

## Kendrick Collimating Cheshire Eyepiece

Congratulations on your purchase of a Kendrick Collimating Eyepiece! It's a practical and easy-to-use tool for insuring that your telescope's optics are always in precise alignment, and therefore capable of rendering the best possible resolution and contrast.

### What is Collimation?

Collimation is the process by which an instrument's optical components are brought into precise alignment with its optical axis and mechanical axis. In other words, all the mirrors and/or lenses should be centered and angled so that light entering the telescope forms a sharp image precisely in the center of the eyepiece. If the optics are not properly aligned, stars will appear not as pinpoints as they should, but rather as flared, teardrop-shaped "comets" or "sea gulls."

### Collimation of Different Telescope Types

Refractor and Maksutov telescopes are collimated at the factory and generally should not need further adjustment. If collimation does become necessary later, it is best to have it done at the factory, since these scopes usually possess no user-adjustable collimation settings. Collimation is more of an issue with Newtonian reflectors and Schmidt-Cassegrains. Good collimation is particularly critical for "faster" Newtonians, those with f-ratios of f/6 or lower. Once the collimation is set, it will hold if care is taken in transporting and handling the optical tube. However, any sharp jolts can knock the mirrors out of alignment, as can jostling of the scope in the trunk of a car or temperature changes over a period of time. Fortunately, these telescopes are equipped with adjustment screws that permit easy recollimation.

### Testing Your Telescope's Collimation

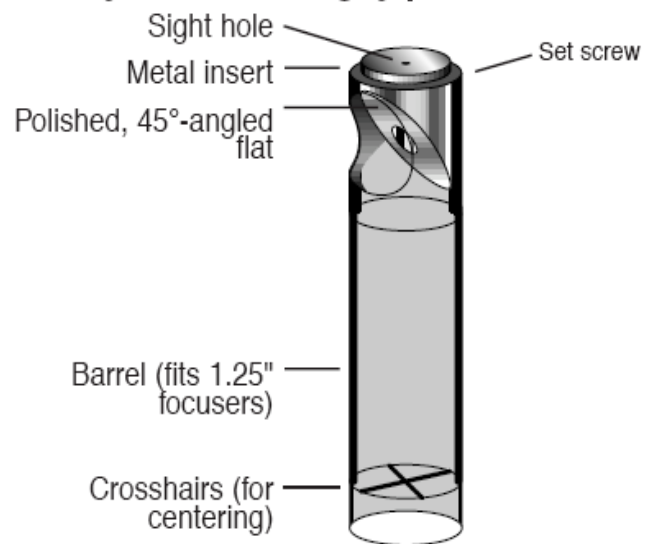
You can quickly determine whether your telescope is properly collimated. Just point it at a bright star and slowly rack the image out of focus by with the focusing knob. If the telescope is correctly collimated, the expanding disk should be a perfect circle. If it is unsymmetrical, the scope is out of collimation. In reflectors and Schmidt-Cassegrains, 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 doughnut. If the "hole" appears off-center, the telescope is out of collimation.

### Purpose of the Collimating Eyepiece

Aligning the mirrors seems easy enough, in theory, but in practice it can be difficult without the proper tools. A common way of collimating—the "quick and dirty" method—is to simply remove the eyepiece and look down the focuser tube to center the mirror reflections. The accuracy of this method, however, is not reliable. For one thing, there is no way to know whether you are looking straight down the focuser tube; your line of sight could be off by a degree or two. Another problem is knowing when the reflections of the mirrors are exactly centered. Just "eyeballing it" isn't precise enough; the reflections

may appear to be centered when in fact they are not. The Collimating Eyepiece will take care of both of these problems, allowing you to achieve precise collimation without "guessing," and thus improve your telescope's performance. The Collimating Eyepiece is a combination of a "sight tube" and a "Cheshire eyepiece." The sight tube's narrow field of view and crosshairs provide a reference for centering the optical elements during the collimation process. A Cheshire eyepiece has a polished flat set in the barrel at a 45 degree angle, which directs light entering from a cutout in the side of the barrel down into the optical path. The Cheshire allows quick and easy collimation of the primary mirror, assuming the mirror has been marked with a spot exactly in its center. (This can be done by first measuring to determine the exact center of the mirror, then marking it with a 1/4"-diameter spot with a black permanent felt-tip marker. (Another alternative is to affix a white paper hole "reinforcement" at the center, if the black spot is difficult to see behind the crosshairs of the Collimating Eyepiece.)

