slightly out of focus. Now slowly turn it in the opposite direction, stopping when you've got the target as focused as you can get it.

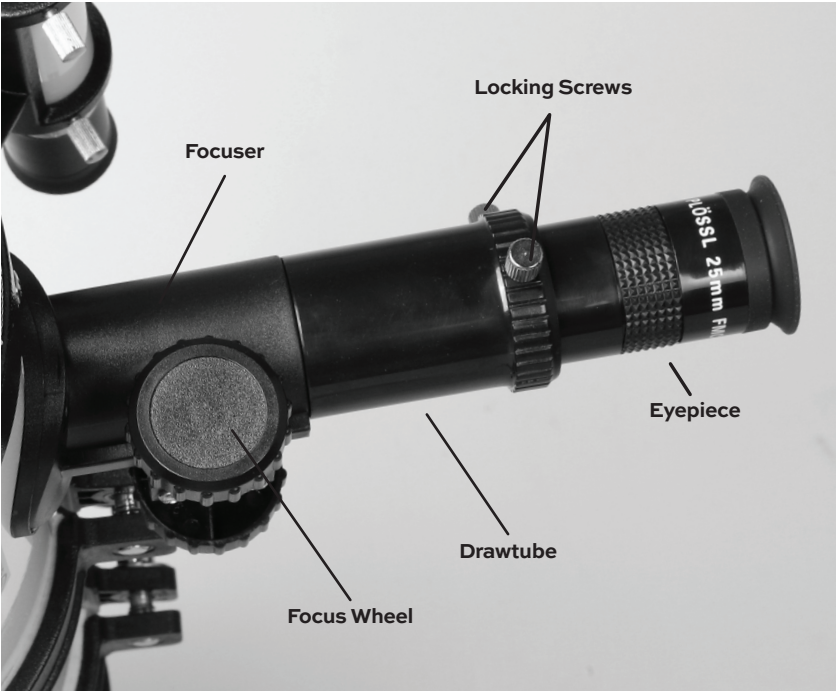


Figure 5.1

Everything Is Upside-down!

When you look in the eyepiece you will notice that everything is upside-down or rotated at an angle. This is normal – it is how a Newtonian telescope works. If you're looking at things on land, it is VERY obvious; but if you're looking in the night sky this effect is not noticed by your brain. Why not? Because your brain knows what's level or at a strange angle when you're looking at things on the land because of the horizon, trees, houses, etc. But when you're looking at the moon, or anything else in the sky, your mind does not use that as a reference, thus it is not bothered by the image being upside-down.

6. How An Equatorial Mount Works / Polar Alignment

Because Earth rotates to the east, the night sky appears to move to the west. Equatorial mounts are designed to counteract the rotation of Earth. By doing that, it is possible for a telescope to follow an object on its nightly journey across the sky.

When you turn the slow-motion controls in the correct direction, you can follow the object. Your equatorial mount has two axes of rotation – right ascension and declination.

The right ascension axis (abbreviated RA) aligns with the rotational axis of Earth – so it moves in nice, smooth circles. This axis aligns with the North Celestial Pole in the northern hemisphere, or the South Celestial Pole in the southern hemisphere.

The declination axis (abbreviated Dec), in conjunction with the RA, allows you to point the telescope anywhere in the sky. Like the RA, it moves in smooth circles.

Because the RA points to the pole, it must be polar aligned.

1. Place the tripod on the ground, making sure one leg is aligned north (or south, if you're in the southern hemisphere).

2. Level the mount by adjusting the length of the three tripod legs.

3. Unlock the RA Lock (Figure 6.1). Rotate the RA axis until the counterweight shaft is pointing straight down over the north-facing leg. Be sure to engage the RA lock when you are done.



Figure 6.1



4. Release the Dec lock (Figure 6.2) so that the optical tube can rotate. Rotate the optical tube until it points north (or south in the southern hemisphere). Engage the Dec lock.

Figure 6.2

5. Determine the latitude of your observing location. This is easy using an app on a smart phone. Use the latitude T-handle knob (Figure 6.3 A) to tilt the telescope mount until the pointer matches the latitude of your latitude scale (Figure 6.3 B). If your smart phone has a level or inclinometer, you can place it on the saddle plate (where the telescope attaches to the mount) and set the angle to match your latitude.

6. If steps 1 through 5 above were performed with reasonable accuracy, your telescope is now sufficiently well-aligned to the celestial pole you can see where you live. Be careful to not move the mount during your observing session. There are ways to improve your polar alignment, but beginners should not attempt this until they become very familiar with how the mount works. Once you start observing, the only parts of the mount that move are the RA and Dec.

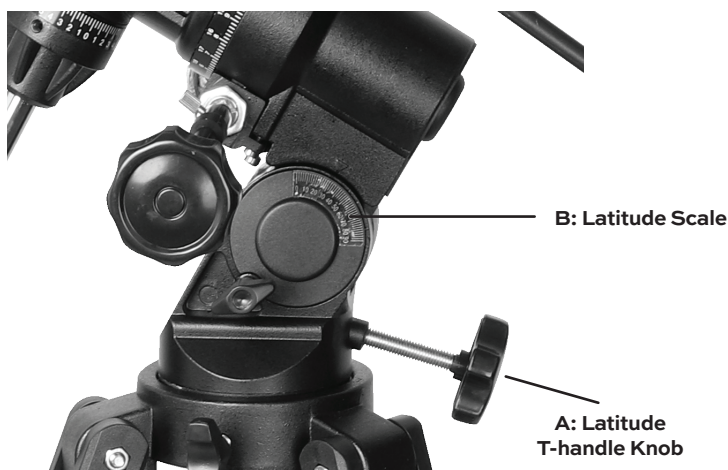


Figure 6.3

7. Balancing the Telescope

In order for the telescope to be stable on the tripod and for it to move smoothly, it must be balanced.

