CHAPTER TWO

Telescopes for Urban Observers

What's the best telescope for the city-bound deep sky astronomer? If you already own an instrument, *that's it*. Almost any telescope, perhaps with a few simple modifications, can work well as your urban starship. Not all telescopes are created equal, however, and if you're thinking of expanding your telescope arsenal or buying your first instrument, you now have the chance to acquire one with your personal observing environment in mind.

Telescope Types

Before you can select a telescope in an educated manner, you need to become acquainted with a few of its characteristics. There are three basic designs: the refractor, which uses a big lens (usually referred to as the "objective") to collect light; the reflector, which uses a large concave mirror (the "primary" mirror) for the same purpose; and the catadioptric telescope, which uses a combination of lenses and mirrors to grab starlight (Figure 2.1 shows the most common designs). Two simple specifications will tell you a lot about a telescope of any design.

The first specification is *aperture*, the diameter (expressed in millimeters for small scopes and sometimes inches for larger ones). This indicates how much light the telescope can collect. *Light* is what you want, whether you observe from the city or the country. Any scope can be magnified to any extent. Plenty of light is what's needed, not the higher magnification. The department stores are filled with "600 power" 60-mm aperture scopes in alluring boxes festooned with Hubble Space Telescope images. Some of these scopes are actually fairly good optically, but, unfortunately, they are completely useless at high magnifications claimed for them. High power with a small

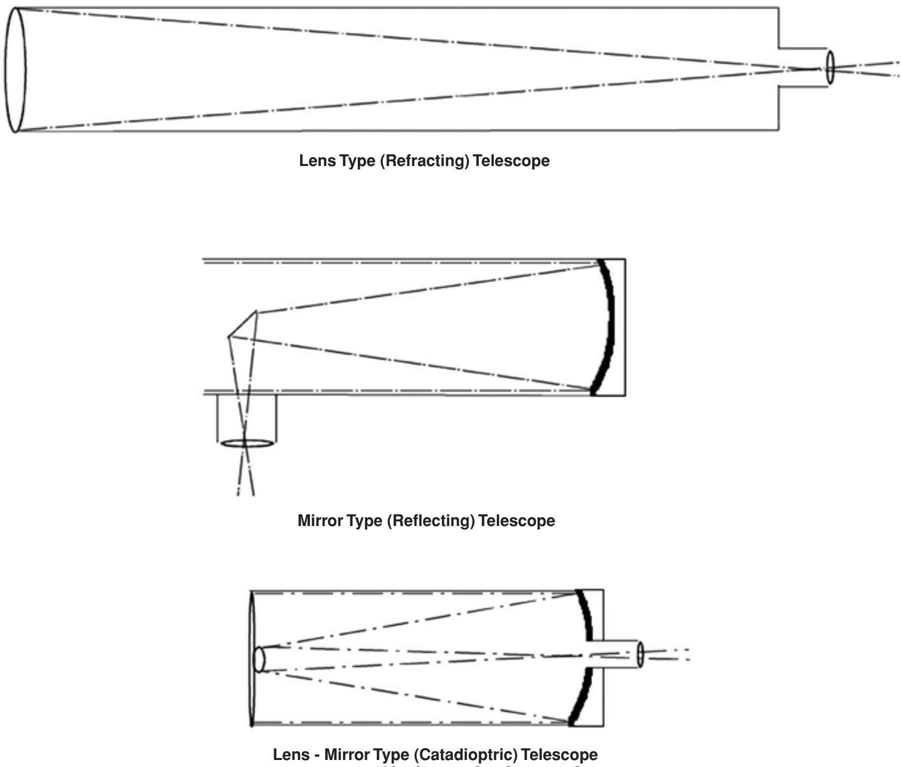

Figure 2.1. Major telescope designs.

telescope makes everything dim to the point of invisibility. Images in the eyepiece must be bright enough for high power to be useful. A deadly dim globular cluster at 300× will show the observer *less* than what he or she could see at 100×. Light gathering power depends on the area of the lens or the mirror, so an objective lens or primary mirror with twice the diameter of a smaller one will collect four times as much light.

The second important specification is the *focal length* of the scope, the distance from the lens or mirror where the image comes to a focus. It is commonly expressed in millimeters, even if the mirror size is given in inches (don't ask me why). Longer focal length telescopes deliver higher magnification for a given eyepiece. A scope with a focal length of 750-mm, for example, will provide 30× with a 25-mm focal length eyepiece, whereas a telescope with a focal length of 1,200-mm will provide a magnification of 48× with the same 25-mm eyepiece (magnification can be calculated by dividing the focal length of eyepiece by the focal length of telescope).

Focal ratio is very similar to focal length. It is the mirror (or lens) aperture divided by the focal length of telescope. A telescope with a 150-mm mirror and a focal length of 1,200-mm has a focal ratio of $f/8$. Similarly, a 150-mm aperture telescope with a focal length of 750-mm yields, a focal ratio of $f/5$. Smaller focal ratios for a given size of objective mean shorter focal lengths, lower magnifications, and wider fields.

Larger focal ratios denote larger magnifications and narrower fields. These focal ratio numbers will soon become second nature to you when it comes to evaluating telescopes. If you see "*f*/4," you'll think "low magnification and wide field." A focal ratio of "*f*/10" will mean "high magnification, narrow field." With these few simple scope characteristics in mind, you're almost ready to start considering "which scope" in detail. Before looking at urban telescope candidates, however, I want to put to rest an old and silly myth.

The Urban Aperture Myth

You've heard it before, from local amateurs, on Internet astronomy discussion groups, and even from prominent astronomy authors who should know better: "If you live in the city or heavily light-polluted suburbs, don't buy a large aperture scope. A big mirror or lens will collect more light, but this will include more sky glow, more light pollution. The sky background in a big scope's field of view will be so bright that you'll see more with a smaller instrument. Get a 4-inch refractor, not an 8-inch Schmidt-Cassegrain or 12-inch Dobsonian reflector." Sounds reasonable and sensible. Big scopes gather more light, both from distant deep sky objects (DSOs) and from the background sky glow in your light-polluted skies. Choose a nice, small scope instead.

The problem with this theory is that it is a nonsense. Even though a big scope does collect more light from the bright sky background, *its deep sky images always look brighter and more detailed.* In order to prove or disprove this urban-aperture-limitation theory, I set up a small aperture 4.25-inch Newtonian reflector next to my largest scope, the 12.5-inch Dobsonian. I then pointed both at M13, the marvelous globular star cluster in Hercules. Assuming the urban-aperture theory was correct, the views in both instruments should have been similar. The 12.5-inch Dobsonian would yield an image so washed out by bright sky background glow that no more details would be visible in the cluster than in the 4.25-inch Newtonian reflector.

When the smaller scope was pointing at M13, I inserted an eyepiece that yielded 48× and took a look. It looked nice! The great cluster was easily visible, bright, and seemed as if it might *want* to resolve into myriad stars with higher magnification, but I wasn't able to see any individual stars at 48×, not even around the cluster's edges. What would I see in the 12.5-inch scope? I moved the eyepiece to the larger scope, where it gave the roughly comparable magnification of 65×. WOW! M13 didn't just look *nice*—despite my less than dark skies, it was a *marvel*. Many, many tiny cluster stars were visible, and, with the globular riding high in the sky, I seemed to resolve it across its very core with averted vision. It wasn't just a round glow; it was a big ball of stars. What a difference!

