INSTRUCTION MANUAL

Orion®
AstroView™ 90mm EQ

#9024 Equatorial Refracting Telescope

TELESCOPES & BINOCULARS

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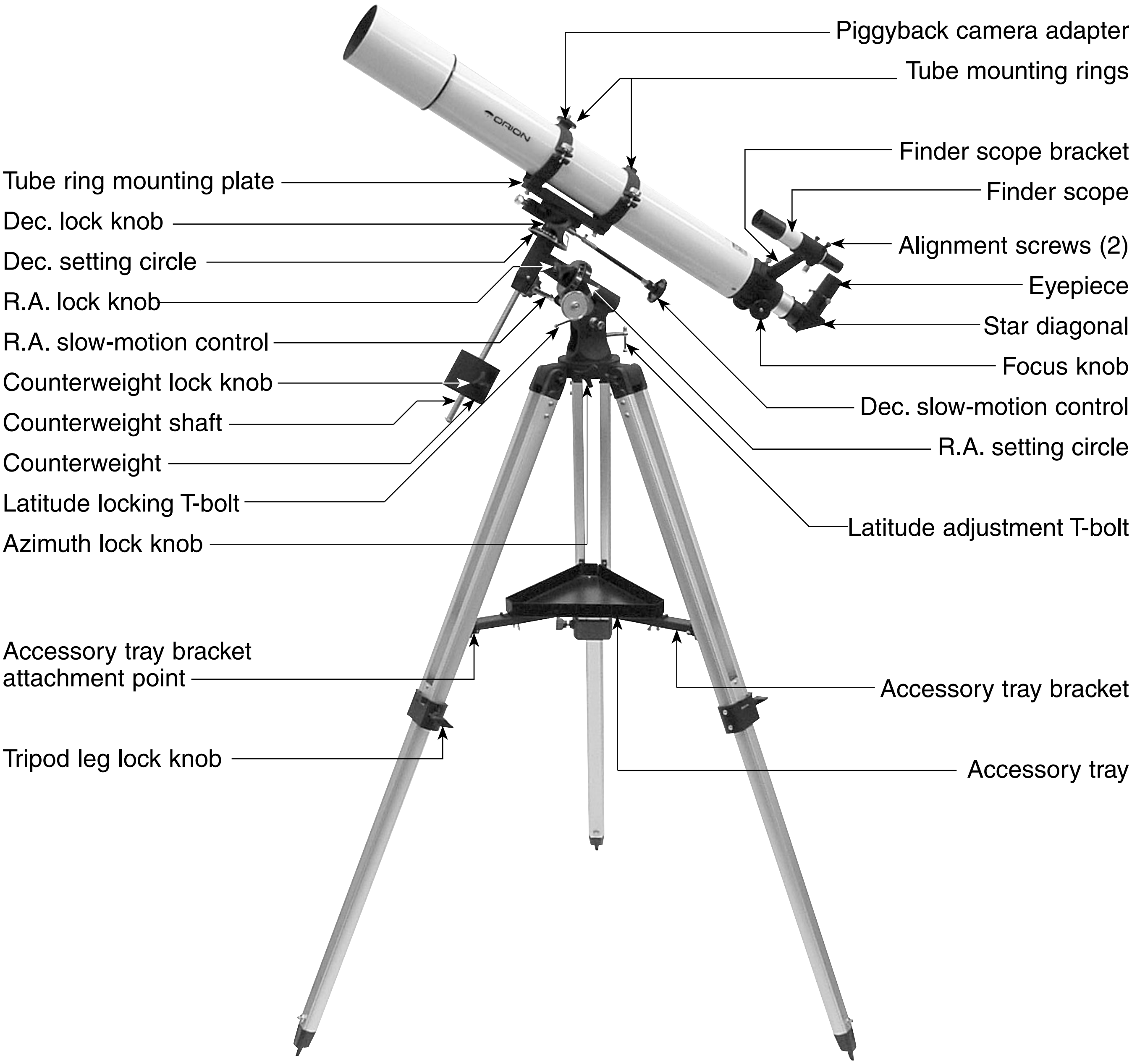

Figure 1. AstroView 90 EQ Parts Diagram

Congratulations on your purchase of a quality Orion telescope. Your new AstroView 90mm EQ Refractor is designed for high-resolution viewing of astronomical objects. With its precision optics and equatorial mount, you'll be able to locate and enjoy hundreds of fascinating celestial denizens, including the planets, Moon, and a variety of deep-sky galaxies, nebulas, and star clusters.

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

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

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1	German-type equatorial mount
2	Slow-motion control cables
1	Counterweight
1	Counterweight shaft
3	Tripod legs
1	Accessory tray with mounting hardware
1	Accessory tray bracket
2	Optical tube mounting rings (located on optical tube)
1	6x30 achromatic crosshair finder scope
1	Finder scope bracket with O-ring
1	Mirror star diagonal (1.25")
1	25mm (36x) Sirius Plössl eyepiece (1.25")
1	10mm (91x) Sirius Plössl eyepiece (1.25")
1	Objective lens dust cap
4	Assembly Tools (2 wrenches, Phillips-head screwdriver, flat-head screwdriver key)

2. Assembly

Carefully open all of the boxes in the shipping container. Make sure all the parts listed in the parts list are present. Save the boxes and packaging material. In the unlikely event that you need to return the telescope, you must use the original packaging.

Assembling the telescope for the first time should take about 30 minutes. No tools are needed other than the ones provided. All screws should be tightened securely to eliminate flexing and wobbling, but be careful not to over-tighten or the threads may strip. Refer to Figure 1 during the assembly process.

