Prompted by discussion on sci.astro.amateur, and further seduced by the fact that no one in my local observing group had one, I recently bought a used optical tube assembly (OTA) for a Meade 127 mm (five-inch) f/9 "ED" refractor. After preliminary tests and evaluation, I report the following:

1) The Meade 127 ED I bought has a quite good achromatic objective, though by no means a perfect one.
2) Mechanical quality of the OTA is good to excellent.
3) At present new and used prices -- I paid $1200 for a bare-bones OTA with simple tube rings and with finder bracket (but no finder) -- I consider the unit a good value.
4) The Meade 127 ED is not as well color-corrected as Vixen and Takahashi fluorite doublet refractors, or Astro-Physics triplets.
5) The Meade 127 ED is not an apochromat, in either the technical or the colloquial sense of the word. Meade calls it "apochromatic"; Meade is lying.

Truth is in the details, however, so here they are.

According to the seller, I am the third owner of this particular 127 ED, and the consensus of the two previous was that this unit is one of the better ones Meade has turned out. Reading those words made me a little nervous, however, not just because they might be false, but also because they might be bad news even if true. Meade's optical quality control has been a matter of much debate recently. Three of the four Meade objectives I have previously owned have had good to excellent optics, and the fourth was cheerfully replaced by the factory under warranty, but even so, the buyer of a used telescope, with no warranty protection, does not sleep easily.

The unit showed up in due course, well packed by the seller in a special home-built shipping unit -- he observed that I was acquiring not only a fine telescope, but also a handsome piece of student furniture. I opened it eagerly, hauled out the OTA, sat it on the counter like a small beached whale, then pulled the dust cap and found -- hoorah! -- that the optics had escaped intact from the clutches of UPS. I took it home, cleaned it off, and set about figuring how to set it up. I won't tell you what I used for a mount -- suffice it to say that the Society for Prevention of Cruelty to Great Polarises has a warrant out for my arrest. Seriously, I was surprised to find that the GP does in fact handle a telescope of this size, though I expect that even a little wind will render it unusable. But that was the biggest mount I had, and a recently-purchased half-pier brought the eyepiece up to more comfortable levels, and the OTA proved lighter than expected, so I was indeed in business.

Though light, the OTA seems solid. The cell has push-pull adjustments. The dew cap is held on with a setscrew. The huge rack and pinion focuser moves smoothly, with little play, and with adjustable tension. There are at least four internal baffles.

The finder bracket arrived late, in a separate package, but that didn't stop me, and the notorious curse of foul weather for months after acquiring a new telescope held off. I was able to perform a cursory test within a few days.

As a rule of thumb, a doublet using extra-low dispersion glass ("ED" glass) as one of its components, will produce only about thirty percent as much longitudinal chromatic aberration as one made with good glass of more conventional types. Five-inch refractors made with conventional-glass doublets are starting to show embarrassing amounts of color, at focal lengths as long as f/15, so I was eager to see whether the designer of this faster instrument had asked too much of the fancier optical material. The quick answer was that the tradeoff was well made -- for at 190x, the Meade showed only the barest hint of a violet fringe on a vertically-running portion of the edge of the Moon's disc -- less than I see in my 80 mm f/11.4 Vixen conventional doublet. (It is important to pick a vertically-running part of the edge of the Moon for this test, for portions inclined more toward the horizontal might show color from atmospheric refraction alone.) Bright stars, even Vega, showed only a faint violet haze, again much less than similar conventional doublets. The 127 ED certainly showed a lot less color than an old-style five-inch f/15.

By the time the instrument had settled down thermally, I was ready for a star test. I chose one of the stars at the corners of the Great Square. Racking the eyepiece inside focus until four or five diffraction rings were visible gave a pleasingly regular pattern -- just like the ones in Suiter's book for a good, unobstructed system -- embedded in only a trace of violet glow. Racking the same distance outside focus produced a puzzle: The pattern was not clean at all -- there was a broad greenish haze with a smaller set of purplish blue features superimposed, the most prominent of which was a single blue ring, of diameter about seventy percent of the diameter of the largest diffraction ring seen at the corresponding inside-focus position. I suspected a combination of spherochromatism and perhaps a zonal aberration -- I wish I knew more about the star test -- and decided to pursue the matter on another night. I did notice, however, that as I was beginning to rack the eyepiece outside of focus, for the first tiny movement the central disc of the diffraction pattern stayed quite sharp and turned purple: Thus red and blue light were both coming to focus longwards of green, so that the instrument was an achromat, not an apochromat, at least, not in the strict technical sense of the word. (See the appendix on "What's an `Apochromat'?")