Maybe the comparison wasn't exactly fair? The 12.5-inch scope's slightly higher magnification could have given it an overwhelming advantage. I searched around in my eyepiece box and came up with a longer focal length ocular that gave me a magnification of 45× in the 12.5-inch instrument. Nope! The view in the 12.5-inch scope was still better, much better, than the attractive but unresolved view in the 4.25-inch. Frankly, in the 4.25-inch scope, M13 looked like a fairly unimpressive smudge. A bright smudge, but a smudge nevertheless. Also, to my eye, the field background really didn't look much brighter in the 12.5-inch scope than it did in the 4.25-inch. The background was bright in both instruments, but, to me, not noticeably moreso in the larger instrument.

Maybe the aperture gap was just too great. Perhaps an 8-inch would be a more worthy opponent for the big 12.5-inch than the little 4.25-inch in the city? I set up an 8-inch $f/7$ Newtonian reflector that I had on hand and took a look at Hercules. The cluster was better than it was in the 4.25-inch scope, but the view was not nearly as good as in the big 12.5-inch Dobsonian. M13's appearance in the 8-inch was considerably better than it was in the 4.25-inch scope, though—some stars were easily visible. The conclusion was unavoidable. In the city, as in the country, *aperture wins*. The larger your lens or mirror, the better the view.

When people ask me about the urban-aperture myth these days, I reply, "If you observe in light-polluted areas, always choose the largest aperture telescope you can afford and transport. In the city, aperture always wins." In fact, I've come to believe that aperture is more important in the city than it is in the country or suburbs. From a dark site, a surprisingly small scope will show a lot of deep sky objects in detail. At a pitch-black desert location, my little 4.25-inch reflector would undoubtedly have done better on M13 than it did in the city. No, it still wouldn't have kept up with the 12.5-inch scope, but the cluster would've looked better; some stars would have been resolvable.

If the sky is bright, you need all the aperture horsepower you can muster. Don't let anybody convince you otherwise with tales about the "bright sky background." If the field in your larger aperture telescope looks annoyingly bright, increase the magnification—that will darken it. But at *any* magnification, deep sky objects will show more detail with large aperture than with a small scope.

How Much Aperture?

The foregoing would seem to eliminate small telescopes for city use. That's not strictly true. Large aperture is always best, all things being equal, but all things are *not* usually equal. My big Dobsonian-mounted Newtonian works for me, living in a single-family home with a backyard, but if you live on the 12th story of an apartment building, you'll find hauling a big scope up and down a bit troublesome in an elevator and completely impossible if you have to negotiate stairs at any point—to access your building's roof, for example. If you're in a situation where you have to transport the scope to observe, pick a telescope with only as much aperture as you can *handle*. Try not to go too small, though.

If you can gain a sizable performance increase by going to a larger telescope that's only slightly more difficult to move, by all means do so. For example, given the choice between a 4-inch medium focal length refractor and a 6-inch Newtonian reflector, I'd always choose the 6-inch Newtonian reflector. The 6-inch reflector is slightly more difficult to move around than the 4-inch refractor, but only slightly, and it's worth the extra trouble for those additional 2 inches of aperture. Since it's an area that counts, the jump from 4 inches to 6 inches makes a big difference in what you can see. You'll hear a lot about the superiority of refractors with respect to contrast and image sharpness. Some of what you hear is true, but for the urban deep sky observer, again, the prime requirement is *light*. A 6-inch reflector will deliver more precious light than the 4-inch refractor.

How Much Focal Length?

Given the choice between a short focal length, small focal ratio scope, say, a 6-inch $f/4$ (focal length 600-mm) and a 6-inch $f/8$ (focal length 1,200-mm) for use in the city, I'd pick the $f/8$. Why? Larger telescopes are not handicapped by bright city skies any more than smaller telescopes, but all telescopes are naturally troubled by the relatively bright background of a low-power field delivered by scopes in light-polluted areas. In the country, nothing is nicer than touring the heavens with a low-magnification eyepiece. The sky background is velvety black and objects stand out in stark relief. In the city, the sky in your eyepiece is light gray rather than black. There's less contrast between the sky background and deep sky objects, and some dimmer DSOs may disappear altogether. Luckily, we can combat this bright field effect. Higher *magnification* increases the *contrast* between an object and the sky background—which is not to mention that you can duplicate country conditions by using high power, but it does help.

Why choose a larger focal ratio and longer focal length telescope for the urban use? A larger focal ratio scope produces *higher magnifications* for any given eyepiece. It's easier to reach a usable magnification for the city with common eyepiece focal lengths with a larger focal ratio scope. You don't have to resort to short focal length eyepieces—which are often uncomfortable to use—to achieve the higher powers you need, as you may have to do with a small focal ratio, wide field telescope.

Another benefit of large focal ratio instruments is their optical quality. Large focal ratio optics are always easier to make than smaller focal ratio optics, so, for a given price, a larger focal ratio scope may be considerably better optically than a smaller focal ratio scope.

A small focal ratio telescope may be desirable for the urban observer for easy portability, however. Smaller focal ratio, shorter focal length refractors and reflectors have shorter, lighter tubes than large focal ratio, long focal length instruments, making them easier to transport and store, which may be critically important for the apartment dweller.

Which One?

A quick browse through the amateur astronomy magazines will reveal a multitude of advertisements for a bewildering array of telescopes. The prospective 21st century telescope buyer is lucky that there is so much to choose from, but the endless color ads and manufacturers' enthusiastic claims and counterclaims make the task of picking a telescope confusing and maybe just a little bit frightening. The following section is designed to make this process less scary. In the next few pages, I'll look at the major telescope types with an eye toward their suitability for use in the city. I'll also consider some specific models. Since there are more commercial telescopes available today than

I could possibly provide educated hands-on reports for, the fact that a certain brand or model is not represented here does not necessarily mean that it is a bad scope or a bad scope for the city. It may just mean that I haven't gotten around to trying it. But the listed telescopes are my favorites and ones that I've had the chance to use in the city—often extensively.

The Refractor

Prior to about 20 years ago, the refractor, the time-honored "big lens" telescope, was dead when it came to amateur astronomy. Refractors, once much-loved by amateurs, had, with their big price tags, colorful images (as in chromatic aberration) and long, unwieldy tubes been left in the dust during the 1970s and 1980s by Schmidt Cassegrains and big Dobsonian (Newtonian) reflectors. But the refractor has staged a remarkable comeback, and it is now once again a popular and logical choice for any amateur and certainly for the city observer.

What brought the refractor back? Three things. First, the premium color-free apochromatic objective lens designs pioneered by Astro-Physics and TeleVue in the United States and Takahashi in Japan. Refractors suffer from chromatic aberration—a problem that's plagued these scopes since Galileo's day. An achromatic refractor, i.e., a telescope with a two-element objective made of crown and flint glass, the most popular design of refractor objective lens for the last couple of centuries, cannot bring all colors of light to focus at the same point. The practical effect of this is that bright objects like the Moon, Jupiter, Venus, and brighter stars are ringed with purple halos. This "excess" color is not only distracting—for some observers, very distracting, as some people seem more bothered by chromatic aberration than others—it tends to obscure detail and soften the image.

The apochromatic ("without color") refractor solves the chromatic aberration problem. Sophisticated lens designs and innovative materials—the use of fluorite "glass" is common—make the "color purple" a thing of the past. The color-free nature of these telescopes allows them to show the refractor's strengths to best advantage: good contrast due to the lack of a central obstruction (from a secondary mirror), a maintenance-free sealed tube, and little need to allow the telescope to adjust to outdoor temperatures. Couple this with the mechanical perfection the APO makers lavish on their *beautiful* creations, and you have very capable telescopes with heirloom quality. Naturally, this comes at a high price. Apochromatic telescopes are the most expensive telescopes per inch of aperture, and the prices really skyrocket once you get above the fairly modest aperture of 5 inches.

