The Astro-Tech Collimating Eyepiece

For best performance, all reflecting telescopes require regular collimation (aligning the telescope's mirrors with its optical and mechanical axes). If the mirrors are centered and correctly angled (collimated), the light entering the telescope will form a sharp image at the eyepiece or camera focal plane. If your mirrors are not collimated properly, stars can look like flared or teardrop-shaped "comets" or "sea gulls" rather than as pinpoints, as shown to the right in Figure A, and lunar and planetary detail will be smeared.

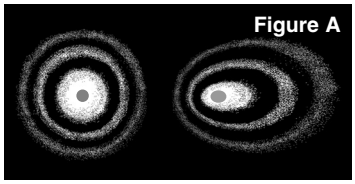


Figure A

A Newtonian reflector will generally hold its collimation if care is taken in transporting and handling the optical tube. However, sharp jolts, transporting the scope over bumpy roads in the trunk of a car, temperature changes, or storing the scope on its side for long periods may knock the mirrors out of alignment. Fortunately, Newtonian reflectors are equipped with adjustment screws that permit easy recollimation.

You can quickly check your telescope's collimation by pointing it at a bright star and slowly racking the image in and out of focus. In a collimated telescope, the expanding disk of the star's image should be a series of circular rings on both sides of focus, as seen in the left image in Figure A, above. If the disk is asymmetrical or lopsided, the scope is out of collimation. The dark circular shadow of the diagonal mirror should be in the center of the out-of-focus rings, like the hole in a doughnut. If the hole appears off-center, the telescope is out of collimation.

The Astro-Tech collimating eyepiece is a combination sight tube and Cheshire eyepiece. The sight tube portion has a narrow field of view and crosshairs that provide a reference for centering the optical elements during collimation. The Cheshire eyepiece portion has a semi-reflective polished flat set in the barrel at a 45° angle. This directs light entering from a cutout in the side of the barrel down into the optical path to give you a target for aligning the primary mirror.

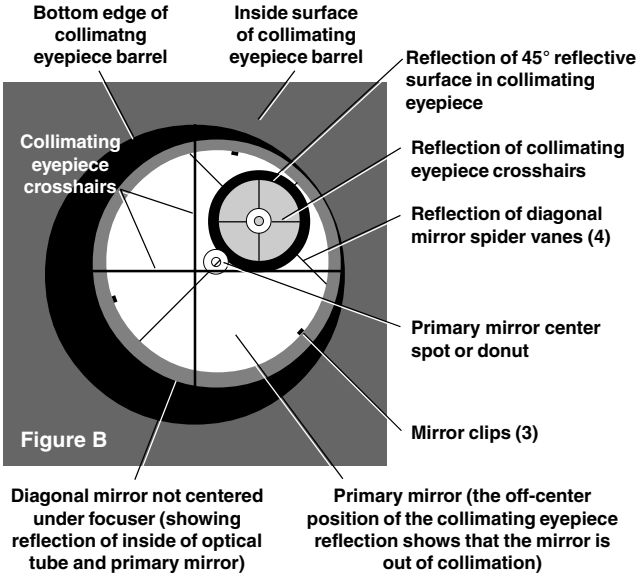
The Cheshire allows quick and easy collimation of the primary mirror, assuming the mirror has been marked with a spot or donut exactly in its center. If the mirror was not center-spotted at the factory, measure to determine the exact center of the mirror, then use a black permanent felt-tip marker to mark the center with a 1/4" diameter spot. If the black spot is difficult to see behind the crosshairs of the collimating eyepiece, affix a loose-leaf binder's white paper reinforcement at the center of the mirror. Because the center spot or donut is in the shadow of the diagonal mirror, it does not appear in the telescope image.

You can collimate your scope during the day or indoors, when it is easier to see what you are doing. When outside, never point the telescope or the cutout in the side of the collimating eyepiece at or near the Sun, or serious and instant eye damage could result! At night, a red flashlight aimed at the cutout in the side of the collimating eyepiece will provide the necessary light.

If there is an eyepiece in the telescope, remove it and insert the collimating eyepiece into your 1.25" focuser. If you have a 2" focuser, use an optional 2" to 1.25" adapter to hold the eyepiece. Rotate the eyepiece in the focuser until the cutout in its side aims at an available external light.

While looking through the small sight hole in the top of the collimating eyepiece, insert the eyepiece far enough into the focuser so that the bottom edge of the eyepiece tube appears slightly wider than the outer edge of the diagonal mirror.

Figure B: View through the collimating eyepiece showing a diagonal mirror that is not centered and a primary mirror that is out of collimation.



Make sure there is adequate light so that when you look through the sight hole, you can see the edges of the diagonal mirror clearly. Tighten the thumbscrew on the focuser to secure the collimating eyepiece in place.

