INSTRUCTION MANUAL

Orion® 6" Newtonian Imaging Reflector

#9786

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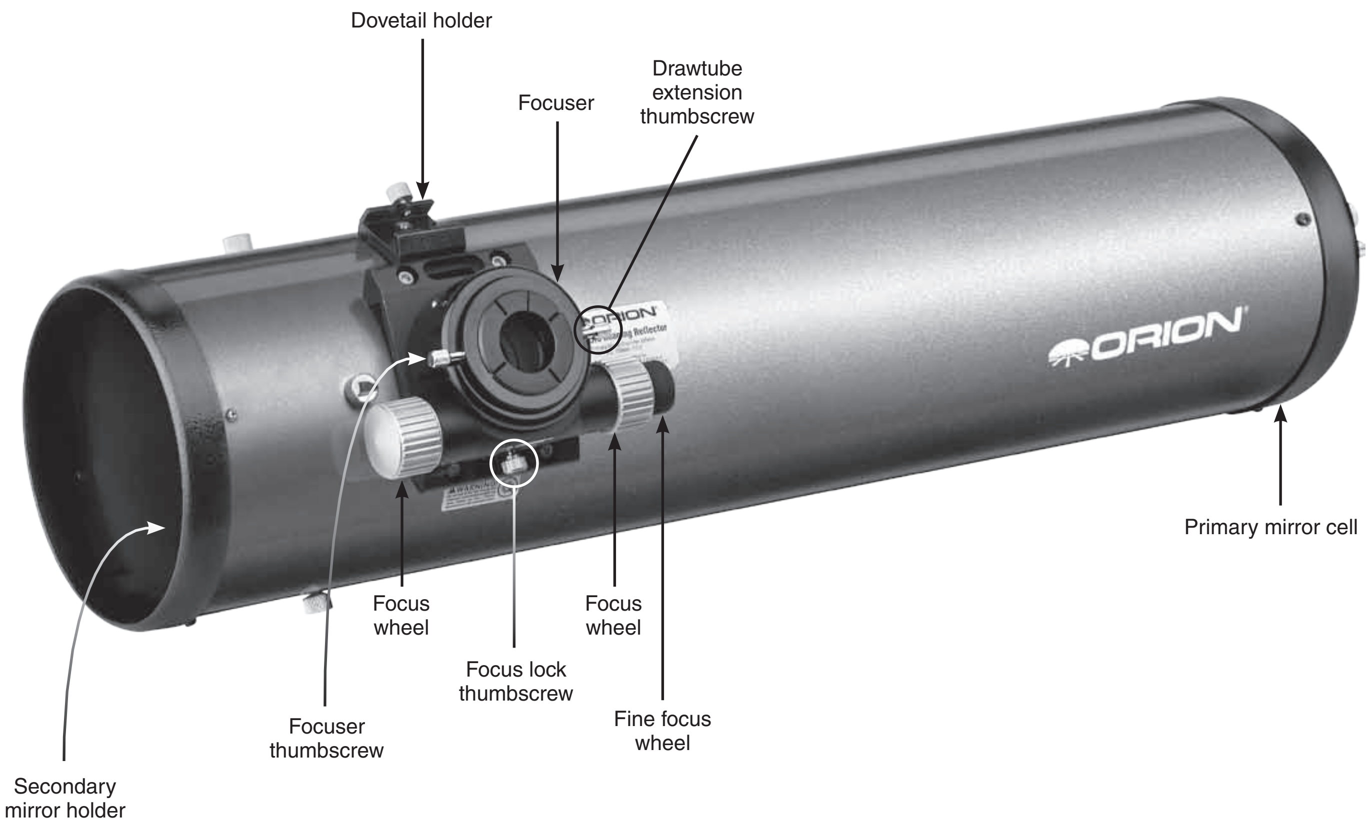

Figure 1. The 6" Newtonian Imaging Reflector.

Congratulations on your purchase of an Orion 6" Newtonian Imaging Reflector.

Your 6" Newtonian Imaging Reflector is a Newtonian reflector telescope with high quality optics and excellent mechanical construction. It has been specially optimized for use with astronomical CCD imaging cameras. These instructions will help you set up and use your telescope.

Getting Started

The 6" Newtonian Imaging Reflector comes nearly fully assembled from the factory. The telescope's optics have been installed and collimated, so you should not have to make any adjustments to them.

