

INSTRUCTION MANUAL

Orion[®] Observer[™] 70 EQ

#9882 Equatorial Refractor Telescope



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Welcome to the exciting world of amateur astronomy. Your new Observer 70 EQ Refractor is a quality optical instrument that will deliver countless hours of exciting stargazing, from magnified views of the Moon, star clusters, and nebulas to glimpses of Jupiter’s moons and Saturn’s rings. The Observer 70 includes everything you need to go from box to backyard in less than half an hour.

These instructions will help you set up, use, and care for your new telescope.

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1. Unpacking

The entire telescope system will arrive in one box. Be careful unpacking the box since some of the contents are small and easy to overlook. We recommend keeping the box and all original packaging. In the event you need to ship the telescope to another location, or return it to Orion for warranty repair, having the proper packaging will help ensure that your telescope will survive the journey intact.

Warning: Never look directly at the Sun through your telescope or its finder scope—even for an instant—without a professionally made solar filter that completely covers the front of the instrument, or permanent eye damage could result. Young children should use this telescope only with adult supervision.

Make sure all the parts in the parts list are present. Familiarize yourself with their features and compare them to the callouts on Figures 1, 2, and 3 when possible. If anything appears to be missing or broken, immediately call Orion Customer Support (1-800-676-1343) for assistance.

2. Parts List

- 1 Optical tube assembly (1)
- 2 Tube Rings (6) (located on optical tube)
- 1 Equatorial mount (5)
- 2 Slow motion control cables (8,9)
- 3 Tripod legs (10) with attached accessory tray bracket (11)
- 1 Accessory tray (11) with attachment screws
- 1 Counterweight shaft (26)
- 1 Counterweight (7)
- 1 EZ Finder II reflex sight (4)
- 1 EZ Finder II mounting bracket (17)
- 3 Tripod attachment screws with wingnuts and washers (32)
- 3 Leg lock knobs (13)
- 1 Latitude adjustment T-bolt (30)
- 1 25mm Explorer II eyepiece (3)
- 1 10mm Explorer II eyepiece
- 1 Dust cover
- 1 90° Mirror star diagonal

Observer 70 Refractor

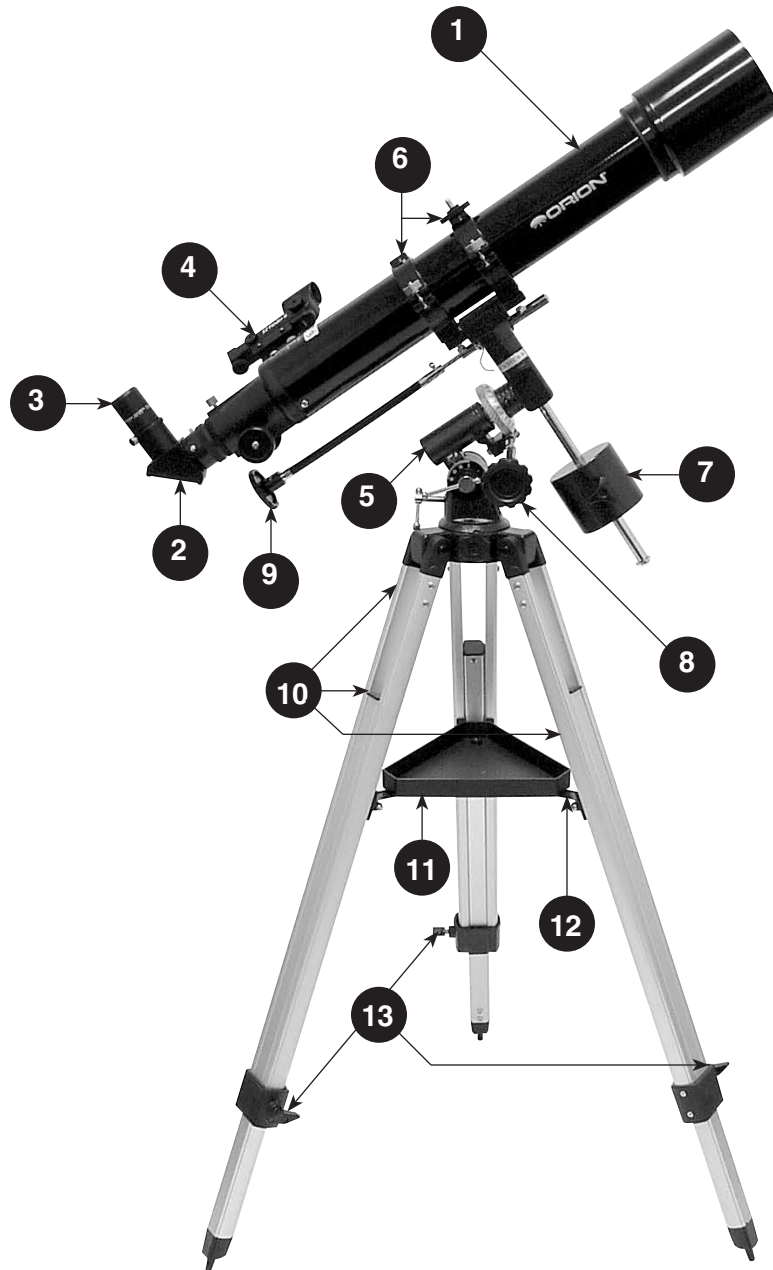


Figure 1. Observer 70 EQ Components

The Basic Components of Your Telescope

Figure 1 shows the fully assembled Observer 70 EQ. All the major components of the telescope are described and numbered to help you identify each part and understand its use. Refer back to this figure when assembling the telescope.

1 Optical tube

This is the main optical component of the telescope. The glass lens at the front of the tube gathers incoming light and focuses it by bending (or refracting) the light rays. The tube assembly has several parts built into it, which are shown and discussed in detail in the next section.

2 90° mirror star diagonal

The diagonal contains a mirror that reflects the light gathered through the optical tube to the eyepiece. The diagonal is angled to allow for viewing objects that are high in the sky from a comfortable position.

3 25mm Explorer II eyepiece

The eyepiece is the part of the telescope that you actually look through to see things. The focal length of the eyepiece and the telescope determines the magnifying power of the telescope. Magnification is discussed in more detail in the Using Your Telescope section.

