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A Small Refractor Shootout NexStar 80, Orion ED80, TV85 and the TMB80

4/2004 Tom Trusock - [Click to e-mail author](#)



Editors Note – a big thanks to Markus Ludes of APM Telescopes for the extended loan of the TMB 80 refractor. Thanks Markus!



The small refractor.

Nearly everybody's got one, had one or is going to have one (or more). From the ubiquitous Short Tube 80, to the semi-mythical AP Stowaway; the plain fact is that small refractors abound in amateur astronomy, and with good reason. Their advantages are legion; portable, lightweight, fairly easy to mount, they yield high contrast images. Additionally the owner typically has no collimation worries and refractors withstand the trip from a warm house to a cold backyard with few issues. Great for travel, quick peeks and wide fields, they come in nearly every price point, color and style.

This article takes a look at four different small refractors from across the various price points; the common Chinese 80mm f5 in the Celestron NexStar variation (donated by [Hands on Optics](#)), an Orion ED80, a TV85 (on loan from a reader) and a TMB80 (on loan from [APM Telescopes](#)). It will also attempt to answer (among other things) that perennial question, “What does the extra cash I spend get me?” Before we begin, we should probably define a few terms.

Refractors come in two basic breeds (albeit with several subspecies), achromatic or apochromatic. An achromat (or achro), is an arrangement of lenses designed to bring two widely separate colors (wavelengths) of light to a common focus. An achro usually uses inexpensive crown and flint glasses in a doublet (two lens) arrangement. This was such an improvement in longitudinal chromatic aberration (false color) over earlier designs using a single lens that it was given the name achromat - literally meaning "without color". However when compared to other more modern designs, it's usually fairly obvious that this is not strictly true. The residual chromatic aberration or secondary spectrum shows itself as a violet haze around bright objects - the faster the focal ratio, the worse the effects of the chromatic aberration. While it partly depends upon the individuals color perception and tolerances, this purple fringe will eventually begin to impact the performance of the scope, "hazing out" fine detail - especially at higher powers.

Enter the apochromat. Although fluorite would not be available until after World War II in sufficient sizes for use in telescope objectives, early manufacturers experimented with different types of glass showing abnormal dispersion properties (glass that bends light really well) in an attempt to bring three different colors to focus and eliminate the “Purple Haze” left in achromats. The mid to late 80’s saw a dramatic rise in the number of apochromatic scopes available to the amateur astronomer, and names like Brandon, Astro-Physics and Tele Vue became well known. Today apochromats come in a variety of configurations from multiple manufacturers. There’s no denying that some are more color free than others, but most manufacturers tend to stay away from the semi-apo label, simply because there isn’t really a clear cut optical definition of the term. Thus we have two types of refractors: achromatic refractors whose lenses are manufactured from flint and crown glasses, and apochromatic refractors which use special dispersion glasses like FPL-53 or fluorite (crystal) to further correct for false color. In this article we will examine both types of scopes.

NextStar 80

Achromatic Doublet
80mm Aperture
F5 focal ratio
1.25” rack and pinion focuser
Synta
OTA Price - ~\$150-\$200
Package Available? - Yes
Price as tested - \$339.00
Available from: [Hands On Optics](#), [Digitec](#), [Astronomics](#), [OPT](#) and others

Available in many different configurations, the basic Short Tube 80 (test version was the NexStar 80) is a traditional crown and flint achromatic doublet. The general rule of thumb for these scopes is that to reduce



false color to tolerable levels, the focal ratio must be around three times the size of the objective in inches, for an 80mm (3.15 inch) scope, this means that the focal ratio should be around f9. The NexStar 80 is an f5. As you might expect, false color abounds. Even at low powers, bright objects like Sirius, Luna and Venus are ringed with a purple halo.



At higher powers, the chromatic aberration becomes especially intrusive and masks fine details on Luna; low contrast areas such as domes and rilles are particularly affected. Lunar shadows become more purple than black, and some may find this visually distracting. But this scope really isn't intended for high power inspection of the moon and planets. It's made for low powers and wide fields, and it does about as well as its limited aperture allows in those areas. Strangely, what we thought were the biggest limitations of this scope aren't in its (surprisingly) well figured achromatic objective – nor are they to be found in the plastic fit and finish. No, the biggest problem we had with the NexStar 80 was the supplied mount. These inexpensive goto mounts are very popular with amateurs, but honestly, I'm at something of a loss to explain why.