Please keep the original shipping box! In the unlikely event you should need to ship the telescope back to Orion for warranty repair service, you should use the original packaging. The box also makes a very good container for storing the telescope when it is not in use.

Attaching the 6" Newtonian Imaging Reflector to a Mount

The 6" Newtonian Imaging Reflector can be attached to a mount by the use of optional tube rings. Tube rings with an inner diameter of 182mm (7.16"), such as Orion item #7375, are needed. First attach the tube rings to your telescope mount, then place the optical tube in the tube rings.

Use of Optional Finder Scope and Eyepieces

The 6" Newtonian Imaging Reflector OTA does not come with a finder scope or eyepieces in order to grant the user the greatest versatility in customizing the instrument to suit their tastes. However, certain rules for using accessories still apply.

To connect a finder scope, simply unthread the thumbscrew on the dovetail holder (Figure 1), and insert the base of the finder scope bracket. Retighten the thumbscrew to secure the finder scope and bracket in place. Finder scopes that do not use a dovetail bracket will need to be attached by some other means.

Almost any 1.25" or 2" eyepiece can be used with the 6" Newtonian Imaging Reflector.

To use 2" eyepieces, you will need to remove the 1.25" eyepiece adapter by loosening the drawtube thumbscrew by a few turns and lifting the adapter out of the focuser. Place your 2" eyepiece in the focuser drawtube and secure it in place with the thumbscrew.

In order to use a 1.25" eyepiece in the focuser, the 1.25" eyepiece adapter is needed. Place this adapter into the drawtube like a 2" eyepiece, and loosely secure it with the thumbscrew. Insert a 1.25" eyepiece into the adapter, and secure the eyepiece by further tightening the thumbscrew. Tightening the thumbscrew compresses the 1.25" eyepiece adapter, which in turn secures and precisely centers the 1.25" eyepiece.

The Dual-Speed Low-Profile Crayford Focuser

The 6" Newtonian Imaging Reflector comes equipped with a high-quality dual-speed low-profile Crayford focuser. Crayford focusers generally perform better than rack-and-pinion models because the design eliminates "focus shift." Focus shift occurs when an image changes position in the eyepiece during focusing. The Crayford design provides constant tension via four "roller bearings" and the focus shaft, so the drawtube cannot move perpendicular to the desired motion.

The Crayford focuser provides a minimum focus height of 43mm, which is excellent for imaging applications that require extra in-travel. The focuser also features a built-in extendable drawtube which adds up to 44mm of travel yielding a total focus range of 68mm. Extension of this drawtube is required to achieve focus in an eyepiece with the telescope. To extend the drawtube, loosen the drawtube extension thumbscrew (Figure 1) and gently pull the drawtube upwards to the preferred position. Tighten the drawtube extension thumbscrew to lock the extension in place. The extendable drawtube is a welcome feature when switching between an eyepiece and imager, as no external extension tubes are required.

Dual-Speed Focus Adjustments

The focuser features dual speed adjustment with the fine focus wheel. This small black knob located on the side of the right-hand focus wheel allows precise focus adjustment at a ratio of 11:1, meaning eleven turns of the fine focus wheel equals one turn of the focus wheel.

Use the focus wheels to achieve rough focus on your target object, then use the fine focus knob to coax out even more detail. You'll be amazed at the amount of detail the fine focus knob allows you to view on targets such as the lunar surface, planets, double stars, as well as other celestial objects.

If you find that the focus wheels are too tight or too loose, you can make adjustments to the drawtube tension by using the drawtube tension adjustment set screw located on the bottom of the focuser, between the focus wheels. Make adjustments to this set screw with the provided 2.5mm hex key until the focuser motion feels comfortable. Please note that you must have at least some tension applied to the focuser drawtube or else it will not move when you turn the focus wheels.

Once you have achieved focus, you can lock the focuser in place by tightening the focus lock thumbscrew located between on the bottom of the focuser between the focus wheels (Figure 1). Locking the focuser in place can be especially useful for imaging applications. Be sure to loosen the focus lock thumbscrew before making additional focus adjustments.