During assembly (and anytime, for that matter), Do not touch the surfaces of the telescope objective lens or the lenses of the finder scope or eyepieces with your fingers. The optical surfaces have delicate coatings on them that can easily be damaged if touched inappropriately. Never remove any lens assembly from its housing for any reason, or the product warranty and return policy will be void.

1. Lay the equatorial mount on its side. Attach the tripod legs one at a time to the mount using the screws installed in the tops of the tripod legs. Remove the screw from the leg, line up the holes in the top of the leg with the holes in the base of the mount, and reinstall the screw so it passes through the leg and the mount. Make sure that a washer is between the screw head and the tripod leg and between the wingnut and tripod leg. Tighten the wingnuts only finger-tight, for now. Note that the accessory tray bracket attachment point on each leg should face inward.
2. Tighten the leg lock knobs at the base of the tripod legs. For now, keep the legs at their shortest (fully retracted) length; you can extend them to a more desirable length later, after the scope is completely assembled.
3. With the tripod legs now attached to the equatorial mount, stand the tripod upright (be careful!) and spread the legs

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.***

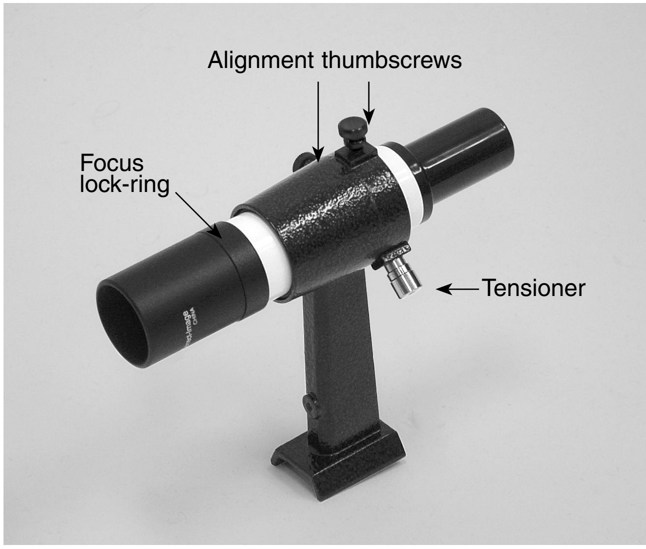

Figure 2a. The 6x30 finder scope and bracket


Figure 2b. Inserting the finder scope into the finder scope bracket

apart enough to connect each end of the accessory tray bracket to the attachment point on each leg. Use the screw that comes installed in each attachment point to do this. First remove the screw, then line up one of the ends of the bracket with the attachment point and reinstall the screw. Make sure the accessory tray bracket is oriented so that the ribs in its plastic molding face downward.

4. Now, with the accessory tray bracket attached, spread the tripod legs apart as far as they will go, until the bracket is taut. Attach the accessory tray to the accessory tray bracket with the three wingnut-head screws already installed in the tray. This is done by pushing the screws up through the holes in the accessory tray bracket, and then threading them into the holes in the accessory tray.
5. Next, tighten the screws at the tops of the tripod legs, so the legs are securely fastened to the equatorial mount. Use the larger wrench and your fingers to do this.
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—located directly above the latitude locking T-bolt—is pointing to the mark at "40.") To do this, loosen the latitude locking T-bolt, and turn the latitude adjustment T-bolt until the pointer and the "40" line up. Then tighten the latitude locking T-bolt. The declination (Dec.) and right ascension (R.A.) axes may need repositioning (rotation) as well. Be sure to loosen the R.A. and Dec. lock knobs before doing this. Retighten the R.A. and Dec. lock knobs once the equatorial mount is properly oriented.
7. Slide the counterweight onto the counterweight shaft. Make sure the counterweight lock knob is adequately loosened so the metal pin the knob pushes against (inside the counterweight) is recessed enough to allow the counterweight shaft to pass through the hole in the counterweight.
8. Now, with the counterweight lock knob still loose, grip the counterweight with one hand and thread the shaft into the equatorial mount (at the base of the declination axis) with the other hand. When it is threaded as far in as it will go, position the counterweight about halfway up the shaft and tighten the counterweight lock knob.
9. Attach the two tube rings to the equatorial head using the screws that come installed in the bottom of the rings. First remove the screws. then push the screws, with the washers still attached, up through the holes in the tube ring mounting plate (on the top of the equatorial mount) and re-thread them into the bottom of the tube rings. Tighten the screws securely with the smaller wrench. Open the tube rings by first loosening the knurled ring clamps.
10. Lay the telescope optical tube in the tube rings at about the midpoint of the tube's length. Rotate the tube in the rings so the focus knobs 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.
11. Now attach the two slow-motion cables to the R.A. and Dec. worm gear shafts of the equatorial mount by positioning the thmb screw on the end of the cable over the indented slot on the worm gear shaft. Then tighten the thumb screw.
12. To place the finder scope in the finder scope bracket, first unthread the two black nylon screws until the screw ends are flush with the inside diameter of the bracket. Place the O-ring that comes on the base of the bracket over the body of the finder scope until it seats into the slot on the middle of the finder scope. Slide the eyepiece end (narrow end) of the finder scope into the end of the bracket's cylinder opposite the adjustment screws while pulling the chrome, spring-loaded tensioner on the bracket with your fingers (Figure 2b). Push the finder scope through the bracket until the O-ring seats just inside the front opening of the bracket's cylinder. Now, release the tensioner and