4 EZ Finder II reflex sight

This is a special “finder” that helps you aim the telescope and locate objects in the sky for viewing. The EZ Finder II generates a red LED “dot” that shows where your telescope is aimed. The use of the EZ Finder II is discussed in the Getting Started section.

5 Equatorial mount

This mount couples the optical tube (1) to the tripod. It also serves to allow tracking of celestial objects with the telescope when properly polar aligned. See the Aligning the Equatorial Mount section for more details.

6 Tube Rings

These rings attach to the equatorial mount (5) and hold the optical tube (1).

7 Counterweight

This counterweight will balance the optical tube (1) when it is being aimed at celestial objects.

8 Right ascension slow-motion control cable

This cable, along with the declination slow-motion control cable (9) is used to make small movements in right ascension when aiming the telescope. Right ascension is explained in the Aligning the Equatorial Mount section. This cable is also used to “track” stellar objects and keep them in the field of view

9 Declination slow-motion cable

This cable, along with the right ascension slow-motion control cable (8) is used to make small movements in declination when aiming the telescope. Declination is explained in the Aligning the Equatorial Mount section.

10 Tripod legs

These aluminum tripod legs support the telescope and can extend from 27" to 50" long.

11 Accessory Tray

This tray is a convenient place for holding extra eyepieces and other small pieces of equipment.

12 Accessory tray bracket

This bracket holds the accessory tray (11) to the tripod.

13 Leg lock knobs

These knobs lock the tripod legs into place. Loosen them to lengthen or shorten the tripod legs. Tighten them once you have the leg at the desired length. Be certain that all three tripod legs are equally extended to assure your telescope is level.

Observer 70 Telescope Tube



Figure 2a. Optical tube components



Figure 2b. Observer 70 focuser detail

Details of the Optical Tube and Components

Figure 2a shows the details of the Optical Tube (1) and its various parts. The optical tube is shown attached to the mount for clarity. Figure 2b is a close up of the focuser with even more detail.

14 Objective lens

This is the main optical component of the telescope. It is an achromatic, fully coated 70mm lens.

15 Glare/Dew shield

This is a simple “hood” for the objective lens (14) that prevents dew formation and stray light from hitting the lens.

16 Equatorial mount head

The top of the equatorial mount (5). This is where the optical tube (1) is attached to the mount.

17 EZ Finder II mounting bracket

The EZ Finder II (4) is secured to this bracket, which will then be attached to the optical tube (1).

18 Focuser drawtube

This is where the 90° mirror star diagonal (2), or other optional diagonal, is inserted. The drawtube is adjusted by the turning the focus wheel (19), which adjusts a rack-and-pinion system to bring objects into focus.

19 Focus wheels

These wheels, when turned, move the focuser drawtube (18) in or out. Use it to bring things into focus when you are looking in the eyepiece (3).

20 Diagonal holder thumbscrews

These two thumbscrews secure the 90° mirror star diagonal (2) into the focuser drawtube (18). These should only be loosened to remove or rotate the star diagonal.

21 Eyepiece holder thumbscrews

These thumbscrews hold the eyepiece in position. Tighten them after inserting an eyepiece (3); loosen them before removing or changing eyepieces.

Observer 70 Tripod and Mount

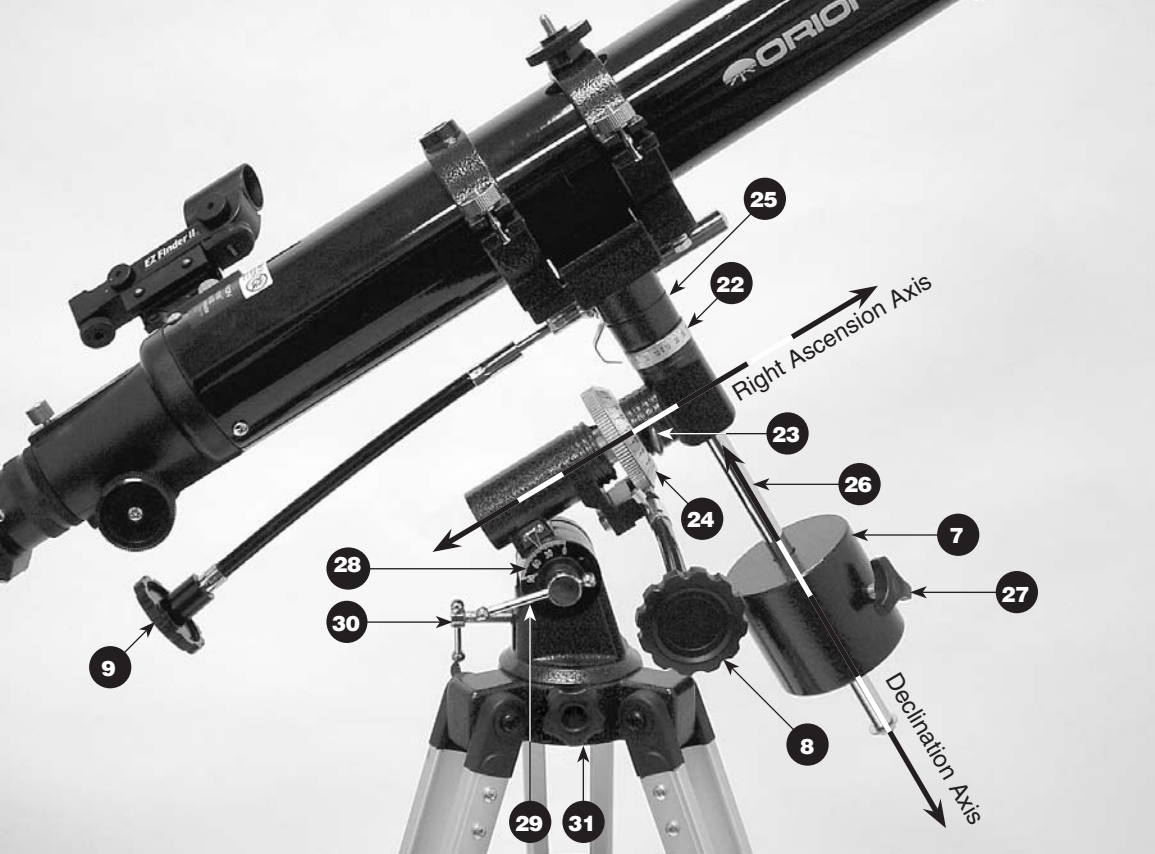


Figure 3a. Equatorial mount detail.