Of the four times we had the mount in the field, on every single default alignment, the computer drove the scope into the mount. Another gripe involved the inability of the scope to point to zenith. Additionally, Keith and I were both puzzled over why some folks feel the need for goto on something that's essentially an oversized finder. I've owned a couple of different Autostar and NexStar driven mounts, and I'm very familiar with computerized pointing, so I know the issues we experienced weren't due to user error, but rather inherent design issues. In a scope intended for a beginner, this is pitiful. The last thing a tyro needs is to be frustrated by overly complex or poorly designed equipment while trying to pick up a new hobby. The OTA is a worthwhile investment if you are looking for a low cost, low power wide field scope, but I'd have to recommend that a newcomer steer clear of the NexStar scope, and opt for a non-goto version.

This scope had, by far, the most color on any object but it star tested quite well, and was a capable performer if someone is looking for a wide field scope. While not my first choice for lunar observing, it did fairly well - as long as you kept the powers low and the looks quick. As we increased magnification; false color became more and more intrusive, masking detail and drawing attention to itself. As for the fit and finish; it's a low



cost Synta. Plastic mixes with metal throughout, and the 1.25" rack and pinion focuser is "lubricated" with the now infamous syntaglu, making focusing at high powers a bit of an issue. But honestly, that's not that much of a concern because quite bluntly, you won't be taking this scope to the same powers you would the others. It's not designed for that. The Celestron NexStar version of the scope is supplied with a manual (a good thing too...).

Orion ED80

Apochromatic Doublet
80mm Aperture
F7.5 focal ratio
2" Crayford focuser
Synta
OTA Price - \$499.00
Package Available? – Yes
Available from:
[Astronomics](#), [Digitec](#),
[Anacortes](#), [OPT](#), and others

The Orion ED80 is, quite simply, an amazing value for the money. If you are considering one, you may wish to read my [comprehensive review](#). You can purchase it as a lone OTA or outfitted on a small GEM. The

ED80 is another Chinese (Synta) scope, but it's one of their first forays into apo-land, and while there are still some issues remaining, they did a fairly decent job if you consider the price point.

Optically, the ED80 hung in there with the rest of them, and I'll detail that later. There was just a touch of green and purple on Sirius, and a slight hint of color in the shadows of the moon. After adjustment, the scope was in nearly perfect collimation, showing a hint of a busted first diffraction ring at high powers – but nothing that seriously affected the image. The ED80 took power quite well, and pulled quickly away from the NexStar80 in this regard – lunar details were sharp with just a small amount of purple haze to deaden contrast. Optically, the ED80 performed very



similarly to the TV85. Interestingly the ED80 outperformed the like aperture achro even on deep sky, largely due to the fact that more of the energy is concentrated in the airy disk.

Mechanically, it was fairly typical Synta – it arrived out of collimation, and had a couple of issues that needed to be attended to: small paint

chips on the OTA and a squeaky focuser. The focuser is a 2" Crayford and is smooth and

buttery. Some users have reported issues when hanging lots of heavy equipment off the back as there is no real focuser lock.



In long duration testing, I've discovered that on one of the two samples I've been using the lens cell has worked itself loose and needed to be tightened. Obviously this is not something that you really want to see.

The rest of the ED80's drawbacks are quite well documented in my other review, but I'll summarize them here: mechanical fit and finish issues (paint chips, squeaky focuser), lack of (collimation)

adjustment screws for the lens cell, oversized body for the 80mm lens (a pity, because in my opinion it's just a little too big to make a travel scope – packing it along isn't an issue, but mounting it is), and lack of a retracting dew shield. Still, the 80ED epitomizes value. No manual was supplied.

Tele Vue 85

Apochromatic Doublet
85mm Aperture
F7 focal ratio
2" Rack and Pinion Focuser
Tele Vue
OTA Price - \$1680.00
Package Available? – Yes
Available from: [Astronomics](#),
[Digitec](#), [Anacortes](#), [OPT](#), and
others

The TV85 is one of those instruments that nearly every amateur has seen at one point or another. It's probably one of the best selling apochromatic refractors in America, and with good reason. At 85mm, it's small enough to be portable, but large enough to keep many amateurs happy.



