Explore Scientific 127 ED
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Last summer while on my second trip to the Julian Starfest here in southern California, I got a chance to spend some time with Scott Roberts of Explore Scientific as we were both staying in the Big Cat Cabin at Chuck Kimball's Artists' Loft B&B (both the star party and Artists' Loft get a big thumbs up, by the way). While there, I was checking out the David Levy Mak Newt they have and we got to talking about doing a review of it and / or their flagship scope, the 127 ED Triplet APO. Up for review here is the latter.

Before we delve into the meat of the review, there are a few things worth noting and clearing up. First, while I've met and spent some time with Scott, Russ, Jamie and the rest of the crew at Explore (their office is just down the road from me), I've got no specific interest in the company. Second, while I picked the scope up from them personally, this is, effectively, a random sample. When their scopes arrive from China (ES is owned by JOC, Jinghua Optics and Electronics Company), Scott and his crew unpack them and give them a series of tests to make sure that nothing bad happened on the long trip. Scott had called to let me know that a new batch was in and that I could stop by to pick one up some time in the next few days. When I arrived, an employee was unpacking scopes and checking them out (mechanical and artificial star tests) and about halfway through a large stack. I got the one he'd just finished and even I didn't know exactly when I'd make it there to pick one up. So, this was as random a selection as we could hope for here. Third, it's worth pausing on this. Every scope is unpacked and tested before it is sent to the warehouse. That's not something you see every day.

Overview
The 127ED is a 127 mm, f/7.5 (952 mm focal length), air-spaced triplet refractor that uses a third element of HOYA FCD1 ED glass to improve color correction over an achromat that currently goes for $1999. The package comes with a 2" 99% reflective dielectric diagonal, an illuminated 8x50 finder scope, a Crayford focuser with a 10:1 fine-focus knob, a user-adjustable lens cell, a removable dew shield, and a solid transport / storage case (Figure 1). For mounting purposes, it comes with a set of rings that form a cradle when the Vixen-style dovetail and handle are attached. The latter feature is something I've not seen often, but is a welcome addition. Riding atop the rings is a removable handle that doubles as a place to mount a guide scope (as you can see in the photo, there's a slot in the handle for screws to pass through). It comes with a one-year warranty that can be extended to five years with registration.