1. Firmly hold the optical tube to ensure it does not swing freely. Loosen the RA lock (Figure 6.1). The optical tube now moves freely around the axis. Rotate the telescope so that the counterweight shaft is parallel (horizontal) to the ground (Figure 7.1).



Figure 7.1

2. Unlock the counterweight lock knob and slide the counterweight along the counterweight shaft until the telescope remains in one position without tending to drift down in either direction. Tighten the counterweight lock knob, locking the counterweight in position.
3. With the counterweight shaft still parallel with the ground, lock the RA.
4. Unlock the Dec axis (Figure 6.2). The telescope now is able to move freely around the Dec axis.
5. Loosen the cradle ring locks so the telescope tube easily slides back and forth in the cradle. Do not loosen them so much that the rings open.
6. Move the telescope in the cradle rings until the telescope remains in one position without tending to drift down in either direction (Figure 7.2).

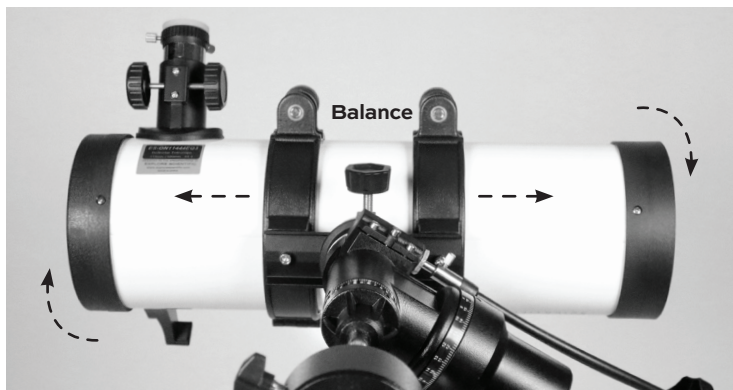


Figure 7.2

7. If you cannot get the telescope to balance you can change the position of the dovetail.
8. Engage the Dec lock.

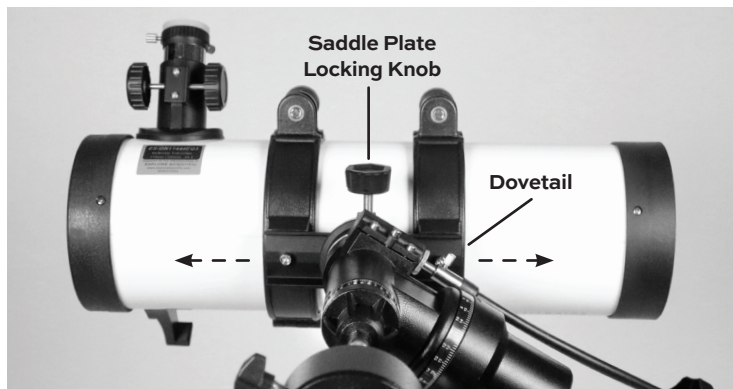


Figure 7.3

9. Holding the telescope with one hand, loosen the saddle plate locking knob until you can slide the dovetail in the saddle plate (Figure 7.3). **YOU MUST BE CAREFUL TO NOT LET THE TELESCOPE FALL OUT OF THE SADDLE PLATE.**
10. When you have gotten it to balance, as described in No. 6 above, tighten the saddle plate lock.
11. Unlock the RA and Dec, then rotate the telescope to the home position, then engage the RA and Dec locks (Figure 6.1 & 6.2).

The telescope is now properly balanced on both axes.

8. Pointing The Telescope

You can point the telescope in any direction simply by unlocking the RA and Dec locks (Figure 6.1 & 6.2). It sounds simple enough but learning to move it takes practice. You should do this multiple times before trying to use your mount under the stars. You can do it inside, in the comfort of your home.

Set up the mount and telescope, pointing the RA axis north, as described above. If you are in the southern hemisphere, all mentions of north should be changed to south.

It is best to unlock one axis to learn how it moves, then lock it and try the other axis. When you unlock an axis you should make sure to have a good grip on the telescope, so it does not swing wildly.

When you are ready, grip the telescope and unlock both axes. Move it around. It's easy to point it at things in the northern sky; but you'll find that if you want to point the telescope in the northeastern sky, the eyepiece of the telescope

must be on the western (left) side of the mount – which puts the front of the telescope in the eastern sky. For something in the western sky, the eyepiece end must be on the east (right) side of the mount.

What about the southern sky? Same thing. Holding the telescope, rotate the Dec axis until the telescope points south – you'll be standing on the north side of the mount. If you want to look in the southeastern sky, the eyepiece must be on the west (right, as you are now standing) side of the mount. The reverse if you want to look in the southwestern sky.

Yes, it seems somewhat odd. With practice, you can master the skill. Now that you know how to move the mount, you can use the finderscope to point the telescope at your target. Pointing at the moon, a planet or a bright star is pretty simple. Put the finderscope on the target and lock the RA and Dec axes. If you are close to the target but not on it, use the slow-motion controls to move the mount until the object is in the eyepiece. Again, this is a skill you must develop. The more you use your telescope the better you'll get.