The second reason refractors returned was an emphasis on smaller focal ratios. In their earlier incarnations as amateur telescopes, most "featured" focal ratios as large as $f/16$. Few were seen "faster" (i.e., with smaller focal ratios) than $f/12$. This was done in an effort to reduce chromatic aberration, as at large focal ratios with their resulting long focal lengths, color is reduced for any achromatic objective. In theory this is a good idea, but at these very large focal ratios, once you got above a few inches of aperture, fields were very small and magnifications very high for any given eyepiece. Photography of deep space objects was difficult due to the very long exposures such "slow" optical systems required. In addition, the tubes were long and awkward (almost

6 feet long for a 4-inch telescope), and discouraged the user from moving the scope often, whether to dodge lights or to travel to dark sites. All in all, these telescopes were for an older version of amateur astronomy, one that focused on Moon, planets, and a few bright DSOs.

Today's refractors, and especially the apochromats, offer up delicious wide fields and fast focal ratios that make them attractive to deep sky fans. With focal ratios from $f/5$ to $f/6$ typically, a stunning view of the Pleiades or the whole sword of Orion is possible in the smaller apertures. This smaller focal ratio popularity has also affected the achromats, which now hover around $f/8$–$f/10$, with $f/5$ s also popular. It is almost unheard of to find any type of refractor with a larger focal ratio than $f/10$ these days. This works very well for the apochromats; they can deliver low powers and wide fields but, due to the superb quality of their optics and the lack of color problems, they still allow high magnification viewing. Achromats with shorter focal ratios are less successful. Even at $f/10$, color is quite noticeable, and, due to chromatic aberration, higher magnifications cause rapid breakdown of image sharpness.

The final key to the resurgence of the lens-scope? The influx into the West of very inexpensive but relatively well-made Chinese (Mainland and Taiwan) refracting telescopes. At this time, most of the Chinese refractors are traditional achromats, but they are relatively well made and perform well considering their low prices. These low prices have allowed many of us to enjoy an experience that, for those of us who entered astronomy in the 1960s or before, always seemed impossibly expensive: owning a "big" 6-inch refractor.

Are refractors a good choice for the urban astronomer? Yes and no. They are a very good choice if portability is a major concern. An $f/5$ or $f/6$ refractor in the 5-inch or smaller aperture range is easily manageable, even if the owner must reach her viewing site via multiple flights of stairs. The problem comes when it's time to increase magnification. Urban observers often use higher powers than country-based astronomers. As explained earlier, this darkens the field of view and allows DSOs to pop out of the normally gray sky background. If the $f/5$ or $f/6$ telescope in question is an apochromat, no problem. Just run the power up as much as you want. But be aware that you may have to use very short focal length eyepieces to reach this desired power.

If the refractor in question is a small focal ratio achromat, however, you may find it all but unusable in the city. A 4-inch $f/5$ Chinese achromat, for example, will often "top out" at around 100×. At higher magnifications, images become impossibly blurry due to a variety of optical imperfections, and that is a big problem in the city, as 100× is often not nearly enough power.

Does that mean urban astronomers have to pay for an apochromat if they want a refractor? Maybe not. My tests have shown that at least some bargain Chinese achromats can be pushed to higher powers if you are content to stay away from the Moon, planets, and bright stars. Avoiding the bright, color-plagued objects helps these scopes keep it together magnification-wise a little longer. But even on dimmer DSOs there's no avoiding the fact that the short achromats deliver their sharpest images at low powers.

If there's one thing that argues against the refractor, achromat or apochromat, as an urban astronomy tool, though, it's aperture. 6 inches, 150-mm, of aperture is about where the city astronomer needs to *start*. That's big enough to start pulling some interesting objects out of the light pollution. 8 inches, 200-mm, of aperture is even better. Unfortunately, even a lightly built Chinese 6-inch refractor is B-I-G. It's not something you'll want to waltz from one side of the yard to the other to avoid porch lights, much less carry down four flights of stairs. Premium 6-inch refractors are even worse. They and their mounts are large and very expensive. An 8-inch apochromat is not only huge (as a portable scope), it's hugely *expensive* for most amateurs. In contrast, an 8-inch Newtonian reflector is relatively light, inexpensive, and especially on the deep sky, can deliver *most* of the image quality of an APO costing 10 or 20 times as much.

Refractors have a lot of charm, and I wouldn't fault you for choosing any of the scopes listed below, but for those of us condemned to do most of our observing under the glow of sodium streetlights, there are arguably better choices.

Synta

While most of the telescopes in our survey are sold under a single name, the Synta refractors are confusingly offered wearing many badges. These popular telescopes, both "short-tube refractors" and longer focal length scopes, all made by the same Taiwanese firm, are widely available in the United States and Europe under numerous brand names, with "Skywatcher" and "Konus" being plentiful in Europe and the U.K. and "Orion" and "Celestron" being the name plates on most U.S. models. They are all very much the same with typically the only difference from one brand to the next being the color of paint on the tube.

Synta's Short-Tube Refractors

Synta produces a full line of short focal length achromatic refractors, all with focal ratios of $f/5$. In addition to the original short tube, the Short Tube 80, an 80-mm $f/5$ refractor, which was the first Synta to become popular with U.S. amateurs, the company also offers a 102-mm $f/5$, a 120-mm $f/5$, and a (seldom seen in America) 150-mm $f/5$. How good are these scopes? Pretty good, considering their low prices. In some ways the best of the lot is still the 80-mm $f/5$ (Plate 2). Its smaller objective with its smaller amount of chromatic aberration and resulting ability to take higher magnifications than its bigger brothers makes it more versatile. It's a little handicapped for city use because of its small aperture and small focal ratio, though. The larger models display more excess color and are less able to handle higher magnifications, but, as mentioned earlier, staying on the deep sky enables them to do higher powers more gracefully than if you attempted the Moon and planets, subjects for which they are not well suited.

Synta's Medium Focal Length Refractors

Synta is famous for its short tubes, but its medium focal length telescopes are nearly as popular, with the 102-mm $f/10$ refractor a close second in popularity to the 80-mm $f/5$. All these refractors have focal ratios close to $f/10$ and all come equipped with workable German equatorial mounts, the medium-sized EQ3 for the 102-mm and the EQ4 for the larger models. In addition to the 102-mm, Synta offers a 120-mm and a 150-mm refractors.

All of Synta's larger focal ratio refractors with their resulting longer focal lengths are reasonable choices for urban use. One thing the prospective buyer should remember, however, is that the focal ratio of $f/10$ is still small when it comes to reducing color in achromats. Focal ratios would have to be half again as large for color to begin to disappear, especially with the 120-mm and 150-mm telescopes. These refractors can do a good job on the deep sky, however, with only the brightest stars showing much disturbing color.

Meade

Meade's Achromatic Refractors

The U.S. company, Meade Instruments Corporation, is most well known for its Schmidt Cassegrain telescopes (SCTs), but it also offers some refractors of interest to the urban astronomer. Once you get beyond the small, cheap department store scopes Meade imports and sells, you are left with three interesting achromats. The ETX 80 is a short focal length $f/5$ refractor on a computerized fork mount. Equipped with its Autostar controller, this little wonder will automatically find over a thousand objects. In another class altogether are the AR5 and AR6 refractors (127-mm and 152-mm apertures, respectively). These telescopes are part of the company's LXD-75 series, and are mounted on German equatorial mounts that, with the included Autostar computer, will automatically point them at tens of thousands of objects. Naturally, only a small subset of these will be visible from our light-polluted haunts.

