#04411

Collimating Eyepiece

Never look at the sun with this telescope! Serious permanent eye damage, including blindness, can occur.

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

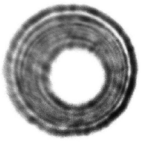
What is Collimation?

Collimation is the process of aligning the telescope's optics so the mirrors are precisely positioned relative to each other and the telescope tube. For a reflector telescope, both the primary and secondary mirrors must be accurately aligned.

Accurate alignment ensures the sharpest possible images and should be checked occasionally. With practice, collimation is straightforward and can be done in daylight. Keep in mind even a telescope without technically perfect collimation can still allow you to see good views of the night sky. While collimation is very important, don't let small deviations stop you from observing.

Checking 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 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.



Out of Collimation



Collimated

In newtonian reflectors and 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.

The purpose of the Collimating Eyepiece

Aligning the mirrors may seem straightforward in theory, but in practice it can be challenging without the right tools. A common "quick and dirty" method is to remove the eyepiece and look down the focuser tube while trying to center the reflections of the mirrors. The problem with this approach is that it is not very precise. There is no reliable way to know if you are looking straight down the focuser tube, and even a slight shift in your viewing angle can affect what you see. It can also be difficult to judge when the mirror reflections are truly centered. Simply eyeballing it often is not accurate enough, and reflections that appear centered may still be slightly off. A collimating eyepiece solves these problems by guiding your line of sight and providing a clear reference, allowing you to align the optics accurately and get the best possible performance from your telescope.

While it might seem a bit intimidating at first, It's important to remember even a telescope that is collimated only marginally well can still allow us to see things in the night sky, and the process of aligning the optics generally becomes easier and more familiar with time and practice. Do not be discouraged if the telescope is not perfectly aligned with your first few attempts at this process, especially if you are new to the hobby.

Before making any adjustments to the telescope please take the time to observe and become familiar with the components of the telescope.

Using the Collimation Eyepiece to Align A Newtonian Telescope

The Orion Collimating Eyepiece is a simple precision machined tool. It consists of four major parts. The first being the main tubular aluminum housing which supports and centers the optical components. Starting from the back of the collimation tool, we have the viewing aperture which is located on the very end of the wider portion of the tool, with the printed logo. This is the portion we look into when using the tool. This small aperture allows for a precision alignment. Next is the illuminator which is the silver colored 45° surface. The job of this elliptical reflecting surface is to direct diffuse light down onto the final component of this tool: the crosshair wires. These wires give us a reference for centering the reflections within the telescope optics and make it much easier to get an accurate alignment of the system.

Begin the collimation process by setting up your telescope in a well lit area. Having a bright wall or area to point the telescope at can help you to see the different parts inside the telescope. Be sure the telescope cannot accidentally be pointed at the Sun, and do not point it at a bright light when aligning the mirrors.

Before we put the tool into the telescope, let's familiarize ourselves with some of the parts, and what they look like. This will make adjusting the telescope much easier to understand. Begin by looking into the small hole at the end of the collimation eyepiece; this is the end opposite of the wires. While looking into the eyepiece, notice how the wires look. Now, rotate the eyepiece in a circle while looking through it. You can see the wires dim and get bright as the reflector points toward the light and away from the light. This will be useful for us later in the process.

Next, let's examine the telescope and become familiar with some of the internal parts. Remove the front cover of the telescope and look down into the front of the tube. You should be able to see a round mirror at the bottom of the tube. At the center of this mirror there is typically a small circular marking. This marking is called the Primary Mirror Center Spot; it is the central marking spot located on the primary mirror.

Next, look at the front of the telescope opening. You should see a cross structure with a small circle in the middle of it. This is the secondary mirror spider support. This holds and positions the secondary mirror, which directs the light from the primary mirror into the focuser, which is located on the side of the telescope.