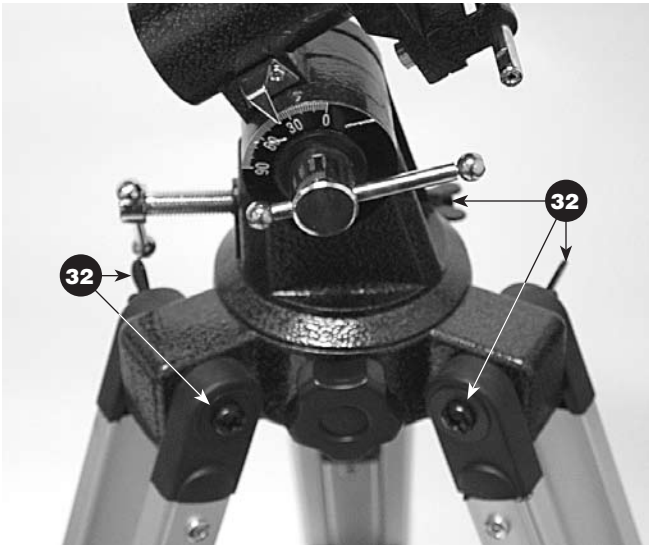


Figure 3b. Observer 70 EQ tripod leg and mount attachment detail.

Details of the Tripod and Mount

Figure 3a shows a close up of the telescope's mount and tripod. Important features are pointed out for greater clarity and detail. Figure 3b shows close-up detail of the tripod legs (10) attached to the equatorial mount (5).

22 Declination setting circle

This circle will indicate where the telescope is pointing in the declination axis. Declination is explained in the Aligning the Equatorial Mount section.

23 Right ascension lock knob

This knob is loosened when you want to make large movements in the right ascension axis. Tighten it when the telescope is in the general area of what you want to view.

24 Right ascension setting circle

This circle will indicate where the telescope is pointing in the right ascension axis. Right ascension is explained in the Aligning the Equatorial Mount section.

25 Declination lock knob (opposite side)

This knob is loosened when you want to make large movements in the declination axis. Tighten it when the telescope is in the general area of what you want to view.

26 Counterweight shaft

This metal shaft holds the counterweight (7).

27 Counterweight lock knob

This knob should be tightened at all times to keep the counterweight (7) on the counterweight shaft (26). Loosen it only to adjust the balance of the telescope as described in the Balancing the Telescope section.

28 Latitude scale

This scale gives a general indication of the latitude setting of the equatorial mount (5).

29 Latitude lock T-bolt

This bolt must be loosened to make adjustments in the latitude of the telescope.

30 Latitude adjustment T-bolt

This bolt use used to make adjustments in the latitude setting of the equatorial mount (5).

31 Azimuth lock knob

Loosening this knob will allow the equatorial mount (5) to be adjusted in azimuth (left/right) without changing the position of the tripod.

32 Tripod leg attachment screws

These screws attach the tripod legs (10) to the equatorial mount (5). Each screw has a wingnut and two washers.

These items are included with your telescope, but are not shown in Figures 1, 2 or 3.

10mm Explorer II eyepiece

This is a second, high-power eyepiece, providing 70x magnification. For more details, see the Using your Telescope section.

Dust Cover

Use this to cover the objective lens when the telescope is not in use. It will prevent dust from gathering on the objective lens.

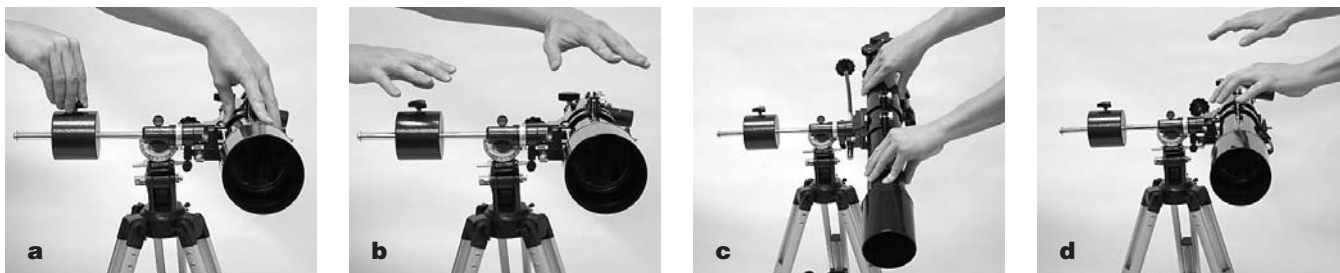


Figure 4a-d. Proper operation of the equatorial mount requires that the telescope tube be balanced on both the R.A. and Dec. axes. (a) With the R.A. lock lever released, slide the counterweights along the counterweight shaft until it just counterbalances the tube. (b) When you let go with both hands, 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.

3. Assembly

Assembling the telescope for the first time should take about 30 minutes. You will need any tools other than the ones provided. As a general note, tighten all screws securely to eliminate flexing and wobbling, but be careful not to over-tighten and thereby strip the threads. Refer to Figures 1 through 3 during the assembly process.

During assembly (and any other time, for that matter), do not touch the surfaces of the telescope objective lens or the lenses of the finder scope and eyepiece with your fingers. These optical surfaces have delicate coatings that can easily be damaged if touched. Never remove any lens assembly from its housing for any reason, or the product warranty will be voided.

Begin set-up of the telescope by assembling the tripod and mount first:

1. Lay the equatorial mount (5) on its side. Attach the tripod legs (10), one at a time, to the base of the mount by sliding a tripod leg attachment screw (32) through the top of a leg and through the holes in the base of the mount. The washers should be on the outside of the tripod legs. Secure the wing nuts finger-tight. Figure 3b shows a close-up detail of the screws attaching the tripod legs to the mount.
2. Install and tighten the leg lock knobs (13) on the bottom braces of the tripod legs (10). For now, keep the legs at their shortest (fully retracted) length; you can extend them to a more desirable length later, once the tripod is completely assembled.
3. Stand the tripod and mount upright and spread the tripod legs (10) apart as far as they will go, until the accessory tray bracket (12) is taut. Connect the accessory tray (11) to the accessory tray bracket with the three wing screws installed in the tray. Push the wing screws up through the holes in the accessory tray bracket and thread them into the holes in the accessory tray.
4. Tighten the tripod leg attachment screws (32) at the tops of the tripod legs so the legs are securely fastened to the mount. Use the Phillips head screwdriver and/or your fingers to do this.