### Anatomy of the Collimating Eyepiece



Because the spot is positioned where the shadow of the secondary mirror falls, it does not cause light loss or diffraction. The polished flat projects a bright annulus (doughnut) of light into the optical path, providing a "target" for aligning the primary mirror.

### Newtonian Reflectors

1. With the telescope pointed away from the Sun, look into the front of the telescope tube. Check that the secondary (or diagonal) mirror is positioned in the center of the tube; use a ruler if necessary to measure the distance from the center of the secondary mirror holder to the inside of the tube on different sides. You may have to adjust the spider vanes or stalk. Also, check to see that the primary mirror is centered in the optical tube. A quick visual inspection usually suffices. If the primary is obviously not centered, it will need to be repositioned in its mirror cell.



2920 Dundas Street West  
Toronto, ON, L7J 2S4, Canada  
Tel: 416-762-7946  
Fax: 416-762-2765

- Next, if there is an eyepiece in the telescope, remove it. Look down into the open focuser tube. You will see the secondary mirror and mirror holder as well as reflections of the secondary mirror and its holder, the primary mirror, and your eye. It's pretty confusing, so refer to Figure 1 to sort them all out. (This figure shows what you would see if both the primary and secondary mirrors were out of alignment and the secondary mirror were not centered below the focuser tube.)
- Now insert the Collimating Eyepiece into the focuser and look into the sight hole. You'll notice that the field of view is narrower than it was when you were looking through the open focuser tube. You'll also notice that instead of seeing a reflection of your eye, you now see a bright annulus in the reflection of the secondary mirror. The annulus is the reflection of the polished 45° flat of the Collimating Eyepiece.

Check whether the secondary mirror is centered underneath the focuser. Use the crosshairs at the bottom of the Collimating Eyepiece as a reference. The center of the secondary mirror should lie right at the intersection of the crosshairs. If it doesn't, adjust the position of the mirror holder until it is centered (Figure 2). For "spider-type" holders, this is usually done by turning the threaded rod that the secondary mirror mount is attached to. For single stalktype holders, you may have to bend the stalk to center the mirror. Refer to your telescope's manual for more specific instructions.

- Now you need to adjust the tilt of the secondary mirror so that the entire reflection of the primary mirror is precisely centered in the secondary mirror (and, thus, also on the crosshairs of the Collimating Eyepiece). Use the three collimation screws on the secondary holder to adjust the tilt. The reflection of the primary mirror is centered

there is an even ring of space between it and the outer edge of the secondary mirror (Figure 3). Don't worry that the reflection of the secondary mirror is off-center; you'll fix that in the next step. If you do not see the reflection of the primary at all, the tilt of the secondary is way off, and more tinkering with the collimation screws will be necessary. If the mount is a single stalk, you will have to bend it to the correct position.

- Now it's time to adjust the tilt of the primary mirror. Using the three collimation bolts at the bottom of the optical tube, located behind the primary mirror, turn one at a time until the secondary mirror reflection moves into the center of the primary mirror reflection. The spot in the middle of the primary mirror should be exactly centered in the bright annulus. Now, the view through the Collimating Eyepiece should resemble Figure 4. The reflection of the primary mirror is centered in the secondary mirror, and the reflection of the secondary mirror is centered in the reflection of the primary mirror. If everything is centered on the crosshairs of the Collimating Eyepiece, the telescope is in collimation—tuned up and ready for action!

### Schmidt-Cassegrains

With Schmidt-Cassegrain telescopes, collimation is best performed using a "star test," but reasonable collimation can be achieved with the Collimating Eyepiece. There is only one collimation adjustment for Schmidt-Cassegrains: the tilt of the secondary mirror. Insert the Collimating Eyepiece directly into the visual back of the telescope. The shadow of the secondary mirror will appear as a dark circle near the middle of the field-of-view. Adjust the three Allen-head screws located in the center of the front corrector plate to center the secondary mirror on the crosshairs. Do not loosen the screws more than two turns, or the secondary mirror could fall off its mount! Likewise, do not adjust the screw in the middle of the secondary mirror cell. It holds the mirror in place. Final fine-tuning of collimation on reflectors or Schmidt-Cassegrains can be done with a "star test" using a high-power eyepiece.