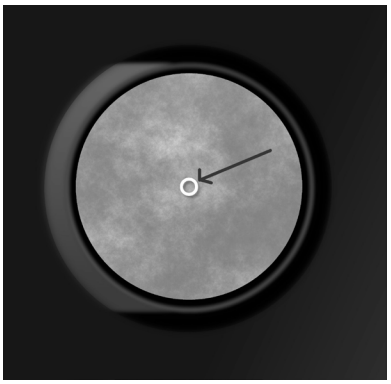
Without the eyepiece in the focuser, look into the focuser. You will see the secondary mirror which is supported in the center of the tube, a reflection of the primary mirror, and an image of the object on which the telescope is pointed. Let's look at some simulated images.

Looking into the focuser, you'll first see the secondary mirror. This is an elliptical mirror positioned at a 45° angle. It looks circular from this perspective because it is tilted. There will be many other things reflected in this mirror, but, for now, take note of how the mirror is just below the focuser in the center of the tube. It will look like this:

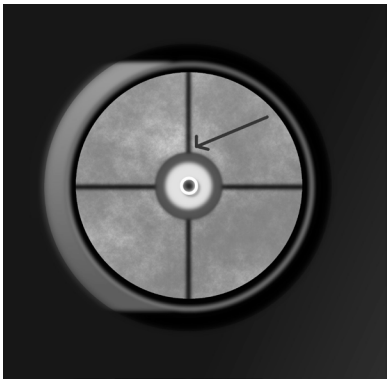


Looking deeper into this view, you should notice the primary mirror reflection down at

the bottom of the tube. The primary mirror center spot we viewed earlier should be visible.



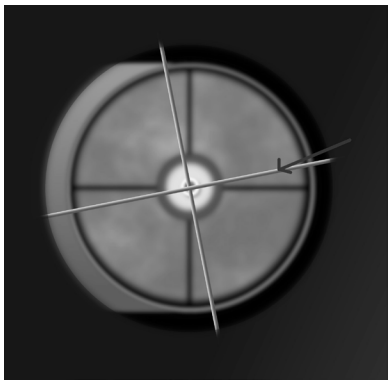
Looking further still, the spider and secondary mirror support structure we saw earlier when looking into the front of the telescope will be visible. This is the large cross structure.



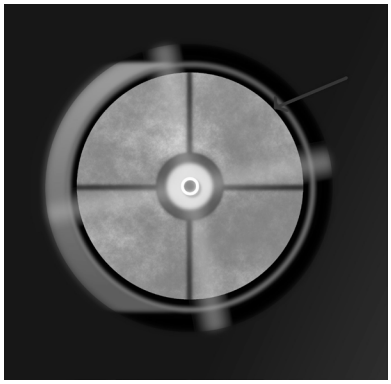
Finally, you might notice a reflection of your eye, and that’s a good sign that the alignment is probably not too far off.

Before we insert the collimation eyepiece into the telescope and begin assessing the quality of the mirror alignment, let's take one last look at the collimation eyepiece on its own. Holding it back up to your eye, looking through the small hole opposite the wires, notice how the wires look. Focus on them and see how crisp they become. Now, looking through the eyepiece still, look at something far away, across the room. Notice the wires are still visible, but they blur and become diffuse. It seems as if you can almost see through them.

Fully insert the collimation eyepiece into the telescope so it sits against the flared shoulder. Rotate the eyepiece while looking into the telescope and find the position where the wires are best illuminated by the ambient light. The wires might be at an angle, and that’s okay. The image should look something like this:



Now shift your focus to the primary mirror and its center spot and notice how the view changes. The wires blur, and the edge of the primary mirror and the center spot become crisp. At this point, you might notice the center spot is not in line with the cross hairs, or the intersection of the spider and secondary mirror are not aligned with the crosshairs. This is a great observation and part of what will need to be adjusted in just a little bit.