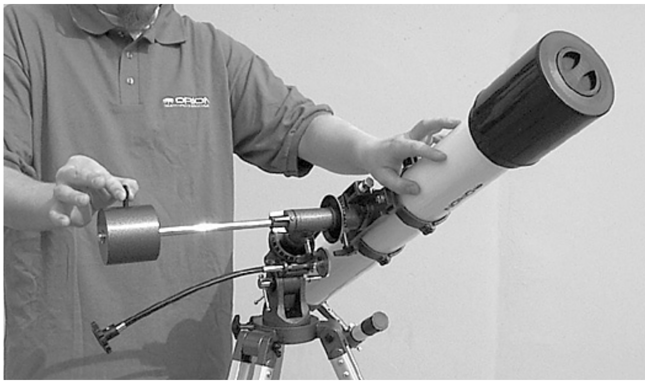

Figure 3a. Balancing the telescope with respect to the R.A.axis by sliding the counterweight along its shaft.

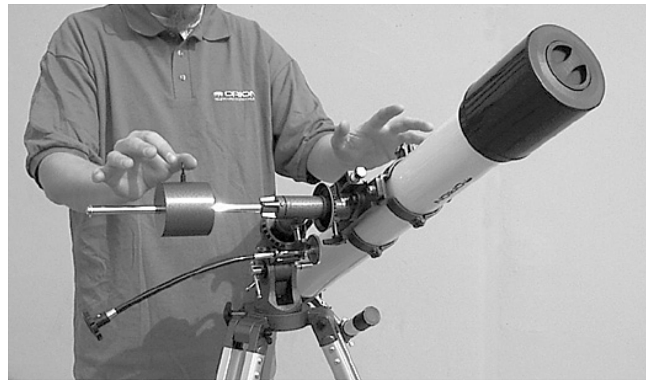

Figure 3b. The telescope is now balanced on the R.A. axis. That-is, when hands are released, the counterweight shaft remains horizontal

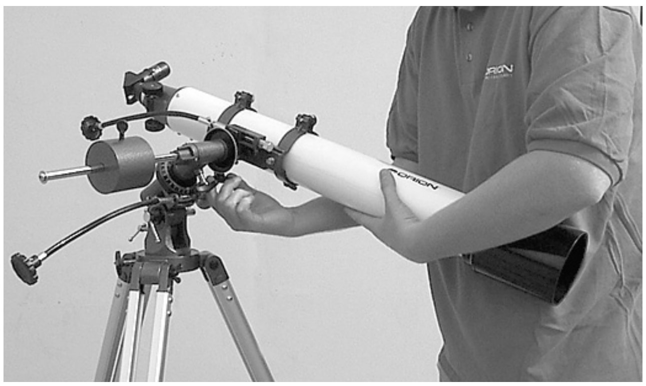

Figure 3c. Preparing the telescope to be balanced on the Dec. axis by first releasing the Dec. lock knob.

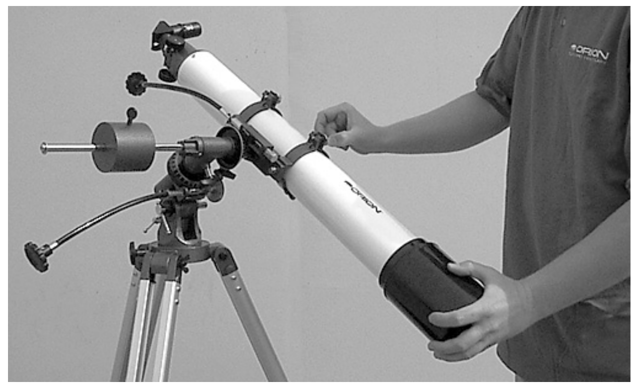

Figure 3d. Balancing the telescope with respect to the Dec. axis. As shown here, the telescope is out of blance (tilting).

Figure 3e. Telescope is now balanced on the Dec. axis, i.e., it remains horizontal when hands are released.

tighten the two black nylon screws a couple of turns each to secure the finder scope in place.

13. Insert the base of the finder scope bracket into the dovetail slot on the top of the focuser housing. Lock the bracket in position by tightening the knurled thumbscrew on the dovetail slot.
14. Insert the chrome barrel of the star diagonal into the focuser drawtube and secure with the thumbscrew on the drawtube.
15. Then insert an eyepiece into the star diagonal and secure it in place with the thumbscrews on the diagonal. (Always loosen the thumbscrews before rotating or removing the diagonal or an eyepiece.)

3. 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 R.A. axis, then the Dec. axis.

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

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, with the counterweight shaft still in the horizontal position.
5. With one hand on the telescope optical tube, loosen the Dec. lock knob (Figure 3c). The telescope should now be able to rotate freely about the Dec. axis. Loosen the tube ring clamps 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 3d).
6. Position the telescope in the mounting rings so it remains horizontal when you carefully let go with both hands. This is the balance point for the optical tube with respect to the Dec. axis (Figure 3e).
7. Retighten the tube ring clamps.

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

4. Aligning the Finder-Scope

A finder scope has a wide field of view to facilitate the location of objects for subsequent viewing through the main telescope, which has a much narrower field of view. The finder scope and the main telescope must be aligned so they point to exactly the same spot in the sky.

Alignment is easiest to do in daylight hours. First, insert the lowest-power (25mm) eyepiece into the star diagonal. Then loosen the R.A. and Dec. lock knobs so the telescope can be moved freely.