I also looked at Saturn. The seeing was not perfect -- my star test had the in-focus Airy disc always visible, but the rings always in motion. Nevertheless, Saturn looked very fine in those occasional instants when the seeing was best -- at 190x, I could see the Cassini division as a feature of noticeable width, not just a line. I could see the crepe ring and the prominent dark band in the southern hemisphere of the planet. It was a promising view.

Later in the week, I went out earlier in the evening, for a longer test run. I had dug out an old set of Wratten eyepiece filters, to investigate the star test at various wavelengths. While waiting for telescope and atmosphere to settle down, I took a look at Jupiter, at 190x. Despite unsteady conditions, the Galilean satellites all showed distinctly non-stellar discs, of different sizes. Jupiter went behind a tree shortly, but later on I enjoyed views of Saturn and of the Moon similar to those of the previous evening.

For star testing, I chose Vega -- a demanding target. With no filters, 190x revealed the same patterns as before. I repeated the tests with red (Wratten #25A), green (#58) and violet (#47) filters in alternation. The outside-focus ring was still present with each of the filters, though it was diminished in intensity with the green or red filter, compared to the violet filter and to no filter at all. Furthermore, the distribution of intensity in the inside-focus pattern was different for the three filters. Compared to the edge, the relative brightness of the center was about the same with the green filter as for no filter at all, but the center was relatively brighter with the red filter, and relatively dimmer with the violet one. This change in intensity is spherochromatism, also known as chromatic variation of spherical aberration -- the system's figure is different in different wavelengths. Spherical aberration of opposite signs in red and violet is another hallmark of the plain achromat, and another indication that the design is not an apochromat in the technical sense of the word. The Wratten filters were very useful for these tests, though they are far from perfect. Wrattens have very broad bandpasses which are not sharply delineated: A good set of narrow-band filters would have been much more illuminating.

These star tests were performed with a 6 mm Vixen Lanthanum eyepiece. I repeated enough of them with another eyepiece -- an 8 mm Brandon -- and with another star -- Polaris -- to be confident that the results were not peculiar to just Vega or to just that eyepiece.

I attribute the less-than-perfect star test to a combination of longitudinal color, spherochromatism, and possibly a minor zonal error. All the text and pictures I have seen, that aid in interpretation of star tests, are for monochromatic images. I know very little about how to unravel test results in which different colors of light do different things.

Polaris was of course split wide open, so for a lark I tried a much more demanding multiple star, gamma Andromeda. The wide pair of this system was well separated, again "of course", but I was delighted to see at 456x just the barest hint of elongation of gamma-two Andromeda in what, on checking, turned out to be the right position angle. I only logged the elongation as "suspected", but even that is quite an achievement for five inches of aperture.

My third night out with the 127 ED was for the occultation of Aldebaran by the Moon, on October 18-19, 1997. I went to Fremont Peak, near Salinas, California. Seeing was better than on the first two nights, and the telescope had a long cool-down riding in the back of my car. Jupiter at 228x showed much rich detail, and the steadier view of Saturn confirmed all the features I had glimpsed fleetingly on the preceding evenings. I had not brought my Wratten filters, but I demonstrated the by now familiar star test results to several other observers, using Altair and 228x. We also repeated those tests with yet another eyepiece -- a 6 mm Zeiss Abbe orthoscopic, with no significant difference except that the Zeiss orthoscopic showed less intrinsic glare than the Vixen Lanthanum -- as had the 8 mm Brandon. The other observers present all seemed impressed with the telescope, and promised not to tell the SPCGP where I was.

I did a little Messier hunting -- no surprises there -- then moved on to the Moon. Plato was several days away from the terminator, so much that there were no shadows in or near it, but even so, I could see at 228x three or four white spots on the floor of the crater, three of which were at positions of some of the craterlets shown in Rukl's atlas. Nearer the terminator, in an area of contrasty shadows, I could see the well-developed rille system on the floor of Atlas. The 127 ED was showing all the detail depicted in Rukl.

Not too many telescopes were present, but I got to do one neat comparison test. Someone had an Intes 6-inch f/12 Maksutov. I was curious to compare it to the 127 ED, because I own an Intes 6-inch f/10, yet cannot do side-by-side comparisons with my own telescope since I have only one mount large enough for the 127 ED or for the Intes. The Meade seemed to be giving a slightly more contrasty view of Saturn than did the Intes; that's about what I would have expected, from comparing my own Intes with other five-inch refractors.