Just edging out the other refractors in our test, the TV85

did slightly outperform the ED80 on deep sky objects, but truth be told, it was hard telling. Collimation was dead on in the TV85, and when seeing stabilized I was rewarded with glimpses of perfect diffraction rings.

Mechanically, the TV85 was a joy to use. Fairly lightweight, and easy to mount compared with the

TMB, it showed none of the mechanical issues prevalent in the inexpensive Synta scopes.



The TV85 shows about the same amount of false color the ED80 does; green and purple on Sirius, and on Luna, tinges of violet in the shadows (note that we probably would never have noticed this slight amount of color on the moon if we hadn't had the TMB80, ED80 and TV85 sitting side by side). Overall lunar performance was on a par or perhaps ever so slightly above the ED80, and the scope took magnification with aplomb, up to and in excess of the 60x per inch rule. The TV85 is not baffled in the traditional sense, and uses Al Nagler's now traditional flocking paper (the other three scopes use knife edge baffles). This didn't seem to make a lot of difference, as in practice the views were just as contrasty as the ED80, but didn't have quite the punch of the TMB.

One of the largest pluses to the TV85 is the fact that Al Nagler has designed a system around it. It sounds like a small thing, but the fact that it comes with one of the smaller cases on the market, and is available with a standard package that includes everything you need to observe (sans tripod, which they sell separately) is really a step in the right direction for most users. Packed in its supplied case, it took up far less space than the StellarVue cases I wound up using to store the other scopes.

Fit and finish is typical Tele Vue – that is to say top notch. Optically and mechanically, this scope was a great performer.

A manual is supplied.

Any drawbacks? Well, although it's one of the smoothest rack and pinion focusers I've ever used, it is still a rack and pinion focuser. Additionally, as good as the optics are, there's still a touch of false color. Moreover, while it was one of the smallest of the three apo's, it still was a little heavier than I would want to mount for extensive travel use.

TMB80

Achromatic Fluorite Triplet
80mm Aperture
F7.5 focal ratio
2" Dual Speed Feather Touch Focuser
TMB/APM/SV
Priced as Tested: ~\$1990 from APM
Package Available? – No
Available from: [APM](#), [TMB](#) and [StellarVue](#)

The TMB80 seems like it should be my dream scope, and optically, it's not far off. An 80mm fluorite triplet, this scope has ZERO false color either in or out of focus.

It comes with a two piece tube – one section is removable to let the scope come to focus without a corrector for binoviewing – and a two speed Feather Touch focuser on the end. The Feather Touch is without question, one of the best focusers on the

market. There were, however, some fairly minor fit and finish issues. The TMB arrived with a couple of small paint chips and a tiny ding/mark on the OTA. In addition the



supplied tube ring, while functional, is not the quality I would expect with a premium refractor in this price range. I was unable to mount it directly to a Gibraltar, Telepod Head or a G11 universal plate, and wound up securing the OTA with a single screw. While this worked, I wouldn't recommend it for constant use.

But still, the best place to judge a scope is under the stars. Images

were crisp and snapped to focus as you would expect, and were very pleasing – however there was one optical gotcha as well. A star test on the scope immediately after I took it out of the house (before reaching thermal equilibrium) showed a distinct triangular/trapezoidal shape to the extra and intra-focal patterns. This is most likely indicative of a pinched lens, and continuing tests while the scope was equalizing seemed to agree as the pattern gradually reverted to the expected circular pattern as the OTA cooled. The other scopes in this round up showed no signs of similar issues. However, even with this “oddity” in the star test, the TMB80 still outperformed the rest of the pack.

The single most striking thing about the TMB80 was its complete and total lack of color. In focus or out of focus, images were pristine. The only times we noted a touch of color in the eyepiece, it was due to differential refraction or the eyepiece we were using. Lunar shadows were absolute pitch black, and even Sirius didn't show any color. Outside of the cool down issues, this scope was an absolute gem. APM rates this particular OTA at 1/10 wave, and I'd have to agree.

Optically (outside of that *ONE* little issue), it was without question the best sample of the four. As expected, given the perfect color correction and the traditional knife edge baffles, the TMB80 yielded the best contrast of any scope on the field – but don't get me wrong, it didn't stomp all over the other apos – not by any stretch of the imagination. The differences were subtle yet evident to the experienced eye.