The focuser can be rotated, should the need arise. This requires a 1.5mm hex key (not included). To reposition the focuser, loosen the 4 small socket-head set-screws that are located within the base. Rotate the focuser to the preferred position and carefully tighten the four set screws with the 1.5mm hex key. Be sure to keep the focuser flat against the base to ensure proper alignment.

Calculating Magnification (Power)

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:

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

For example, the 6" Newtonian Imaging Reflector, which has a focal length of 750mm, used in combination with a 25mm eyepiece, yields a magnification of

$$\frac{750\text{ mm}}{25\text{ mm}} = 30\text{x}$$

Every telescope has a useful limit of power of about 45x-60x per inch of aperture. 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") will usually 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 observed 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.

Astroimaging with the 6" Newtonian Imaging Reflector

The 6" Newtonian Imaging Reflector has been specifically designed for use with astronomical CCD imaging cameras like the Orion StarShoot, but other imaging systems such as digital SLR cameras will also work well with the telescope. The secondary mirror of the 6" Newtonian Imaging Reflector has been sized appropriately to provide a fully illuminated field of view for Orion StarShoot cameras and most popular digital SLR models.

Unlike most Newtonian reflector designs, the 6" Imaging Reflector's secondary mirror has been recessed further into the tube to prevent off-axis glare from being detected by imaging devices. Glare can contaminate night-sky images by reducing image contrast and giving the object a "soft" appearance.

To use your CCD camera with the 6" Newtonian Imaging Reflector, the camera must have a 1.25 inch "nosepiece". Otherwise an external camera adapter with T-threads is required. All Orion StarShoot cameras feature this nosepiece (Figure 2). Insert the nosepiece equipped camera into the focuser just like an 1.25" eyepiece.

If your camera does not include a 1.25" nosepiece, you have a digital SLR, or if you wish to utilize a secure T-thread connection with a CCD camera like the Orion StarShoot, a zero-profile camera adapter is required (available from Orion). The zero-profile adapter is inserted into the focuser just like a 2" eyepiece and provides T-threads for attachment of digital SLR T-rings or T-threaded CCD cameras.

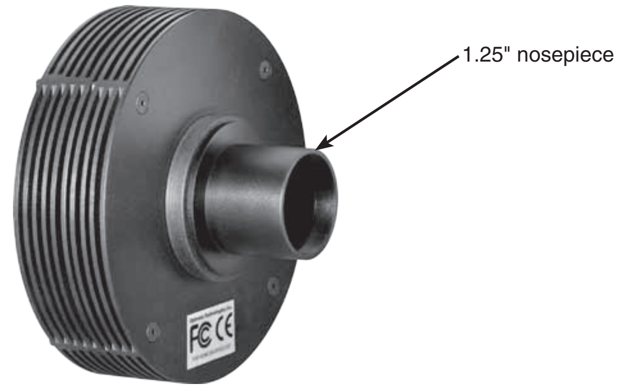

Figure 2. To use a CCD camera with the 6" Imaging OTA, the camera must have a 1.25" nosepiece, like the Orion StarShoot Imaging cameras, or else an external camera adapter with T-threads is required.

To attach a digital SLR to the telescope, remove any attached lenses and connect a model-specific T-ring to the camera body. Thread the T-ring onto the zero-profile adapter to complete attachment. To securely attach a CCD imaging camera like the Orion StarShoot via T-threads, remove the 1.25" nosepiece and thread the CCD camera onto the zero-profile camera adapter to complete attachment.

Due to its imaging-optimized design, no external extension tubes are required to appropriately couple the telescope to an imaging camera.

To record an image of a night-sky object, you will need to first acquire and center the object with an eyepiece. You may need to extend the focuser's built-in extension tube to achieve focus with an eyepiece. Once you have centered the target object in the eyepiece field of view, remove the eyepiece and insert your CCD camera into the telescope's focuser (don't forget to retract the built-in extension tube if it has been extended). Secure the camera with the thumbscrew on the focuser. Use the focus and fine-focus wheels to bring the image into focus.

Collimating the Optics

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

To check optical alignment, remove the eyepiece and look down the focuser drawtube. You should see the secondary mirror centered in the drawtube, as well as the reflection of the primary mirror centered in the secondary mirror, and the reflection of the secondary mirror (and your eye) centered in the reflection of the primary mirror, as in Figure 3a. If anything is off-center, proceed with the following collimating procedure.