Other comparisons I can do from memory: The Meade 127 ED does not give quite as good images as late-model Astro-Physics 130 mm refractors, or as Takahashi 5-inch fluorites. Indeed, the Meade 127 ED shows more in-focus chromatic aberration than either Vixen and Takahashi fluorite doublets (which are almost color-free, but will show a trace of violet haze if you know where to look for it), or Roland Christen's late-model Astro-Physics triplets. These latter telescopes appear to show no chromatic aberration whatsoever, on any object, and are the only refractors which I have ever seen that warrant the adjective "apochromatic" in the colloquial sense (see appendix). (Note that I do not know for sure whether the Christen designs are in fact apochromats in the technical sense.)

(The 127 ED is a great telescope for comparison with Astro-Physics 130s. What the Meade does better, it does by its own superior virtue; what the 130s do better is because they have 3 more mm of aperture...)

Thus although the Meade 127 ED has a fine objective -- at least, mine does -- it is not quite the telescope for purists that the modern fluorite doublets or the Astro-Physics triplets are; anyone who buys a Meade ED will sooner or later see a Vixen or Takahashi fluorite, or a Christen triplet, and be disappointed, for it is these telescopes that create that rabid fanaticism which causes enthusiasts to swear, "You can have my refractor when you pry it from my cold, dead hands."

When disappointment arises, perhaps the unhappy owner will say to Meade, "What you sold is not what you advertised -- an apochromat; I want my money back." I will be curious what Meade does in such cases, because their advertising is manifestly absolutely false -- they wouldn't have a leg to stand on, to justify the label "apochromatic", if it came to a court case. You can tell the judge I said so. I am not certain the error is deliberate -- folks who prepare ad copy often don't know the first thing about what they are selling -- but as a corporation, Meade is lying: There is surely enough optical expertise within their walls to know the ED doublet they sell is not an apochromat in the technical sense, and is not sufficiently color-free to warrant the colloquial meaning of "apochromat".

Yet there is no reason to allow the reputation of a nice achromat to be besmirched by the shoddy business practices and dishonest advertising of its manufacturers. My Meade 127 ED optical tube assembly is a fine telescope, and at $1200 (used) was an excellent value. I expect to keep it for a long time to come.

############### Appendix -- What's an `Apochromat' ###############

"Apochromat" is one of those words that has a precise technical meaning, but has entered popular usage with a colloquial meaning that is somewhat different. Here is an overview of what the term means.

If you plot focal length of a given telescope vertically, versus wavelength of light horizontally, what you are hoping to see is a straight, horizontal line -- all wavelengths of light come to focus at the same point. Any telescope which uses only reflecting optics to form its image will meet that goal -- Newtonians do it regularly. Yet, put lenses in the system, and the nice straight line disappears. One task of the optical designer is to make the graph nearly enough straight, over the wavelengths of visible light, so that no error of color is apparent. Just how straight it has to be depends on the aperture and focal ratio of the telescope.

In a common-sized refractor whose objective is a simple lens, the curve of focal length versus wavelength is an inclined line -- blue focuses shorter than red -- of such steepness that only a small portion of the visible spectrum is in focus at once. Simple-lens refractors indeed show enormous color fringes about their images.

Add a second piece of the right glass, and the graph is a broad, flattish curve, concave up. The designs used generally have the low point of the curve at green wavelengths -- green focuses shorter than any other wavelength -- and red and blue approximately equally out of focus. This is the conventional achromat, in the technical sense. With common glass types, it is hard to make the curve flat enough to result in an image that appears color-free -- it takes small lenses and long focal ratios to do so. ED glass makes the task easier -- the curve is squashed by about a factor of four compared to regular types of glass. Fluorite flattens the curve by another factor of two or more. Thus ED achromats are better than conventional ones, and fluorite achromats better still, as far as color correction goes.

A third piece of glass, of a type well chosen, can make the actual graph fit the straight line even better. The curve now resembles a very stretched-out horizontal "S". It comes up from below the straight line at one end of the spectrum, crosses the line, flattens out, dips back below the line, and rises, crossing one more time, and continuing to rise, at the other end of the spectrum. This "three-crossings" property is one of the features which define an apochromat in the technical sense. Such a lens is sometimes said to "bring three colors to the same focus". I will get to the other property later. With good choices of glass, an apochromat can offer better color correction than a conventional achromat. Not all apochromats do that -- some early ones used the extra design freedom to make a lens that would be in focus simultaneously for visual light and for blue and near-ultraviolet light, so that one could focus visually and use early, blue/ultraviolet sensitive photographic emulsions to take a well-focused picture.