The TMB80 is somewhat reminiscent of the Bizarro (a TV85 with its tube shortened for binoviewing, no longer in production) in that you can remove a section of the tube and use your binoviewer without a corrector. When coupled with a pair of 24 Panoptics this ability meant that it was able to achieve a TFOV slightly wider than two degrees! This is quite impressive if you are after wide field binoviews. A caution though – while the brighter targets were fairly impressive (M42, M35, etc..) in my opinion, 80mm is a bit small for binoviewing DSOs. On the other hand, I found the TMB/binoview combination to perform very well on the moon and planets – particularly at higher power, and for some this may well be worth the price of admission.



There was no manual supplied.

Any drawbacks? Well to be blunt, fit and finish was not what I would expect from this caliber of a scope. Note that APM informs us this particular OTA has been discontinued, and I'd assume/hope that these issues will be addressed in future versions that carry the same lens – especially the thermal issue. While in practice it turned out not to matter much when compared to the rest of the field, it may cause some purists undue anxiety. Additionally, in what was something of a mix up at the shop, the dew shield evidently was installed without the retaining ring, as on the version we were supplied the dew shield slides all the way down the tube. If I were interested in the ultimate travel scope, weight might be a concern as well. Although it's small (tiny with the tube extension removed) I personally would want something a little lighter and easier to mount for travel.

Field Notes

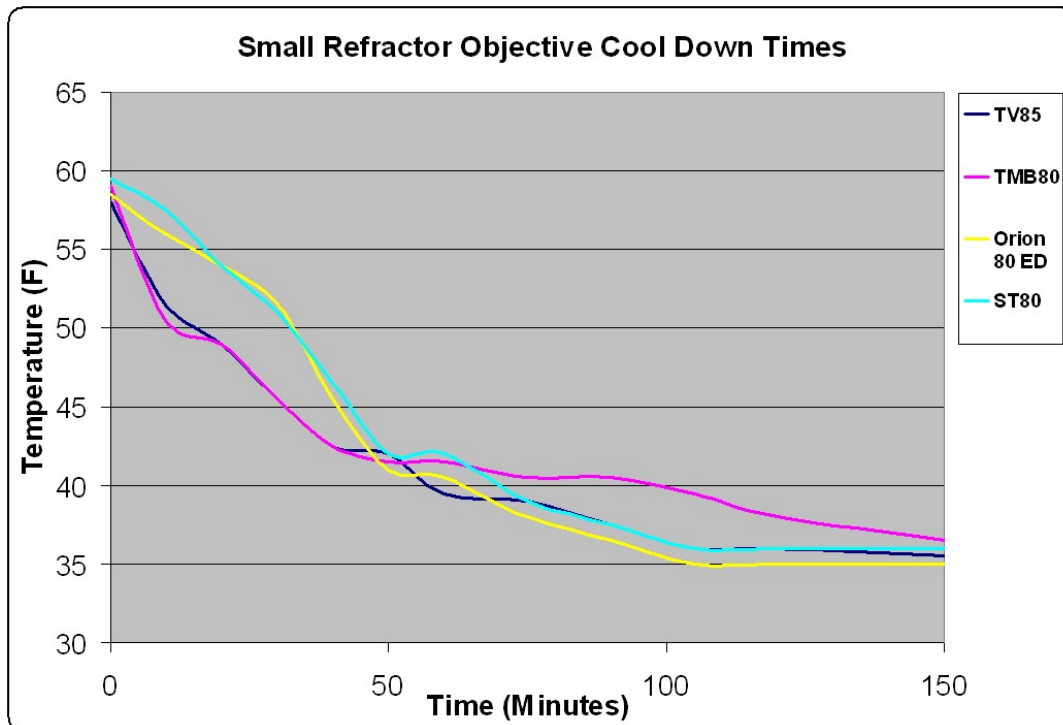
Under the stars, all four scopes performed well, and fairly similarly, at low powers on wide field deep sky objects. The apo's did slightly outpace the lone achro (because of the spurious color falling outside the airy disk). While both the TV85 and TMB80 were slightly ahead of the ED80. Interestingly the increased contrast in the color free refractor (TMB) seemed to make up for the tiny difference in aperture, and the TMB and TV panned out about equal for DSO's. On lunar and planetary targets, the TMB and TV came in neck and neck at first and second, while the ED80 came in a close third with the N80 falling further behind.