9. Slow-Motion Controls

The slow-motion controls give you the ability to make slight adjustments in where the telescope is pointing.



Figure 9.1

You can use the controls in conjunction with the finderscope until you get the target in the eyepiece. Once you see it in the eyepiece, you can use the controls to fine tune the telescope to get the target centered. As the object moves out of the eyepiece simply turn the RA control to move it back into the center, or even the other side of center. If you turn it the wrong direction and the object moves out of the eyepiece, simply turn it the other direction. If you have a good polar alignment, the RA axis is the only one you need to turn. If, however, the target is drifting out of the eyepiece and the RA does not keep it in view, turn the Dec control. Using these controls you can easily follow the target across the sky.

10. Determining Magnification

The word magnification describes how much closer a telescope makes an object appear.

There are two parts to calculating magnification: focal length of the telescope and focal length of the eyepiece (the number on the side of the eyepiece).

To calculate magnification, divide the focal length of the telescope by the focal length of the eyepiece.

$$\frac{\text{Telescope Focal Length}}{\text{Eyepiece Focal Length}} = \text{Magnification}$$

For example, this 134mm Newtonian telescope has a focal length of 650 mm. Using the 25 mm eyepiece, the math is:

$$\begin{array}{ccc} 650 \text{ mm} & / & 25 \text{ mm} = 26x \\ \text{Telescope} & & \text{Eyepiece} & & \text{Magnification} \\ \text{Focal Length} & & \text{Focal Length} & & \end{array}$$

That means what you're looking at is magnified 26 times – called 26x. If you use an eyepiece of a different focal length, simply remember the formula: telescope focal length divided by the number on the side of the eyepiece.

Eyepieces can be purchased that have a shorter focal length, which means it will offer more magnification. Many beginning telescope users think that high power is where it's at: Sometimes, that's true.

But that high power creates some tough situations.

1. The object gets dimmer
2. Focusing becomes more of a challenge
3. Keeping the target in the eyepiece is hard because not only have you highly magnified the size, you have magnified the speed it moves by the same amount. So, you're going to have to move your telescope more often.
4. You will magnify the seeing conditions in the air between you and space. If the stars are twinkling, then that's going to impact how the moon, planets, galaxies and all the other heavenly wonders look.

That's why you should start your evening's observing using the eyepiece with the lower magnification (the biggest number on the side). Why? Because at low power you have a better chance of getting an object in the eyepiece and centered.

If you start out at a high power, the chance of finding your target in the eyepiece is slim. Once centered, go to the next lower focal length eyepiece and center it again. You can keep doing this until you reach a point that the viewing is not good.

Limits of Magnification

Each telescope system has a theoretical limit to its magnification power. A good rule of thumb is a telescope’s useful magnification is 2 times the aperture in millimeters. Your telescope is 134 mm in diameter, meaning the maximum magnification is going to be 268x.

$$\frac{\text{Telescope Focal Length}}{\text{Telescope Diameter (x2)}} = \text{Max. Eyepiece Focal Length}$$

What eyepiece would give that magnification? Here’s the math: Focal length of the telescope divided by 268.

$$\begin{array}{ccc} & / & / \\ 650 \text{ mm} & / & 268 \text{ mm} = 2.4 \text{ mm} \\ \text{Telescope} & \text{Telescope} & \text{Max. Eyepiece} \\ \text{Focal Length} & \text{Diameter(x2)} & \text{Focal Length} \end{array}$$

You need an eyepiece with a focal length of 2.4 mm. Trust us when we say that is pushing things to the limit. Unless you have perfectly stable, clear conditions and a sky free from light pollution, achieving that magnification is not going to happen. Under typical skies, the object is going to be blurry, dim, and jumping around – and zipping out of the eyepiece in mere seconds.

Low to medium powers – like those offered by the eyepiece that came with your telescope – offer the most pleasurable experience.

11. Collimating the Optics

All Newtonian telescopes have two mirrors: A primary mirror (the big one) and a secondary mirror.