Checking and Adjusting the Secondary Mirror

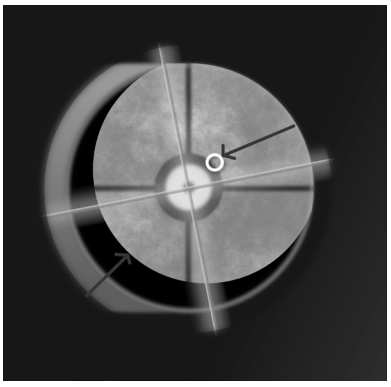
The first mirror to check and adjust when collimating the Newtonian telescope is the secondary mirror, located near the telescope’s focuser. The center spot on the primary mirror, along with the crosshairs of the collimation eyepiece, are what we will use to adjust the secondary mirror. Looking back into the collimation eyepiece that has been installed in the telescope, notice the eyepiece crosshairs and see if the center spot aligns with the crosshairs. When it is perfectly centered, the center spot on the mirror can seem to form a four leaf clover shape around the crosshairs. This is a perfect alignment!

If you do not see the center spot aligned with the wires, the secondary mirror will need to be adjusted. The secondary mirror is the small mirror mounted at the front of the telescope by the focuser. Looking in the front of the telescope tube you should see four strips of material, suspending a circular piece with several screws in it. There are three small screws for a triangle and one center screw. It is almost never necessary to adjust the center screw as this is not an adjustment that can be knocked out of place through use or rough handling.

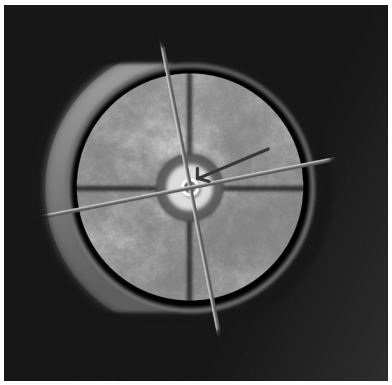
Choose one of the three screws at the front and slightly tighten it while looking into the telescope. Did the center spot move closer or further away from the wire crosshairs? If it moved further away, slightly loosen it back to the original position and choose a different screw. Slightly tighten this second screw while looking into the collimation eyepiece. Did the center spot move closer or further away from the crosshairs? If it moved further away, slightly loosen it back to the original position and choose the last of the three screws. Slightly tighten this screw until the spot is as close as it can get to the center of the crosshairs without passing through to the other side and moving farther away.

At this point, if the spot is not exactly bisected by the crosshairs, move back to a different screw and repeat the process until the circular center spot is bisected by the crosshairs.

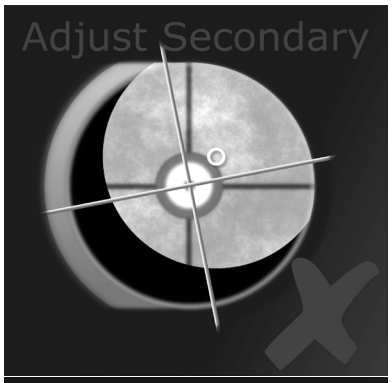
The view through the telescope might look like this when the secondary mirror is misaligned. Notice the edge of the primary mirror is far off to the side, and the center spot is not aligned with the crosshairs of the collimation eyepiece. It's important not to confuse the crosshairs of the eyepiece with the spider structure of the telescope.

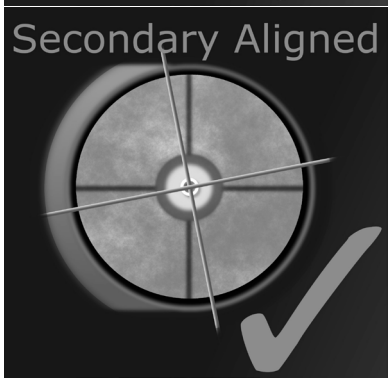


When the secondary mirror is properly aligned, the view will look like the following image. Notice the center spot on the primary mirror and the wires of the collimation eyepiece intersect at the center of the view.