The scopes that got used the most were the TMB80 and the TV85 – both premium refractors, I'd have to say we spent a bit more time playing with (ahem – urr **testing**, Ed.) the TMB because of it's ability to use a binoviewer without any form of corrector – talk about wide-field nirvana!

Of these two top notch scopes (TMB and TV), we initially had a hard time telling which was delivering superior planetary performance. When Saturn was high in the sky, both of

us had the impression that the TMB was delivering better views. Yet if we went a little closer to the horizon, the differences vanished. We noted a slightly warmer (yellow) image in the TV85, and a slightly cooler (blue) one in the TMB. Neither would be noticeable without doing a side by side, and which you prefer depends on your personal preferences.

The majority of our testing was done in late February and early March. Typically we took the scopes from a 65 deg F house out into weather that ranged from 20 to 45 degrees. While cool down does not typically have a great effect on the views with a small refractor, we found it interesting to note that cool down times for the three doublets (N80,



ED80, TV85) are fairly similar, but that the fluorite triplet (TMB80) took longer to reach final equilibrium. It only seems natural that the larger mass of the triplet lens would retain heat better.

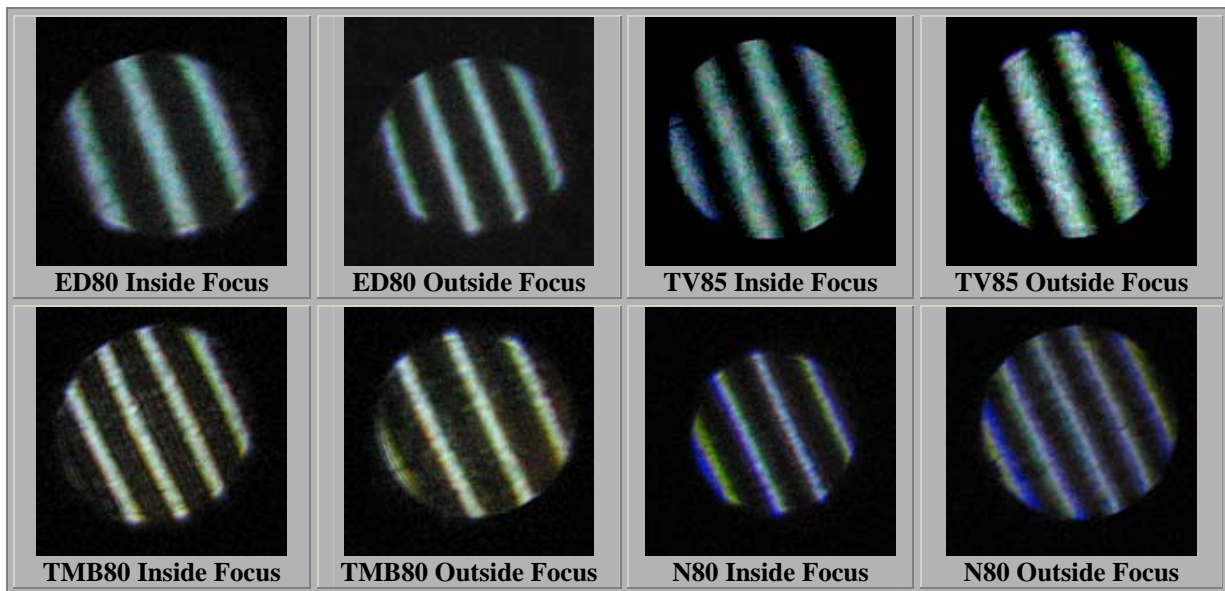
Surprisingly, while the Feather Touch on the TMB was very nice, we found that on scopes of these focal lengths, both the ED80's crayford and the TV's rack and pinion are functionally, just about as good. Depending on your observing conditions, you may like them a little better - the big knobs and the rubberized grips are nice for gloved observers and cold weather.

Although large and very bright targets like M42 and M35 are best for these scopes, we were able to grab some of the brighter galaxies. From dark skies, M81 and 82 make a nice couple for a small scope, as do the brighter Leo Triplets; M65, M66, NGC3268 and M105, M95, M96. While you can also spot some of the brighter galaxies off Leo's Tail, there is no fear of getting lost in the Coma Cluster.