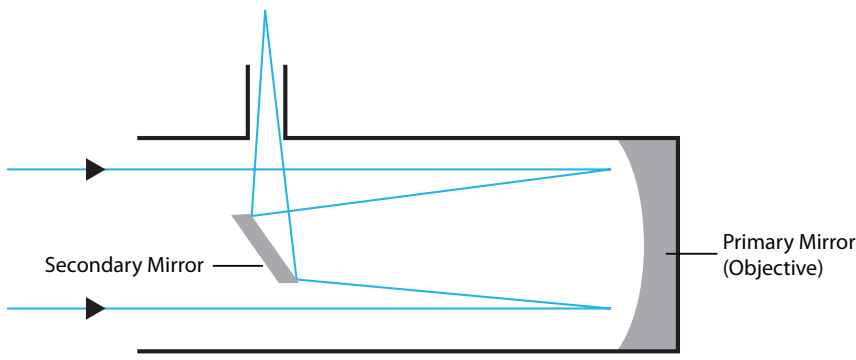


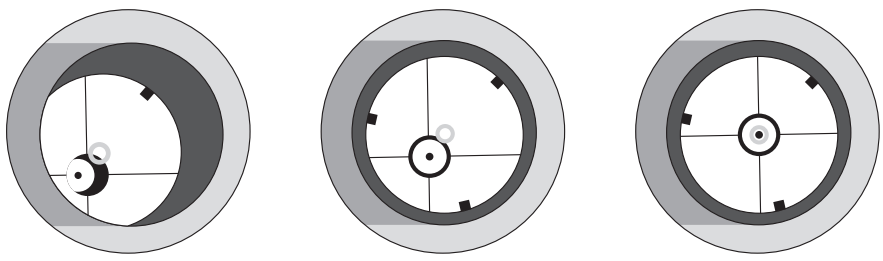
Figure 11.1

The primary mirror on your telescope is center marked with a small ring. Why? This center mark offers a way to get very precise collimation if you are using an optional collimation tool – like a laser collimator. Don’t worry about the ring being visible when you look through an eyepiece – the ring is hidden by the secondary mirror.

Although the optics in your telescope were collimated in the factory, they may have moved during shipment. The procedure is straightforward and should take only a few minutes – once you learn it. We find it easiest to work on collimation in a brightly lit room. This is especially true when you are learning how to do it. Collimation is done in three steps.

Out of collimation examples.

Collimated example.



Rough Collimation

Collimating the secondary mirror (Figure 11.1): If the telescope is collimated you should see the concentric images of your eye, reflections of the secondary mirror and primary mirror, primary mirror center mark and the focuser (Figure 11.2). If the telescope does not look like Figure 11.2 or looks like one of the out of collimation examples below, continue on to the next steps.

- 1: Draw tube barrel
- 2: Primary mirror reflection
- 3: 4 vanes of secondary mirror holder
- 4: Secondary mirror reflection
- 5: Your eye
- 6: Primary mirror center ring mark

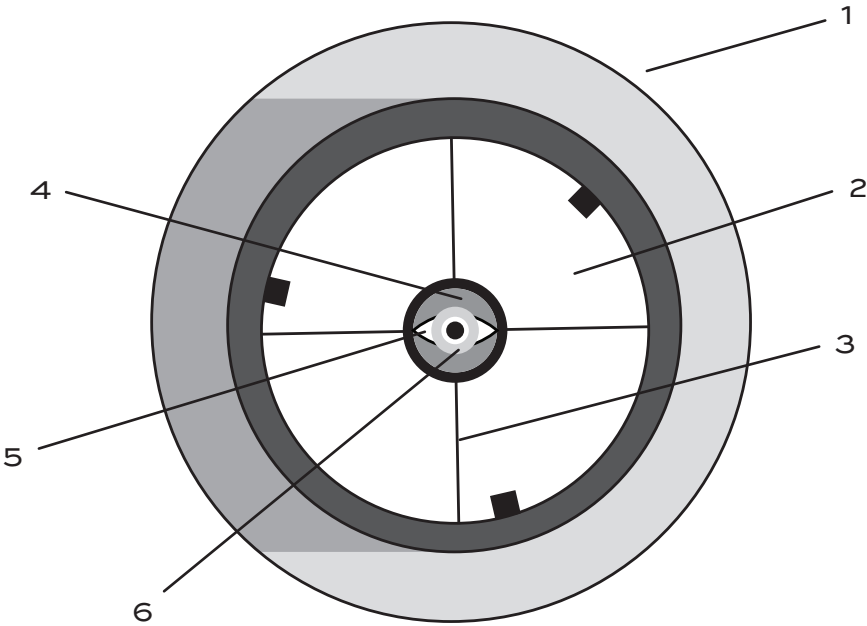
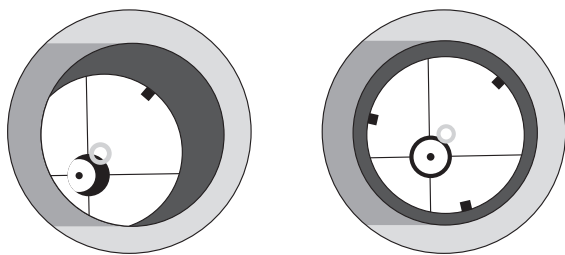


Figure 11.2



Out of collimation examples.

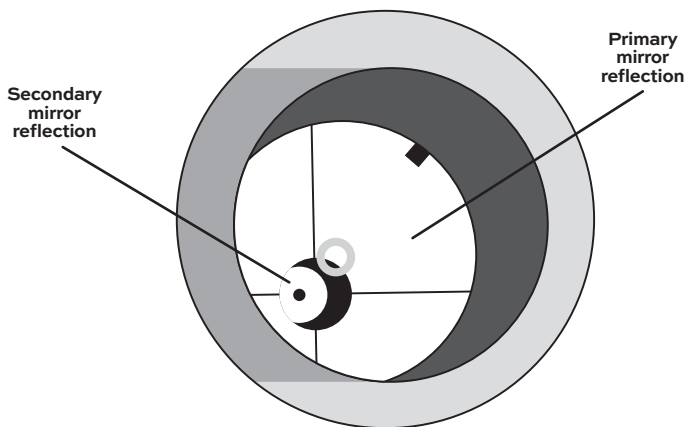
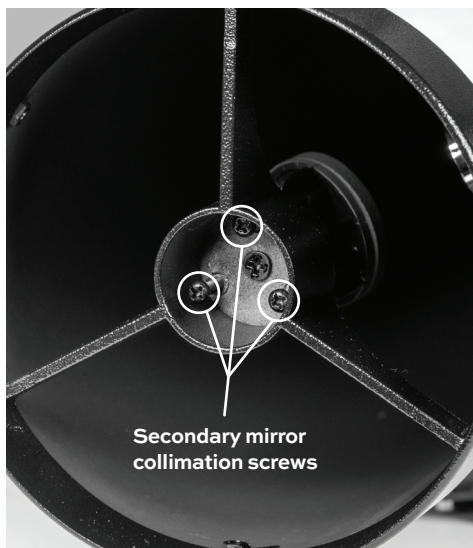