The Collimating Cap and Primary Mirror Center Mark

Your 6" Newtonian Imaging Reflector comes with a collimating cap. This is a simple cap that fits on the focuser drawtube like a dust cap, but has a hole in the center and a silver bot-

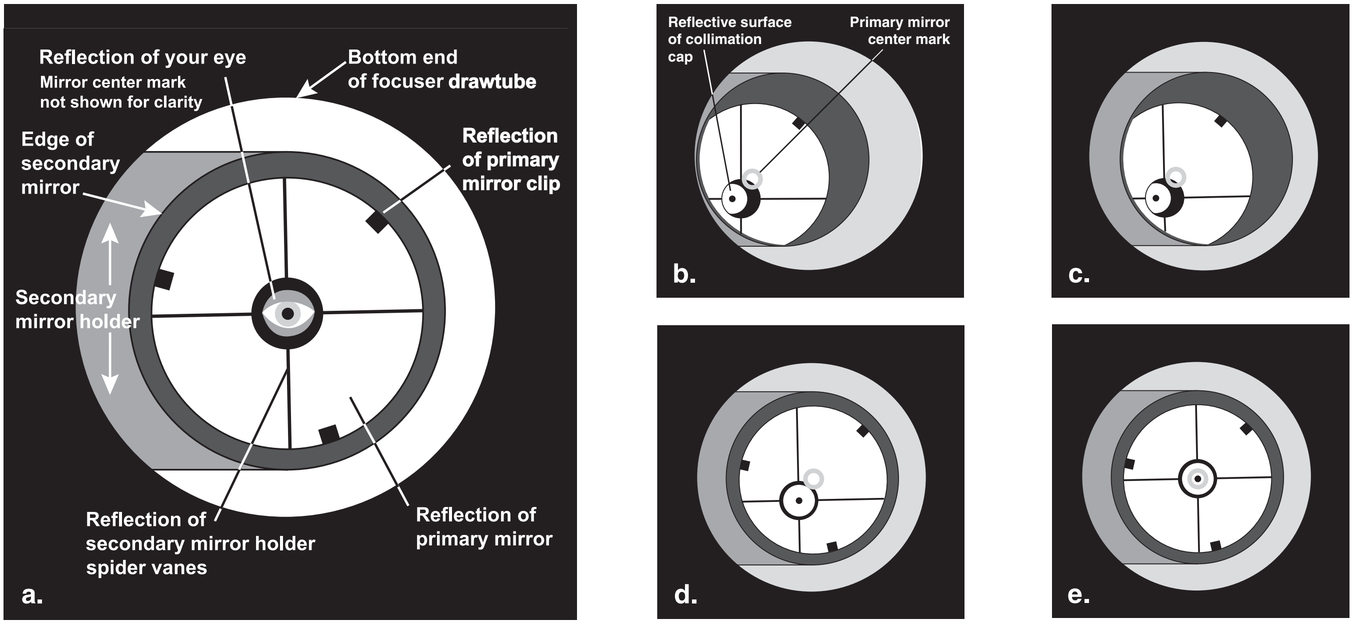

Figure 3. Collimating the optics. **(a)** When the mirrors are properly aligned, the view down the focuser drawtube should look like this. **(b)** With the collimation cap in place, if the optics are out of alignment, the view might look something like this. **(c)** Here, the secondary mirror is centered under the focuser, but it needs to be adjusted (tilted) so that the entire primary mirror is visible. **(d)** The secondary mirror is correctly aligned, but the primary mirror still needs adjustment. When the primary mirror is correctly aligned, the "dot" will be centered, as in **(e)**.

tom. This helps center your eye so collimating is easy to perform. Figures 3b through 3e assume you have the collimating cap in place.

In addition to the collimating cap, you'll notice a small ring label on the exact center of the primary mirror. This "center mark" allows you to achieve a very precise alignment of the primary mirror; you don't have to guess where the center of the mirror is. You simply adjust the primary mirror position (described below) until the reflection of the hole in the collimating cap is centered inside the ring.

Note: The center ring sticker need not ever be removed from the primary mirror. Because it lies directly in the shadow of the secondary mirror, its presence in no way adversely affects the optical performance of the telescope or the image quality. That might seem counter-intuitive, but it's true!