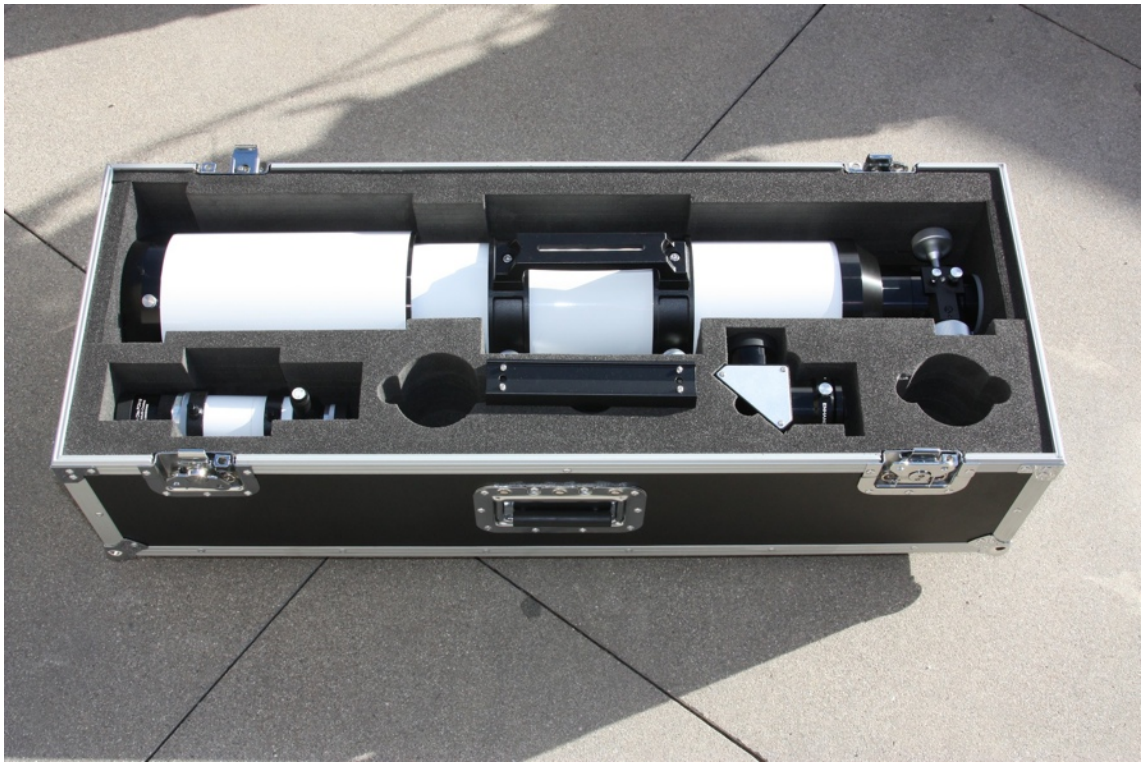

Figure 1: Scope and included accessories

Now, I've never considered myself a "refractor guy". I've had a few in my day for sure, but I've never identified myself in that way. Any time I've gone for something more than 4", it's had a mirror and even those 4" scopes (my current Borg 101 ED and a TMB 105/650 LW I used to have) have been short focal length instruments. Come to think of it, no refractor I've ever owned has had more than about 650 mm of focal length (WO 66, Orion ST80, TMB 80SS, and SV Nighthawk rounding out the 3" and below crowd). So, to me, a 5" f/7.5 is a pretty big refractor. Add to this the mantra on various Internet groups that this is a lot beefier than a popular 120ED scope and I was expecting to be stunned by the size.

Stunned is the wrong word, though. Impressed? Sure. It's a lot bigger than the bantam-weight Borg 101ED I use (typically run at f/4) and nobody would call it "small". But, potential customers needn't be all that concerned with the size on many popular mounts. In its shortest configuration (with the dew shield removed), it's about 33.5" long (with the dew shield attached it extends to 42" long). The bare OTA clocks in at 12.8 lbs. Add the dew shield and you're up to 15.8 lbs. Toss in the rings and dovetail and you're at 18 lbs. Get it fully loaded with the finderscope and diagonal and you're right at 20 lbs. This is all right on par with typical 8" f/4 - f/5 scopes. Unlike those options, if you're really concerned with weight (e.g., if I were imaging with this on my previous mount, a Tak EM-10), you could replace the 3 lb dew shield with a piece of Kydex and be ready to image in 15 lbs.

Included Accessories

One of the things that struck me about the 127ED (and the Levy Mak Newt I got to play with for a bit) is that it's almost as if the manufacturer is spending a good amount of time and effort to think about what will make the owner's experience better. Go figure! Let me explain what I mean here. First, the fit and finish are excellent. Seams are tight, the mechanicals move smoothly, and the paint job is top notch. It goes beyond that though in that the included accessories are both excellent and well thought-out. The dovetail is setup to allow you to remove cone error (4 bolts on it let you square up the OTA if needed). The finder is not only optically very nice, but its reticule is illuminated. Nice! I just love the carry handle and the fact that they thought enough to stick a slot in it that allows you to mount accessories on it. 1.25" prism? Nope, a solid 2" 99% dielectric model for the diagonal. Finally, the case is just fantastic. As I said, it's as if they sat down to think about what the potential owner will actually do with the scope. We'll store it and need to bring it to a dark sky site (so a good case is a real plus). Even GOTO mounts need alignment stars (so a nice straight-through finder that lets us quickly center things is a plus). Astrophotographers will want to strap on a guide scope or piggy back a DSLR with a lens on there (so, some way to bolt something on is a real plus). Get the picture? It's a really well thought-out package in which nothing feels cheap, nothing seems missing, and nothing seems like it needs to be replaced out of the box. There's a lot of added value in the package.