The ETX 80 is a cute little scope. I own and use the very similar ETX 60 (now discontinued), and have had a lot of fun with it. Unfortunately, its short focal length means that, like the Synta short tubes, it's best suited for dark skies and wide-angle DSO viewing. In my experience, it can beat the Synta 80-mm $f/5$ in the city, since the go-to feature means that it's easier to locate objects in bright skies. Image quality is similar to the 80-mm in brightness, but the 80-mm $f/5$ s usually do better on the planets.

The AR5 and AR6 are interesting for a couple of reasons. First, their prices are surprisingly modest. They also possess apertures that move into the range suitable for deep sky viewing in the city. Most observers have given good reports on the optics that, while imported, seem slightly better on average than those in the comparable apertures Synta telescopes. The Chinese-made LXD-75 GEM mounts seem well-thought out if a little rough around the edges, and the computer features really work if the telescope is carefully aligned.

Meade's ED Refractors

Meade also offers a line of "almost" apochromats, the ED series. They are more expensive than the achromats, but much less pricey than true apochromats from premium class telescope makers. These telescopes, available in apertures from 4 to 7 inches, as tube assemblies only or on computerized mountings, have been reasonably popular with amateurs. With the exception of the 4-inch, they are a little heavy for the average urban observer, though, and, mechanically they have had a few problems.

The focusers on Meade's inexpensive AR scopes are considerably better, for example, than those on the more expensive ED models. Meade has done little advertising and promotion of these instruments in recent years, and, while they are still offered, I'm not sure how much longer they will be around. I expect them to be replaced by comparable aperture Chinese ED semi-apochromats "any day now."

TeleVue's Telescopes

TeleVue is justly famous among amateur astronomers for its premium wide-field eyepieces (see Chapter 3), but it also produces refractors second to none. The TV line starts out with the 70-mm Ranger and Pronto. These both telescopes use the same 70-mm *achromatic* objective (albeit with ED glass elements), but differ on mechanical features, with the Pronto, which features a 2-inch focuser, being heavier and more expensive. Both the Ranger and Pronto have been discontinued recently, but are still available from many dealers.

When it comes to genuine apochromatic refractors, TV offers the $f/6$ TV60 (60-mm), the $f/6.3$ TV76 (76-mm), the $f/7$ TV85 (85-mm), the $f/5.4$ NP101 (101-mm), and the $f/8.6$ TV102 (102-mm). All the APOs feature 2-inch focusers and premium fittings. TeleVue sells a line of alt-azimuth mounts in various sizes, but the telescopes are normally sold without mountings, allowing the user to choose one that best suits her/his needs.

The TeleVue APO refractors are excellent in every way. The images produced by those I've used have been as good or better than those of any apochromat I've tried. There are a couple of drawbacks to these fine scopes, however. First, there's the price. Like all top-of-the line refractors, they are expensive, with prices ranging from 700 US$ for the Ranger to 3,600 US$ for the NP101. Remember, these figures do not include the extra expense for mountings. The lowest priced TeleVues, the Ranger and Pronto are achromats. They may be somewhat better than the average Synta Short Tube when it comes to chromatic aberration, but will not be color free.

You do have to expect to pay for perfection, of course, and that's what the TVs deliver. But there's a second and more serious quibble. A 4-inch is a 4-inch is a 4-inch. No matter how finely crafted a telescope is, aperture is *still* the key, no matter what the design. A 4-inch is *usable* in the city, but more aperture is better. The 101 and 102 scopes are the *minimum* for serious urban work. If you can pay the fare, though, go for it. A TV101 or 102 on a comfortable alt-azimuth mount and equipped with a digital setting circle (DSC) computer (also available from TeleVue) is a portable setup that will last a lifetime and one that may surprise you with its performance, even under city lights.

Astro-Physics

If any name is associated with the rebirth of the refractor, it's "Roland Christen." Mr. Christen, the founder of the U.S. firm Astro-Physics Incorporated, "AP," has been turning out world-class refractors for over 20 years. His telescopes are considered by many amateur astronomers to be the best in the world. Currently offered are the $f/7$ Stowaway (92-mm), the $f/6$ Traveler (105-mm), the $f/6$ Starfire (130-mm), and the $f/7$ Starfire (155-mm). The Starfires are all literally *color free*, and the color error in the smaller scopes is so small as to be of technical interest only. In addition to the telescopes, Astro-Physics also sells their own line of computer-equipped go-to German equatorial mounts.

Can anything bad be said about Astro-Physics telescopes? Not really. For what they are, they are exquisite. Naturally, as with the TeleVues, this comes at a price. While very reasonable when compared to other premium brands, the APs don't come cheap—the 92-mm costs 2,880 US$ and the top-of-the-line 155-mm quipped with all the options commands as much as 8,800 US$. On suitable mounts, the 5- and 6-inch refractors, like all examples of their breed, are less than portable, and, in most cases, not something the apartment dweller should consider. Aperture is a problem, too. A 6-inch aperture is good, but not great when you're faced with bright skies. Finally, you can't just go out and buy an AP. To get one, you'll wait three years or *longer*. Despite their prices the scopes are very popular and are produced in very limited numbers. "AP" is currently in the process of switching from the above telescope models to some new designs, and that may possibly result in even longer waiting list for these super-premium telescopes.

Others

For the "price is no object" crowd there's Takahashi. These Japanese APOs are very close in image quality to the TVs and APs. The trade-off is that they are considerably more expensive. They are available immediately—no waiting list—however. An up and coming company in the U.S. is "TMB Optical." This concern, named after the initials of owner/designer Tom Back, is producing telescopes that are very well regarded by amateurs, are comparable in quality to the rest of the premium pack, and, at this time, are available a lot sooner than the APs. For the achromatic refractor enthusiast, D&G Optical (U.S.) makes achromats in a variety of focal lengths (including long ones) that are in the premium class compared to the humble Syntas.

Newtonian Reflectors

If you ask an advanced amateur astronomer which telescope is "best" as a first, serious purchase, 9 out of 10 times the reply will be "Newtonian reflector." These simple, inexpensive telescopes do have a lot to offer observers—in or out of the city. Their main strength is certainly their dollar/aperture ratio. When it comes to aperture for your telescope money, nothing beats a Newtonian. There are some expensive, premium examples, but it is quite possible to get a working 16-inch Newtonian for just over 1,000 U.S.$. This design is also quite versatile; a properly made Newtonian with a well-made primary mirror is capable of handling a wide range of magnifications and delivering outstanding images of planets and DSOs.

Potential problems with Newtonians for the urban astronomer? The lower priced models are Dobsonians, "dobs" (named after their popularizer, John Dobson), which are Newtonians mounted on simple alt-azimuth up–down/left–right mounts usually made of wood or particle board. Their tubes are often made of cardboard Sonotube™ concrete form tubing. These "cheap" construction materials are not as bad as they sound—wood and Sonotube™ provide a sturdy and thermally stable body for a Newtonian. Unfortunately, the simple Dobsonian mounting is not easily equipped with motorized go-to for automatic object location, which is a desirable—highly desirable—feature for the urban astronomer. Dobs *can* be furnished with Digital Setting Circle computers that will help guide you to objects, but in my experience these DSC systems are not nearly as accurate as go-to. Tracking is also not easily implemented. With a Dobsonian, you'll be nudging the scope continually to keep objects in view, and this can be annoying at the higher powers used in the city.

Thanks to the Taiwanese and Mainland Chinese telescope factories, nicely priced motorized equatorially mounted Newtonians that can automatically track the stars are now available in addition to alt-azimuth mounted Dobsonians. The equatorial telescopes are generally found in smaller focal ratios than the dobs, something that, as we've said, the urban observer may not find as useful as higher focal ratios. But the high quality of the current Chinese mirrors means that the equatorial scopes can often be pushed to as high a magnification as needed while maintaining sharp, clear images. The larger apertures of these scopes, 8 and 10 inches, means that even at $f/5$ it's fairly easy to produce high powers without intolerably short eyepiece focal lengths.