To Recap the following two images show the secondary mirror misaligned, and the secondary mirror properly aligned:





NOTE:

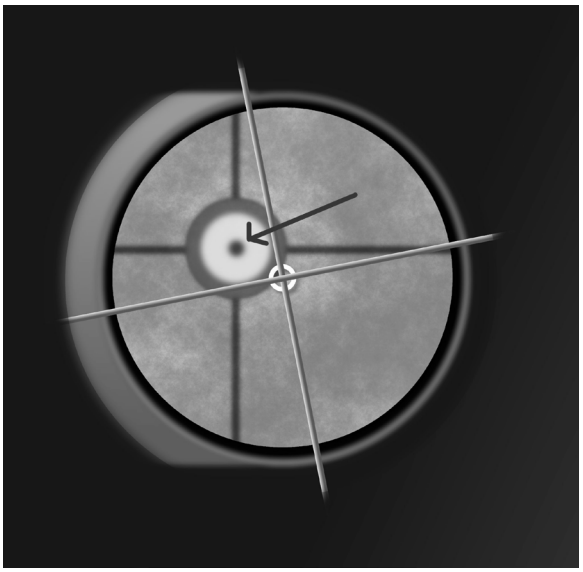
If both the primary and secondary mirror are off, things can look really confusing. It's important to always adjust the secondary mirror first, and then the primary. It's totally acceptable to go back to the secondary to make a small adjustment after the fact if

needed, and the same for the primary. It's ok to go back and make adjustments.

Checking and Adjusting the Primary Mirror

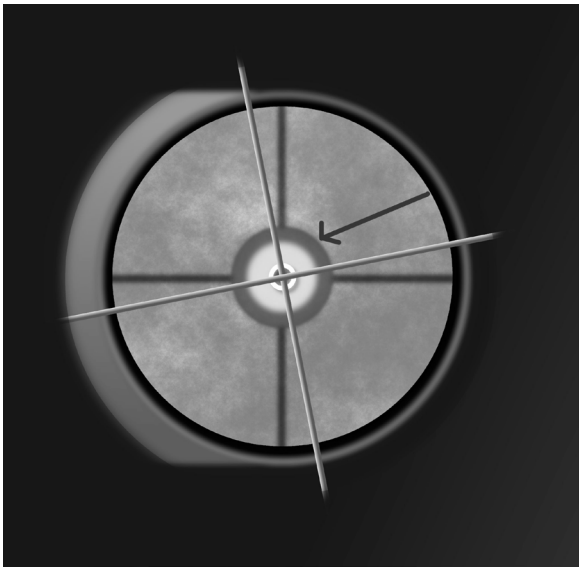
Now that the secondary has been adjusted so the center spot on the primary mirror aligns with the collimation eyepiece wires, we will want to adjust the primary mirror.

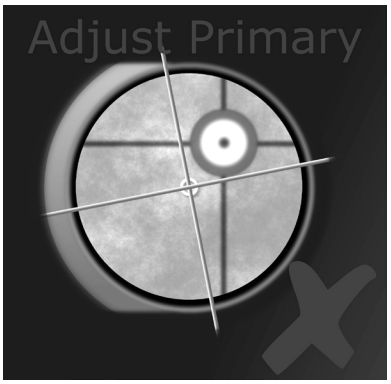
When adjusting the primary mirror, judge its alignment based on the reflected view of the collimation eyepiece. To see what part of the view this is, cover and uncover the small reflector on the side of the collimation eyepiece while looking into the telescope. The portion that seems to appear and disappear as you cover and uncover it is the reflection we will use to align the primary mirror. Look in the Orion Collimation Eyepiece and see if the primary mirror needs to be adjusted. The following two images will show a reflection in the primary mirror of the collimation tool, secondary mirror, and spider. If the reflection is centered, no major adjustments likely need to be made. If the reflection is off to the side like the following image indicates, then the primary mirror is in need of adjustment.