5. To install the latitude adjustment T-bolt (30), thread it into the hole in the back of the equatorial mount (5) until tight.
6. Orient the equatorial mount as it appears in Figure 1, at a latitude of about 40°, i.e., so the pointer next to the latitude scale (28) is pointing to the mark at "40." To do this, loosen the latitude lock T-bolt (29), and turn the latitude adjustment T-bolt (30) until the pointer and the "40" line up. Then retighten the latitude lock T-bolt. The declination (Dec.) and right ascension (R.A.) axes may need re-positioning (rotation) as well. Be sure to loosen the R.A. and Dec. lock knobs (23,25) before doing this. Retighten the R.A. and Dec. lock knobs once the equatorial mount is properly oriented.
7. Thread the counterweight shaft (25) into the equatorial mount (5) at the base of the declination axis (shown in Figure 3a) until tight.
8. Remove the screw and washer on the bottom of the counterweight shaft (26) and slide the counterweight (7) onto the shaft. Make sure the counterweight lock knob (27) is adequately loosened to allow the counterweight shaft to pass through the hole. Position the counterweight about halfway up the shaft and tighten the lock knob. Replace the screw and washer on the end of the shaft.
9. Open the tube rings (6) and remove them from the optical tube (1). Unthread the hex head screws and washers from the bottom of the tube rings. Position one of the tube rings on the top of the equatorial mount head (16) as shown in Figure 1. Line up the hole in the mount with the hole in the tube ring, then push the hex head screw, with washers attached, up through the mount and thread it into the tube ring. Tighten the screw with the small wrench. Repeat this for the other tube ring. Note that one of the tube rings has a small plastic disc with a threaded shaft on it. This is for attaching a camera and is not used for attaching the tube rings to the mount.
10. Lay the optical tube (1) in the tube rings (6) at about the midpoint of the tube's length. Rotate the tube in the rings so that the focus wheels (19) are on the underside of the telescope. Close the rings over the tube and tighten the knurled ring clamps finger tight to secure the telescope in position.

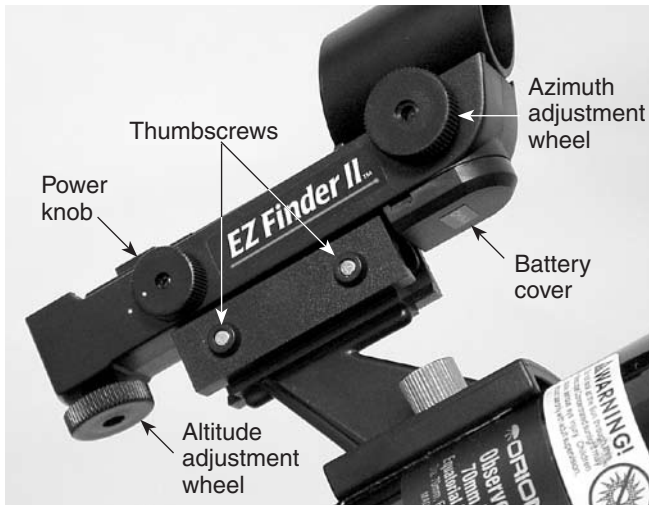


Figure 5. The EZ Finder II reflex sight

11. Attach the two slow-motion cables (8,9) to the R.A. and Dec. worm gear shafts of the equatorial mount (5) by positioning the thumbscrew on the end of the cable over the indented slot on the worm gear shaft and then tightening the thumbscrew. We recommend that the shorter cable be used on either end of the R.A. worm gear shaft and the longer cable on the Dec. worm gear shaft.
12. Unthread the two knurled metal thumbnuts located on the optical tube (1) and place the holes on the base of the EZ Finder II mounting bracket (17) over the two threaded shafts. Then thread the metal thumbnuts back on the shafts to secure the mounting bracket to the optical tube.
13. Attach the EZ Finder II reflex sight (4) to the EZ Finder II mounting bracket (17). Loosen the two securing thumbscrews on the EZ Finder II (Figure 5) and slide it onto the mounting bracket. Tighten the two securing thumbscrews. You will align the EZ Finder II later, in the Getting Started section.
14. Insert the chrome barrel of the 90° mirror star diagonal (2) into the focuser drawtube (18). See Figure 2b. Secure the star diagonal with the diagonal holder thumbscrews (20).
15. Insert the chrome barrel of the 25mm Explorer II eyepiece (3) into the open end of the star diagonal (2). Secure the eyepiece in the diagonal with the eyepiece holder thumbscrews (21).

Your telescope is now fully assembled and should resemble Figures 1-3.

4. Getting Started

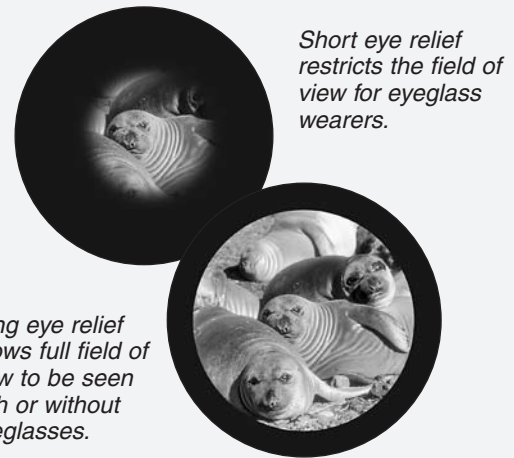
Balancing the Telescope

To insure smooth movement of the telescope on both axes of the equatorial mount, it is imperative that the optical tube be properly balanced. We will first balance the telescope with respect to the right ascension (R.A.) axis and then in the declination (Dec.) axis.

Do You Wear Eyeglasses?