Point the main telescope at a discrete object such as the top of a telephone pole or a street sign that is at least a quarter-mile away. Move the telescope so the target object appears in the very center of the field of view when you look into the eyepiece. Now tighten the R.A. and Dec. lock knobs. Use the slow-motion control knobs to re-center the object in the field of view, if it moved off-center when you tightened the lock knobs.

Now look through the finder scope. Is the object centered in the finder scope's field of view, (i.e., at the intersection of the crosshairs)? If not, hopefully it will be visible somewhere in the field of view, so that only fine adjustment of the two finder scope alignment thumb screws will be needed to center it on the crosshairs. Otherwise you'll have to make coarser adjustments to the alignment screws to redirect the aim of the finder scope.

Note: The image seen through the finder scope appears upside down. This is normal for astronomical finder scopes. The image through the telescope will be inverted left-to-right, which it normal for telescopes that utilize a star diagonal.

Once the target object is centered on the crosshairs of the finder scope, look again in the main telescope's eyepiece and see if it is still centered there as well. If it isn't, repeat the entire process, making sure not to move the main telescope while adjusting the alignment of the finder scope.

The finder scope is now aligned and ready to be used for an observing session. The finder scope and bracket can be removed from the dovetail slot for storage, and then re-installed without changing the finder scope's alignment.

Focusing the Finder Scope

If, when looking through the finder scope, the images appear somewhat out of focus, you will need to refocus the finder scope for your eyes. Loosen the lock ring located behind the objective lens cell on the body of the finder scope (Figure 2a). Back the lock ring off by a few turns, for now. Refocus the finder scope on a distant object by threading the objective lens cell in or out on the finder scope body. Precise focusing will be achieved by focusing the finder scope on a bright star. Once the image appears sharp, retighten the lock ring behind the objective lens cell. The finder scope's focus should not need to be adjusted again.

5. Setting Up and Using 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 4) 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 (polar) axis, using only the R.A. slow-motion cable. But first the R.A. axis of the mount must be aligned with the Earth's rotational (polar) axis—a process called polar alignment.

Polar Alignment

For Northern Hemisphere observers, approximate polar alignment is achieved by pointing the mount's R.A. axis at the North Star, or Polaris. It lies within 1 degree 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 Polaris.

To find Polaris in the sky, look north and locate the pattern of the Big Dipper (Figure 5). 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 degree from the SCP, but it is barely visible with the naked eye (magnitude 5.5).

For general visual observation, an approximate polar alignment is sufficient:

Figure 4. The equatorial mount.

1. Level the equatorial mount by adjusting the length of the three tripod legs.
2. Loosen the latitude locking T-bolt. Turn the latitude adjusting T-bolt 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 locking 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 and rotate the telescope optical tube until it is parallel with the R.A. axis. The pointer on the Dec. setting circle should read 90°. Retighten the Dec. lock knob.
4. Loosen the azimuth lock knob and rotate the entire equatorial mount left-to-right 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 equatorial mount so the telescope points North. Retighten the azimuth lock knob.

The equatorial mount is now approximately polar-aligned for casual observing. More precise polar alignment is required for astrophotography. Several methods exist and are described in many amateur astronomy reference books and astronomy magazines.

Note: 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.

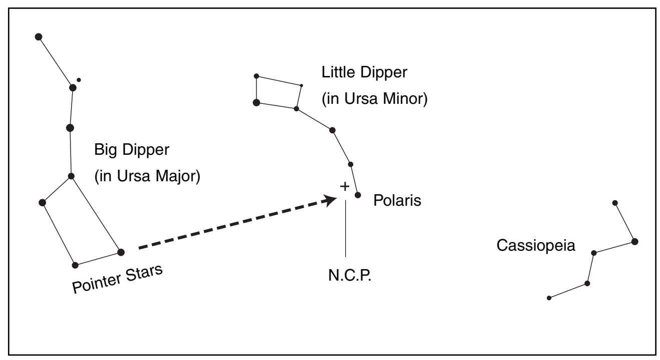

Figure 5. To find Polaris in the night sky, look north and find the Big Dipper. Extend an imaginary line from the two "Pointer Stars" in the bowl of the Big Dipper. Go about five times the distance between those stars and you'll reach Polaris, which lies within 1° of the north celestial pole (NCP).

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

The R.A. and Dec. slow-motion control cables 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 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 telescope's finder scope. If it isn't, use the slow-motion controls to scan the surrounding area of sky. When the object is visible in the finder scope, use the slow-motion controls to center it. Now, look in the telescope with a long focal length (low magnification) eyepiece. If the finder scope is properly aligned, the object should be visible somewhere in the field of view.

Once the object is visible in the telescope's eyepiece, use the slow-motion controls to center it in the field of view. You can now switch to a higher magnification eyepiece, if you wish. After switching eyepieces, you can use the slow-motion control cables to re-center the image, if necessary.

The Dec. slow-motion control cable 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 should 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). 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. The Dec. slow-motion control is not needed for tracking. Objects will appear to move faster at higher magnifications, because the field of view is narrower.

Optional Motor Drives for Automatic Tracking and Astrophotography

An optional DC motor drive can be mounted on the R.A. axis of the AstroView's 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.

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 R.A. setting circle is scaled in hours, from 1 through 24, with small marks in between representing 10-minute increments (there are 60 minutes in 1 hour of R.A.). The lower set of numbers (closest to the plastic R.A. gear cover) apply to viewing in the Northern Hemisphere, while the numbers above them apply to viewing in the Southern Hemisphere.

The Dec. setting circle is scaled in degrees, with each mark representing 1° 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, and 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 60 arc-minutes in 1 degree of declination).

