CHAPTER THREE

Accessories for Urban Observers

Accessories are the bane and delight of every amateur astronomer's existence. You never stop buying. Of course, many of the "must-haves" are really superfluous impulse purchases. Who can resist buying *just one more* eyepiece from a dealer's table at a star party? But there is no doubt that you really do need quite a bit of equipment in addition to a telescope in order to enjoy productive observing.

Many of the accessories you'll need as an urban observer are exactly the same as those required by any working amateur astronomer. But some are more important for us than they are for country observers—light-pollution filters, for example. Sometimes one type of accessory is better for city use than another. We tend, for example, to gravitate toward medium focal length eyepieces for "low power" use rather than the long-focal length "big glass" used under dark skies. In this chapter, we'll discuss what you need and how you should invest those usually limited astronomy dollars wisely.

Light-Pollution Reduction Filters

When a new city lights astronomer starts seeing advertisements for "light-pollution" or "light-pollution reduction" (LPR) filters, she or he immediately thinks the problems with bright city skies are over. Screw one of these filters (Plate 9) onto the end of an eyepiece and you're magically transported to dark country skies and galaxies are everywhere! Sorry, but it just isn't so. LPR filters can help, but, as always, there ain't no such thing as a free lunch. Filters are a compromise, and cannot substitute for dark country conditions, but they can make your city-based viewing more profitable and more enjoyable.

LPR filters for use by amateur astronomers started appearing in the 1980s, coincidental with expanding suburbs and growing light pollution in the U.S. and Western Europe. The concept behind these filters is simple: coat a piece of optically flat glass with multiple layers of substances designed to reflect certain wavelengths of light. These coatings are chosen so that all wavelengths generated by Earthly light sources—incandescent, sodium, and mercury vapor lights—are rejected by the filter, reflected away by the coating layers before they enter the eyepiece. The LPR filter does not make deep sky objects (DSOs) brighter. Its ability to reject light-pollution wavelengths merely means that it increases the *contrast* between the sky background and the object of interest. The background sky becomes darker due to the subtraction of earthly sky glow without the target object being made much dimmer by the filter.

With one of these LPR filters screwed onto the telescope end of your eyepiece, then, only the light from distant DSOs reaches your eyes? Dark sky paradise in downtown London or Manhattan? Unfortunately, this good idea doesn't work quite as well as we'd wish. Like anything else, an LPR filter is not 100% effective. Some unwanted wavelengths do make it through the filter. The main problem, though, is that the light of the stars falls into the same range, the same band of wavelengths, as that from man-made light sources. That means that in addition to blocking the light from the ground, your filter also blocks the light from the stars. Because of this, we can immediately eliminate light-pollution filters as a tool for viewing galaxies. Galaxies are composed of stars, and *their light is attenuated by filters*. Forget other stellar subjects—open and globular star clusters—too.

So why waste your money on an LPR filter (they sell for about 100 US$ or 100 UKP)? What good are they? They won't do a thing for clusters and galaxies, but LPR filters can work spectacularly well for diffuse and planetary nebulae. This is a good thing, since nebulae are probably hurt more by light pollution than any other object, even more than galaxies. The presence of an LPR filter can easily make the difference between getting a good view of a nebula from the city and not seeing it at all. But *which* filter? Dealers' advertisements tout a number of oddly and confusingly named products, "OIII" ("oh-three"), "UHC," "hbeta" and more.

At this time, light-pollution filters, no matter who makes them, fall into three categories: "mild/broadband," "medium/narrowband," and "line filters." Mild filters are represented by the Meade Broadband and the Orion U.S. Skyglow, and are available from a number of other manufacturers as well, both in the U.S. and Europe. Their primary characteristic is their wide "passband." They pass a wide range of wavelengths of light. That is both good and bad. It's good in that these filters will "work" on many different objects, and don't dim field stars much. The "bad" is that they don't reduce background sky glow much, either. By allowing-in a fairly wide range of wavelengths, including those emitted by the stars, a large amount of earth-based light sources are also passed.

Should you buy a mild filter? In my judgment, probably not. They do very little for the visual observer. Sure, the field looks good, with lots of stars visible. Even galaxies are not dimmed much by a wideband. Unfortunately, neither is the background glow of light pollution. These filters darken the field slightly, and only slightly. They may improve the view of a nebula that's easy to see from the city already—M42 in Orion, for example—but only minimally. They are mainly of use for photographers who need or want to try to image with low focal ratio scopes from the city, or by country observers seeking to enhance views of nebulae a little without attenuating field stars.

I've occasionally heard broadband filters referred to as "galaxy filters." It would be nice if there were a light-pollution filter that could enhance galaxies, of course, and some wideband users claim that they darken the sky enough without dimming the target galaxy to improve its appearance. My tests reveal, however, that, without exception, galaxies look better without one of these filters than with one in or out of the city. The broadband filters are not galaxy filters. Sadly, *there are no galaxy filters*.

