by Chris Garvey and Eddie Guscott

MOONFISH® 80mm f/6.8 Apochromatic Refractor

In the first issue of PA, the Skywatcher (Synta) ED80 was reviewed. The results of the optical evaluation were quite exceptional considering the low price. It was however, let down a little by the standard of engineering, particularly the quality of the focuser.
From the same region of the globe, William Optics refractors have become extremely popular, with a variety of small aperture APOs and low dispersion achromats. Part of this popularity is due to the imaging suitability of these types of instruments, the lower prices, the beautiful appearance and engineering quality of these refractors, and the inclusion on some of them of the now popular dual speed focusers. The manufacturer of one of the 80mm refractors they offer also make this instrument available (*with maybe some minor alterations*), for other companies to badge and retail. Moonfish are one such company. Their latest offering is an 80mm f/6.8 (*f/6.9 in the PDF instruction manual)* doublet APO refractor, using ED (low dispersion) glass in one of the elements.

This particular telescope is badged and offered by at least four suppliers (from a swift flit around dealer internet sites), and possibly several more. There are very minor differences in the appearance, the main one being the anodized tube colour, but essentially they are the same instrument. Retail prices between dealers range between <£400 and <£500 for essentially the same piece of equipment.
The Moonfish ED80 retails at £395 and when ordered, arrived with other accessories (*also reviewed in this issue*), in a smart foam lined case. The Moonfish ED80 has a striking blue anodized gloss tube, (red being the other popular colour, and black in the case of a US badged version). All other major external parts are gloss black anodized. An attractive tube assembly then, and cosmetically blemish free.
The telescope has a sliding dew shield and capped with an aluminium lid. Separating the focus assembly from the main tube is a serrated band. When twisted anti-clockwise the focuser is free to revolve through 360°. This is a useful facility, particularly when a camera or star diagonal is not in a convenient position. A clockwise twist locks the mechanism again. Internally, the tube assembly is blackened with an array of baffle positions (*actually, ridges on an internal plastic cone that screws into the rear of the OG cell housing*), to reduce any unwanted reflections.
The focuser is a dual speed Crayford type focuser with an 11:1 gear ratio for fast and fine focusing. The fast focus section of the assembly is rubber covered for grip, and the fine focussing is smooth enough to move the Crayford by

The doublet f/6.8 objective lens is fully multi-coated

The telescope and accessories arrived in a smart, foam lined case

The Moonfish ED80 has a striking blue anodised gloss blue tube

simply sliding a finger along the surface. No backlash or slippage was noticed, even pointing at the zenith, *(the facility for tightening or loosening the friction grip is via a screw on the underside of the focuser*). On a telescope of this price, a focuser of this quality is very impressive. Even my difficult to impress non-astronomer faintly interested partner was moved to state 'Ooh, this is nice isn't it, oh yes I could get along with one of these. Why haven't you got one of these on any of your telescopes'?
The drawtube is marked in millimetre and centimetre stages. This is a focus repeatability scale, although of limited use in the dark even with a flashlight, due to the lack of a reference marker on the outer section of the focus assembly, and the highly reflective nature of the gloss black anodizing.

There are three methods for mounting this telescope. 1. The 'L' bracket *(a 70mm long foot)*, can be removed and optional tube rings attached. 2. The 'L' bracket has two ¼ Whitworth holes on the underside that permit the telescope to be tripod mounted. 3. The 'L' bracket is wedged along the edges and the PDF instruction manual suggest the telescope can be directly mounted onto Vixen, Meade and Celestron German equatorials (*presumably certain other Synta German equatorials too*). However, clamping the telescope onto an equatorial and marking the wedge foot on such a beautifully finished refractor seems a shame, besides, the foot is only short and there is no room for adjustment if balancing is required. For this test, a simple Synta 7" dovetail rail was modified and attached to the foot. This allowed the freedom to slide the scope for balancing purposes, and consequently the rail was marked not the foot.