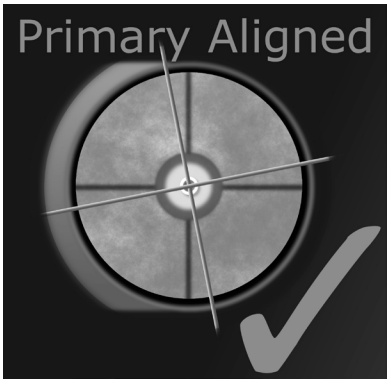


NOTE: Even though the center spot on the primary mirror is aligned properly with the blurry collimation tool crosshairs, the reflection of the secondary mirror and spider vanes in the view might be offset some. Meaning, the blurry crosshairs of the collimation eyepiece might not perfectly align with the sharper crosshairs of the secondary mirror spider/support as seen in the reflections. The important part is that the center spot of the primary is centered on the crosshairs, and the reflection of the collimation eyepiece lines up with the crosshairs of the collimation eyepiece.

Before calling the final alignment "Good," it is best to look for the bright but smaller reflection of the collimating tool in the telescope's mirrors. In the center of the bright circle will be a small dark dot. This is the hole you look through on the tool. This spot should be centered on the primary mirror center spot, as well as the collimation eyepiece crosshairs for the greatest accuracy. The perfectly collimated view might look like this, where all visible parts are centered.



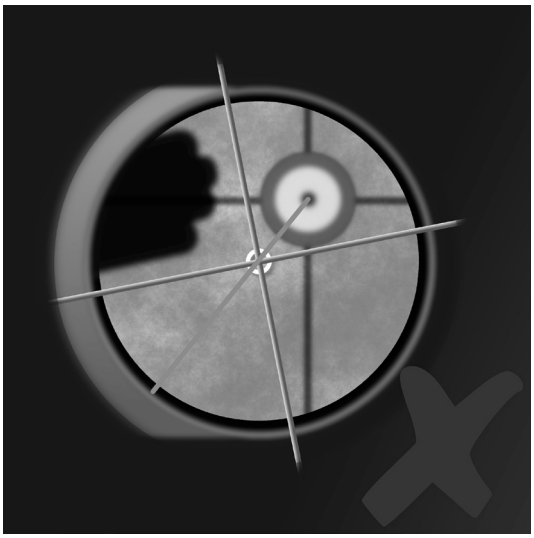


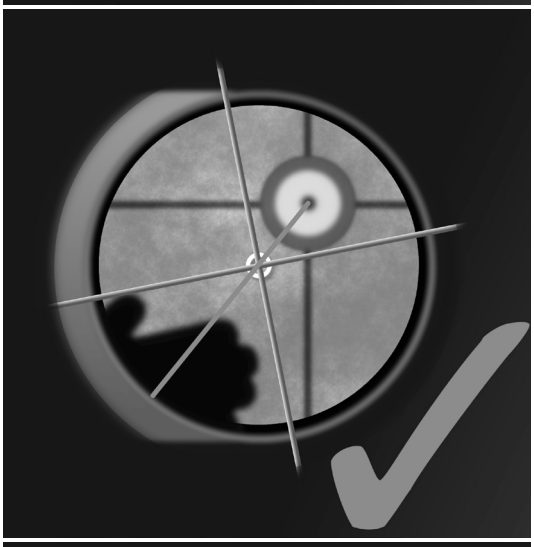


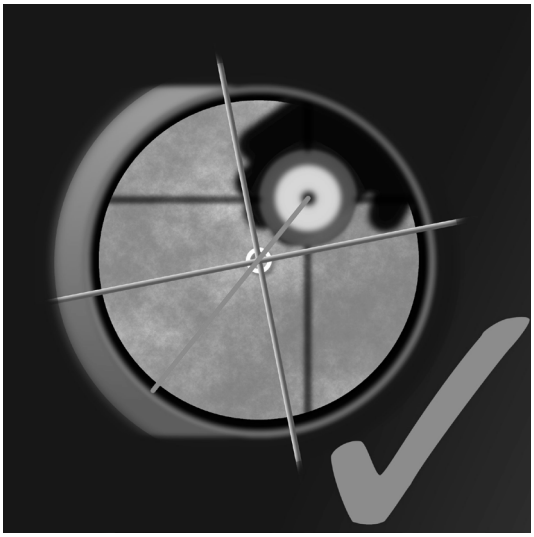
Tips and Tricks for Adjusting the Primary Mirror