All in all, Newtonians are a laudable choice for the city. They fulfill our prime requirement—they deliver lots of light—at bargain prices. They are also easy to transport in sizes up to about 12 inches, don't require long to adjust to outdoor temperatures—any telescope mirror must cool down or warm up to ambient outside temperature before it can deliver its best images—and can provide images easily equal to those of any other design of telescope.

One thing to be aware of when considering a Newtonian as a city scope is what I call "The Only Enemy of Good Enough is More Better" syndrome. With prices for Dobsonian Newtonians so reasonable, novices may be tempted to buy bigger than is easily portable in an urban environment. Consider 12 inches the *absolute* upper limit and 10 inches the *practical* aperture limit for most city-based observers.

Meade Dobsonians

Meade Instruments has been selling a line of Sonotube Dobsonians (Plate 3) since the early 1990s, and these simple telescopes have garnered much praise for their optics. Until recently, these "StarFinder" Dobsonians were available in 6-, 8-, 10-, 12-, and 16-inch apertures. Meade has now changed focus, going to Schmidt Newtonians (see the "Catadioptric" section) for their smaller non-SCT design scopes, and only the 12- and 16-inch StarFinders are now available new. The 6-, 8-, and 10-inch sizes are plentiful used, though.

While all these telescopes have surprisingly excellent optics, you'll often hear them described as "kits." That's because at the very low prices Meade asks for these scopes (845 U.S.$ for the 12.5-inch $f/4.8$, and 1,245 U.S.$ for the 16-inch $f/4.5$) they've had to scrimp on everything other than the mirrors. The focusers (plastic) and finders

(30-mm) need immediate replacement, and the nylon bearing pads should be discarded and Teflon used in their place if the motions of these scopes are to be smooth.

Despite this kit status, the 12.5-inch scope, especially, can be a real workhorse for the urban astronomer. It's a little heavy, true, but if you can observe from your backyard it's not bad to set up at all, though younger and lightly built observers should, if possible, try moving the 12.5-inch scope unassisted before committing to it. The generous aperture allows you to cut through light-pollution to the point where *galaxy after galaxy* in Virgo, for example, is visible from many sites. Globular clusters take on form and substance as great globes of stars and not just round, fuzzy balls with this scope, and, should you want to look at the planets, the 12.5-inch StarFinder can provide surprising results, besting some much more expensive competitors. The 16-inch? Unless you've got a situation where you can rig up a means of rolling this scope out of a garage or shed to observe, it's really too big to consider. Also, the inexpensive particleboard mount that works reasonably well with the 12.5-inch StarFinder becomes a weak point (literally) with this much larger and heavier instrument.

Synta

These Chinese Dobsonians are, frankly, tremendous buys, and will find favor with any amateur. The optics, while maybe not quite as good as those found in the Meades, are very good indeed, and the attractive metal tubes, nicely finished rocker boxes, and good assortment of included accessories (depending on the seller, often two Plossl eyepieces, a simple collimation tool, and a spring system to help with tube balance) make these imports attractive for everyone. Their rugged construction and their ability to be transported in one-piece (the spring-aided balance system holds the tube and rocker box mount together if desired) makes these nearly perfect for the urban astronomer. The Synta Dobsonian lineup at this time includes an $f/8$ 4.5-inch, an $f/8$ 6-inch, an $f/6$ 8-inch, an $f/4.7$ 10-inch, and an $f/4.9$ 12-inch. Like Synta's refractors, these Dobsonians are available from a variety of distributors in the U.S. and Europe under various brand names and with varying prices.

My only negative comment regarding these telescopes is that the metal tubes, while attractive, actually have poorer thermal characteristics than the cardboard Sonotube™ found on other inexpensive Dobsonians—it may take longer for them to adjust to outdoor temperatures than telescopes with cardboard tubes. The Synta dobs are real winners, though, in the city or out, and the 8-inch, in particular, provides a wonderful combination of performance, price, and focal length for use under light-polluted skies.

Premium Dobsonians

"Dobsonian" doesn't just mean "cheap" anymore. Amateurs can now purchase premium priced and premium quality near-custom-made dobs from companies like Obsession and Starmaster in the U.S. These telescopes, which can be had in apertures of 30 inches and *larger*, are only sold in truss tube configurations. Although their prices are high, large truss tube dobs can deliver remarkable performance to the user who is able to store and transport them.

The truss tube telescope design (see Plate 4) is the current darling of Dobsonian users. In addition to a rocker box mount like those of the Sonotube dobs, it consists of a mirror box that holds the primary mirror, truss poles that take the place of a solid tube, and an upper cage assembly that carries the secondary mirror and focuser. The purpose of this design is to make large-aperture Dobsonians practical—these big scopes can be easily broken down into manageable components for transport. Keep in mind, though, that even the mirror box of a large truss tube telescope will be impossible for many apartment dwellers to manage. Not only will you have to get it and the other components down to street level, something that may be very difficult in apertures above 16 inches, you'll have to find a place to keep it. I still think 12.5-inch scope is a good maximum aperture for most city dwellers, no matter what the scope design.

Europe and the U.K.

Until fairly recently, the Dobsonian has not enjoyed as much popularity in the U.K. and in Europe as it has in the U.S., but that is now changing. In addition to native makers of custom, high-quality truss tube scopes, Meade and other U.S. dobs are regularly imported, as are the Synta Dobsonians, which are sold under the Skywatcher, Konus, and other labels.

One interesting entry in the U.K. is the imported Helios "Skyliner" Dobsonian. This reasonably priced scope, in addition to the features common on other far-eastern dobs, includes alt-azimuth setting circles, which, in conjunction with a suitable computer program, can help users find objects. This is a nice feature for urban observers, and one I'm surprised other dob makers have not picked-up on.

Equatorially Mounted Newtonians

There was a time when it looked as if Newtonian reflectors mounted on German equatorial mountings (GEMs) were as an endangered species as the refractor. Only a few were found for sale, and many of these were in the premium-price category. This style of telescope hadn't changed with the times, either. Heavy (but not overly steady) mounts were the order of the day and discouraged amateurs who needed to move the scope around the yard or down flights of stairs from considering one.

Things began to change for the better when Meade brought out a line of GEM Newtonians in the 1990s, the StarFinder equatorials, which were somewhat successful despite pedestal style tripods that made them less portable than the average city dweller might have wished. Meade built 6-, 8-, 10-, and 16-inch GEM versions (the optical tubes are almost identical to those on the dob scopes) until fairly recently when most of the StarFinder GEMs were phased out with the coming of the LXD 75 Schmidt Newtonian line. At this time, only the 16-inch GEM StarFinder is still available, and it is even harder to transport and shakier on its mount that the Dobsonian version.

Even though most of the Meades are gone, things continue to look better and better for the Newtonian fancier who wants a scope on a mounting that can be equipped with drives for tracking. Synta and another firm in Taiwan, Guan Sheng, are pumping new life into a scope genre that most thought was past its heyday. Orion in the U.S. and Skywatcher and Konus in the U.K. and Europe are, again, the most common names you'll find on Chinese GEM Newtonians.