Before you can use the setting circles to locate objects, the mount must be well 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.

Calibrating the Right Ascension Setting Circle

1. Identify a bright star near the celestial equator (Dec. = 0°) and look up its coordinates in a star atlas.
2. Loosen the R.A. and Dec. lock knobs on the equatorial mount, so the telescope optical tube can move freely.
3. Point the telescope at the bright star near the celestial equator 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. Loosen the thumb screw located just above the R.A. setting circle pointer; this will allow the setting circle to rotate freely. Rotate the setting circle until the pointer indicates the R.A. coordinate listed in the star atlas for the object. Retighten the thumb screw.

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.

1. Loosen the Dec. lock knob and rotate the telescope until the Dec. value from the star atlas matches the reading on the Dec. setting circle. Remember that values of the Dec. setting circle are positive when the telescope is pointing north of the celestial equator (Dec. = 0°), and negative when the telescope is pointing south of the celestial equator. Retighten the lock knob.
2. Loosen the R.A. lock knob and rotate the telescope until the R.A. value from the star atlas matches the reading on the R.A. setting circle. Remember to use the lower set of 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 finder scope, assuming the equatorial mount is accurately polar aligned. Use the slow-motion controls to center the object in the finder scope, and it should appear in the telescope's field of view.

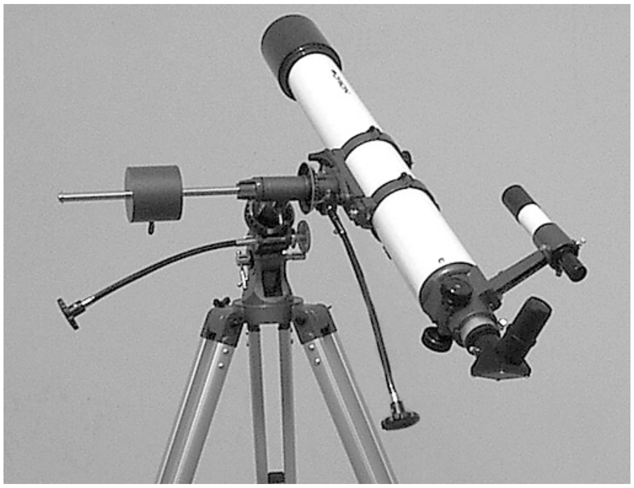

Figure 6a. Telescope pointing south. Note that in all these illustrations, the mount and tripod remain stationary; only the R.A. and Dec. axes are moved.

Figure 6b. Telescope pointing north.

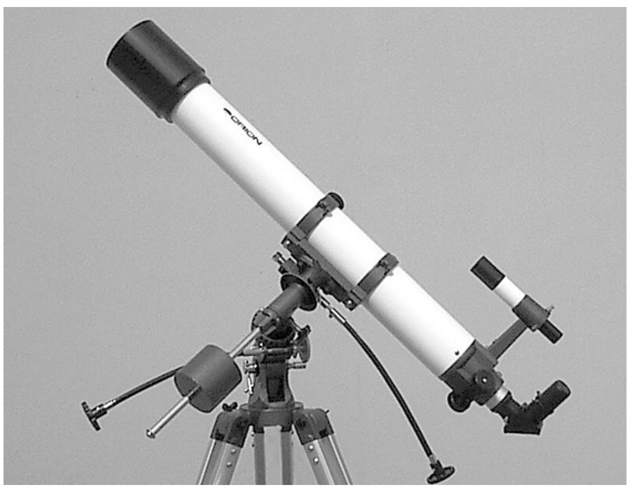

Figure 6c. Telescope pointing east.

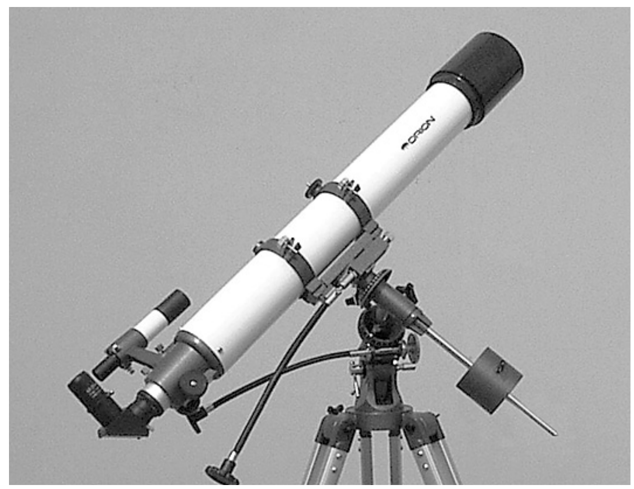

Figure 6d. Telescope pointing west.

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. 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 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 and rotate the telescope until it is pointing straight overhead. The counterweight shaft 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 6 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 are, first that you only move it in R.A. and Dec., not in azimuth or latitude (altitude), and second, the counterweight and shaft will not always appear as it does in Figure 1. In fact, it almost never will!

6. Using Your Telescope—Astronomical Observing

Choosing an Observing Site

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

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

Cooling the Telescope

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

Let Your Eyes Dark-Adapt

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

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

Aiming the Telescope

To view an object in the main telescope, first loosen both the R.A. and Dec. lock knobs. Aim the telescope at the object you wish to observe by "eyeballing" along the length of the telescope tube (or use the setting circles to "dial in" the object's coordinates). Then look through the (aligned) finder scope and move the telescope tube until the object is generally centered on the finder's crosshairs. Retighten the R.A. and Dec. lock knobs. Then accurately center the object on the finder's crosshairs using the R.A. and Dec. slow-motion controls. The object should now be visible in the main telescope with a low-power (long focal length) eyepiece. If necessary, use the R.A. and Dec. slow-motion controls to reposition the object within the field of view of the main telescope's eyepiece.