We are almost done. The second property that has to do with the technical definition of an apochromat is how well it corrects spherical aberration at various wavelengths. A conventional achromat has zero spherical aberration at only one wavelength -- typically, green. In telescope-maker's terms, the figure is good at only one wavelength. In a classic three-lens apochromat, there are two wavelengths at which spherical aberration is zero, and if the design is well done, the instrument will be better corrected for spherical aberration at other wavelengths, than an achromat.

Thus an apochromat, in the technical sense:

1) Has an "s-curve" graph of focal length versus wavelength, so it "brings three colors to the same focus", and

2) Has zero spherical aberration at two different wavelengths.

So much for the technical definition. If you've made it this far the rest is easy -- the colloquial definition of an apochromat is simply an instrument which shows no false color in its images. As I said before, there are vast numbers of instruments out there which are superb apochromats in the colloquial sense -- any Newtonian will do (except those few that use prism diagonals instead of mirror diagonals). (Newtonians of course have other aberrations, such as coma and the distortion of the diffraction pattern created by diagonal and spider, but they are indeed color-free.)

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On the afternoon of 27 June, 1998, I took my Meade 127ED 5-inch f/9 refractor, with my new Losmandy G-11 equatorial mounting, to Fremont Peak State Park, near San Juan Bautista, California. I had had the Meade for more than six months, and initial tests showed it to be a quite nice achromat (though not an apochromat -- Meade falsely so advertises its ED refractor line). Yet between El Nino and the absence of bright planets from the winter sky, I had not done much lunar or planetary work with it. Saturday the 27th provided a several-day-old Moon in conditions that made dark sky and good seeing likely, so I could at least start to remedy the lack.

The Meade is overmounted on the G-11 -- a rare occurrence for telescopes owned by me. I had previously used it on a Great Polaris, which worked, but only with minimal wind and maximal care to avoid starting it wiggling. Yet the new mounting made it so stable that one observer, attempting to jiggle the tube to make a faint fuzzy more easily seen, commented that it was hard to do so. With the tripod legs fully extended and the optical tube assembly balanced, the eyepiece height range was just about right, too -- I required a step up only when observing very close to the horizon, and had to kneel to use the finder only when locating objects very close to the zenith.

The G-11 itself continues to be impressive: That night was only the second time I had set it up in the field. I am still tweaking the mount in various small ways -- Velcro patches here and there, yellow rubber dipped coatings on knob heads and other small parts that might get lost in the dark -- but I continue to like its ease of setup, robustness, and precision. I am sure I will find some other telescopes to overload it with soon.

Tolerable seeing even before sunset promised better for the night to come. Mercury was bright enough to be an easy object in early twilight, but was too much chromatically dispersed by atmospheric refraction to show any telescopic detail. As darkness gathered, I turned again to the Moon, and examined the region of the crater Petavius with 228x (5 mm Vixen Lanthanum eyepiece). I well remember the first view I had of Petavius and its spoke-like large rille, through my Celestron 14 many years ago: "Canals!" I declaimed to the other observers who had gathered to share the view. None of them knew anything about lunar features, either.

On this night the Petavius Rille did not look entirely canal-like, but the crater and the surrounding landforms showed a rich variety of detail. There were several other excellent, larger, telescopes on hand for comparison. I spent a while studying the same area through a late model Astro-Physics 180 EDT. The big Christen triplet certainly showed more than my smaller ED doublet -- as well it should. But the view through the lesser aperture was respectable. My Meade 127ED was running in the big leagues without disgracing itself. I have said before, that this telescope is a quite good achromat and -- at $1200 for the used optical tube assembly -- was an excellent value, and I say so again. Woe and alas, net opinion seems to suggest that not all of the Meade ED doublets are as good as the one I have.

The 127ED received one compliment worthy of note: One of our regular observers had brought his daughter. I neglected to ask her age, but she was not too far one way or the other from turning teen-aged. She looked at the Moon through the Meade and said appreciatively, "Daddy, why doesn't your telescope do that?"