What makes the imported GEM Newtonians workable is the ubiquitous EQ4 mounting as shown in Plate 5. This telescope mount started life a few years ago as a not-too-good clone of the famous (and now relatively expensive) Japanese Vixen Great Polaris Mount. Early on, the EQ4 couldn't hold a candle to the Vixen, but, somewhat surprisingly, Synta has continued to improve this mounting with advances like the addition of ball-bearings to the RA axis and a better grade of lubricant than the initial glue-like grease found in the first examples to hit the West. While this mounting can sometimes stand disassembly and relubricating by mechanically competent amateurs, it works quite well off the shelf now, being almost as good for the visual observer as the Vixen. Its low price (the EQ4 is available sans drives for less than 300 US$) means that inexpensive—but capable—equatorial Newtonians are now possible.

Synta's GEMs

While equatorial Newtonians in apertures less than 6 inches are plentiful, my opinion is that the urban deep sky observer should pass these by. The 6-inch Syntas are so inexpensive (less than 400 US$) that there's really no reason to settle for smaller aperture. Up to this time, the most widely available Synta scopes have been a 6-inch $f/5$, often seen on the EQ3 mount, which is sufficient for the 6-inch, but noticeably lighter than the EQ4, and an 8-inch $f/5$ on the EQ4 mount. These scopes are capable of good work, and though, as was mentioned earlier, the urban user might wish for a little extra focal length to make higher magnifications possible without having to resort to shorter focal length eyepieces or barlow lenses, at $f/5$ these tubes don't stress their mounts and they will easily take higher powers.

Orion U.K. and Parks (U.S.)

Don't want an inexpensive Chinese equatorial Newtonian? There are premium GEM Newtonian models available even in this era of big dob and SCT domination. In the U.K., Orion Optics (no relation to the U.S. firm of the same name) offers *very* high quality 6–12-inch tube assemblies mounted on Japanese made Vixen equatorial mounts. The smaller apertures on their Vixen Great Polaris mounts are fairly easy to haul around despite the fact that piers are provided as standard equipment in lieu of tripods. In the U.S., the California firm, Parks Optical, goes all the way up to 16 inches with Newtonians on in-house-built mounts. While the optics are usually outstanding, the mountings on the Parks scopes could have been brought straight from the 1960s in a time machine. Very heavy and somewhat shaky, they are not something I'd want to handle in the city.

GEMs to Avoid

One type of equatorially mounted reflector to avoid is the "short tube." Short tube refractors can be nice, but most of the short tube reflectors just don't make it. A "short tube" reflector can be easily identified by its specs. The given focal ratio ($f/10$ is common) or focal length of the scope is much larger than the short, stubby tube of the scope would indicate. The manufacturers achieve this by installing a built-in barlow amplifying lens in the light path. This barlow does extend the focal length of the fast Newtonian mirrors used in these telescopes, but the quality of this barlow (which is all it is, though advertising often refers to it as a "corrective optics assembly" or similar) is usually low, with the result often being excess color and soft images.

Stay completely away from the Chinese GEM-mounted 6-inch Newtonians found on Ebay. These telescopes possess spherical-shaped mirrors rather than the parabolic primary mirrors required for sharp images in a Newtonian. This results in *extremely* poor images at the low focal ratios of these scopes' primary mirrors ($f/5$ or $f/4$ usually).

Catadioptric Telescopes (CAT)

What would be the characteristics of the perfect telescope for exploring deep space from the city? It would have a long focal length that would allow us to achieve medium and high powers easily. It would be easily adaptable for DSCs or go-to, making it easy to find elusive objects in guide-star deprived urban skies. It would feature generous aperture to pull faint fuzzies out of the murky city heavens. Above all, it would be compact and portable. For many amateurs the telescope design that fulfills these requirements best is the catadioptric (CAT), the lens–mirror hybrid that has become exceptionally popular with amateur astronomers over the past 30 years.

Schmidt Cassegrain Telescope (SCT)

The SCT, the Schmidt Cassegrain telescope (Plate 6), is not the *only* CAT used by amateurs. The Maksutov Cassegrain, the Maksutov Newtonian, and the Schmidt Newtonian have their fans, too. However, while I might be accused of being a little biased, since I've become known as "Mr. SCT" for my unabashed love of this telescope design, there are good reasons why the Schmidt Cassegrain telescope may be the ultimate "city scope." There's a lot that can be said about SCTs, you could even write an entire book on the subject (I have), but "SCT theory" can be summed up in relatively few words.

Being a catadioptric scope, the SCT includes a lens in its design. This is the large, thin corrector "plate" mounted at the end of the tube. SCTs use easy to fabricate spherical primary mirrors. Unfortunately, in a condition similar to chromatic aberration in refractors, a spherical mirror can't bring all rays of light to the same focus. This would result in blurred images lacking in detail. The SCT's corrector plate removes this spherical aberration and allows its spherical mirror to produce images as sharp as a Newtonian's parabolic-shaped primary.

Meade and Celestron SCTs

Want an SCT? I don't blame you. Luckily, the choices here are fairly easy since the telescopes made by the California firms Meade and Celestron are the only ones available outside very expensive semi-custom units produced by a few firms in limited numbers. What are today's SCTs like? If there's any telescope make that has embraced fancy computers and electronics, it's the Meade and Celestron SCTs.

Current top of the line scopes, Meade's LX200 GPS series and Celestron's Nexstar GPS line, feature a bevy of electronic options including automatic alignment via built in Global Positioning System satellite receivers, digital compasses and electronic levels. These scopes will, when powered up, find their position, locate North, and slew to appropriate alignment stars. All the user has to do is center these stars in the eyepiece as instructed by the display on the telescope's computer hand-controller and hit "Enter." Thereafter, both the Meade and Celestron GPS SCTs will reliably and accurately point at any object in the sky.

The Meades are available in apertures of 8, 10, 12, 14 and 16 inches while the Celestrons come in 8, 9.25, 11 and 14-inch sizes, the prices of which begin at 2,195 U.S.$ for the Meade and 1,999 U.S.$ for the Celestron. All Meade and Celestron SCTs are $f/10$ focal ratio scopes, Meade having recently discontinued its $f/6.3$ optics option. Celestron also sells a line of GPS compatible go-to-equipped heavy duty GEM scopes, the CGEs, but their large, heavy mounts are really a bit much for urban observers.

The next tier down in SCT-land is non-GPS go-to scopes. These models, Meade's LX90 and LXD75 SCTs and Celestron's Nexstar(i) and AS series, feature full go-to capabilities, but the user must set time, date, latitude and longitude; and find North before the scopes will locate objects on their own. While not as convenient as the GPS units, spending a few minutes entering data into the scope hand controller is a small price to pay for being able to view any one of the thousands of objects in these telescopes' internal libraries at the touch of a button for the rest of the night. Meade's LX90 (8-inch) and the Celestron Nexstar (i) (5 or 8-inch apertures available) are traditional fork-mounted telescopes, while the new LXD75 SC-8-inch SCT and the Celestron AS GT scopes (available in 5, 8 and 9.25 and 11-inch apertures) use Chinese German equatorial mounts equipped with computer controlled drives.

The Meade LXD 75 SC8 SCT uses the same Chinese GEM mounting as the AR5 and AR6 refractors, and, like them, and seems fairly accurate when correctly aligned. Enhanced coatings, the UHTC group, are available for this telescope and for all the SCTs Meade makes for an extra charge.

The Celestron AS GT telescopes use a go-to-equipped Synta EQ4 mount (called the "CG5" by Celestron) that works amazingly well considering the fairly low cost of the GT series. All these telescopes are available with Celestron's version of enhanced coatings, "XLT," for slightly more money and with non-computerized, non-go-to EQ4 mounts for less.