While looking through the sight hole of the collimating eyepiece, check to see if the diagonal mirror is physically centered under the focuser. The center of the diagonal mirror should be right at the intersection of the collimation eyepiece crosshairs. Ignore the reflections in the diagonal at this point, but simply check to see if the diagonal is physically in the proper location.

If the mirror is not physically centered under the focuser, adjust the position of the diagonal mirror holder until the mirror is centered. This may involve loosening the center bolt on the spider to rotate the threaded rod holding the diagonal mirror holder from side to side, adjusting the height of the diagonal mirror holder up and down on the threaded rod, adjusting the spider vanes to center the diagonal in the tube, etc. Most telescopes

will have been assembled with the diagonal in the proper position at the factory, so few (if any) adjustments will be needed.

Refer to your telescope's manual for more specific instructions on adjusting the diagonal, if needed.

Once you are sure the diagonal is physically centered under the focuser, adjust the tilt of the diagonal mirror so that the entire reflection of the primary mirror is precisely centered in the diagonal mirror. Use the three collimation screws on the diagonal holder to adjust the tilt. The reflection of the primary mirror is centered when there is an even ring of space between it and the outer edge of the diagonal mirror and the center spot on the mirror is centered under the crosshairs of the collimating eyepiece (Figure C, to the left). Do not be concerned if the small reflection of the diagonal mirror is off-center as seen in Figure C; you'll fix that in the next step. If you do not see the reflection of the primary at all, the tilt of your diagonal is way off, and more tinkering with its collimation screws will be necessary.

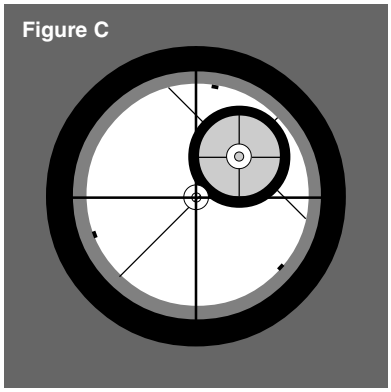


Figure C

Once the primary mirror has been properly centered in the diagonal, it's time to adjust the tilt of the primary mirror. The tilt is adjusted using the three collimation screws on the back end of the optical tube (at the bottom of the primary mirror cell). Your scope may have three pairs of push/pull collimation screws (one larger than the other in each pair). The larger screws usually do the collimating while the smaller screws lock the mirror's position in place once it is collimated. These smaller lock screws must be loosened before any collimation adjustments can be made to the primary mirror using the larger collimation screws.

To start, turn the smaller locking thumbscrews a few turns each counterclockwise to loosen them. Then try adjusting one collimation screw at a time, looking into the collimation eyepiece to see if the small diagonal mirror reflection has moved closer to, or further away from, the center of the primary mirror reflection.

When tightening one screw, you will have to loosen the two screws opposite by the same amount, and vice-versa (when loosening one screw, tighten the opposite two by the same amount).

Normally motions on the order of 1/8 turn will make a difference, with only about 1/2 to 3/4 turn being the maximum required. Do not remove or back out the collimation screws more than one to two turns.

Continue to tighten or loosen one screw at time until the diagonal mirror reflection moves into the center of the primary mirror reflection. The center spot or donut in the middle of the primary mirror should be exactly centered in the bright ring that is the reflection of the 45° reflecting surface in the collimating eyepiece. Now, the view through the collimating eyepiece should resemble Figure D, to the right.

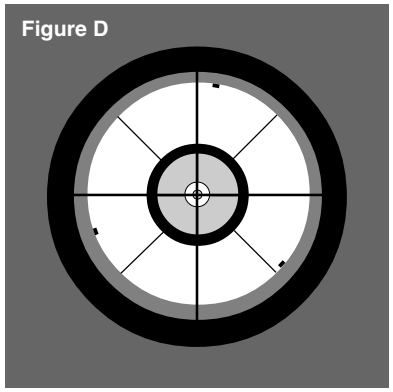


Figure D

The reflection of the primary mirror is centered in the diagonal mirror, and the reflection of the diagonal mirror is centered in the reflection of the primary mirror.

Once everything is centered on the crosshairs of the collimating eyepiece, retighten the locking screws to secure the collimation (do not overtighten). Your telescope is now collimated and ready to provide you with sharp, high-contrast images.

Because there are no lenses in the Astro-Tech collimating eyepiece, care and maintenance is minimal. It is a good idea to wipe down the collimating eyepiece before each use to remove any obvious dirt on the outside of the collimating eyepiece so that the dirt does not get into the telescope tube when you use it.

To clean the eyepiece, use a blower bulb to remove dirt from inside the barrel, and simply wipe the outside with a damp cloth. Make sure not to touch the crosshairs, which are relatively delicate, as you might bend or break them. Use the supplied hard 1.25" end cap to protect the crosshairs when you are not using the eyepiece.

The Astro-Tech collimating eyepiece is machined aluminum, so it's very durable, and small scratches or dents will not affect its performance.