Focuser

For an astrophotographer like me, the focuser is critical (and thus deserves its own heading). The focuser is typical of many imported scopes today, which is to say that it's a quite reasonable Crayford style with a nice 10:1 fine-focus knob mounted on one side. Motion of the 2" drawtube is smooth and there are adjustments available on it to suit the tension to your needs and taste. The drawtube has a range of 4.75" and I had no troubles reaching focus with my cameras (QSI 540 wsg, Canon DSLR, and QHY 8Pro tried) at prime focus, with a HoTech field flattener in place, or with any of my eyepieces. All fittings on the focuser and diagonal come with compression rings rather than simple set screws for secure, non-marring attachment of accessories.

There was never any thought of it slipping with any of the loads I put on it. Rigs like the DSLR and the QHY8 Pro were handled with aplomb. In it's full "wsg" format (filter wheel, shutter, and off axis guider), the QSI 540 clocks in at about 3 lbs and it handled it well. With that level of load, there is a small amount of flex, but the system remained quite usable.

Optics

While I'm no pro at star-testing (I don't consider myself qualified to judge a quarter vs. a third vs. an eighth wave of spherical aberration yet), I'm not entirely naive here either. The scope turned in a very nice star test. Collimation was spot on and there was no sign of astigmatism. Diffraction patterns looked nicely symmetric with the only clear difference being the color. Inside focus, there is a blue / violet halo surrounding the yellow / green core of rings. Outside focus, there is a yellow / green surround to the blue / violet core.

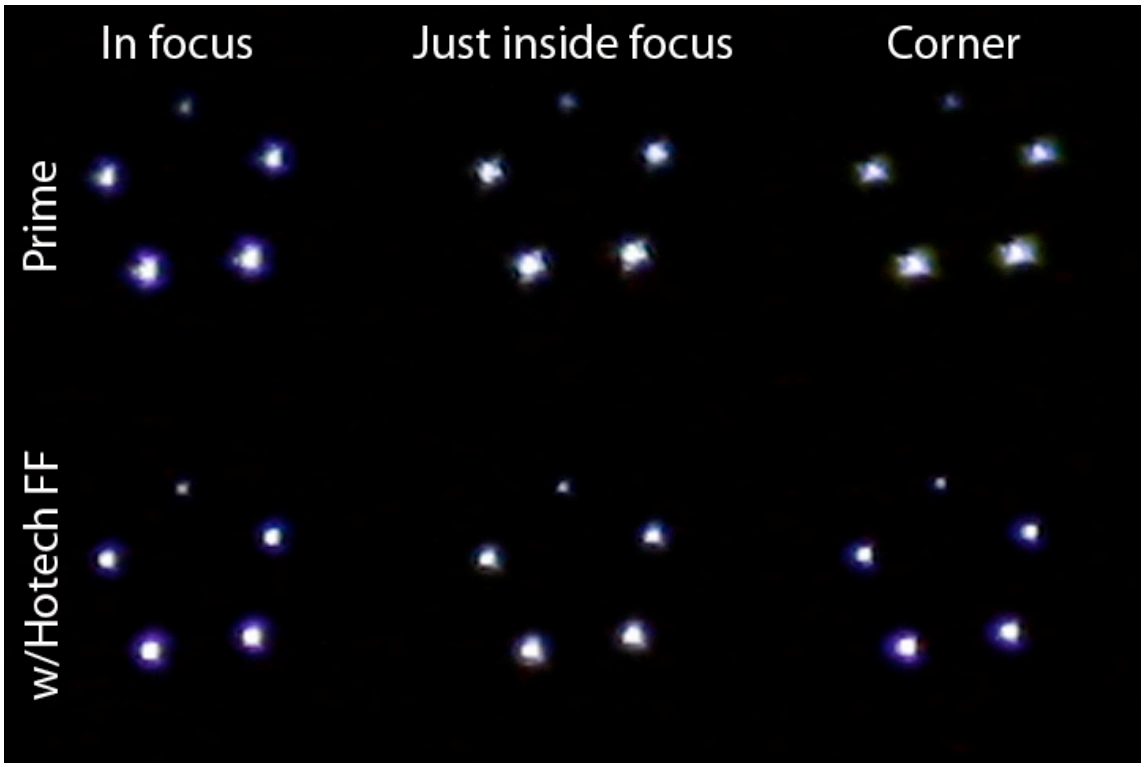

Figure 2: Single frames from an artificial star test (Hubble Optics 5-star artificial star) taken at best focus in the center of the frame (left), just inside this focus point (middle) and at best focus but from the corner of an APS-sized frame (right). Individual frames were taken both at prime focus (top) and with the addition of a Hotech SCA Field Flattener (bottom). The slight deviations from round here are the result of thermal effects ("local seeing" effects) and not a cause for concern.

