

Collimation of Newtonian Telescopes

The Newtonian telescope is as far as I am concerned the most cost efficient, stable (especially when on a Dobsonian mount) and comfortable (again when on a Dobsonian mount) telescope you can buy. They can be easily modified and are easily adjusted – through the much maligned technique of collimation. I am completely biased in this and despite the efforts of numerous friends, I have never found other systems attractive or comfortable to use.

As a long-standing member of SGL, I find that there are regular threads about collimation where people struggle to appreciate the logic behind each step and I hope here to provide a summary of my own method of collimation which may be similar to some but hopefully is written in a way which is easy to follow and shows that there's nothing to fear. For the purposes of this paper I am using my usual tool, which is a Cheshire/Sight tube combination tool, referred to from here onwards as a Cheshire.

The five 'rules' of collimation

1. Before you start adjusting anything, check it. Often the elements described do not need to be adjusted but should be checked and if OK move on to the next step.
2. Never panic. Unless you drop something, anything you do can be adjusted back again.
3. Always take precaution against dropping things down the tube. This includes things in your pockets, the adjustment tools and the secondary mirror. It's often best to adjust the collimation with the tube at a 45 degree angle approximately. This does a couple of things. As well as reducing the likely impact of something being dropped, it also means you are collimating to an 'average' scope position.
4. Whilst you can get your collimation spot on before a session, there will be circumstances where the dynamics of a scope in use will put the collimation out slightly. Don't worry about this, just enjoy the views. Factors such as seeing quality, lack of cooling, light pollution and local thermals are likely to have a bigger impact on the view than a slightly misaligned collimation. If it comes down to a choice of less than perfect views or no observing because of fiddling with a scope, I'd choose less than perfect observing any day.
5. Develop your own method. If it gives you sharp, contrasty views, especially at high magnification, the chances are you are 'close enough'. This paper summarises 'my way'.

You will notice that at no point do I refer to the oft quoted essential alignment using mirror clips. In my opinion this is quite confusing, especially if your primary does not have them. It's also not necessary to consider them as following the process below will ensure your optics are aligned correctly.

Things to do:

- Try to meet up with someone that is well versed in collimation. It's so much easier to understand if shown than it is to read about it.
- Work carefully and accurately.
- Make sure you have enough time – if not, just enjoy the scope for another night.
- Use your red torch to light the face of the Cheshire if collimating in the dark.
- Get the help of a friend if you have a long OTA.

- If you can perform slight modifications to add a milk carton washer, and tool free adjusters (see below). Less tools = less risk of dropping something.
- Always have your extension tubes and adapters in the same position as you would when observing. This means that your scope will remain more accurately collimated.

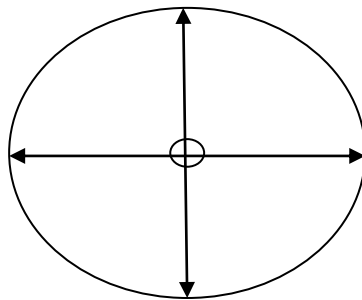
Things to avoid:

- Dropping anything on your mirror.
- The sun if collimating in the daytime.
- Over-tightening anything. If you grunt or strain your knuckles you've probably overdone it!
- Twisted vanes when adjusting the lengths. Hold the vane as you tighten/untighten then connections.

Step One – Spider Vanes

This is a one-off check/adjustment, only required when you first get a scope or when you take out the secondary e.g. to flock the tube. *See rule 1. above.*

What is important is that the central hub is the same distance from the sides of both axes across the tube. They don't all have to be the same if e.g. your tube (like my three scopes) is not perfectly round. This ensures that the secondary stalk is in the physical centre of the tube.



The method for this is to loosen the short side, holding both the vane (so it does not twist) and the nut and then tighten the long side sequentially until they are both the same length to the centre.

Then perform the same on the other two and ensure that all four are tight enough to make the vanes ping a little. A spider which is not adequately tightened can, especially with larger apertures/secondaries, result in the collimation moving as you move from vertical to horizontal. Don't over-tighten though and always hold the vane when tightening and loosening to prevent the vanes from bending/twisting.

Once complete, have a 'common sense' look to ensure the vanes are all at 90 degrees to each other. This step once complete will be highly unlikely to ever need adjusting again but have a quick check every now and again.

Step Two – Focuser

See rule 1. above. Personally, I never really bother with the focuser as there is more than adequate adjustment in the other elements, especially for visual use/collimation. Just ensure it is tightly

connected and that it sits visually square to the tube. You can spend time shimming it to get it perfectly square but it's not really necessary.

