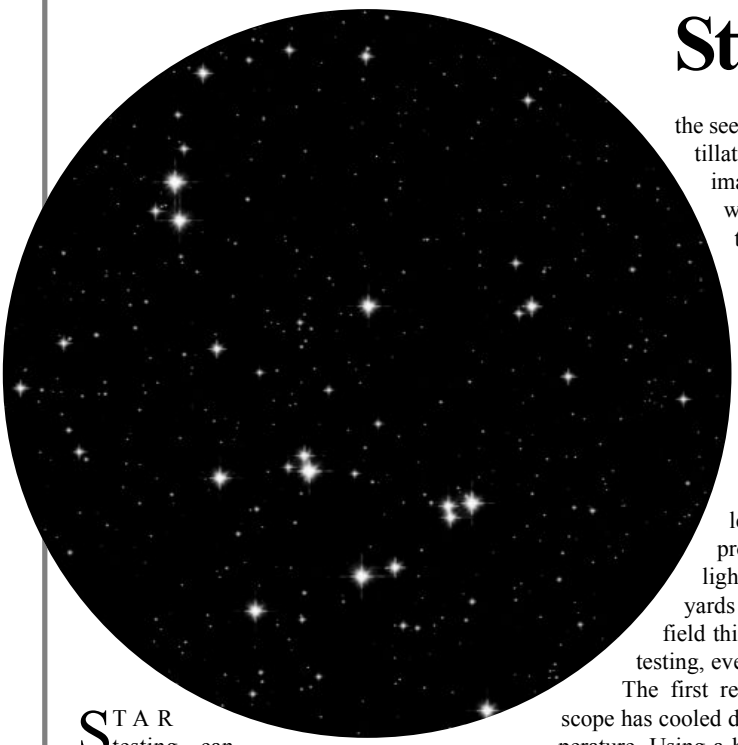
Star testing a telescope



STAR testing can give you an indication of the quality of your telescope's optics but, perhaps more importantly, provides the ultimate method of collimating a telescope's optics and will tell you when your telescope has cooled down to the temperature of the night air and so capable of giving of its best.

To star test a telescope you simply observe a reasonably bright star under high power and observe its image inside focus, at focus and outside focus. If you do not have a tracking mount then Polaris is an obvious choice, otherwise choose a star that is high in the sky so the effects of the atmosphere are least. However, if the seeing is bad and stars are scintillating heavily, then the stellar image breaks up and the test will not be possible. You therefore need to wait for a night of good seeing or, alternatively, use an 'artificial star': on a sunny day you can use the glint of the Sun reflected from a distant television aerial or you can buy a commercial artificial star that uses a white LED and a small length of fibre-optic cable to provide a star-like source of light. Placed perhaps 25 to 50 yards across a garden or playing field this can enable night-time star testing, even when it's cloudy!

The first requirement is that the telescope has cooled down to the ambient air temperature. Using a high magnification eyepiece observe the out of focus stellar image. If it appears have streaks and streamers 'bleeding' away from it, tube currents are distorting the image and you must wait until they subside. This then, is a very good test prior to observing even if you will not be star testing your optics. If, having allowed your telescope to cool down, it is not possible to see concentric circles in the out of focus image and the in-focus image appears to be broken up and dancing around, the atmosphere is too turbulent to make a useful star test.

Star testing will tell you if the telescope is perfectly collimated — most usually required when using a reflecting telescope — and help you collimate it. Web pages such as www.galaxypix.com/Stargazing/collimate.html will give you help in doing this, but the final test is that the out of focus image of a bright star, centred in the field of view, must look perfectly symmetrical with the 'shadow' of the secondary mirror (in a reflector) seen in the exact centre of the stellar disk. Assuming the secondary has been correctly aligned — always the first step — you can then adjust the primary mirror, a touch at a time, until this is achieved.

Now star testing your optics can begin! Rack the focuser from a little inside the focus, through the focus to a similar point outside. If the image of concentric rings remains perfectly circular and appears nearly identical on both sides of focus, you have a superb scope! The contrast of the rings tells you how smooth the mirror is — nicely delineated rings are what you hope to see.

If the slightly out of focus disk looks elliptical rather than circular and its long axis moves through 90 degrees as you move through the focus, the objective (usually a mirror) is suffering from astigmatism. This is often caused by the mirror clamps being too tight (so distorting the mirror) and could well be cured by easing them off.

