ATM Journal 6: Polishing Your Mirror
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Before we discuss next steps in getting your mirror completed, I realize last article I was remiss in discussing an important concept in making sure your pitch lap is effective when you resume polishing after a break of any significant length: cold pressing the lap.

Recalling that pitch is essentially a very viscous fluid at room temperature, one should remember that the actual shape of the lap changes fairly rapidly as it cools and sits drying on the bench. When we resume polishing it's likely that the lap is not a different shape than the surface of the mirror, and must be brought back into perfect synchronization to be most effective in polishing your mirror.

The solution is doing a cold press, which is similar to the warm press you did when first creating the lap but without heating the lap. A cold press should be done immediately before resuming polishing your mirror, and consists of simply placing your lap on the mirror (or vice versa depending on how you prefer to polish) and applying some weight. I normally just cover the mirror and tool with plastic (to ensure that no dirt or stray grit get near the surfaces) and put a bucket of water on top. 10 or 15 minutes later your lap should be ready to go. Some people espouse warming the lap (for example with a light bulb or heat lamp) and doing a warm press but this can be iffy – too much heat and you'll end up closing the channels in your lap. Since you must have channels in the lap you must then either laboriously reopen the channels or remake the lap. Cold pressing works fine.

As mentioned last time, to go to the next step in completing your mirror, you must go about building or otherwise obtaining a Foucault Tester for testing your mirror. Your homework last time to was check out the following website:

http://www.stellafane.com/atm/atm_foucault_tester/atm_tester_main.htm

This site describes the construction of a Foucault (and Ronchi) Tester and a mirror stand in detail. My own tester was built in an evening based on these plans at very low cost – see the picture below to see how my setup looks (note the mirror on the stand in the background upper right).

Without a doubt the process of parabolizing and “figuring” a mirror for use in an astronomical telescope is the most challenging part of grinding your own mirror – many people give up at this point and shelve their mirrors, or send them off to a professional optical company to complete the job. However, with perseverance and help from experienced ATMers locally as well as on the Internet, it's possible to figure your mirror to a higher level of quality than is possible in any but the most meticulous optical houses. Before we describe how to go about it, let's take a step back and understand what we're trying to achieve.

So far, our objective has been to produce a completely spherical surface. In other words, our mirror surface conforms to the theoretical surface of a sphere with a radius equal to the **Radius of Curvature (ROC)** or twice the focal length of our mirror. Unfortunately, a purely spherical surface does not suffice for most telescopes because unless the mirror is relatively small (6” or under) and has a relatively long focal length (f/8 or better) a spherical mirror does not focus all of the light that strikes the mirror to a single point (as shown in figure 1 – note that the curve is very exaggerated)

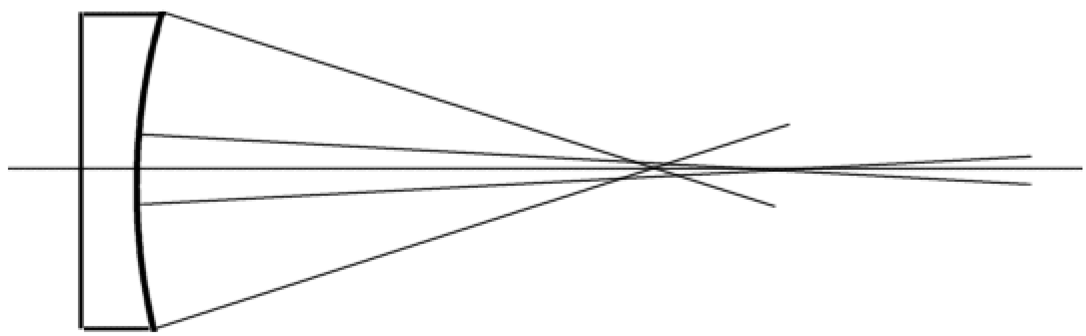

Figure 1 – A Spherical Mirror

Assuming an infinitely distant source and small mirrors with long focal lengths, the difference between where light reflecting off the edge of the mirror and the center is so minimal due to the long light path, a spherical mirror will perform within acceptable limits. For larger or shorter focus mirrors, we must have some way to have all points on the mirror focus correctly – it turns out that a figure of revolution conforming to a Paraboloid will achieve exactly that.