Step Three – Centre the secondary mirror in the focuser

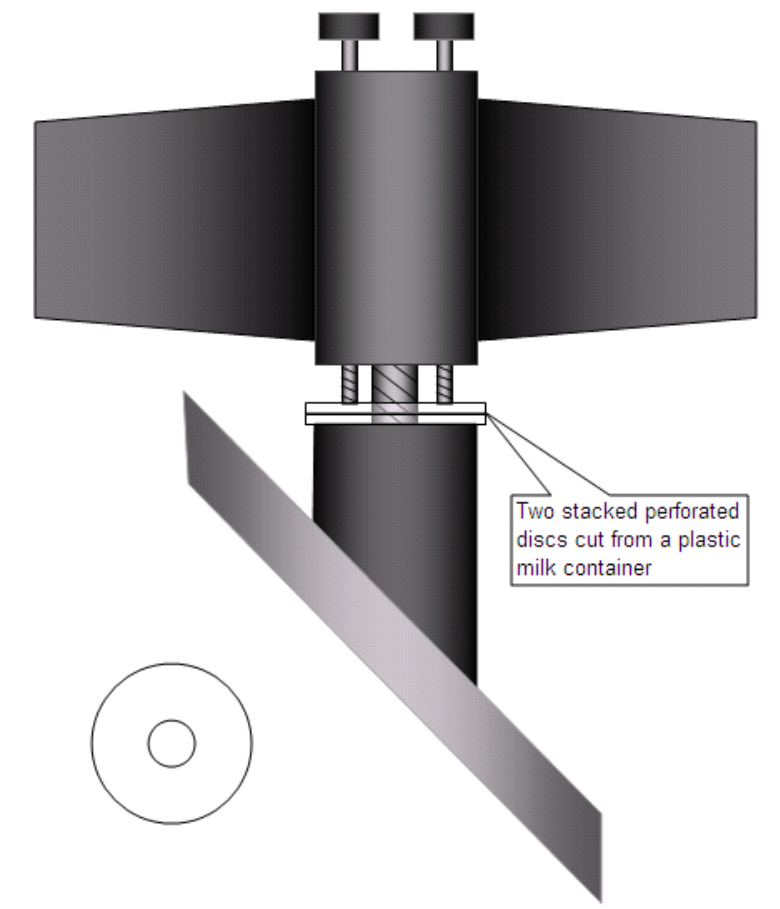
See rule 1. above. What this step does is to ensure that any light collected by the secondary is passed to the eyepiece. This stage seems to create more problems than any other yet it is a simple matter if you introduce less confusion into the picture by blocking the reflection of the primary mirror so that all you see is the secondary.

See rule 3. above. The easiest way to do this is to place a piece of paper between the primary and secondary and then all you see is the secondary (only for this step). There are three adjustments that can be made. Before you start though, ensure that all of your (three) secondary adjusters are the same length. This ensures the mirror is square to the tube central axis. What you are looking for is a perfect circle at the bottom of the drawtube or Cheshire.

I find this stage and step four easier if I use a small piece of tube to block off the 45 degree face of the Cheshire.

The first adjustment is to ensure the secondary is far enough down the tube. The way to adjust this is to loosen the central bolt (you may need to loosen the secondary adjusters) first. If things are tight then hold the central hub as you loosen the adjusters, once the first one is loose the others will be easier. Remember that in most systems the central bolt pulls on the secondary stalk and the three adjusters push on the stalk. If you tighten the central bolt, this pulls the secondary up the tube and vice versa.

Warning. If you need to make more than a minor adjustment to this then you are advised to take the secondary off completely to see how much thread is left on the bolt when in position. The last thing you want is the secondary dropping onto the primary mirror. See rule 3. above.

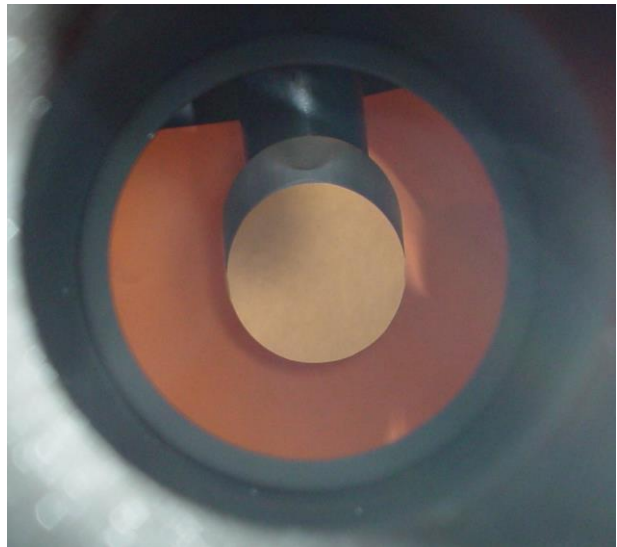


I would actually recommend the removal of the secondary at this stage anyway as you can perform a basic modification which will make step four a little easier. This is to add a 'milk carton' washer to the secondary stalk bearing surface (i.e between the three adjusters and the non mirror end of the stalk). Credit for this mod and the image above goes to our US friend Jason Khadder.