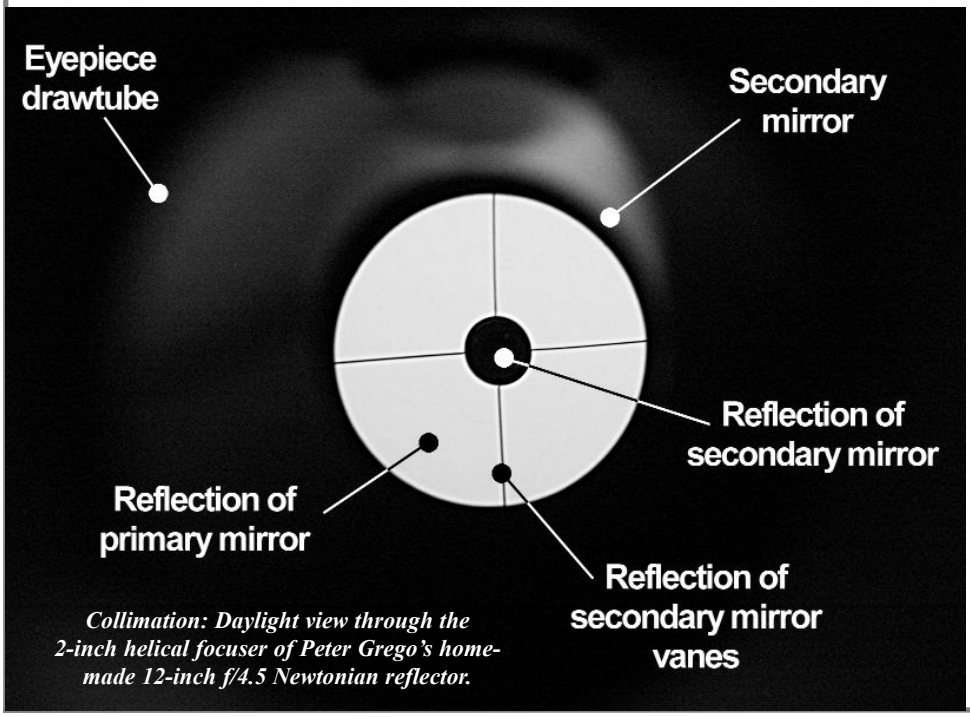
If the inside focus image has a bright outer ring, whilst the outside focus image has a more diffuse look, the objective is suffering from spherical aberration and is undercorrected. If the inverse is seen, the objective is overcorrected. Virtually all telescopes show some over- or undercorrection so do not be too alarmed. The test is exceedingly sensitive!

If the outer ring appears to have little spikes radiating from it, rather like whiskers, then it indicates that your mirror has a turned down edge. If placing a circular mask to block off the outer few millimetres of the mirror removes this effect and has a significant effect on the pattern that you see, such a mask could permanently improve the quality of your telescope's images.

There are many web resources — just put 'star testing' into Google. The freeware *Aberrator* software will show you what to expect to observe, giving a visual guide to star testing: it can be downloaded from http://aberrator.astronomy.net/. Finally, Harold Suiter's book *Star Testing Astronomical Telescopes: A Manual for Optical Evaluation and Adjustment* is the star tester's Bible, and tells you everything that you could possibly want to know about star testing. Details: Harold R. Suiter, Willmann-Bell, ISBN-13: 978-0943396446.

Why not give star testing a try and improve the view through your Newtonian?

Next issue: Astrophotography with a digital SLR.



Collimation: Daylight view through the 2-inch helical focuser of Peter Grego's home-made 12-inch f/4.5 Newtonian reflector.

Star testing, step-by-step

Step 1: Choose a night when the seeing is good. The stars will be seen to scintillate slowly and not too obviously. Set up your telescope to track a bright star high in the sky, or Polaris if you have a non-tracking mount such as a Dobsonian.

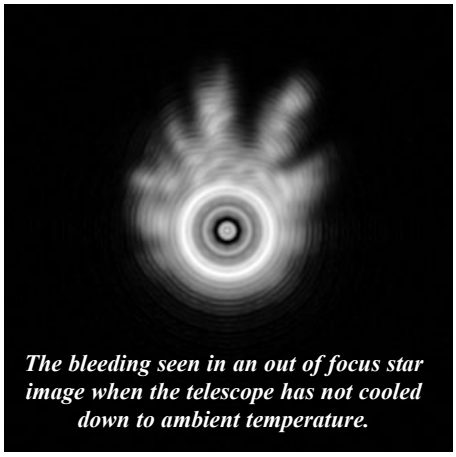
Step 2: When the star is centred in the field of view and the telescope is tracking well, switch to an eyepiece or eyepiece and Barlow lens to give a magnification of around 1.6 times the aperture of the telescope in millimetres (of order x200 to x300).

Step 3: Ensure that the telescope has cooled down to ambient temperature. Defocus the star image to see if it is 'bleeding' — almost like flickering flames spreading out from the central disk. This indicates the presence of tube currents within the telescope. Wait until these subside.

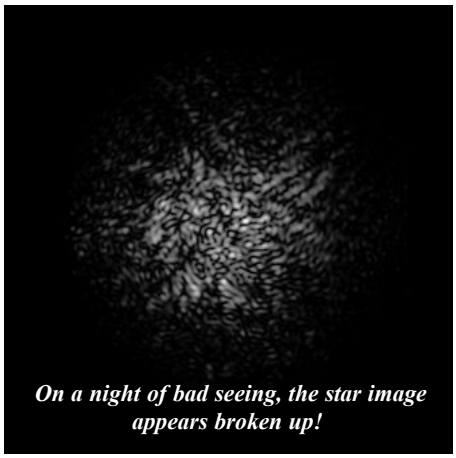
Step 4: Check that the seeing is sufficiently good for a star test. The image must be reasonably stable so that you can see circular rings in the out of focus images. The central bright region of the in-focus image should show a ring around it.