Figure 11.3

Remove the eyepiece from the focuser and, from about a foot away, and with one eye, look through the focuser draw tube. The secondary mirror reflection (your eye) needs to appear round. If the secondary mirror reflection does not appear round (Figure 11.3), tilt it with the three collimation screws (Figure 11.4) that are located on the sky side of the secondary mirror holder.

Do this by first loosening one of the secondary mirror's collimation screws, then tighten the other two. **ALWAYS** loosen one, then tighten at least one if not two. Use a Phillips screwdriver for this task.



IMPORTANT: Turn these screws by very small amounts: No more than 1/8th of turn.

Figure 11.4

If you see that the secondary mirror reflection appears off center from the primary mirror reflection (Figure 11.5), this will be corrected further in the process. This process can only be accomplished by trial and error. If your first effort to adjust the secondary makes it move in the wrong direction, simply loosen another screw and tighten the others to determine the effect it has. Soon you'll be moving it into the correct position.

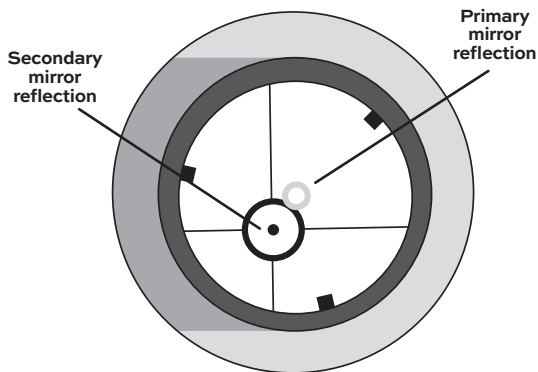


Figure 11.5

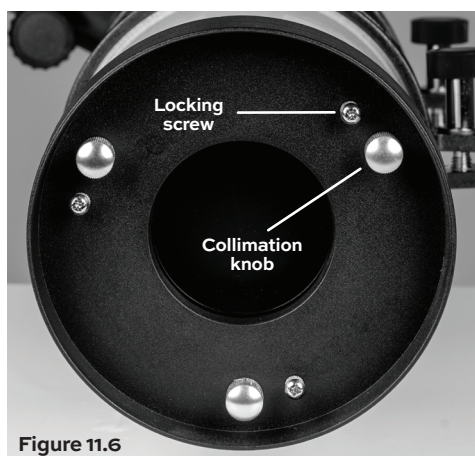
Once the image is round, be sure all the screws are tight.

Adjusting the primary mirror

The goal is to line up the ring mark with the secondary mirror, as shown in Figure 11.2.

Adjust the tilt of the primary mirror by using the three spring-loaded knobs on the bottom end of the telescope (Figure 11.6). Next to the spring-loaded knobs are three small Phillips screws that serve as locks. First loosen the Phillips screws by no more than 2 turns.

While looking through the focuser draw tube, turn one of the spring-loaded knobs about $\frac{1}{4}$ of a turn and observe what happened. If it moved closer,



slowly turn it. Chances are you are going to have to tighten, or loosen, all three screws to get the mirror tilted correctly. This will require trial and error – and patience.

Once you have it centered, gently tighten the Phillips screws. **DO NOT** overtighten them. Remember, the goal is to get the reflection of the secondary mirror centered on the primary mirror.

Figure 11.6

Do not have a quest for perfection! Close enough is good enough, especially for an inexperienced person. Get it close, then get out under the stars. Your skills will improve and you'll be able to get better collimation.

You can achieve precise collimation, but it requires use of optical collimation tools, including a laser collimator, a Cheshire eyepiece, or a collimation cap. Note that if you handle the telescope roughly, you are going to knock it out of collimation. Treat it gently.

Fine Collimation

For fine collimation, it is important that the telescope has cooled down to ambient air temperature. This is because heat exchange from the primary mirror to the air outside goes up the tube. Just like heat rising off hot pavement creates waves that look like mirages, the heat traveling up can cause distortion.

During fine collimation, locate Polaris and view it with high magnification. If the telescope is collimated well, you will see a system of dim rings of light surrounding a central bright spot — the airy disc. You will also notice a dim cross of light coming from this airy disc. This is the diffraction that is caused by the vanes that hold the secondary mirror in place. We have left this cross out of the next figures for clarity. What we want to see is shown in Figure 11.9 – a central airy disc that is surrounded by concentric rings. However, it is much more likely that the picture will be different – more like Figure 11.7. It is essential that you always center the star because outside of the optical axis all stars do show some distorted images. Note: You will get those images only during moments of perfect steady air because air turbulence will distort this image; however, the collimation goal remains the same – getting a concentric star image. So let us assume you have good seeing and your eyepiece shows you something like Figure 11.7.