If you wear eyeglasses, you may be able to keep them on while you observe. In order to do this, your eyepiece must have enough “eye relief” to allow you to see the entire field of view with glasses on. You can try looking through the eyepiece first with your glasses on and then with them off, to see if the glasses restrict the view to only a portion of the full field. If the glasses do restrict the field of view, you may be able to observe with your glasses off by just refocusing the telescope to your unaided vision.

If your eyes are astigmatic, images will probably appear best with glasses on. This is because a telescope’s focuser can accommodate for nearsightedness or farsightedness, but not astigmatism. If you have to wear your glasses while observing and cannot see the entire field of view, you may want to purchase additional eyepieces that have longer eye relief.



1. Keeping one hand on the telescope optical tube (1), loosen the R.A. lock knob (23). Make sure the Dec. lock knob (25) is locked. The telescope should now be able to rotate freely about the R.A. axis. Rotate it until the counterweight shaft (26) is parallel to the ground (i.e., horizontal).
2. Now loosen the counterweight lock knob (27) and slide the weight along the shaft until it exactly counterbalances the telescope (Figure 4a). That’s the point at which the shaft remains horizontal even when you let go of the telescope with both hands (Figure 4b).
3. Retighten the counterweight lock knob. The telescope is now balanced on the R.A. axis.
4. To balance the telescope on the Dec. axis, first tighten the R.A. lock knob (23), with the counterweight shaft (26) still in the horizontal position.
5. With one hand on the telescope optical tube (1), loosen the Dec. lock knob (25). The telescope should now be able to move about freely on the Dec. axis. Loosen the knurled

ring clamps on the tube rings (6) a few turns, until you can slide the telescope tube forward and back inside the rings (this can be aided by using a slight twisting motion on the optical tube while you push or pull on it) (Figure 4c).

6. Position the telescope in the tube rings (6) so it remains horizontal when you carefully let go with both hands. This is the balance point for the optical tube (1) with respect to the Dec. axis (Figure 4d).
7. Retighten the knurled rings clamps.

The telescope is now balanced on both axes. Now when you loosen the lock knob (23,25) on one or both axes and manually point the telescope, it should move without resistance and should not drift from where you point it.

Focusing the Telescope

With the 25mm Explorer II eyepiece (3) inserted into the 90° mirror star diagonal (2) and secured with the thumbscrews, aim the optical tube (1) so the front objective lens (14) end is pointing in the general direction of an object at least 1/4-mile away. Now, with your fingers, slowly rotate one of the focus wheels (19) until the object comes into sharp focus. Go a little bit beyond sharp focus until the image starts to blur again, then reverse the rotation of the knob, just to make sure you've hit the exact focus point.

Operating the EZ Finder II Reflex Sight

The EZ Finder II reflex sight (4) (Figure 5) works by projecting a tiny red dot 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), not a laser beam, near the rear of the sight. A replaceable 3-volt lithium battery provides the power for the diode.

To use the EZ Finder II, turn the power knob clockwise until you hear a "click" indicating that power has been turned on. With your eyes positioned at a comfortable distance from the back of the sight, look through the back of the reflex sight with both eyes open to see the red dot. The intensity of the dot can be 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 dim setting is used under dark skies and a bright setting is used under light-polluted skies or in 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 at least 1/4 mile away, such as a telephone pole or chimney and center it in the telescope's eyepiece. Now, turn



Figure 6. EZ Finder II superimposes a tiny red dot on the sky, showing right where the telescope is pointed.

the EZ Finder II on and look through it. The object will appear in the field of view near the red dot.

Note: *The image in the eyepiece of the Observer 70 will be reversed from left-to-right. This is normal for a refractor telescope using a mirror star diagonal.*

Without moving the telescope, use the EZ Finder II's azimuth (left/right) and altitude (up/down) adjustment wheels (Figure 5) to position the red dot on the object in the telescope.

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 telescope's eyepiece and on the red dot, the EZ Finder II is properly aligned with the telescope. Figure 6 shows how the view through the EZ Finder may look while you are aligning it.

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

Replacing the EZ Finder II Battery

Should the battery ever need to be replaced, 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 5) 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 (+) side facing down and replace the battery casing.

Aligning the Equatorial Mount

When you look at the night sky, you no doubt have noticed that 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 (Figure 3a) 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 (8). But first the R.A. axis of the mount must be aligned

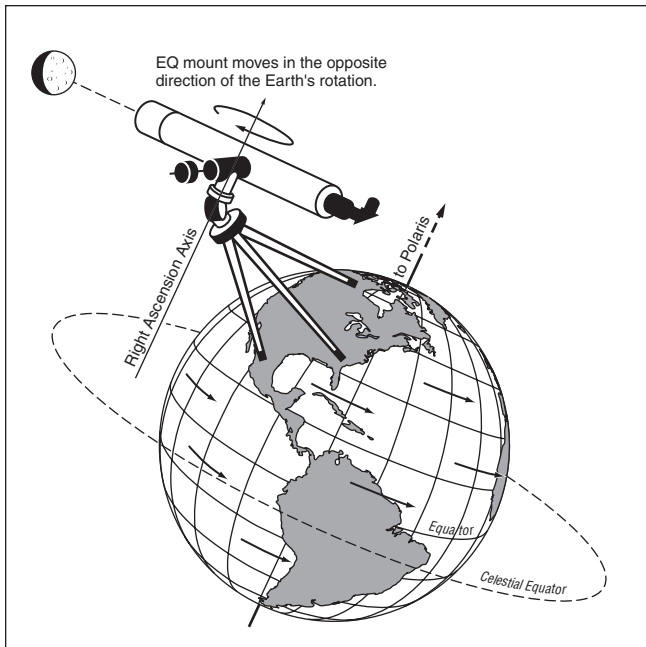


Figure 7. When properly polar-aligned, the equatorial mount can easily “track” objects by compensating for the rotation of the earth.