When aligning the primary mirror, it can be difficult to know which screw to adjust. Partially placing your hand in front of the telescope while looking through the collimation eyepiece can give an idea of which screw needs to be adjusted. While looking in the scope, move your hand around the front of the telescope until it is either opposite of or closest to the offset image of the primary mirror spot. There are three images below that show examples of this step. Once your hand is in a position that corresponds to the reflection's offset, pull your head back from the collimation eyepiece but keep your hand in front of the scope. Make a mental note of where your hand is on the telescope tube so when we look at the back of the telescope, we know in which direction the mirror is offset.

Example: Your hand is in line with the focuser at the front of the telescope. Look for an adjustment knob in line with the focuser at the back of the telescope. If one is not located at that position, look to see if there is an adjustment screw directly across the tube from this position. If not, find the closest adjustment screw to this imaginary line. This will be the screw we want to adjust first.





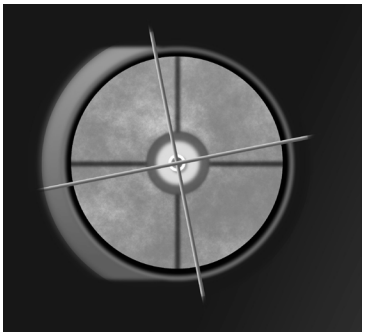


It will take some time and experience to gain a better understanding of how much to adjust each screw and in what direction to turn it. Knowing which screw to adjust is a huge help. Start by turning this screw ¼ of a turn clockwise. Then, look back into the collimation eyepiece to see the results of this adjustment. If the center marking on the primary mirror moves in the direction we want to move, continue to adjust this screw until the reflection is as centered as you can get it. Then perform this step again, placing your hand in front of the telescope observing the offset, finding the position of this offset, and locating which screw to adjust next.

Looking in the collimation eyepiece, all reflections should be centered within one another. If they are not, repeat this process from the start until you are satisfied with the results.

It is important you can see the following:

1. All of the primary mirror reflected in the secondary mirror.
2. The center spot of the primary line up with the crosshairs of the collimation eyepiece.
3. The reflection of the eyepiece in the mirror lines up with the primary center spot and crosshairs.



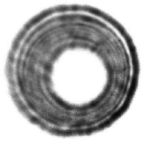
Remember these mirrors do not need to be perfectly adjusted for casual low power observing. For high-magnification, planetary viewing, observing double stars, or for the best possible performance, it is ideal to have them aligned as accurately as possible. **Don't be discouraged if it takes some time to do or even if you can not align them perfectly at first. It will become easier with time and experience.**

Some users find they check and adjust their collimation before every observing session, and this is good practice. Though other users only check from time to time. Either way you choose, the collimation eyepiece will help simplify the collimation process while offering potential for more accurate results. Enjoy your freshly aligned Newtonian telescope!

durable, and small scratches or dents will not affect usage.

Star Testing the Telescope

At night, point the telescope at a bright star and center it in the eyepiece. Slowly defocus the star using the focuser. If collimation is correct, the out-of-focus star should appear as a symmetrical circle with the shadow of the secondary mirror centered, similar to a donut hole. If the shadow is off-center or the disk is unsymmetrical, further adjustment to the primary mirror is needed. Keep the star centered during testing; this is critical. Make slight adjustments to the telescope's position to center the star, if necessary. Polaris, the North Star, is a convenient choice because it remains relatively fixed in the sky.



Out of Collimation



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Orion StarGuard 2 Year Warranty

Visit telescope.com for more information about the Orion StarGuard 2 Year Warranty.