At focus, stars were crisp and chromatic aberration (CA) was minimal. In typical use visually, there is no CA to worry about or become distracted with. For example, one night with an eyepiece to the scope, I was hard-pressed to detect much if anything on

Vega and the lunar limb was clear (turbulence would sometimes bring a slight hue to the surface). This is no achromat. It's not perfect, but it's darn good. For example, on another night out, Sirius did have a detectable violet halo at best focus using my 11 mm Nagler, but it was the kind of thing you could find when looking for, but it didn't present itself as an issue on its own. One thing to note here is that the chromatic aberration (or CA, caused by a shift in the focal position for some colors relative to others) could entirely disappear with a tiny shift of the focuser.

The images of a Hubble Optics artificial star shown in Figure 2 show this effect well. Here, on the left, we have the 5 stars taken at best focus where the violet halo can be seen. In the middle, the focuser has been moved in ever so slightly and the overall image is a fraction of a hair less sharp. As you can see, the image is now free of any spurious color. Astrophotographers with optics that have a curved focal plane will often focus not dead-center but a bit off-axis to split the difference and get a better image overall with the center of the frame being a bit inside the plane and the edges being a bit outside (rather than the center being at the plane and the edges being far off the plane). Instead of a focus position that varies spatially, with CA the focal position varies by wavelength. Here, the difference is small enough that many may intentionally or implicitly split the difference here and choose a focus position that brings more wavelengths very close to focus. (Of course, "best focus" is in the eye of the beholder. If we or our cameras are more sensitive to blue and violet, the middle panel is the "in focus" image.) All this means is that if you're using a one-shot color camera like a DSLR, you'll probably want to check a color image when doing the final focus to make sure you've take out that violet halo and are more like the middle panel. Honestly, your long-exposure shots won't be harmed at all as they will have seeing and tracking causing more softening than that touch of focus

Off-axis, the ES127 really shines. With the focuser in the "in focus" position (left panel), I moved the artificial star image to the upper-right corner of an APS sensor (Canon Rebel XSi). We can see that the stars' focus has shifted a touch (no more violet) and that there is some distortion, but the amount is really quite small (these images are magnified considerably). This is considerably better than I had expected. Typically, as we move away from the center of the FOV, the stars will become at the very least, slightly elongated, aiming inwards. The ES127 does a very nice job at staying clean here in the corner. This was backed up by test shots of a Norman Koren MTF chart that showed a small 25% drop in the LPI that could be resolved in the corner of the frame (this is a good bit better than my Borg doublet at prime, but not as good as the Borg gets with its dedicated reducer / flatteners that take it to < 10% of a drop). What error the ES127 has here was very nicely addressed by a Hotech 2" SCA Field Flattener (ES has their own flattener in the works). As you can see from the bottom panel in Figure 2, the corner image looks exactly like the center image. But really, the corner performance at prime is very good and far better than I anticipated.

Real World Visual Performance

Amateur astronomers can be a hypercritical bunch. If Scope A and B perform identically in all respects except that A out-performs B when Sirius is viewed at the edge of a 31

mm Nagler, we'll often say that A is better than B. This can then go on to let us justify to ourselves why we might pay a lot more for A (for that extra bit of performance, etc.). I can certainly understand this line of thinking, but I also have a very pragmatic side (hence the software I write). So, barring attempts to make it show any faults, what is the scope like?

In short, it's a great scope. No 5" scope is going to let my naked eye resolve M51's arms from my urban yard. What 5" can do, the scope does very well. There are no annoying glares or flares from the moon or neighbor's lights. Contrast is excellent and stars are tight and round with no errors that draw your attention. The moon is a joy to cruise at any magnitude my skies could support. The scope mechanically and optically disappeared and I could focus on whatever I wanted to observe.