The objective lens

The objective lens of this telescope uses SFPL-51 as the rear element. SFPL-51 is another of Ohara's Fluor Crown glasses, and is low in lead and arsenic. SFPL-51 has a lower Abbe number than SFPL-53, (*Ohara list it as 81.6 as opposed to 95 for SFPL-53*) and is less expensive to purchase as a lens manufacturer. The doublet objective lens is fully multi-coated.
The lens doublet cell is not adjustable, which means that the collimation is factory set and needs to be perfect from the outset.

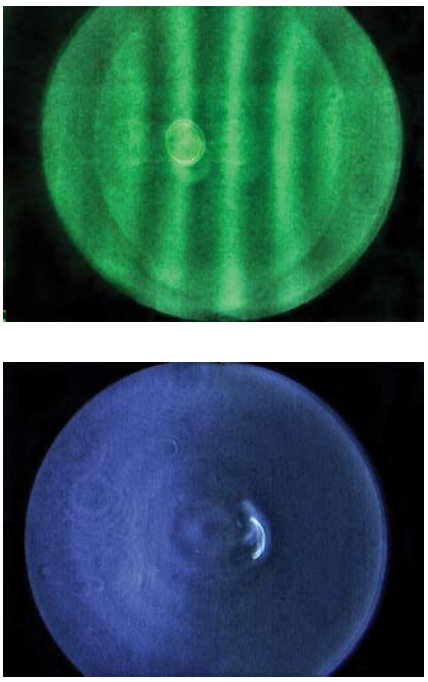
Observing with the Moonfish

The scope was mounted on a German equatorial, and left tracking Vega with a Wratten #58 green filter screwed into a 5mm Monocentric. It is summertime so temperature differences inside and outside the house were minimal. A little pre-heating via convection provided at least a worthwhile difference between the telescope and outside air (17° C). In winter the cool-down times may vary, however this is a relatively small instrument so a great deal of fuss over cool-down is not required. After 20 minutes, the expanded star image was virtually free of thermal noise, with a further

The telescope features a dual speed Crayford type focuser with an 11:1 gear ratio for fast and fine focusing. Note the focus repeatability scale etched onto the drawtube.

20 minutes until no further change in correction error was noticed. The expanded star image showed a moderate but not objectionable amount of under-correction for lower order spherical aberration with a faint contribution from a little roughness. Without the filter, chromatic aberration dominated the pattern on both sides of focus. With a small amount of de-focus inside focus, Vega revealed a green inner with violet surround. In focus, a tiny amount of chromatic aberration surrounding Vega was visible. This was a little disappointing but not altogether unexpected. This is, after all, a doublet of only f/6.8. Fainter stars had any chromatic aberration reduced to virtual invisibility. Not quite the performance of a triplet, but still very good. The separation of close doubles did not appear to be affected by any colour or minor amount of spherical aberration. On a low-lying Jupiter, any faint colour surrounding the limb was not at all intrusive and thus dismissed. On the moon, a small amount of colour hugs the limb, but again the surface was unaffected. It must be added though that even a tiny amount of de-focus introduces a little colour, particularly on the limb and boundaries of light and dark on the lunar surface. It is vital that perfect focussing is achieved to avoid any chromatic aberration showing in the image, the dual speed focuser is a godsend here. A 7mm Pentax XL in a 2.4X Barlow lens (188X) displayed that familiar clear and contrasty refractor image of extended detail, although switching to a 5mm Mono in the Barlow (264X) applied the brakes somewhat, the limit of acceptable image quality with this telescope had been overshot. The image had lost contrast and the integrity of the image was inferior to that at 188X. Even though the maximum useful magnification was already reached by 188X, I suspect that a little less spherical aberration and a touch more smoothness would still have allowed a more coherent image at 264X. It must be remembered that these are mass-produced instruments, and inconsistencies can play a part. After the successful trial of the Synta ED80 in the first issue of PA, it was demonstrated that a level of high image quality was achievable with the small Asian refractors. I also suspect that there will be Moonfish ED80s that have a better-corrected and smoother OG than this particular unit on test, such is the reality of mass-producing precision optical instruments, but for an amateur market.

