Hubble 5-star Artificial Star(s) FAQ

Hubble Optics
http://www.hubbleoptics.com
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Q1: Where do you place the 5-star?
The 5-star can just sit on a tripod top, on a table, or even on a rock; you only need to aim the star roughly towards (no precision aiming needed!) to your telescope; then aim your telescope to the 5-star. The 5-star provides a very wide angle for a very easy usage.

Q2: How far should the 5-star be placed from the telescope?
The 5-star should be placed in distance to you scope about M times of the focal length. M is $336*D/F^3$, where D is the aperture diameter (in inches) and the F is the focal ratio. E.g., if your scope is 10" F/5, then the M is $336*10/5^3 = 336*10/(5*5*5) = 26.88$. So the 5-star need to be M * (D * F) = 26.88 * 10 * 5 = 1344" away, or about 34 m away. Of course, the star should be at least far enough to be within the travel of the focuser.

This formula was derived by Roger W. Sinnott (Sky and Telescope, May, 1991) based on Ray trace for Newtonian reflector, included in Suiter's book. Actually, as Suiter pointed out in his book (5.3.4), this will give "incorrect distance" for SCT. Suiter suggested M to be at least 20 in general, and 24 for an 8" f/10 SCT for a real star test. Our experience and Ray trace indicate that you do need at least this far for a real star test but not nearly as this far for an excellent collimation.

To do a perfect collimation, you do need to go as far as you can see the Airy disk! This has to be done by experiment for your scope. For the collimation purpose; about 70% of the distance used for real star test have been suggested by Suiter.

However, if you are really restricted by space, you still can go much closer to do a (at least a preliminary) star test as long as you can clearly focus on the star, and as long as you know what kind of impact/aberration the closer distance will introduce (yes, spherical aberration!).

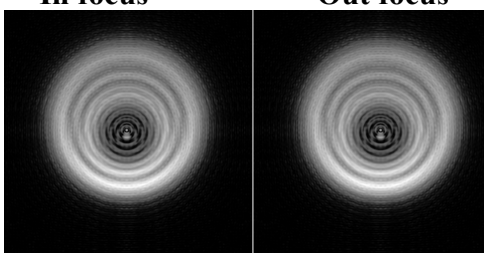
Q3: Which of the 5 stars to use for the star test?
Choose the smallest possible star, but which still give you clear defocused image. You may need to dim the stars with the new batteries by twisting the LED head cap. Basically you change the brightness by adjusting the alignment among the LEDs and the pinholes. You need to change batteries if all stars are too dim to see clearly.

In theory, the diameter of the pinhole should not be larger than the M * Airy disk = M * 1.22 * λ * f /D (where M is the distance factor (see **Q2**), λ is the wavelength, D is the aperture diameter, and f is the focal length)

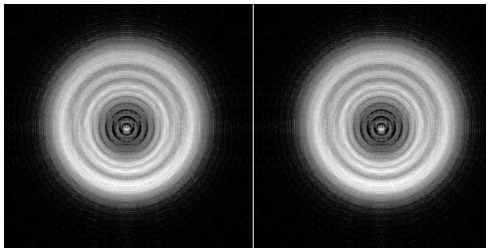
Q4: How to perform the collimation with the 5-star?
First you should check if the scope is in rough collimation by observing a strongly defocused star image (about 10 wavelets, or move focuser in or out until seeing about 10 rings). All rings and shadows should be concentric; if not, please perform the collimation according to the instruction of the telescope until all rings and shadows are concentric. You should do this at a magnification of 25X of your scope's diameter (in inches).

Coma due to misalignment：

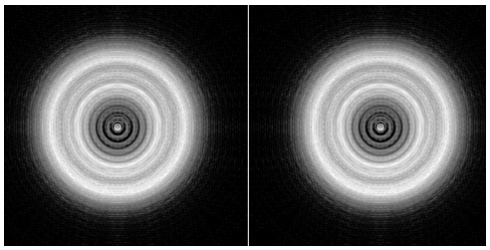
In focus **Out focus**



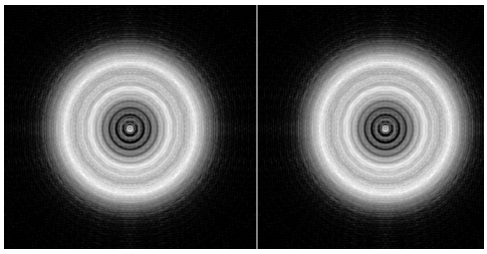
1 wave front coma due to misalignment



1/2 wave front coma due to misalignment



1/5 wave front coma due to misalignment



1/10 wave front coma due to misalignment

Then you need to do a fine and final collimation by observing the focused **50 microns** star image, the famous Airy disk with a magnification of 50X of your scope's diameter (in inches). Use a 2X, or 3X Barlow lens if necessary; you should see a uniform, complete, and concentric Airy disk and diffraction rings if the scope is in perfect collimation. Follow the same procedure to do minor adjustment on your scope until you reach a perfect collimation.

This is the final judgment of the collimation of your telescopes and all other collimation tools and methods! Due to the seeing limit, you will most likely unable to see the Airy disk with a real star!

1/10 and 1/5 wave front comas due to misalignment

Q5: How to perform the star test with the 5-star?
Choose an appropriate star for your scope (**Q2**). After making sure the scope is in perfect collimation (**Q4**), follow the normal star test procedure to perform the test.

Q6: Is there a problem if the magnetic mask is placed in the same plastic bag as the main item, or placed on the pinhole mask when in storage?
It is important to keep them separated when not in use! Over time, the magnetic mask may release very small magnetic particles, which can block the pinholes; and once the pinholes are blocked you may not be able to unblock it by yourself. BTW, the mask also attracts magnetite from ground, which can also block the pinholes.

Q7: After inserting the batteries, the unit cannot be turned on, why?
Please make sure all cells are inserted in right direction, the spring to the negative. Please re-insert all the cells if necessary to make sure all cells are in good contacts.