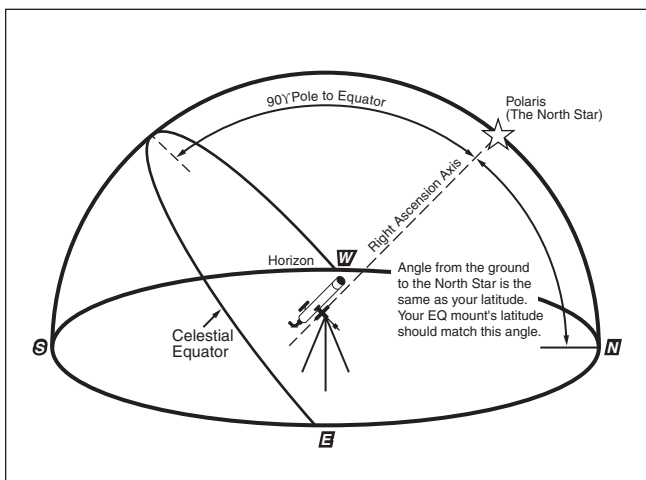


Figure 8. Polar alignment of the Observer 70 EQ is easily done by pointing the telescope’s right ascension axis at Polaris (The North Star).

with the Earth’s rotational (polar) axis—a process called polar alignment.

Understanding Polar Alignment

To understand what you will be doing when polar aligning, look at Figures 7 and 8. The exaggerated telescope mount in Figure 7 shows how you will be aligning the Right Ascension axis (shown in Figure 3a) so that it is parallel to the Earth’s axis and pointing towards the North Star (Polaris). Figure 8 shows what the polar alignment will mean in terms of your location on the Earth and other reference points.

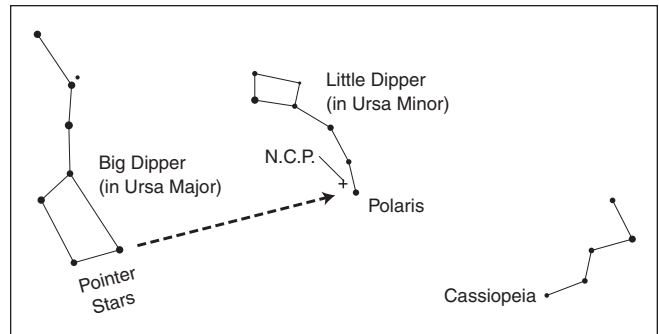


Figure 9. To find Polaris in the night sky, look north and find the Big Dipper. Extend an imaginary line from the two “Pointer Stars” in the bowl of the Big Dipper. Go about five times the distance between those stars and you’ll reach Polaris, which lies within 1° of the north celestial pole (NCP).

The reason for polar alignment is a little tricky to understand; since the Earth is rotating, stars are moving across the sky in an arc pattern for most of the world. If you were standing at the North or South Poles (and were at the top of the rotating globe), the stars would move in a circular pattern overhead, never rising or setting. If you were standing on the equator, the stars would move in straight line overhead. If you faced east, a star that rose directly in front of you would set directly behind you in the West.

However, most of us live at a place on the Earth where the stars rise at one point in the East, move across part of the sky, and set at a different part of the Western horizon. This means that if you were to use an ordinary tripod (which moves in up/down and left/right motions) to mount your telescope, you would have a hard time “tracking” stellar objects. This is where an equatorial mount has the advantage, it may take a little longer to set up, but the effort is worth it. Don’t be intimidated by the setting circles and knobs. It’s actually easier to do than you might think! Once you’ve practiced a few times, you’ll be able to set up the equatorial mount easily.

Polar Alignment

For Northern Hemisphere observers, approximate polar alignment is achieved by pointing the mount’s R.A. axis at Polaris (also called the North Star). 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 9). The two stars at the end of the “bowl” of the Big Dipper point right 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 Observer 70 EQ:

1. Level the equatorial mount (5) by adjusting the length of the three tripod legs (10).

2. Loosen the latitude lock T-bolt (29). Turn the latitude adjustment T-bolt (30) and tilt the mount until the pointer on the latitude scale is set at the latitude of your observing site. If you don't know your latitude, consult a geographical atlas to find it. For example, if your latitude is 35° North, set the pointer to 35. Then retighten the latitude lock T-bolt. The latitude setting should not have to be adjusted again unless you move to a different viewing location some distance away.
3. Loosen the Dec. lock knob (25) and rotate the telescope optical tube (1) until it is parallel with the R.A. axis, as it is in Figure 1. The pointer on the Dec. setting circle (22) should read 90°. Retighten the Dec. lock lever.
4. Loosen the azimuth lock knob (31) at the base of the equatorial mount (5) and rotate the mount so the telescope tube (and R.A. axis) points roughly at Polaris. If you cannot see Polaris directly from your observing site, consult a compass and rotate the mount so the telescope points North. Retighten the azimuth lock knob.

The equatorial mount is now polar aligned.

From this point on in your observing session, you should not make any further adjustments in the azimuth or the latitude of the mount, nor should you move the tripod. Doing so will undo the polar alignment. The telescope should be moved only about its R.A. and Dec. axes.

Use of the R.A. and Dec. Slow-Motion Control Cables

The R.A. and Dec. slow-motion control cables (8,9) allow fine adjustment of the telescope's position to center objects within the field of view. Before you can use the cables, you must 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 (23,25) 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 EZ Finder II (4). If it isn't, use the slow-motion controls to scan the surrounding area of sky. When the object is visible in the EZ Finder II, use the slow-motion controls to center it. Now, look in the telescope's eyepiece. If the EZ Finder II is properly aligned, the object should be visible somewhere in the field of view. Once the object is visible in the eyepiece, use the slow-motion controls to center it in the field of view.

The Dec. slow-motion control cable (9) can move the telescope a maximum of 25°. This is because the Dec. slow-motion mechanism has a limited range of mechanical travel. (The R.A. slow-motion mechanism has no limit to its amount of travel.) If you can no longer rotate the Dec. control cable in a desired direction, you have reached the end of travel, and the slow-motion mechanism must be reset. This is done by first rotating the control cable several turns in the opposite direction from which it was originally being turned. Then, manually slew the telescope closer to the object you wish to observe (remember to first loosen the Dec. lock knob (25)).

You should now be able to use the Dec. slow-motion control cable again to fine adjust the telescope's position.

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, if your equatorial mount is polar aligned, just turn the R.A. slow-motion control cable clockwise. 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 Drives for Automatic Tracking

An optional DC electronic drive can be mounted on the R.A. axis of the equatorial mount to provide 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 (8).

Understanding the Setting Circles

The 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 star catalog.

The mount's R.A. setting circle (24) is scaled in hours, from 1 through 24, with small marks in between representing 10-minute increments. The numbers closest to the R.A. axis gear apply to viewing in the Southern Hemisphere, while the numbers above them apply to viewing in the Northern Hemisphere.