The summertime is not the best for us deep-sky enthusiasts, some even hibernate. A brief tour of the sky from the backyard with the Moonfish ED80 and a trip out into the fens produced no real surprises in the deep-sky performance of this telescope. On a moonless night, the Veil was visible *(with the help of an OIII filter*), and many other Messier objects (*the view preferred without filtration on virtually everything apart from the Veil*), within the reach of 80mm of aperture were prominent and with good contrast. The background sky with this refractor, particularly in conjunction with the Moonfish dielectric diagonal, was dark with no scatter visible. No internal reflections ruined the experience, even with Vega or the moon displaced from the field. The baffle system in this telescope appears to be well designed and fulfilling its role particularly well, something the Synta



Ronchi image (top) and Focault (knife edge) test results for our particular example of the Moonfish ED80

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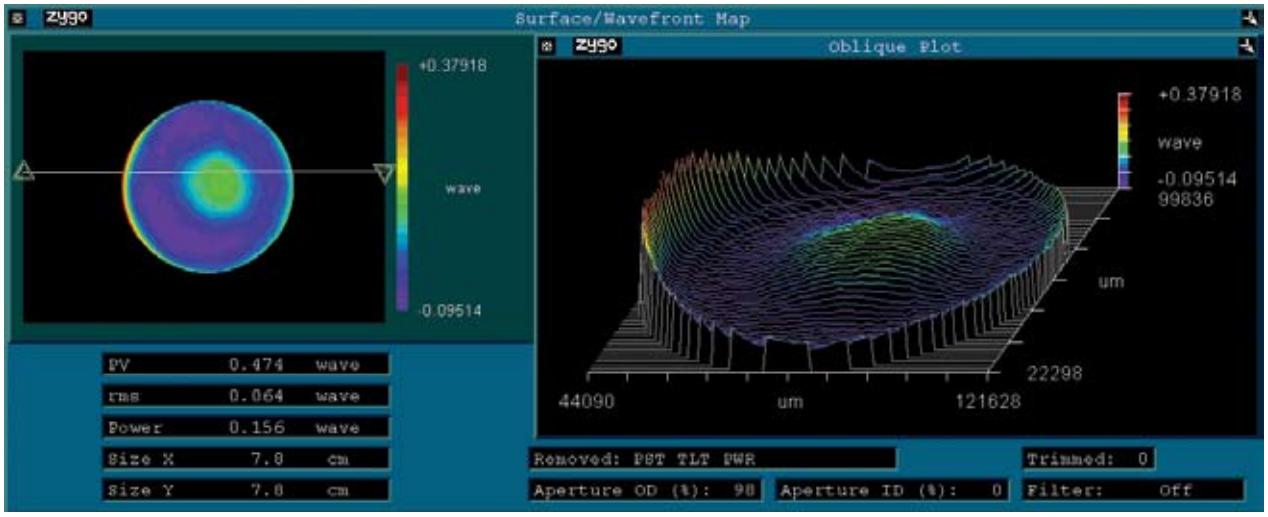

Interferometry results for the Moonfish ED80

ED80 was doing satisfactorily, but not as effectively as this Moonfish refractor.
The standard of engineering, cosmetic finish and the quality of the focuser are the main features that separate this refractor from the less expensive Synta ED80.
I would expect little difference in the optical performance apart from a touch less colour in the f/7.5 Synta. The baffling does make a difference though, and here the more expensive Moonfish has the advantage.

The test bench

The same system used on a Takahashi Mewlon was chosen for the Moonfish 80 ED. A double pass auto-collimation bench using a flat mirror, to pass light through the telescope optics twice. Errors seen are hence double what would be seen on the night sky. A halogen bulb projector illuminating a tiny sphere is the source, the outward and return beam passing through a beam-splitter cube. A 25 lines per mm Ronchi image (*shown on previous page*) clearly reveals the under-correction in the curved lines. The Foucault (knife-edge) image demonstrates the OG to have a clear overall correction error with a sharp turning at the extreme edge, an asymmetry in the edge providing the maximum peak to the P to V figure. Also clearly shown in the knife-edge image are the symmetrical circular polishing zones, which are not blatantly obvious even on the interferograms, *(more evidence of the absolute sensitivity of the Foucault test*). To an optician, these are fingerprints of the mounting method and the polishing methods used in mass-production. A plastic polishing method may have been used here, rather than traditional pitch.