Aligning the Secondary Mirror

It helps to adjust the secondary mirror in a brightly lit room with the telescope pointed toward a bright surface, such as white paper or wall. Placing a piece of white paper in the telescope tube opposite the focuser (i.e. behind the secondary mirror) will also be helpful in collimating the secondary mirror.

With the collimating cap in place, look through the hole in the cap at the secondary (diagonal) mirror. Ignore the reflections for the time being. The secondary mirror itself should be centered in the focuser drawtube. If it isn't, as in Figure 3b, it must be adjusted. Typically, this adjustment will rarely, if ever, need to be done.

Note: When make adjustments to the secondary mirror position, be careful not to stress the spider vanes, or they may bend.

To adjust the secondary mirror left-to-right in the focuser drawtube, use the included 2.5mm hex key to loosen the three small alignment setscrews in the center hub of the 4-vaned spider several turns. Now hold the mirror holder stationary (be careful not to touch the surface of the mirror), while turning the center screw with a Phillips head screwdriver (Figure 4). Turning the screw clockwise will move the secondary mirror toward the front opening of the optical tube, while turning the screw counter-clockwise will move the secondary mirror toward the primary mirror. When the secondary mirror is centered left-to-right in the focuser drawtube, rotate the second-

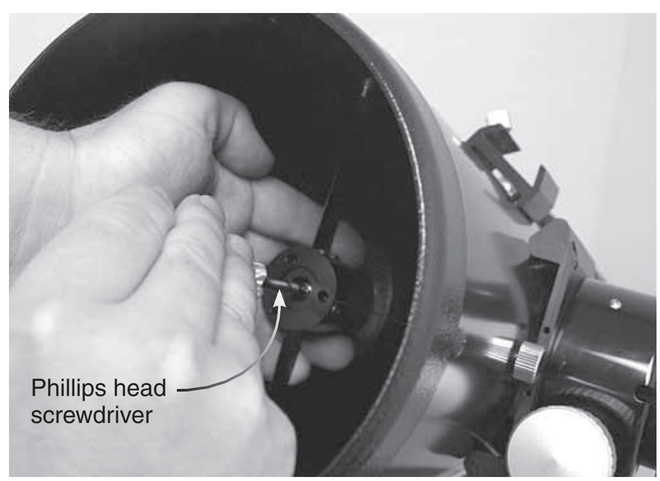

Figure 4. To center the secondary mirror under the focuser, hold the secondary mirror holder in place with your fingers while adjusting the center screw with the Phillips head screwdriver. Do not touch the mirror's surface.

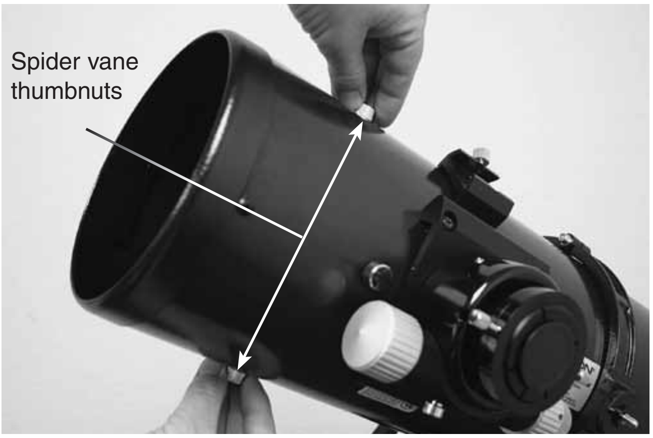

Figure 5. To center the secondary mirror up-and-down in the focuser drawtube, make adjustments to the two knurled spider vane thumbnuts that are perpendicular to the focuser.

ary mirror holder until the reflection of the primary mirror is as centered in the secondary mirror as possible. It may not be perfectly centered, but that is OK for now. Tighten the three small alignment setscrews equally to secure the secondary mirror in that position.

To adjust the secondary mirror up-and-down in the focuser drawtube, adjust the length of the two spider vanes perpendicular to the focuser. This is done by tightening the knurled thumbnuts that secure the vanes to the tube (Figure 5). Loosen one thumbnut, then tighten the other until the secondary mirror is centered in the drawtube.

The secondary mirror should now be centered in the focuser drawtube. Now we will shift our attention to the reflections within the secondary mirror.