Once you feel the mirror is in the correct position, get the adjusters finger tight and look again – further adjustment may be needed. Keep adjusting and checking until right. The next phase is to rotate the mirror so it presents a round circle when viewed down the Cheshire.

I personally, pull out the Cheshire and if necessary use an extension tube to allow a small margin around the secondary mirror. This allows more accurate assessment. Once the position is correct it is unlikely to ever need adjustment again but do check it every now and again.

What you are aiming for is something like this:



Step Four – centre the secondary mirror to the primary mirror

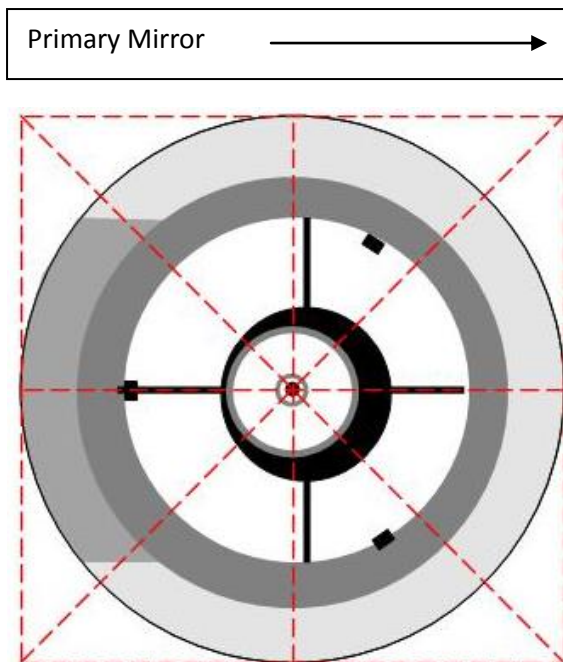
See rule 1. above. In this step you are ensuring that all the light from the primary is collected by the secondary (which has just been adjusted in step three to ensure that any light collected is sent centrally up the drawtube to the eyepiece).

This is also a slightly troublesome adjustment for many people as 1) it is quite fiddly with standard set-up and 2) it's a little hard to get your head around at first as to how the mirrors move – mainly as it's a reflection of a reflection you are seeing.

Assuming you have correctly spaced vanes and a centralised secondary this adjustment should be minor and hardly ever need adjusting again. I check mine each time I observe but it rarely needs adjustment even on my larger scopes.

If you have fitted the milk carton washers, the process is even easier. Before you start, ensure that your three adjusters are 'nipped up' – i.e. not too tight but not slack. Then using your Cheshire, align the cross hairs of the Cheshire so that they intersect with the centre of the donut on the secondary.

See Rule 3. above. The principle of the adjustments is to loosen two and tighten one and this may be necessary unless you have added the milk carton washers. If you have added them then it is usually a case of just adjusting the three studs sequentially to bring the two elements together. Move one and see what happens. Then either adjust back if it's the wrong way or a little more if the right way. If it feels like it's getting tight then perhaps loosen the other two slightly and carry on. We are only talking about small fractions of a turn in all cases. A small adjustment makes a big difference. Go slowly and it becomes more obvious what is happening. This whole process is made easier if you can



replace the secondary adjusters with thumbscrews. Then you don't need tools. If doing this, replace one at a time. Some people worry about secondary offset. This is fixed in the factory generally and you do not need concern yourself with it as such. Ensuring step three is completed means the secondary is in the correct position. It is normal for the spider vanes not to line up with the Cheshire and for there to be a 'lobe' of darkness on the primary side of the correctly adjusted secondary as shown here (Jason Khadder image).

Step Five – Centre the primary mirror to the secondary mirror

You have now reached the 'plain sailing' stage. Congratulations! The adjustment of the primary mirror is actually the most critical component of the whole collimation process and where accuracy matters most. It affects sharpness of image and contrast and if you are short on time, just ensure you check the primary and adjust if required. *See rule 1. above.* This stage usually requires a small turn on one adjuster but sometimes nothing at all. This is also thankfully the easiest of all adjustments to make.

Your collimation will be retained slightly better if before you start, you fully wind in the adjusters to tension the springs and then wind back out by a turn. Some scopes have 'locking bolts' but personally I tend to remove these as they really serve no purpose in a correctly adjusted primary cell. Some scopes have a 'push/pull' system similar to the secondary set-up which is slightly more fiddly but the same processes apply.

Just use two of the adjusters to move the primary donut so it has the black dot inside and evenly spaced. One adjuster will move left / right and one up/down – if you have a longer tube then a friend is useful here. Again thumbscrews or knurled nuts help with ease of adjustment here.

Not many people struggle with this stage as by now they have a fuller understanding of collimation in general.

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