Later in the evening, I mostly loafed around with the telescope, continuing to observe at 228x. A nearby observer was trying to split the double-double in an eight-inch reflector that seemed plagued by tube currents. I showed her a wide and clean separation of all four components of epsilon Lyra, for a mark to shoot at.

I spent quite a while staring at Antares -- some of you may recall a posting last month in which I reported a lot of chromatic disperson of that star in this telescope, compared to similar telescopes nearby. This month I was observing from a different part of the Peak, and the line of sight to Antares nearly grazed the rising hillside to the south. Perhaps for that reason, seeing was much poorer for that object than for any other that I viewed. I could not see the companion this time. But I detected no trace of chromatic dispersion, and I am pretty confident that conditions would have allowed me to see it if any had been present. So perhaps my proposed explanation last month, of tube currents, was correct.

I looked at a number of old favorites. M13 showed resolution all the way across it, with a granular background indicating further faint stars. I could see the elusive "propeller" shape near one edge. M15 was similarly granular to resolved, and much centrally concentrated. M11 was beautiful, with its one especially bright star standing out.

I only tried one object that might be said to be difficult: As I reported in another posting, I looked at NGC 6118 at 36x, to confirm its appearance as seen in a smaller telescope. It was no problem for the five-inch.

Jupiter rose rather late for my level of fatigue. I kept the Meade set up till it had risen about ten degrees. The view at that point was promising, but was certainly more limited by atmosphere than by telescope optics.

I expect I will use the Meade 127ED more as the planets come into view. I will report further.

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On the evening of July 4, 1998, several diehard observers gathered at Fremont Peak State Park, near San Juan Bautista, California, for a look at the Moon. The position of the terminator was well-placed for viewing a "challenge" lunar object, Rima Brayley, which lies at about 21 N, 37 W, in selenographic coordinates. This narrow rille is plotted on the large version of Rukl's _Atlas_of_the_Moon_, the one published by Kalmbach, but not on the smaller Rukl atlas from Hamlyn.

Several more experienced and better-equipped lunar observers than I were present, and I will let them report on the details seen with other telescopes, but persons interested in the performance of my Meade 127 ED 5-inch doublet might like to know that in brief intervals of excellent seeing, I could distinguish the part of the rille immediately due north of Brayley, at 285x (4 mm Vixen Lanthanum LV eyepiece). The rille appeared as a very fine dark line. The sunrise terminator was 30 or 40 Km west of Brayley at the time of the observation. I confirmed this view in a nearby Astro-Physics 180, which showed the rille somewhat more often. After allowing for the difference in aperture, the Meade performed respectably when judged by the standard of the big Christen triplet.

The wrinkle ridge system that is tangent to Brayley on the (selenographic) SW side, that trends SE/NW, was prominent, as was much other detail in the area.

I also looked for a rille plotted but not named by Rukl, that lies at about 21 N, 35 W. I could not see it, although a white albedo feature near that location was prominent. The feature lies a few Km SE of an unnamed peak at about 21.3 N, 35.5 W, and as near as Rukl's atlas allows me to judge, is superimposed on the unnamed rille at that location.

Elsewhere on the Moon, Rima Plato was prominent, Sinus Iridum was magnificent, and it was fascinating to watch changes in the appearance of the rough, textured floor of Gassendi, as the sunrise terminator withdrew across it.

I again succeeded in getting a reasonable split of Antares with the Meade, at 285x. Seeing was about the same as on the previous time when I reported a lot of lateral chromatic dispersion of the image of Antares, of the sort you might associate with atmospheric refraction or tube currents, and the star was at a similar elevation. This time there was no such dispersion in evidence, and that makes only one time in three that I have seen it, so I suspect that the phenomenon had more to do with meteorological conditions outside the tube or within it than with some intrinsic property of the optics. ("Within it" means "tube currents" in this context.)

The Meade also gave a fine split of gamma Virginis at 285x -- the star is no challenge for 5 inches of aperture at this epoch. And I used lower magnifications to give a couple of passers-by a view of some Messier open and globular clusters, which were about the best deep-sky objects I could find in the moonlit sky.

It was fun teasing the serious Loonies about their avocation. "How many objects have you logged on the Moon?" one asked. "Just one -- the Moon," I answered, referring to the fact that my card index of things I have looked at has no entries for individual craters and the like. "Why," he continued, "I have seen thousands of things on the Moon." To which I replied, "I don't know why you bother looking at it -- it's not even a planet." We left it that if I found craters in any other part of the sky, I would let him know real soon.