Focusing the Telescope

Practice focusing the telescope in the daytime before using it for the first time at night. Start by turning the focus knob until the focuser drawtube is near the center of its adjustment range. Insert the star diagonal into the focuser drawtube and an eyepiece into the star diagonal (secure with the thumbscrews). Point the telescope at a distant subject and center it in the field of view. Now, slowly rotate the focus knob until the object comes into sharp focus. Go a little bit beyond sharp focus until the image just starts to blur again, then reverse the rotation of the knob, just to make sure you hit the exact focus point. The telescope can only focus on objects at least 50 to 100 feet away.

Do You Wear Eyeglasses?

If you wear eyeglasses, you may be able to keep them on while you observe, if your eyepieces have enough "eye relief" to allow you to see the whole field of view. You can try this by looking through the eyepiece first with your glasses on and then with them off, and see if the glasses restrict the view to only a portion of the full field. If they do, you can easily observe with your glasses off by just refocusing the telescope the needed amount.

Calculating the Magnification

It is desirable to have a range of eyepieces of different focal lengths, to allow viewing over a range of magnifications. To calculate the magnification, or power, of a telescope, simply divide the focal length of the telescope by the focal length of the eyepiece (the number printed on the eyepiece):

Telescope F.L. ÷ Eyepiece F.L. = Magnification

For example, the AstroView 90 EQ, which has a focal length of 910mm, used in combination with the suppled 25mm Sirius Plössl eyepiece, yields a magnification of:

910 ÷ 25 = 36x

Every telescope has a useful magnification limit of about 2x per millimenter of aperture. This comes to about 180x for the AstroView 90. Claims of higher power by some telescope manufacturers are a misleading advertising gimmick and should be dismissed. Keep in mind that at higher powers, an image will always be dimmer and less sharp (this is a fundamental law of optics). The steadiness of the air (the "seeing") can also limit how much magnification an image can tolerate.

Always start viewing with your lowest-power (longest focal length) eyepiece in the telescope. After you have located and looked at the object with it, you can try switching to a higher power eyepiece to ferret out more detail, if atmospheric conditions permit. If the image you see is not crisp and steady, reduce the magnification by switching to a longer focal length eyepiece. As a general rule, a small but well-resolved image will show more detail and provide a more enjoyable view than a dim and fuzzy, over-magnified image.

"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 the stars are twinkling noticeably when you look up at the sky with just your eyes, the seeing is bad and you will be limited to viewing with low powers (bad seeing affects images at high powers more severely). Planetary observing may also be poor.

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

Avoid looking over buildings, pavement, or any other source of heat, as they will cause "heat wave" disturbances that will distort the image you see through the telescope.

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).

Rotating the Diagonal

When looking at objects in different areas of the night sky, the eyepiece may become positioned so that is uncomfortable or impossible to look through. If the eyepiece is in an undesirable position, the diagonal can be rotated in order to provide a more comfortable viewing angle. First, loosen the thumbscrew on the eyepiece adapter, but make sure to hold the diagonal in place so that it won't fall to the ground. Also, secure the eyepiece in the diagonal so that it won't fall out when rotating the diagonal. Retighten the thumbscrew on the eyepiece adapter once the diagonal has been rotated to an appropriate position.

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 possibly hundreds of 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 NASA 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 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!

A. The Moon

With its rocky, cratered surface, the Moon is one of the easiest and most interesting targets to view with your telescope. 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 on the surface 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. Try using a 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 star diagonal to attach the Moon filter).

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 AstroView 90 EQ. The primary attraction is sunspots, which change shape, appearance, and location daily. Sunspots are directly related to magnetic activity in the Sun. Many observers like to make drawings of sunspots to monitor how the Sun is changing from day to day.

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

C. The Planets

The planets don't stay put like the stars (they don't have fixed R.A. and Dec. coordinates), so you'll have to refer to www.telescope.com or to charts published monthly in *Astronomy, Sky & Telescope,* or other astronomy magazines to locate them. Venus, Mars, Jupiter, and Saturn are the brightest objects in the sky after the Sun and the Moon. Not all four of these planets are normally visible at any one time.

JUPITER The largest planet, Jupiter, is a great subject to observe. 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. If atmospheric conditions are good, you may be able to resolve thin cloud bands on the planet's disk.

SATURN The ringed planet is a breathtaking sight when it is well positioned. The tilt angle of the rings varies over a period of many years; sometimes they are seen edge-on, while at other times they are broadside and look like giant "ears" on each side of Saturn's disk. A steady atmosphere (good seeing) is necessary for a good view. You may probably see a tiny, bright "star" close by; that's 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 If atmospheric conditions are good, you may be able to see some subtle surface detail on the Red Planet, possibly even the polar ice cap. Mars makes a close approach to Earth every two years; during those approaches its disk is larger and thus more favorable for viewing.

D. Stars

Stars will appear like twinkling points of light in the telescope. Even powerful telescopes cannot magnify stars to appear as more than points 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 the image of a star slightly can help bring out its color.

E. Deep-Sky Objects

Under dark skies, you can observe a wealth of fascinating deep-sky objects, including gaseous nebulas, open and globular star clusters, and 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. Don't 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 such faint objects.) But as you become more experienced and your observing skills get sharper, you will be able to discern more subtle details.