Try turning the main mirror spring-loaded collimation knobs (after loosening the Phillips screw locks). When you are turning the correct screw in the proper direction, you will notice that the distracting “tail” is getting shorter. (Figure 11.8)



Figure 11.7

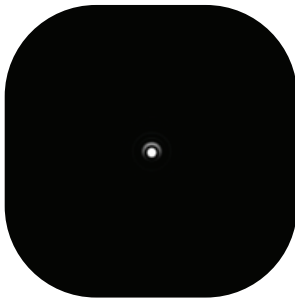


Figure 11.8

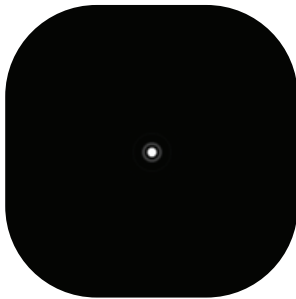


Figure 11.9

Remember to recenter the star after you have turned a screw. When the telescope is perfectly aligned, you will see the picture of Figure 11.9 (when the air is perfect). While using your telescope you will get a feel for this – it does not make sense to spend a lot of time on collimation when the air is moving too much.

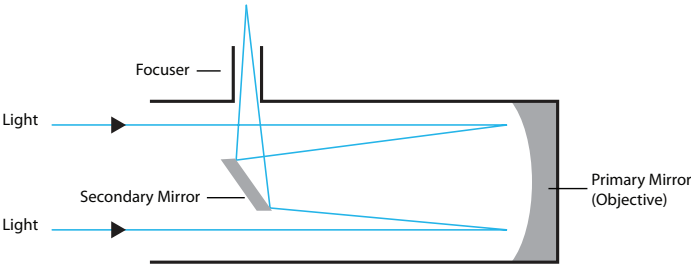
Important: Outside the optical axis (the middle of the field of view) all stars will be distorted and show tails directed to the edge of the field of view. If you are using cheap eyepieces those star images will be even more distorted because the off-axis aberrations of the telescope and the eyepiece will add up. For this reason, it is essential to recenter Polaris after every turn of a collimation screw because the turning of the screw will also shift the star from its centered position. As mentioned before, it may not be possible to get a sharp star image during periods of turbulent air. In this case try to achieve a symmetrical image during collimation. If you don't see any more improvement, abort the process. During nights of unsteady seeing, it is not recommended to use high magnification. Try to enjoy low magnification objects like nebulae, clusters and galaxies on those nights instead of fretting over the bad conditions.

12. Care and Maintenance

It will not be long before you can see dust on the primary mirror – especially if you use a bright flashlight. The bright flashlight makes the dust look MUCH worse than it is. It takes a lot of dust on a mirror for it to need cleaning. If you look down the tube and can see your reflection in normal room light, it does not need cleaning.

If you believe your telescope primary mirror needs cleaning, contact Customer Support (866.252.3811) for assistance.

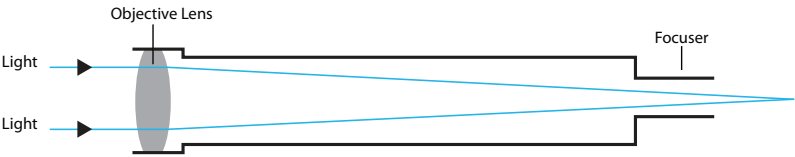
13. Telescope Basics



Types Of Telescopes:

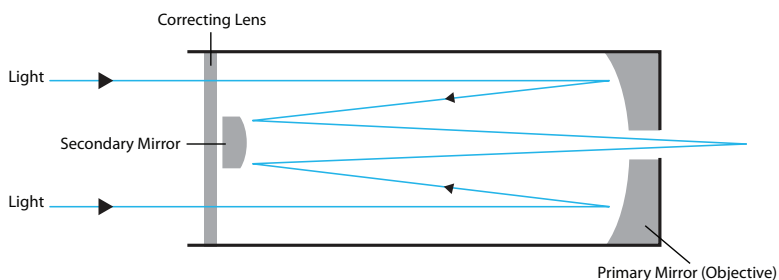
Reflector

A reflector telescope uses mirrors to gather and focus light. Light enters the telescope through its open front end and travels to the concave primary mirror at the back. From there the light is reflected back up the tube to a flat secondary mirror, which sits at a 45° angle in relation to the eyepiece. Light bounces off of this secondary mirror and out through the eyepiece. A reflector telescope is designed for astronomical use. Terrestrial objects may appear inverted, sideways or at an angle depending on how your tube is oriented due to optical design. This rotation is perfectly normal on all Newtonian reflectors and will not affect astronomical viewing.



Refractor:

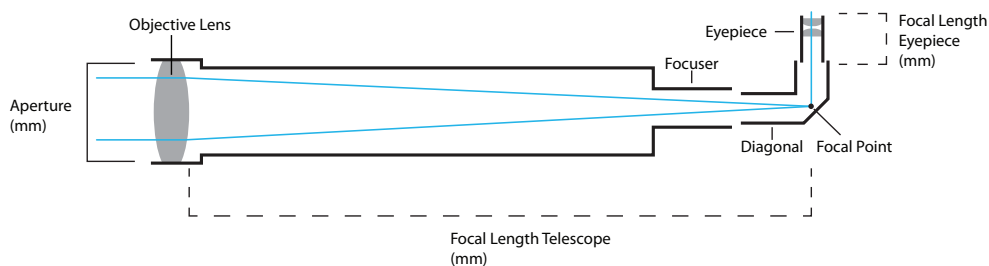
A refracting telescope uses a collection of lenses to gather and focus light. A refractor’s views will be upside down if a diagonal is not in use. A standard diagonal will generate a “right side up” image, however, it will rotate the image on the vertical axis (mirror image). To get the “right side up” image without the rotation, you will need to use a special diagonal with an erect image prism.