The scope we used least was the NexStar 80, and as we indicated above, that had more to do with the mount than the fact it was a fast achro. Remembering that old age and treachery beats youth and skill every time, after a couple of initial sessions with the NexStar, I managed to push it off on my observing buddy. He *tried* to use it three times, and wound up getting frustrated enough to nearly pitch the mount across the street. Now before you write and tell me “Oh, you guys just didn’t know how to use the NexStar system” let me make a couple of comments. I owned a NexStar 5 for over a year (for me, that’s a *very* long time to keep a scope – think in dog years). That was a wonderful telescope, and I had great success with it. My observing partner was pretty familiar with the system, and has used several different types of DSC’s and goto platforms (hanging around me he tends to get exposed to a lot of different stuff). Both my observing buddy and I are computer geeks, and used to working with all sorts of finicky technology, and finally while I’m sure the system could be made to work, we both felt there were too many inherent limitations (such as the scope’s inability to point to zenith – it often seemed to want to slew through zenith when going to a target as well), to put up with goto on what’s essentially an oversized finder scope. We both felt it would be easier and faster to simply move the scope ourselves rather than have the computer do it. The single plus the NexStar mount has for these size scopes is that it provides tracking in a very small package – if you can get it aligned.

Optical Evaluations

As witnessed by the Ronchi tests, all scopes had good optics.



Note the similarity in color between the TV85 and ED80, the white color of the TMB, and the extra purple / blue seen in the NexStar 80. This is a fairly good example of their overall color correction. All photos were taken using an artificial star under similar conditions.

Decisions, Decisions

So I guess the big question becomes what scope do you buy?

Well – in this case, that’s fairly easy if your purchase is economically driven or if all you care about is low power wide field views. Going for the least expensive option leaves you money to spend in other areas. The biggest limitation to a Short Tube 80 like the NexStar is that its false color hinders its performance on the moon, planets (and to a much more limited amount) even somewhat on deep sky. That’s not to say that they can’t provide nice views, these scopes can, and do. Especially if used in the context for which they are intended – wide fields and low powers. And since you will mainly be using it at low powers, you can mount it on a lightweight camera tripod, which makes for extreme portability. There’s also the “I didn’t pay a whole lot for it, so if it gets dinged it’s not that big of a deal” factor. Don’t underestimate that.

NexStar/Short Tube 80	
Hots	Notes
<ul style="list-style-type: none"> • Inexpensive • Wide fields • Lightweight 	<ul style="list-style-type: none"> • Fit and Finish issues • Significant Chromatic Aberration • 1.25” Focuser • No sliding dew shield

However, if you can afford to, I’d urge you to step up to a small apo. The performance differences are somewhat self-evident, and even effectively give you a little deeper reach. They certainly make better allowances for the use of high powers. Ideally, a good apo can do both wide fields and high powers. The ED80 makes a good introductory apo. It is value priced (albeit not nearly as good as they were when they were first introduced), yet gives decent performance. The mechanics are workmanlike, the fit and finish has issues, and you may have to send it back a couple of times to get acceptable optics, but I’ve seen several very good samples that

Orion ED80	
Hots	Notes
<ul style="list-style-type: none"> • Inexpensive • Wide fields • High powers • Apo • 2” Crayford 	<ul style="list-style-type: none"> • Fit and Finish issues • Minor Chromatic Aberration • No sliding dew shield • Focuser may slip

stack up well against scopes costing hundreds more.

Another step up is the Tele Vue 85. I’ve got to hand it to Al Nagler here. The way his scopes are packaged is nothing less than genius. With Tele Vue, you don’t buy a scope so much as you buy a system, and everything is tailor made. Sure, you can get similar accessories for other scopes on the market, but there is something about having the entire system designed to work together. Buy an 85? Need a case? One comes supplied. Want a mount? No need to worry about if that mounting ring will fit on a travel mount – just buy one of ours... at the end, an observer could wind up with a complete Tele Vue system; scope, mount, eyepieces, and even computer. All color coordinated, and perfectly matched. But even with the TV85, there’s still that teeny tiny nagging amount of false color. Some won’t notice it, most won’t care, but a few it will drive batty.