The Dec. setting circle (22) is scaled in degrees, with each mark representing 2.5° increments. Values of Dec. coordinates range from +90° to -90°. The 0° mark indicates the celestial equator. When the telescope is pointed north of the celestial equator, values of the Dec. setting circle are positive, while when the telescope is pointed south of the celestial equator, values of the Dec. setting circle are negative.

So, the coordinates for the Orion Nebula listed in a star atlas will look like this:

R.A. 5h 35.4m Dec. -5° 27'

That's 5 hours and 35.4 minutes in right ascension, and -5 degrees and 27 arc-minutes in declination (there are 70 arc-minutes in 1 degree of declination).

Before you can use the setting circles to locate objects, the mount must be correctly polar aligned, and the R.A. setting circle must be calibrated. The Dec. setting circle has been permanently calibrated at the factory, and should read 90° whenever the telescope optical tube is parallel with the R.A. axis.

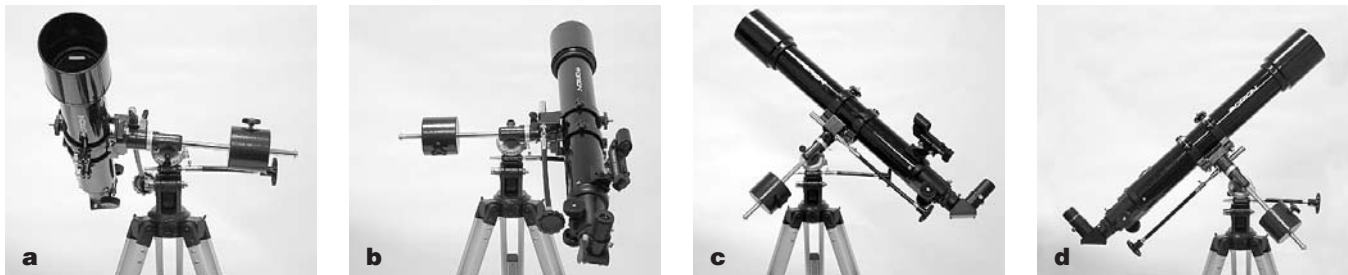


Figure 10a-d. These illustrations show the telescope pointed in the four cardinal directions (a) north, (b) south, (c) east, (d) west. Note that the tripod and mount have not been moved; only the telescope tube has been moved on the R.A. and Dec. axes.

Calibrating the Right Ascension Setting Circle

1. Identify a bright star in the sky near the celestial equator (Dec. = 0°) and look up its coordinates in a star atlas.
2. Loosen the R.A. and Dec. lock knobs (23, 25) on the equatorial mount (5), so the telescope optical tube can move freely.
3. Point the telescope at the bright star whose coordinates you know. Lock the R.A. and Dec. lock knobs. Center the star in the telescope's field of view with the slow-motion control cables.
4. Rotate the setting circle until the metal arrow indicates the R.A. coordinate listed in the star atlas for the object.

Finding Objects With the Setting Circles

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

Loosen the Dec. lock knob (25) and rotate the telescope until the Dec. value from the star atlas matches the reading on the Dec. setting circle (22). 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.

Loosen the R.A. lock knob (23) and rotate the telescope until the R.A. value from the star atlas matches the reading on the R.A. setting circle (24). Remember to use the upper set of numbers on the R.A. setting circle. 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 the field of view of the EZ Finder II (4), assuming the equatorial mount is accurately polar aligned. Use the slow-motion controls to center the object in the EZ Finder II, 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. In Figure 1 the telescope is pointed north, as it would be during

polar alignment. The counterweight shaft is oriented downward. But it will not look like that when the telescope is pointed in other directions. Let's say you want to view an object that is directly overhead, at the zenith. How do you do it?

One thing you DO NOT do is make any adjustment to the latitude adjustment T-bolt (30). That will nullify the mount's polar alignment. Remember, once the mount is polar aligned, the telescope should be moved only on the R.A. and Dec. axes. To point the scope overhead, first loosen the R.A. lock knob (23) and rotate the telescope on the R.A. axis until the counterweight shaft is horizontal (parallel to the ground). Then loosen the Dec. lock knob (25) and rotate the telescope until it is pointing straight overhead. The counterweight shaft (26) is still horizontal. Then retighten both lock knobs.

Similarly, to point the telescope directly south, the counterweight shaft should again be horizontal. Then you simply rotate the scope on the Dec. axis until it points in the south direction.

What if you need to aim the telescope directly north, but at an object that is nearer to the horizon than Polaris? You can't do it with the counterweight down as pictured in Figure 1. Again, you have to rotate the scope in R.A. so the counterweight shaft is positioned horizontally. Then rotate the scope in Dec. so it points to where you want it near the horizon.

To point the telescope to the east or west, or in other directions, you rotate the telescope on its R.A. and Dec. axes. Depending on the altitude of the object you want to observe, the counterweight shaft will be oriented somewhere between vertical and horizontal.

Figure 10 illustrates how the telescope will look pointed at the four cardinal directions—north, south, east, and west

The key things to remember when pointing the telescope is that a) you only move it in R.A. and Dec., not in azimuth or latitude (altitude), and b) the counterweight and shaft will not always appear as it does in Figure 1. In fact, it almost never will!

5. Using Your Telescope

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

Light Pollution

Most of us live where city lights interfere with our view of the heavens. As our metropolitan areas have become more developed, the scourge of light pollution has spread, washing out many stars and nonstellar celestial objects from our sight. Faint deep sky objects become difficult or impossible to see through the murk of light pollution. Even bright nebulae like the Orion and Lagoon Nebulae lose much of their delicate detail. The Moon and planets are not affected; they require steady air more than dark skies, so they remain good targets for city-dwelling observers.

The International Dark-Sky Association is waging the fight against light pollution. The IDSA was founded in 1988 with the mission of educating the public about the adverse impact that light pollution has on the night sky and astronomy. Through educational and scientific means, the nonprofit IDA works to raise awareness about the problem and about measures that can be taken to solve it.