Catadioptric:

A catadioptric telescope uses a combination of mirrors and lenses to gather and focus light. Popular catadioptric designs include the Maksutov-Cassegrain and Schmidt-Cassegrain.

Refractor Telescope



Telescope Terms to Know:

Aperture:

This figure, which is usually expressed in millimeters, is the diameter of a telescope's light-gathering surface (objective lens in a refractor or primary mirror in a reflector). Aperture is the key factor in determining the brightness and sharpness of the image.

Objective Lens:

The objective lens is the main light-gathering component of a refractor telescope. It is actually composed of several lens elements.

Diagonal:

This accessory houses a mirror that deflects the ray of light 90 degrees. With a horizontal telescope tube, this device deflects the light upwards so that you can comfortably observe by looking downwards into the eyepiece. The image in a standard diagonal mirror appears upright, but rotated around its vertical axis (mirror image). To get an image without this rotation, you will need to use a special diagonal with an erect image prism.

Eyepiece:

An eyepiece is an optical accessory comprised of several lens elements. It determines the magnification of a particular observing setup.

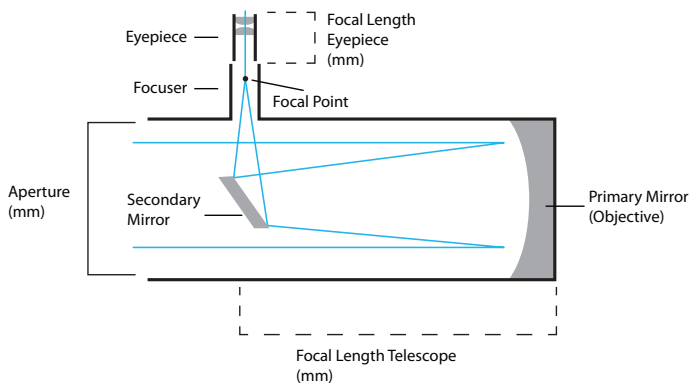
Primary Mirror:

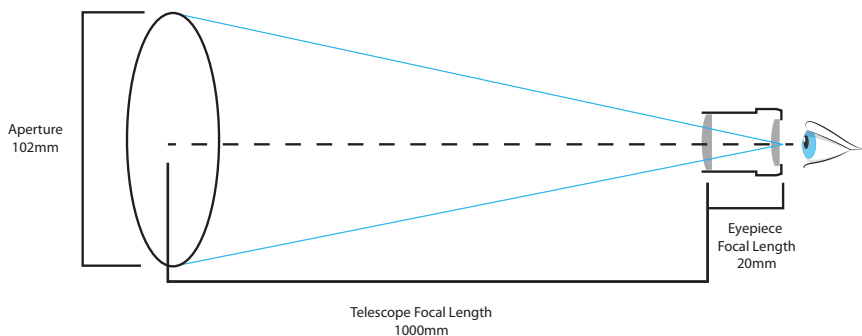
The primary mirror is the principle light-gathering surface of a reflector telescope.

Secondary Mirror:

A secondary mirror is a small mirror that sits at a 45° angle in relation to the primary mirror of a reflecting telescope. Light from the primary mirror is reflected back up the tube to the secondary mirror. The light is directed from this mirror up into the eyepiece.

Reflector Telescope





Magnification:

The magnification corresponds to the difference between observation with the naked eye and observation through a magnifying device like a telescope. If a telescope configuration has a magnification of 30x, then an object viewed through the telescope will appear 30 times larger than it would with the naked eye. To calculate the magnification of your telescope setup, divide the focal length of the telescope tube by the focal length of the eyepiece. For example, a 20mm eyepiece in a telescope with a 1000mm focal length will result in 50x power, which will make the object appear 50 times larger. If you change the eyepiece, the power goes up or down accordingly.

$$\text{Focal Ratio} = \frac{\text{Telescope Focal Length}}{\text{Telescope Aperture}}$$

Focal ratio

The focal ratio of a telescope is determined by dividing the telescope's focal length by its aperture (usually expressed in millimeters). It plays a key role in determining a telescope's field of view and significantly impacts imaging time in astrophotography. For example, a telescope with a focal length of 1000mm and a 100mm clear aperture has a focal ratio of f/10.

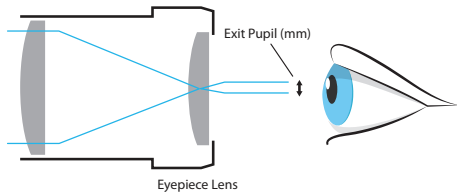
$$\text{Magnification} = \frac{\text{Telescope Focal Length}}{\text{Eyepiece Focal Length}}$$

Focal length (Telescope):

The focal length is the distance in millimeters between the objective lens or primary mirror and the point at which entering light rays converge — otherwise known as the focal point. The focal lengths of the telescope tube and the eyepiece are used to determine magnification.