The Celestron fork-mount go-to scopes, the Nexstar 8 and 5(i) possess single-arm forks rather than the usual two-arm design seen on the Nexstar GPS scopes and all the Meades, but they are quite stable and also very light and easy to transport. One interesting feature of these Celestrons is that the user can add an external GPS receiver module to them if desired, giving them many (though not all) the capabilities of the GPS scopes. The Nexstar 5 offers decent aperture and go-to in a lightweight package. This is the only sub-8-inch SCT currently available.

The non-GPS Meade fork-mounted telescope, the LX90, is fully computerized, and is one of the most popular and most reasonably priced go-to telescopes made. For a surprisingly low price, the user gets a computer equipped instrument capable of being used in comfortable, stable alt-azimuth mode attached directly to a tripod, or in equatorial configuration on an optional "wedge," where it is capable of taking amazingly good long exposure deep sky photos.

At the bottom of the SCT pyramid are the non-go-to manually operated SCTs. Unfortunately, these appear to be a dying breed. Meade and Celestron are of the opinion that consumers want computerized telescopes now, so offerings in this realm are limited. Meade has just discontinued its only remaining manual fork-mounted scope, the 8-inch LX10. Celestron has likewise discontinued its non-go-to Celestar.

At the time I'm writing this, it's still possible to get a new LX10 from many dealers, and that might not be a bad idea if you want a solid, inexpensive SCT that's not loaded down with computers. This is a "traditional" fork-mounted SCT quite similar to the first models Meade offered over 20 years ago. It is a nice little scope with a modest price, a light but reasonably stable fork mount, and an accurate motor drive powered by a 9-volt battery.

Again, if I had to choose a telescope design for city-bound observing, it would be the SCT. No doubt about that. It's just so darned adaptable: Lots of focal length with the ability to "reduce" it for wider field views using optional "reducer/corrector" lenses. Easy adaptability for film or CCD imaging. Fully computerized go-to, which is a wonderful, almost indispensable tool for the urban astronomer. Relatively good transportability in apertures from 5 inches to 11 inches. If there's not a perfect scope for the urban scene, the SCT at least comes close.

While SCTs are considerably more expensive than Newtonians, they are still surprisingly inexpensive considering their many features. This leads some city observers to decide to forego an 8 or 10-inch SCT in favor of a 12- or 14-inch one. Think long and hard before considering one of the "big ones." While a GEM mounted 14-inch like the Celestron CGE 1400 might be barely practical in the city, one of the Meade 12- or 14-inch fork-mounted scopes is big and tremendously heavy, much bigger and heavier than any apartment dweller will want to own. Be aware that the 14 inchers, especially, are much larger than they look in those pretty magazine advertisements. They are also far too heavy for one person to lift, much less carry down several flights of stairs.

The SCT shopper should be aware that models come and go rapidly in the competitive SCT market, with Celestron currently being in the process of introducing a lower priced GPS scope, the "CPC," and Meade coming out with a line of premium SCT-like instruments, the RCX-400s.

Maksutov Cassegrains Telescope (MCT)

The Maksutov Cassegrain, "MCT," an example of which, the Meade ETX 125, is shown in Plate 7, is very similar to the SCT. The only differences are the thick, spherical "deep-dish style corrector plate" and larger focal ratios of the MCTs. You often hear beginning amateurs being advised to "stay away" from MCTs because their large focal ratios, $f/12$

to $f/15$ usually, and resultantly longer focal lengths "make them unsuitable for deep sky work." Nothing could be farther from the truth. All the large focal ratios mean is that the MCT owner must use longer focal length eyepieces to reach low magnifications than an SCT user, for example. While this can create problems for the suburban or country astronomer trying to squeeze every last of bit field size out of her scope, it is really not a concern in the city. Urban astronomers *want* more magnification. Actually, even under dark skies, many DSOs can benefit from more power than most observers apply. And anyone, anywhere can benefit from the usually superb optics of MCTs.

While the MCT is, for some observers, saddled with longer focal lengths, it pulls ahead of the SCT—at least a bit—in optical quality. The sphere-shaped corrector plate/lens that is used in the Maksutov Cassegrain design is decidedly easier to fabricate than the SCT's thin, complex-shaped corrector, so the MCT corrector is easier to do well in all apertures. Because of its longer focal length main mirror, the secondary mirror on MCTs is smaller than that on SCTs, enabling the Maksutovs to deliver slightly more contrasty images than the SCT, images often on a par with those delivered by APO refractors costing many times more. Drawbacks? Not many. The biggest is that MCTs above about 7 inches are very expensive. That is because the corrector must be made from a single, very thick piece of glass. Finding an adequate "blank" becomes an expensive proposition in the larger apertures.

The Meade MCTs

If one MCT has come to mean "Maksutov" in the minds of today's amateur, it's Meade's amazing ETX. This remarkable scope began as a 90-mm clone of the very expensive Questar MCT, but it has evolved over the years into a little wonder equipped with a go-to drive system (using the same Autostar hand controller supplied with the LX90 and the LXD75) and is now available in apertures of 90, 105, and 125-mm. These instruments provide very fine images on a par with any telescope in their aperture ranges.

Liabilities? A few. The go-to system can be slightly difficult for beginners, especially those without much knowledge of computers, but this goes for any go-to-equipped scope. The ETX does use a lot of plastic in its construction to keep both cost and weight down. In most cases this has not caused problems with the scopes, and Meade continues to improve both ETX hardware and software. If there's any real problem with the ETXes, it's their aperture. The maximum available, 5 inches, isn't always adequate if your sky is as bad as mine is. But a light, inexpensive go-to scope like this is a godsend for many urban users. All the ETX models, like Meade's SCTs, can be ordered with enhanced UHTC coatings.

Meade also offers a larger MCT, the LX200 GPS 7-inch Maksutov. This Mak, on the same go-to fork-mount system offered for the SCTs, is full featured and is and currently sells for 2,695 US$, which is less than the price of many manufacturers' 7-inch MCT optical tubes alone. The 7 has, unfortunately, been a problematical scope over its lifetime. One difficulty has been the optics: the 7-inch Maks have varied from barely average to excellent from sample to sample. It now appears that Meade has cleaned up its optical act with this instrument, however. Then there's cool down. Contrary to popular belief, most MCTs do not have inherently longer cool down times than SCTs, but the Meade 7 is a different animal.

Like most MCTs, the LX200 Mak has a longer tube than an SCT, aperture for aperture. This is due to the longer "native" focal length primary mirror used in this design. The 7-inch with its longer tube and heavy corrector plate was difficult for

Meade to balance on the fork mount. To remedy this, *a lead weight* was added inside the scope's rear cell. This worked, but, unfortunately, the lead soaks up a lot of heat and radiates this for quite a while, meaning cool-down time is extended. Any telescope needs to adjust to outdoor temperatures before its optics can deliver their best images. A built in fan helps with cool down to some extent, but the scope still needs quite some time to cool off compared to an 8-inch SCT. Despite these difficulties, the combination of a "big" MCT and the LX200 GPS mount is a powerful one for city-dwellers.

Russian MCTs

Since the early 1990s, Russian MCTs from the firms Intes, Intes Micro and Lomo have been aggressively marketed in the West. In the beginning, quality was catch-as-catch-can, but over the past ten years Russian output has improved to the point where these telescopes can give even the highest-toned APO refractors some pretty stiff competition. Of particular interest are the Intes 6-inch MK67 and MK66 MCTs. These Maksutov Cassegrains are optically excellent and provide enough aperture for the urban astronomer to actually see something. The only difference between these two models is their focusing systems. The MK67 focuses via a Crayford focuser (which moves the eyepiece in and out to focus). The MK66 is intriguing since it uses a moving mirror focuser and accepts any of the many accessories developed for American SCTs. Unfortunately, Intes has recently announced that it is leaving the amateur telescope business, but the 66 and 67 should remain available new for quite some time.