Remember that the higher the magnification you use, the dimmer the image will appear. So stick with low power when observing deep-sky objects, because they're already very faint.

How to Find Interesting Celestial Objects—Starhopping

Star hopping, as it is called by astronomers, is perhaps the simplest way to hunt down deep-sky objects to view in the night sky. It entails first pointing the telescope at a bright star close to the object you wish to observe, and then progressing

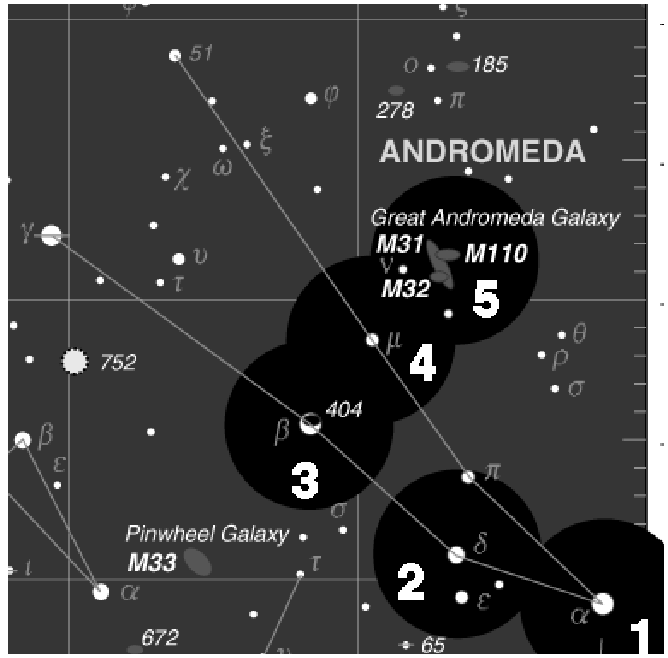

Figure 7. Starhopping is a good way to locate hard-to-find objects. Refer to a star chart to map a route to the object that uses bright stars as guideposts. Center the first star you've chosen in the finder scope and telescope eyepiece (1). Now move the scope carefully in the direction of the next bright star (2), until it is centered. Repeat (3 and 4). The last hop (5) should place the desired object in the eyepiece.

to other stars closer and closer to the object until it is in the field of view of the eyepiece. It is a very intuitive technique that has been employed for hundreds of years by professional and amateur astronomers alike. Keep in mind, as with any new task, that star hopping may seem challenging at first, but will become easier over time and with practice.

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

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

Determine in which constellation the object lies. Now, find the constellation in the sky. If you do not recognize the constellations on sight, consult a planisphere. The planisphere gives an all-sky view and shows which constellations are visible on a given night at a given time.

Now, look at your star chart and find the brightest star in the constellation that is near the object you are trying to find.

Using the finder scope, point the telescope at this star and center it on the crosshairs. Next, look again at the star chart and find another suitably bright star near the bright star currently centered in the finder. Keep in mind that the field of view of the finder scope is about 7°, so you should choose another star that is no more that 7° from the first star, if possible. Move the telescope slightly, until the telescope is centered on the new star.

Continue using stars as guideposts in this way until you are at the approximate position of the object you are trying to find (Figure 7). Look in the telescope's eyepiece, and the object should be somewhere within the field of view. If it's not, sweep the telescope carefully around the immediate vicinity until the object is found.

If you have trouble finding the object, start the star hop again from the brightest star near the object you wish to view. This time, be sure the stars indicated on the star chart are in fact the stars you are centering in the eyepiece.

7. Astrophotography

Moon Photography

This is perhaps the simplest form of astrophotography, as no motor drive is required. All that is needed is a T-ring for your specific camera. Connect the T-ring to your camera body, and remove the diagonal and eyepiece from the telescope's focuser. Then thread the camera and T-ring directly onto the telescope's focuser, coupling the telescope and camera body.

Now you're ready to shoot. Point the telescope toward the Moon, and center it within the camera's viewfinder. Focus the image with the telescope's focuser. Try several exposure times, all less than 1 second, depending on the phase of the Moon and the ISO (film speed) of the film being used. A remote shutter release is recommended , since touching the camera's shutter release can vibrate the camera enough to ruin the exposure.

This method of taking pictures is the same method with which a daytime, terrestrial photograph could be taken through the AstroView 90.

Planetary Photography

Once you've mastered basic Moon photography, you're ready to get images of the planets. This type of astrophotography also may be used to capture highly magnified shots of the Moon. In addition to the T-adapter already mentioned, a single-axis electronic drive and universal 1.25" camera adapter are also required. The electronic drive is necessary because of the longer exposure required for planetary photography. The longer exposure time would cause the image to blur if no motor drive were used for tracking. The equatorial mount must be precisely polar aligned, too.

As before, connect the T-ring to your camera. Before connecting the universal camera adapter to the T-ring, an eyepiece must be inserted and locked into the body of the adapter. Start by using a medium-low power eyepiece (about 25mm); you can increase the magnification later by using a higher-power eyepiece. Then connect the entire camera adapter, with eyepiece inside, to the T-ring. Insert the whole system into the telescope's focuser drawtube and secure firmly with the thumbscrew.

Aim the telescope at the planet (or Moon) you wish to shoot. The image will be highly magnified, so you may need to use the finder scope to center it within the camera's viewfinder. Turn the motor drive on. Adjust the telescope's focuser so that the image appears sharp. The camera's shutter is now ready to be opened. A remote shutter release must be used or the image will be blurred beyond recognition! Try exposure times between 1 and 10 seconds, depending on the brightness of the planet to be photographed and the ISO of the film being used.