Focal length (Eyepiece):

The focal length is the distance in millimeters between the center of the first lens element in an eyepiece and the focal point. The focal lengths of the telescope tube and the eyepiece are used to determine magnification. Short eyepiece focal lengths produce higher magnifications than long eyepiece focal lengths.



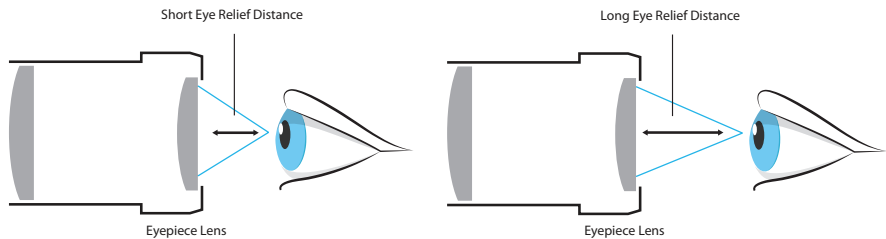
Exit Pupil = $\frac{\text{Eyepiece Focal Length}}{\text{Telescope Focal Ratio}}$

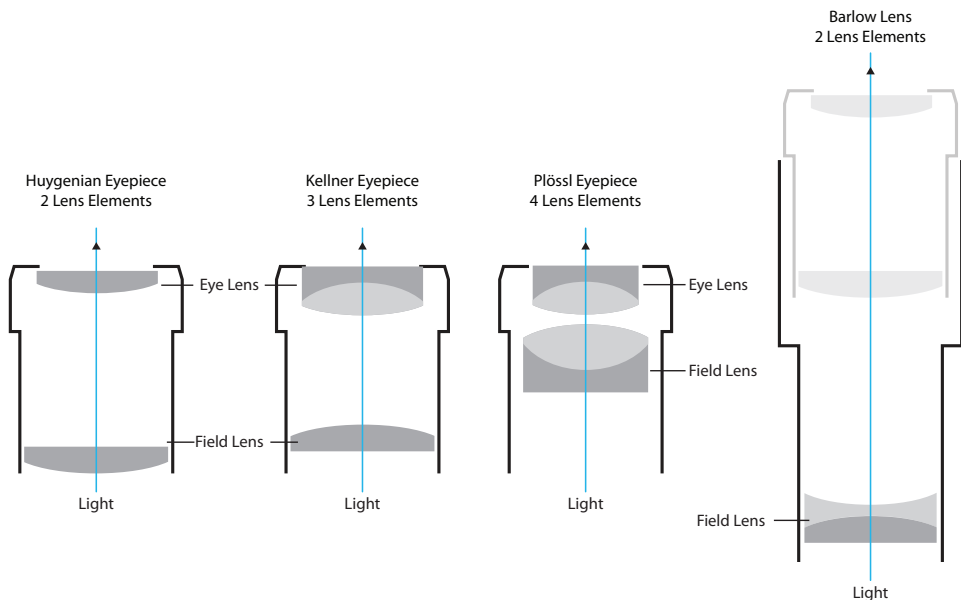
Exit Pupil

The exit pupil is the diameter of the beam of light coming out of the eyepiece. To calculate exit pupil, divide the focal length of your eyepiece by your telescope’s focal ratio. For example, if you use a 20mm eyepiece with an f/5 telescope, the exit pupil would be 4mm.

Eye Relief

Eye relief is all about a comfortable viewing experience because it is the distance at which you need to position your eye from the eyepiece’s outermost surface to enjoy the full field of view. This characteristic is of special concern to observers who wear glasses to correct an astigmatism, because a long enough eye relief is necessary to allow room for glasses.





Huygenian Eyepieces:

A Huygenian eyepiece uses two plano-convex lenses separated by an air gap. They have a fairly narrow apparent field of view.

Kellner Eyepieces:

A Kellner eyepiece uses three lens elements - two of which are paired together in an achromatic doublet design to minimize chromatic aberrations. They typically produce an apparent field of view around 45°.

Plössl Eyepieces:

A Plossl eyepiece uses two doublets (a pairing of lens) for a total of four lens elements. This eyepiece design delivers sharp views and an apparent field of view of approximately 50°, which works well for both planetary and deep sky viewing.

Barlow Lens:

A Barlow lens effectively increases the focal length of a telescope. It is inserted between the eyepiece and the focuser/diagonal (depending on the optical setup) and multiplies the magnification power of the eyepiece. For example, a 2x Barlow will double the magnification of a particular eyepiece.

14. Specifications

ES-ON13449EQ3 - 134mm EQ Reflector

Primary Mirror Diameter:	134mm
Primary Mirror Coating:	Aluminum with silicon dioxide (SiO2) overcoat
Secondary Mirror Minor Axis Dia.:	43mm
Central Obstruction:	39.8mm
Focal Length:	650mm
Focal Ratio:	f/4.8
Focuser:	Rack-and-pinion, accepts 1.25" accessories
Eyepieces:	1.25" 25mm and 10mm Plossl
Eyepiece Magnification:	26x and 65x
Finderscope:	6x30 achromatic
Mount:	German equatorial
Tripod:	Aluminum
Total Instrument Weight:	18 lbs., 4.3 oz.



© Explore Scientific, LLC. 1010 South 48th Street, Springdale AR 72762.
Website: www.explorescientific.com | Toll Free: 866.252.3811 | All rights reserved. Made in China.

Contents, colors and specifications may vary.

V2025.1