Tele Vue 85	
Hots	Notes
<ul style="list-style-type: none"> • Wide fields • High powers • Apo • 2” R&P Focuser • TV system and accessories 	<ul style="list-style-type: none"> • Minor Chromatic Aberration • Expensive

That leaves us with the TMB80. I initially had a hard time placing the market for this scope. To get rid of that little bit of false color in a doublet design, you have to step up to a fluorite triplet which adds an extra bit of glass on the front – to counter balance that,

TMB80	
Hots	Notes
<ul style="list-style-type: none"> • Wide fields • True Apo – absolutely no false color • 2” Feather Touch Focuser (Dual Speed) • Excellent for low power binoviewer use • Top notch optics 	<ul style="list-style-type: none"> • Minor fit and finish issues • Triplet lens + Feather Touch focuser = heavy scope • Expensive

you put on one of the best focusers on the market, but unfortunately that’s heavy too. The result however, is an OTA that optically provides some of the most color free and best performance out there, but at a premium price.


While compact, it is a heavy little guy, and you need to put it on a sturdy mount – for me anyway, this would rule out a travel scope. In fact, although all of these scopes are a bit larger than I would like for a travel scope, the TMB is definitely the “big fish in the small pond”... (Hmmm – could this mean there is a shoot out of the even smaller refractors yet to come?

TV76, FS60, etc...??) While the binoview feature is truly cool, I doubt I would use it much as I’ve learned that I like some aperture behind my binoviewer. For the purist, the TMB80 represents the best optics money can buy, but there were some fit and finish issues with our sample – however, as I noted, we have been informed that this tube has been / is being discontinued, but the lens apparently lives on. I can see how this scope would appeal to astro-photographers – superb optics coupled to a state of the art focuser. These folks don’t care about weight as they have the scope sitting on a platform intended for astrophotography. This lens also would appeal to the amateur who, no matter the cost, wishes to rid themselves of that last little touch of false focus color.

Report Card

Any rating scale is a subjective thing. What I see as important, you may choose to discount altogether. For example, price may not be an object, or you may not see fit and finish as important as optics.

You may elect to live with large amounts of false color on your small refractor because your other scope is a 25 inch Obsession. This might be your only scope, and you want the absolute best optics you can get your hand on no matter the cost. Binoviewer use may be the end all be all, or you may just not care. Weight might be an issue if you do a lot of traveling, or the scope may spend all it’s time piggy backed on top of your AP130 on the G11. Get the picture? Bottom line is, every body has to decide what’s best for them, and what’s best for me, may not be what’s best for you. The key to buying (or owning) any scope is to pick what fits you best - your price point, your observing style, your lifestyle. What’s a good choice for one observer may be a very poor choice for another. That being said, here’s our report card.

				
	NexStar 80	Orion ED80	Tele Vue 85	TMB80
Deep Sky Performance	C	B	A	A
Planetary Performance	D	B	B+	A
Fit and Finish	C-	C	A	B
False Color**	D-	B	B	A
BinoViewer Use	F	C	B	B+
Useable on small lightweight mount	A	C+	B	C-
Price	A	B	C	C-
Widest Field	~4.5 / A	~4.4 / A	~4.4 / A	~4.4 / A
Focuser	1.25" / C	2" / B	2" / B+	2" / B+
Class Participation***	D	C	A	A
Final Grade	C	B-	B+	B+

* All items as compared to scopes of similar aperture and class

** You might be wondering as to the lack of an A+ for the TMB's color correction. It's simple, really. I don't give A+'s. In essence, that's giving 11 out of 10 possible. You just can't do better than perfect.

*** Class Participation denotes which scopes we developed a preference for after repeated use.

And now, as the pig says: "Th-th-th... that's all folks!"

Oh... you **still** wanna know what I'd pick? Honestly? No holds barred? Well, I'm gonna do like any good teacher would and leave you to make your own decisions.

In other words, I ain't gonna tell ya.

Suggested Reading / Further Resources

A Survey of Refractive Systems for Astronomical Telescopes by Roger Ceragioli –
<http://www.atmsite.org/contrib/Ceragioli/newrefractor/index.html>

Defining apochromatism by Thomas Back –
<http://voltaire.csun.edu/tmb/definition.html>

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*While a certified card carrying aponaut, even Tom was glad to move into
some serious aperture for upcoming reviews...*