### Care and Maintenance

Because there are no lenses in the Collimating Eyepiece, care and maintenance is minimal. It is a good idea to remove any obvious dirt on the inside or outside of the eyepiece so that the dirt does not get into the telescope tube during the collimation process. To clean the eyepiece, use a blower bulb or a moist cotton swab to remove dirt from inside the barrel, and simply wipe the outside with a damp cloth. Make sure not to disturb the crosshairs, as bending or breaking may result. Your best bet is to store the Collimating Eyepiece in a case for easy access. If you drop the eyepiece, don't worry. It's made of machined metal, so it's very durable, and small scratches or dents will not affect usage. Should the metal insert containing the sight hole become loose, reposition the insert so that the polished 45°-angle flat faces directly toward the cut-away opening in the barrel, then tighten the tiny set screw near the top of the barrel with a watch-repair screwdriver.

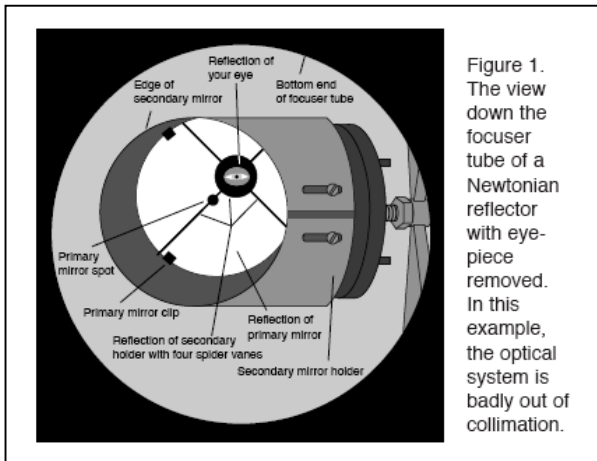


Figure 1. The view down the focuser tube of a Newtonian reflector with eyepiece removed. In this example, the optical system is badly out of collimation.

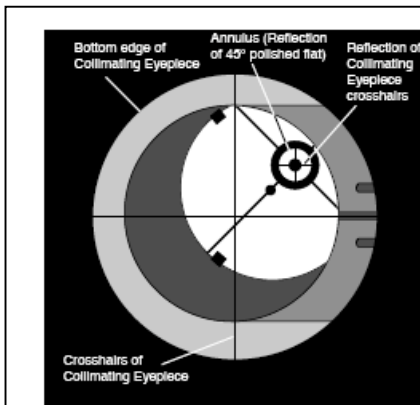


Figure 2. Secondary mirror centered under focuser tube, viewed through the Collimating Eyepiece (as are the next two illustrations).

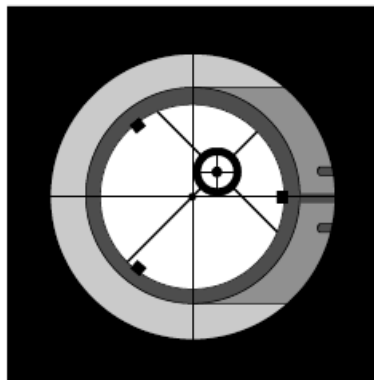


Figure 3. Secondary mirror correctly aligned (tilted).

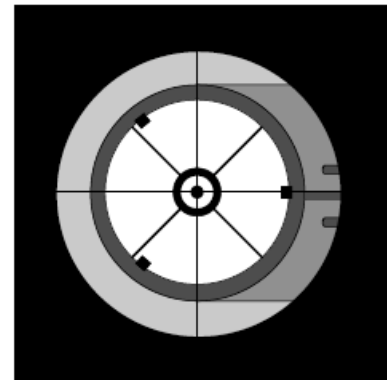


Figure 4. Primary mirror correctly aligned. The telescope's optical system is now collimated.