Step 5: Check that the telescope is collimated. If the image 'skews' to one side or the shadow of the central obstruction in the out of focus image is not perfectly central then the telescope is out of collimation and needs to be collimated before continuing.

Step 6: Finally, carry out the star test to check for astigmatism and figuring errors in the lens or mirror as detailed in the article. If testing a mirror, repeat the tests with a mask over the mirror to reduce the aperture by ~1 cm (5 mm all round).

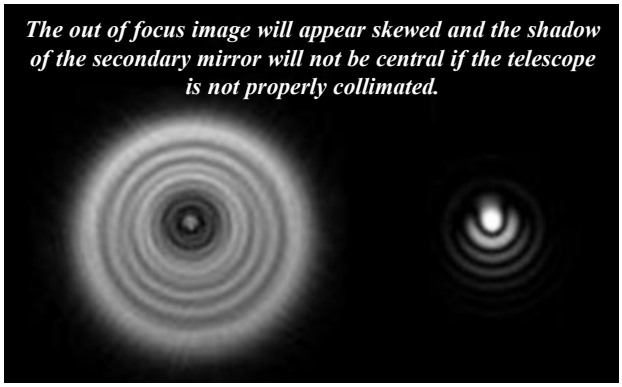


The bleeding seen in an out of focus star image when the telescope has not cooled down to ambient temperature.

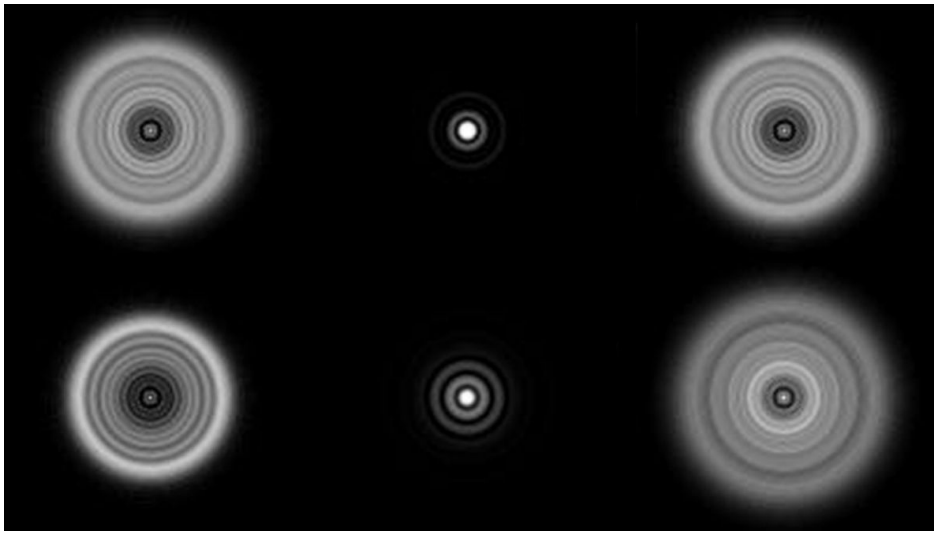


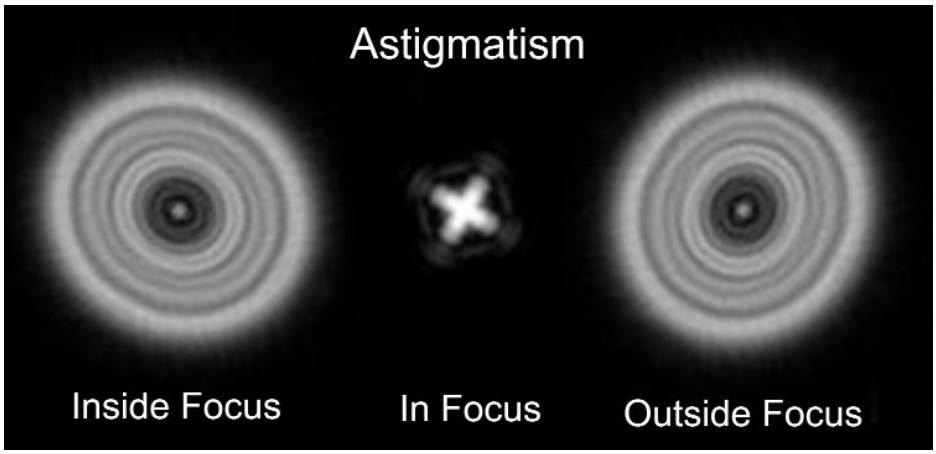
On a night of bad seeing, the star image appears broken up!

Below: The three images below show the star test of a perfect objective: the inside and outside of focus images are identical. The lower three images show the effect of spherical abberation: on one side of focus the outer ring is brighter and more pronounced whilst on the other side of focus the image is softer and the rings less pronounced.



The out of focus image will appear skewed and the shadow of the secondary mirror will not be central if the telescope is not properly collimated.





The image is slightly elliptical and the axis rotates through 90 degrees as one racks through focus. Images courtesy Ian Morison.