Interferometry

Using the Zygo MK IV interferometer and a test beam of 632.8nm produced the following results:

With Piston, Tilt and Power removed.

Peak to Valley (PtoV) wavefront error – 0.474 (approx. ½ wave).

Root Mean Square (RMS) – 0.064 (approx. 1/15th). Using our (should be familiar by now) equation for finding the Strehl ratio – 1 – $(2\pi RMS)^2$ gives us a figure of 0.838. A Strehl ratio corresponding to the generally accepted diffraction limit, but nothing very exciting.

An inspection of the breakdown reveals that coma and astigmatism are contributing a vanishingly small 1/200th and 1/333rd respectively to the total RMS error. We can take from this that there is no pinching or astigmatism from figuring error, and that the telescope is correctly collimated.
The largest error contribution to the PtV wavefront error and RMS figures is between ¼ and 1/5th wave PtV and 0.019 (approx. 1/52) RMS of polishing roughness. Also 1/7th wave PtoV and 0.037 (1/27th) RMS due to lower order spherical aberration.
This small amount of SA3 and polishing roughness error can nevertheless be seen, even in a small refractor, in the limit of image integrity at higher powers.

Conclusion

Another fine small refractor with acceptably good optics, and exceptionally high quality mechanics and cosmetic finish.
The future looks mouth-watering

M33, a face on galaxy in Trinagulum was imaged through the Moonfish ED80 with a ST2000XM CCD camera. Exposures totalling 150 minutes through filters were combined to produce this colour image.
All sub exposures were 120 seconds.

NGC6960, part of the veil Nebula, was imaged through the Moonfish ED80 with a ST2000XM CCD camera. Exposures totalling 180 minutes through filters were combined to produce this colour image.
All sub exposures were 120 seconds.

for refractor enthusiasts. Recommended.

Wish List

- A little more QC on the objective lenses please
- A detachable dovetail rail would save marking the foot of this beautiful telescope

CG2006

Astrophotography

The Moonfish ED80 was a pleasure to use. There were no hesitant moments after attaching a heavy (and expensive) CCD camera, wondering if the focuser would hold the camera in place. It was very steady, with no slippage of the drawtube, as has been found in some refractors when heavy cameras are attached, and the telescope pointed upwards.

I must admit that the telescope seemed quite heavy compared to some 80mm refractors, but with the excellent mechanics and solid tube, maybe this was to be expected.

Focusing was very smooth, achieving rough focus quickly and then using the 11:1 fine focus mode to get as sharp a focus as could be achieved under a night of less than average seeing.

The telescope was attached to the mount by way of the 'L' bracket, as tube rings were not supplied. I was dubious that this arrangement would keep the telescope flexure free, but as can be seen by the images on the previous page, the telescope stayed in place exactly throughout the exposures.

The stars were a little larger than I would have liked, but I can only put this down to the seeing on the particular evenings concerned.

The images were processed in PhotshopCS with just levels and curves and a little selective sharpening. There was no attempt made to alter the appearance of the stars in the image or any glow around them.

The full resolution processed images were sent to an independent amateur astrophotgrapher, Peter Carson for evaluation with no information given on the telescope used.

He commented "General overall impression, very good. Star colours well represented and no obvious aberrations on a casual inspection. The image covers a large area of sky so the telescope has to work hard to properly illuminate this area, which it has done well.

On very close inspection the stars on the right hand side of the image are showing a small amount of false green on the right side of the star images. The star images generally look a little large, this could be the processing, slightly poor focus or seeing.

The star images at the perimeter of the image show a very slight amount of coma, which would possibly appear worse if the focus could be improved.
The bright star (52 Cygni) has significant false green to one side of the image which I assume is not a processing anomaly.

Having said all the above, it is a very nice image of which I would be proud. The small amount of aberration present could probably be cleaned up easily with a bit Photoshop fiddling".

Thanks for the comments, Peter.

I should add that the two images were completed over two separate nights, and the focus did not have to be changed from one night to the next, even though there was a small temperature differential between the two sessions.

I could have a lot of fun with this telescope.

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Tube diameter - 90mm

Tube length (with all retracted) - 457mm

Tube weight - 3kgs (6.55lbs)

Limit of drawtube travel - 80mm

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