Do you need help dealing with local officials to control street or building lighting in your area? The IDA's extensive support materials can show you how. Help preserve dark skies, join the IDA today! For information, write to IDA, 3225 N. First Ave., Tucson, AZ 85719-2103 or visit their website: www.darksky.org.

The best way to avoid immediate problems with light pollution, however, is to take your telescope to where there are dark skies. You will be amazed at how many stars you can see when you get away from the city lights.

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, which 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 your naked 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.

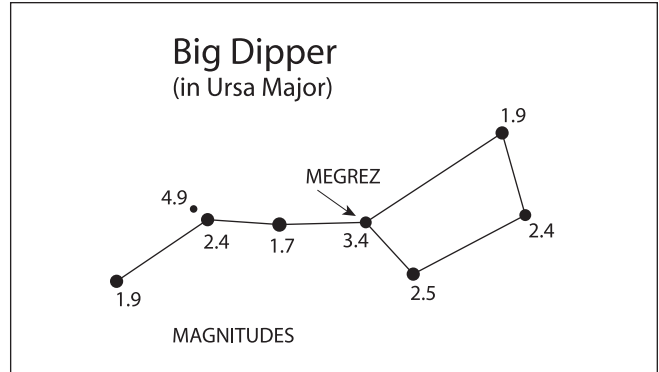


Figure 11. Megrez connects the Big Dipper's handle to its “pan”. It is a good guide to how conditions are. If you can not see Megrez (a 3.4 mag star) then conditions are poor.

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).

If you cannot see stars of magnitude 3.5 or dimmer then conditions are poor. Magnitude is a measure of how bright a star is—the brighter a star is, the lower its magnitude will be. A good star to remember for this is Megrez (mag. 3.4), which is the star in the “Big Dipper” connecting the handle to the “dipper”. If you cannot see Megrez, then you have fog, haze, clouds, smog, or other conditions that are hindering your viewing (Figure 11).

Eyepiece Selection

By using eyepieces of different focal lengths, it is possible to attain many magnifications or powers with the Observer 70. Your telescope comes with two Explorer II eyepieces (Figure 12): a 25mm, which gives a magnification of 28x, and a 10mm, which gives a magnification of 70x. 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.

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

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

For example, the Observer 70 EQ, which has a focal length of 700mm, used in combination with the 25mm eyepiece, yields a magnification of:

$$\frac{700\text{mm}}{25\text{mm}} = 28\text{x}$$



Figure 12.
The 10mm and 25mm
Explorer II eyepieces.

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 finding and centering an object much easier. Trying to find and center objects with a high power (narrow field of view) eyepiece is like trying to find a needle in a haystack!

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

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

What to Expect

So what will you see with your telescope? You should be able to see bands on Jupiter, the rings of Saturn, craters on the Moon, the waxing and waning of Venus, and many bright deep-sky objects. Do not expect to see color as you do in NASA photos, since those are taken with long-exposure cameras and have "false color" added. Our eyes are not sensitive enough to see color in deep-sky objects except in a few of the brightest ones.

Remember that you are seeing these objects using your own telescope with your own eyes! The object you see in your eyepiece is in real-time, and not some conveniently provided image from an expensive space probe. Each session with your telescope will be a learning experience. Each time you work with your telescope it will get easier to use, and stellar objects will become easier to find. Take it from us, there is big difference between looking at a well-made full-color NASA image of a deep-sky object in a lit room during the daytime, and seeing that same object in your telescope at night. One can merely be a pretty image someone gave to you. The other is an experience you will never forget!

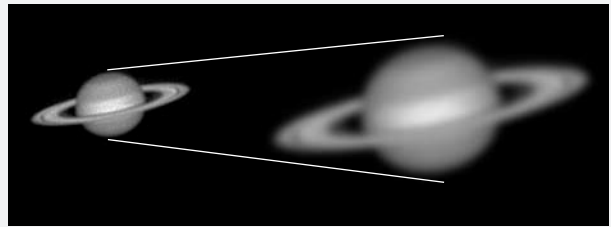
Objects to Observe

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

Magnification Limits

Every telescope has a useful magnification limit of about 2X per millimeter of aperture. This comes to 140X for the Observer 70. Some telescope manufacturers will use misleading claims of excess magnification, such as "See distant galaxies at 640X!". While such magnifications are technically possible, the actual image at that magnification would be an indistinct blur.

Moderate magnifications are what give the best views. It is better to view a small, but bright and detailed image than a dim, unclear, oversized image.



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 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 Observer 70. 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.

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 (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 Observer 70 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.

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.

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 glob-

ular 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.

To find deep sky objects in the sky, it is best to consult a star chart and planisphere. These guides will help you locate the brightest and best deep-sky objects for viewing with your Observer 70.

6. 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 draw-tube when not in use.

Your Observer 70 telescope requires very little mechanical maintenance. The optical tube is aluminum and has a smooth painted finish that is fairly scratch resistant. If a scratch does appear, it will not harm the telescope.

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 Observer 70's objective lens (14) and the exposed lenses of your eyepieces. Never use regular glass cleaner or cleaning fluid designed for eyeglasses.

Before cleaning with fluid and tissue, 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. For the larger surface of the objective lens, clean only a small area at a time, using a fresh lens tissue on each area. Never reuse tissues.

7. Specifications

Optical tube: Aluminum

Objective lens diameter: 70mm

Objective lens: Achromatic, air-spaced, fully coated

Focal length: 700mm

Focal ratio: f/10.0

Focuser: Rack and pinion, accepts 1.25" eyepieces and accessories

Eyepieces: 25mm and 10mm Explorer II eyepieces, fully coated 1.25"

Magnification with supplied eyepieces: 28x (with 25mm) and 70x (with 10mm)

Tripod: Aluminum

Mount: EQ-1, German equatorial

Star diagonal: Mirror, 1.25"

Finder: EZ Finder II reflex sight

Motor drive: Optional

Weight: 10.5 lbs.

One-Year Limited Warranty

This Orion Observer™ 70 EQ 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 to: Orion Warranty Repair, 89 Hangar Way, Watsonville, CA 95076. If the product is not registered, proof of purchase (such as a copy of the original invoice) is required.

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, and you may also have other rights, which vary from state to state. For further warranty service information, contact: Customer Service Department, Orion Telescopes & Binoculars, 89 Hangar Way, Watsonville, CA 95076; (800) 676-1343.

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