If the entire primary mirror reflection is not visible in the secondary mirror, as in Figure 3c, you will need to adjust the tilt of the secondary mirror. This is done by alternately loosening one of the three alignment setscrews while tightening the other two, as depicted in Figure 6. You will need a 2mm hex key to do this. The goal is to center the primary mirror reflection in the secondary mirror, as in Figure 3d. Don't worry that the reflection of the secondary mirror within the primary mirror reflection (the smallest circle, with the collimation cap "dot" in the center) is off-center. You will fix that in the next step.

Once the secondary mirror is centered in the focuser drawtube, and the primary mirror reflection is centered in the secondary mirror, the secondary mirror is properly aligned, and no further adjustments to it should be needed.

Aligning the Primary Mirror

The final adjustment is made to the primary mirror. It will need adjustment if, as in Figure 3d, the secondary mirror is centered in the focuser drawtube and the reflection of the primary mirror is centered in the secondary mirror, but the small reflection of the secondary mirror (with the "dot" of the collimating cap) is off-center.

The tilt of the primary mirror is adjusted with the three large knurled thumbscrews on the rear end of the optical tube (back of the mirror cell) (Figure 7). The small thumbscrews (with slots in them) serve to lock the mirror in place. Start by loosening each of these smaller thumbscrews a few turns. Use a screwdriver in the slots, if necessary. Now adjust the tilt of the primary mirror by turning one of the large thumbscrews either clockwise or counterclockwise. Look into the focuser and see if the secondary mirror reflection has moved closer to the center of the primary mirror reflection. You can determine this easily with the collimating cap and primary mirror center mark by simply watching to see if the "dot" of the collimating cap is moving closer or farther away from the "ring" on the primary mirror. If it isn't getting closer, try turning the thumbscrew in the opposite direction. Repeat this process for the other two large thumbscrews, if necessary. It will take a little trial-and-error to get the feel for how to adjust the primary mirror to center the dot of the collimating cap in the ring of the primary mirror center mark.

When you have the dot centered as much as possible in the ring, your primary mirror is aligned. The view through the collimating cap should resemble Figure 3e. Make sure the smaller thumbscrews on the back of the mirror cell are tightened to lock the primary mirror in position.

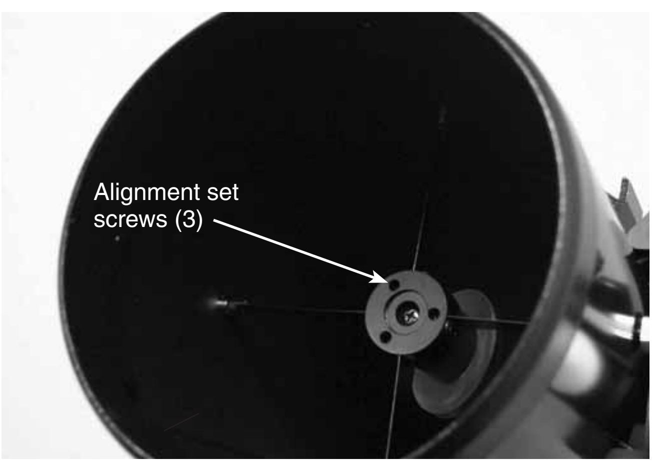

Figure 6. Adjust the tilt of the secondary mirror by loosening one of the three alignment set screws then tightening the other two.

Figure 7. The tilt of the primary mirror is adjusted by turning the three larger thumbscrews.

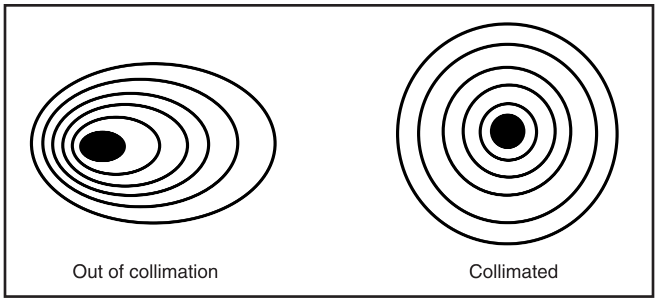

Figure 8. A star test will determine if the telescope's optics are properly collimated. A defocused view of a bright star through the eyepiece should appear as illustrated on the right if optics are perfectly collimated. If the circle is unsymmetrical, as illustrated on the left, the scope needs alignment.