When it comes to mountings, most Russian scopes are sold either without mounts or on Chinese GEM equatorials. Lomo's MCTs, which are just now becoming popular with Western observers, are available in a fork-mount configuration that looks for all the world like a 6-inch SCT. One mistake that many buyers of these relatively inexpensive MCTs make is skimping on the mounts. Maks are almost always heavier than SCTs, and when this is combined with their large focal ratio high magnification characteristics, they demand steady support. A Synta EQ4 or a Vixen Great Polaris is the minimum for a 6-inch Maksutov Cassegrain.

Orion U.K.

One of the most interesting and reasonably priced new MCTs to become available recently is the OMC 140 from Orion Optics in the U.K. This scope is competitive with the Russian instruments in every way, and, from early reports I'm hearing, it may be a notch above the Russians in optical quality. The telescopes are available with a selection of GEM mounts including the EQ4, Great Polaris, and Vixen GPDX German mounts.

Premium MCTs

Questar

If an humble (but optically good) ETX or Intes does not appeal to your sense of style, there are premium priced MCTs available that have for years defined "luxury" in the amateur astronomy world. First and foremost are the Questars. These MCTs, available in 3.5-inch (Plate 8) and 7-inch apertures, were the first Maksutov Cassegrains to become popular with amateurs, and have remained popular despite their always-high prices. The 3.5-inch fetches an amazing 4,000 US$ with minimal accessories, and the new Titanium-bodied fork-mounted 7-inch pushes even higher at 9,000 US$. These are beautiful telescopes, of course, but 3.5 inches is 3.5 inches and 7 inches is 7 inches. Even the very expensive Q7 is a little weak aperturewise when you have to battle heavy light-pollution.

Telescope Engineering Company (TEC)

A little less expensive and larger, too, are the TEC MCTs. This U.S. company, which has made a name for itself with high-quality optics, sells some astoundingly good MCTs. While expensive compared to Meade or Lomo, they are fairly affordable considering their large apertures (for Maks). The TECs range from an 8-inch at 3,700 US$ to a 12-inch at 12,600 US$—these figures are for optical tubes only. At a focal ratio of $f/11$, the 8-inch is both compact and blessed with a comparatively short tube length—this could be just the telescope for the observer wanting a "super SCT." TEC does not provide mountings for its scopes, the expectation being that the buyer will want to choose a quality GEM appropriate for these fine instruments from a third party.

Astro-Physics (AP)

Roland Christen's AP, while noted for its APO refractors, has entered the catadioptric arena recently with a 10-inch MCT that is worthy of the AP name. As with all of this company's other products, the 10-inch is built to the most exacting standards, is produced in limited numbers (meaning that you'll be on a long waiting list for this one just as you would be for one of the refractors), and commands a price commensurate with its quality, 10,900 US$ at the time of this writing. This scope is, like the TECs, sold as an OTA only, but AP can furnish its high-tech go-to GEMs for use with this Mak, the big 900 or 1,200 mounts being suggested for this sizable OTA. For the urban astronomer not fazed by the near 20,000 dollar price tag once a top of the line 10-inch system has been assembled, the only "minus" consideration is the considerable weight of this telescope. The 10-inch OTA is fairly heavy at 33 pounds. Add to this a mounting appropriate for this big telescope and you wind up with something you won't be moving around the backyard in search of tree-free zones.

Schmidt Newtonians Telescope (SNT)

The Schmidt Newtonian design is simple and elegant. Its primary optical component is a spherical primary mirror like those used in SCTs and MCTs. The main difference is that there's no central hole in this mirror for the eyepiece to "look through." As in a Newtonian, light collected by the primary mirror is focused back up the tube to a flat secondary mirror angled at 45° that sends the light through a hole in the upper end of the tube to a focuser. This design incorporates an SCT-style corrector plate. As in the SCTs and MCTs, the corrector lens allows the scope to use the simple spherical primary mirror without the penalty of spherical aberration. It also enables the scope to produce a wide field that's flatter than that delivered by Newtonians. The practical result is that, f-ratio for f-ratio, the SNTs produce much sharper star images out toward the edge of the field than standard Newtonian reflectors. In an $f/4$ Newtonian, stars on the field edge are far from sharp, resembling little comets or seagulls more than pin-point stars. In an $f/4$ SNT, they are satisfying pinpoints.

The Meade SNTs

The SNT has long been neglected by the major telescope makers, with only Meade choosing to produce these telescopes in any numbers for any period of time. Even Meade abandoned the design for a while. No commercial SNT had been available for years when Meade revived the design in 2002 for the LXD55 series. The LXD55 SNTs and the recent upgraded replacement for them, the LXD 75 series, are a 6-inch $f/5$, an 8-inch $f/4$, and a 10-inch $f/4$. These telescopes, mounted on the same computerized GEMs used for the aforementioned AR-5, AR-6, and SC 8 telescopes, and are very inexpensively priced.

I've been able to personally test the 10-inch SNT and was rather impressed. Tube fittings and the scope in general seemed of higher quality than the minuscule price would suggest. Optics were good and sharp, producing better images than a comparably priced Newtonian, and seemed equally capable of wide fields and high powers. My only reservation is of the "why" variety. Most of the time, we city dwellers can't make much use of the relatively low powers these scopes can achieve, and would be happier with a plain, old SCT. The SCT, in addition to it's larger focal ratio, also has in its favor the fact that it can use the hundreds of accessories available for Schmidt Cassegrains—the SNT is an uncommon and rather specialized scope.

Maksutov Newtonian Telescope (MNT)

If you understand the design of the Schmidt Newtonian, the layout of the Maksutov Newtonian is easy to grasp. Take an SNT, make the focal ratio of the primary mirror a little larger ($f/6$ is common), remove the Schmidt corrector plate, replace it with a Maksutov corrector, and you're done! Like MCTs, the MNTs generally stick with longer focal lengths than their Schmidt brothers. This has the advantage of allowing the use of a smaller secondary mirror, which helps improve contrast. If your goal is refractor, APO refractor, quality images, larger aperture, and smaller prices, the MNT may be your telescope, as these are its strengths.

The Intes MNTs

While a Russian company with a similar name, Intes Micro, is also a producer of MNTs, most of the current enthusiasm for these scopes has been generated by the two superb instruments made by Intes. As mentioned earlier, Intes is leaving the scope business, but the MNTs were produced in numbers and will be available for a while new and indefinitely as used scopes. The Intes MNTs include the 6-inch $f/6$ MN61 and the 7-inch $f/6$ MN71. Both telescopes are equipped with secondary mirrors that are small for their apertures compared to those in SCTs or even Newtonians—30 and 36-mm, respectively. This, coupled with the forgiving Maksutov design and superb quality optics in general, makes these scopes come very close to equaling APO refractors of equal aperture. The medium focal ratios of these instruments help them provide both low powers for wide field use and high powers for planets and small DSOs. Their ability to handle higher powers adroitly and good contrast characteristics make these scopes naturals for the city. About the only nits I can pick with regard to these instruments is that their apertures are small for their prices compared to Newtonians, and are the significant weight of these scopes reduces their portability. The 6-inch is manageable at 20 pounds, but will require at least an EQ4 mount. The 7-inch model's 31 pounds will make a mount in the next weight (and price) class a must.

Urban Accessories

What have you got if you've got a scope without accessories—eyepieces, filters, and all the other little doo-dads active observers accumulate? A big paperweight. Every new astronomer will soon come to the realization that astro-buying has just begun with the acquisition of a telescope. Accessories are necessary for everyone, but the choice of proper eyepieces, filters, and other necessary items is particularly critical if you're observing under city lights.