"Piggybacking" Photography

The Moon and planets are interesting targets for the budding astrophotographer, but what's next? Literally thousands of deep-sky objects can be captured on film with a type of astrophotography called "piggybacking." The basic idea is that a camera with its own camera lens attached rides on top of the main telescope. The telescope and camera both move with the rotation of the Earth when the mount is polar aligned and the motor drive is engaged. This allows for a long exposure through the camera without blurring of the object or background stars. In addition to the motor drive, an illuminated reticle eyepiece is also needed. The T-ring and camera adapter are not needed, since the camera is exposing through its own lens. Any camera lens with a focal length between 50mm and 400mm is appropriate.

On the top of one of the tube rings is a piggyback camera adapter. This is the black knob with the threaded shaft protruding through its center. The tube ring with the piggyback adapter on it should be closest to the front of the telescope. Remove the tube rings from the equatorial mount and swap their positions, if necessary. Now, connect the camera to the piggyback adapter. There should be a 1/4"-20 mounting hole in the bottom of the camera's body. Thread the protruding shaft of the piggyback adapter into the 1/4"-20 hole in the camera a few turns. Position the camera so that it is parallel with the telescope tube and turn the knurled black knob of the piggyback adapter counterclockwise until the camera is locked into position.

Aim the telescope at a deep-sky object. It should be a fairly large deep-sky object, as the camera lens will likely have a wide field of view. Check to make sure that the object is also centered in the camera's viewfinder. Turn the motor drive on. Now, look into the telescope's eyepiece and center the brightest star within the field of view. Remove the eyepiece and insert the illuminated reticle eyepiece into the telescope's star diagonal. Turn the eyepiece's illuminator on (dimly!). Recenter the bright star (guide star) on the crosshairs of the reticle eyepiece. Check again to make sure the object to be photographed is still centered within the camera's field of view. If it is not, recenter it either by repositioning the camera on the piggyback adapter, or by moving the main telescope. If you move the main telescope, then you will need to recenter another guide star on the eyepiece's crosshairs. Once the object is centered in the camera, and a guide star is centered in the eyepiece, you're ready to shoot.

Deep-sky objects are quite faint, and typically require exposures on the order of 10 minutes. To hold the camera's shutter open this long, you will need a locking shutter release cable . You will also need to set the camera's shutter to the "B" (bulb) setting for the locking shutter release to work properly. Depress the release cable and lock it. You are now exposing your first deep-sky object.

While exposing through the camera lens, you will need to monitor the accuracy of the mount's tracking by looking through the illuminated reticle eyepiece in the main telescope. If the guide star drifts from its initial position, then use the hand controller of the motor drive to "bump" the guide star back to the center of the crosshairs. The hand controller only moves the telescope along the R.A. axis, which is where most of the corrections will be made. If the guide star appears to be drifting significantly along the Dec. axis, then the mount's slow-motion control cables can be carefully used to move the guide star back onto the crosshairs. Any drifting along the Dec. axis is due to imprecise polar alignment. If the drifting is significant, you may need to polar align the mount more accurately.

When the exposure is complete, unlock the shutter release cable and close the camera's shutter.

Astrophotography can be enjoyable and rewarding, as well as frustrating and time-consuming. Start slowly and consult outside resources, such as books and magazines, for more details about astrophotography. Remember . . . have fun!

8. Terrestrial Viewing

The AstroView 90 may also be used for long-distance viewing over land. For this application we recommend substitution of an Orion 45° Correct-Image Diagonal for the 90° star diagonal that comes standard with the telescope. The correct-image diagonal will yield an upright, non-reversed image and also provides a more comfortable viewing angle, since the telescope will be aimed more horizontally for terrestrial subjects.

For terrestrial viewing, it's best to stick with low powers of 50x or less. At higher powers the image loses sharpness and clarity. That's because when the scope is pointed near the horizon, it is peering through the thickest and most turbulent part of the Earth's atmosphere.

Remember to aim well clear of the Sun, unless the front of the telescope is fitted with a professionally made solar filter and the finder scope is covered with foil or some other completely opaque material.

9. 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 cap on the front of the telescope when it is not in use.

Cleaning the Tube

Your AstroView 90 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 on the tube, it will not harm the telescope. If you wish, you may apply some auto touch-up paint to the scratch. Smudges on the tube can be wiped off with a soft cloth and a household cleaner such as Windex or Formula 409.

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 AstroView's objective lens or the exposed lenses of your eyepieces or finder scope. Never use regular glass cleaner or cleaning fluid designed for eyeglasses. Before cleaning with fluid and tissue, 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 large surface of the objective lens, clean only a small area at a time, using a fresh lens tissue on each area. Never reuse tissues.

10. Specifications

Optical tube: Seamless aluminum

Objective lens: Achromatic doublet, air spaced, optical glass elements

Objective lens coatings: Fully coated with multi-coatings

Objective lens diameter: 90mm (3.5")

Focal length: 910mm

Focal ratio: f/10

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

Magnification: 36x (with 25mm), 91x (with 10mm)

Focuser: Rack and pinion

Diagonal: 90° Star diagonal, mirror type, 1.25"

Finder scope: 6x Magnification, 30mm aperture, achromatic, crosshairs

Mount: EQ-2 German-type equatorial

Tripod: Aluminum

Motor drive: Optional

Weight: 24 lbs.

One-Year Limited Warranty

This Orion AstroView 90 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, P. O. Box 1815, Santa Cruz, CA 95061; (800) 676-1343.

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