A simple star test will tell you whether the optics are, in fact, accurately aligned.

Star-Testing the Telescope

When it is dark, point the telescope at a bright star and accurately center it in the eyepiece's field of view. Slowly de-focus the image with the focus knob. If the telescope's optics are correctly aligned, the expanding disk should be a perfect circle (Figure 8). If the image is unsymmetrical, the optics are out of alignment. The dark shadow cast by the secondary mirror should appear in the very center of the out-of-focus circle, like the hole in a donut. If the "hole" appears off-center, the optics are out of alignment.

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

Care & 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 dust cover on the front of the telescope and the dust cap on the focuser drawtube when it is not in use.

Your telescope requires very little mechanical maintenance. The optical tube 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 household cleaning fluid.

Cleaning Mirrors

You should not have to clean the telescope's mirrors very often; normally once every year or so is fine. Covering the front opening of the telescope with the dust cover when it is not in use will prevent dust from accumulating on the mirrors. Keeping the dust cap on the focuser's 1.25" opening is also a good idea. Improper cleaning can scratch the mirror coatings, so the fewer times you have to clean the mirrors, the better. Small specks of dust or flecks of paint have virtually no effect on the visual performance of the telescope.

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

To clean the secondary mirror, first remove it from the telescope. Do this by keeping the secondary mirror holder stationary while completely unthreading the Phillips-head screw in the center hub of the spider vane assembly (see Figure 4). Do not touch the mirror surface when doing this. Be careful, there is a spring between the secondary mirror holder and the Phillips head screw; be sure it does not fall into the optical tube and onto the primary mirror. Once the Phillips-head screw is unthreaded, the secondary mirror and its holder can be removed from the telescope. Then follow the same procedure described below for cleaning the primary mirror. The secondary mirror does not need to be removed from its holder for cleaning.

To clean the primary mirror, first carefully remove the mirror cell from the telescope. For the 6" Imaging Reflector, you must completely unthread the four screws on the exterior perimeter of the mirror cell (Figure 9). Then pull the cell away from the tube. You will notice the primary mirror is held in the mirror cell with three clips held by two screws each. Loosen the screws and remove the clips.

You may now remove the primary mirror from its cell. Do not touch the surface of the mirror with your fingers. Lift the mirror carefully by the edges. Set the mirror on a clean soft towel. Fill a clean sink free with room temperature water, a few drops of liquid dishwashing detergent, and if possible, a capfull of

Figure 9. To remove the mirror cell from the telescope, the four small Phillips-head screws on the perimeter of the mirror cell must be completely unthreaded.

100% isopropyl alcohol. Submerge the mirror (aluminized face up) in the water and let it soak for a few minutes (or hours if it's a very dirty mirror). Wipe the mirror under water with clean cotton balls, using extremely light pressure and stroking in straight lines across the mirror surface. Use one ball for each wipe across the mirror. Then rinse the mirror under a stream of lukewarm water. Any particles on the surface can be swabbed gently with a series of cotton balls, each used just one time. Dry the mirror surface with a stream of air (a "blower bulb" works great). Cover the mirror surface with tissue, and leave the mirror in a warm area until it is completely dry before replacing it in the mirror cell and telescope.

Specifications

Optical tube:	Steel
Primary mirror:	Parabolic, center marked
Collimation adjustment:	Three spring-loaded thumbnuts to adjust mirror tilt, one thumbnut in-line with focuser, three thumbscrews to lock mirror position
Aperture:	6" (150mm)
Focal length:	750mm
Focal ratio:	f/5.0
Minor axis of secondary mirror:	2.28" (58.0mm)
Secondary mirror offset:	2.9mm away from focuser and 2.9mm towards primary mirror
Mirror coatings:	Aluminum with silicon dioxide (SiO_2) overcoat
Focuser:	Crayford, accepts 2" accessories, dual-speed focus adjustment, rotatable, focus-lock equipped
Minimum focus height:	43mm
Focus travel:	24mm, 68mm with 2" drawtube extended
1.25" adapter:	Included, compression-fit design
Weight:	10.5 lbs.
Length:	30.5"

One-Year Limited Warranty

This Orion 6" Newtonian Imaging Reflector 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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