Figure 3: Test shot of M42 taken with the ES127 ED and a QSI 540 wsg camera using Baader LRGB filters, a Starlight Xpress Lodestar, a Losmandy G11, PHD Guiding, and Nebulosity

Astrophotography Performance
I had two chances to get out for a reasonable amount of time with the ES127 and a camera and I must say I was quite pleased with how well it performed. While many would consider some form of reducer / flattener for the scope, I wanted to see just how well it would perform at prime focus. With the QSI 540 and the QHY8 Pro, prime focus is just over 1.5" / pixel - a very nice trade-off between resolution, FOV, and SNR.

Since time was short and the skies were bright (these are under fairly urban skies), I stuck to brighter targets. The first night out was M42 using my QSI 540 wsg and Baader LRGB filters (Figure 3). The scope performed very well and had I taken the trouble to refocus between filters, the shot would have been even nicer. Stars in one corner began to get a bit distorted (I believe owing to a touch of flex with the heavy camera), but overall it did a superb job. There was a touch of CA around the brighter stars but this could be removed by shifting the overall focus slightly, by refocusing a touch for the blue filter, or by post-processing. Flats showed that the corner of my 15 x 15 mm sensor was over 90% illuminated.

Figure 4: Test shot of M45 taken with the ES 127ED and a QHY8Pro, a Starlight Xpress Lodestar, a Losmandy G11, a Mini Borg guidescope, PHD Guiding, and Nebulosity.

On a second night, I used the larger one-shot color QHY8 Pro on M45. Again, time was a limiting factor (I only managed 2 hours of imaging), limiting the SNR in the image. My goal wasn't to make the prettiest shot of M45 ever made, but rather to see how well the ES127 performed. Here, you can see that there is no evidence of CA at all in the image and the stars are quite nice and round throughout (the left side is very good, although

not perfect in this regard). The large halos around Atlas, Alcyone, and Electra are caused from the camera's optical window and are not related to the scope at all (the source of the reflections is 0.6" from the sensor). Flats showed that the corners of this 24 x 15 mm sensor were about 75% illuminated.

Thus, the scope held up very well to the demands of astrophotography. The field is remarkably flat even at prime. Flatteners like the Hotech (or presumably the ES flattener when it comes out) do an excellent job at taking out the little that is in there (I've verified this under the stars as well as with the artificial star test from Figure 2). Residual color was either non-existent or minimal and my only note here would be for those with heavy cameras to consider a beefier focuser. Those with DSLRs and other lighter cameras needn't be concerned at all.

Gripes

Few things are perfect and, as such, there are a few usability things worth noting in the "con" category. First, I wasn't a big fan of the dewshield and lenscap arrangement. To attach the lenscap, I found I had to remove the dewshield entirely. If the dewshield was flipped over in its storage orientation, I just couldn't get a good enough grip to screw the metal lenscap on. The dewshield itself was very effective at keeping dew off the lens, but it is rather heavy and the remove-flip-and-screw-in-place operation certainly isn't as easy as a sliding setup (it won't ever slide back in the middle of an imaging session, though). Second, I found that getting my fingers to successfully clamp the diagonal solidly in place was a hit-or-miss affair. There was never a danger of the diagonal slipping out, but I would at times think it was solid only to find it still rotated easily. This tended to happen when the screw used to clamp it in place was in a small gap between a corner of the diagonal and the drawtube. Finally, while I love the case, it would be nice if the cutouts were such that the cradle didn't need to be in exactly the right position along the OTA for the tube to fit inside the foam. A little more leeway here to accommodate different balance positions would be nice. As you can see, none of these are exactly deal breakers.

Conclusions

The Explore Scientific 127ED Triplet is a great scope. In fact, if I had to have one and only one scope, this one would certainly be in the running. It's light enough and small enough that travel to dark sites is easy and portable mounts are a real option. It pulls in a lot more light than an 80 mm job and its native focal length of 950 mm is nice both visually and photographically. Even stock it does well at astrophotography and if one were to add a 0.8x reducer / flattener to this gets you down to f/6 and over 1.5 x 1 degrees of sky on an APS-sized DSLR. Thus, it's a great choice if you're going to use it visually, photographically, or both. What's more, it's part of an exceptionally well thought out package that comes in at a very attractive price. Explore Scientific has a winner here.