Paraboloids differ from spheres in that the center has a steeper curvature, focusing the light hitting the centre of the mirror closer in than a sphere, matching the light from the outer sections.

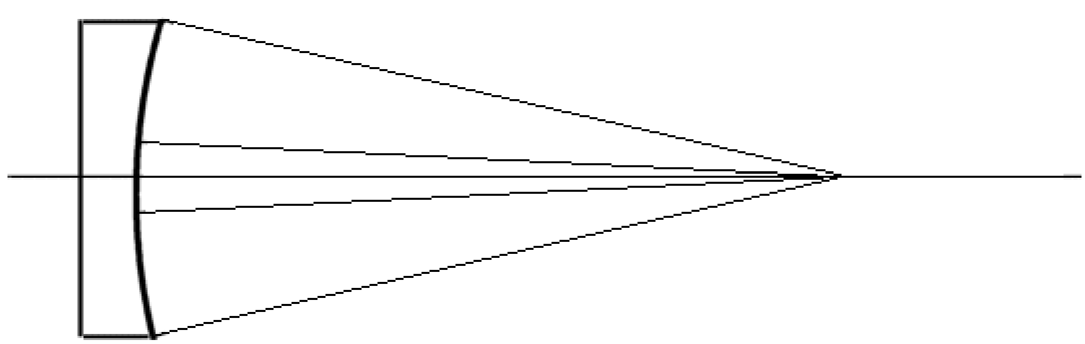

Figure 2 – A Paraboloidal Mirror

So, we learn we must somehow "figure" our mirror to produce a paraboloidal shape and somehow determine if that shape is the one that will properly focus light to our eye. The former means we must adapt our polishing stroke to work more rapidly on the middle of the mirror than the edges. The latter requires that we learn how to measure the exact shape of our mirror to a accuracy of millionths of an inch. Fortunately, simple tests exist to do just that.

In the mid-19th century, Leon Foucault (already famous for his 1851 experiment in the Panthéon in Paris where he used a pendulum to demonstrate the rotation of the Earth, his invention of the gyroscope, and his measurement of the speed of light in air and water – this was one smart fellow!) essentially created the modern metalized mirror telescope and a "knife edge test" to accurately figure these mirrors to sub-wavelength surface accuracy.

The knife edge test takes advantage of the fact that while a light source at infinity will focus at different points for a spherical mirror, a light source located at the center *of the ROC* will have light reflected back to a focus by the mirror. So, by introducing a knife edge into the reflected light from the mirror and seeing where the shadow of the knife edge actually cuts off (nulls) reflected light from the mirror, we can actually determine where the light comes to a focus. More interestingly for non-spherical mirrors, we can determine where different parts of the mirror come to focus so we can measure where the edges, middle, and center zones of the mirror come to focus and qualitatively determine what the shape of our mirror is and how it complies to a perfect paraboloid. Fittingly, this test is called the **Foucault Test**.

Next time, we'll look at how you can measure the surface of your mirror and see what shape it is. In subsequent articles we'll look at how to change the shape of your mirror into a paraboloid, and some ways to fix problems that might occur during the process. Finally, we'll look at some other tests that can be helpful during figuring, including the Ronchi test, and star testing. As always, questions or comments are welcome at gtulloch@shaw.ca

NOTE: The space we have in our newsletter does not permit a full and detailed discussion on these principles – however, the reader is invited to surf to the following web site:

http://www.atmsite.org/contrib/Harbour/Foucault.html

David Harbour has written a most excellent and accessible introduction to the subject. For those who do not have access to the Internet, please let me know and I'll make copies of this publication available to you.