Next up are the narrow-band filters. These filters, like the Orion Ultrablock or the Sirius Optics Nebula Filter, are the bread and butter of the urban astronomer. When properly used, they can make a nebula that is badly compromised in the city, like M17, the Omega Nebula, into a near-showpiece object. I've been constantly surprised at what I can pull out of the sky glow with a narrow-band. Not just the Messier nebulae, either; many faint and obscure NGC and IC clouds are routinely visible from my city sites with an 8-inch SCT and one of these filters. The faint nebulae scattered through Cygnus, Cepheus, and Cassiopeia don't exactly become spectacular—again, LPR filters are *not* a substitute for dark skies—but they are detectable and even enjoyable.

Narrow-band LPR filters work by allowing only very narrow slices of the visible light spectrum to pass. Most filters of this type are actually designed with *two* passbands, one centered on the hbeta region of the spectrum (the red light of hydrogen emitted by many nebulae) and the OIII area (light from the doubly ionized oxygen atoms often present in planetary nebulae). The rest of the spectrum, emitted by mercury vapor and other man-made sources, is attenuated to a surprising degree.

Narrow-band filters are wonderful tools for the urban observer. The only thing you may not like about them is those relatively narrow passbands. With these filters, you get to the point where the stars are being obviously dimmed, and you may find that the star fields don't looks as pretty with the filter in place as without. In my opinion that is a small price to pay for actually being able to *observe* dim nebulae from home. As to which brand to choose, all the narrowband filters on the market in the U.S., UK, and Europe are quite similar, with the main differences being the comparative width of the passbands in the OIII and hbeta regions. Some let in more red hbeta light and others more green OIII (don't expect to see color differences on dim nebulae visually, of course). Practically speaking, the performance of all the narrowband filters I've tried has been remarkably similar. Some current manufacturers of these filters in addition to Orion and Sirius are Baader Planetarium, Thousand Oaks, Meade, Celestron, and TeleVue. All are widely distributed throughout the world.

The third type of light-pollution filter is the "line" filter, which is widely available in two varieties—the OIII which, as you'd guess, has a passband centered on OIII light, and the hbeta, which concentrates on the red section of the spectrum. These filters take their name, "line filters," from the fact that their passbands are so narrow that they are designed to admit only the light from the emission lines of hydrogen or oxygen.

After having been involved in amateur astronomy for 40 years, I've spent a lot of money on accessories of all types—all of which were described in glowing terms by their manufacturers. Only occasionally have I found a piece of equipment that has really lived up to my expectations. The OIII filter is one of these; it is a truly remarkable filter. The OIII can take the dimmest planetary nebulae and make them come alive for the urban observer. With it, I've been able to at least *detect* the Helix Nebula in Aquarius—usually considered a dark sky object only. The Veil Nebula in Cygnus also shines out (dimly) on good nights. Many other planetary nebulae also take on more form and substance with the application of the remarkable OIII.

Nothing in this world being perfect, the OIII isn't all gravy. This is a very *strong* filter, and will definitely subtract dimmer field stars from your view. In addition to making the field less attractive, this can also make it harder to get your eyepiece in focus. The addition of an LPR filter to your eyepiece changes its focus—you have to refocus the scope when you add a filter. This refocusing is easy enough with a broad or narrow-band filter. Just focus on a field star. With the OIII filter in place, however, there may not *be* any field stars to focus on, and it can be quite difficult to get the scope adjusted correctly with only a dim planetary nebula and a few dim stars as subjects. Often you'll find yourself slewing the scope to a bright star that will shine through the OIII. Once focused, though you may have difficulty locating your nebula again.

The OIII tends to work best with larger aperture telescopes in my opinion. To be most effective, the OIII needs a fair amount of light, it seems. This is not to say that it can't be used at all with smaller scopes. I've had some nice views of brighter and larger DSOs with an OIII used with my 80-mm $f/5$ refractor, but the views of any nebula through the OIII seem better with increasing apertures.

Finally, the OIII does not work on all objects. Not all nebulae or even all planetary nebulae radiate strongly in OIII light. While most OIII filters will admit at least some hbeta radiation, an object must be pretty bright in OIII light for the filter to work well. Most diffuse nebulae are improved by the OIII, but some are not. The Orion Nebula, for example, while not really dimmed by an OIII filter is not significantly improved by it in my opinion, either.

The final commonly available nebula filter for your consideration is the hbeta. This is often referred to as the "California" or "Horsehead" filter. The reason for these monikers is that the hbeta is mainly used in attempts to see those two *extremely* faint nebulae, which radiate almost all their light in the dim, red hbeta band. The hbeta filter is nice if you're chasing these legendary nebulae from dark skies, but is not of much use under sodium streetlight in the city. No matter which filter you use to combat heavy light pollution, you are not likely to catch a glimpse of the Horsehead or California from the city or even the suburbs—even with a rather large telescope.

There are a few other nebulae that respond well to the hbeta, but they are, if anything, even more challenging than the Horsehead and the California. When used on bright nebulae, an hbeta can be somewhat effective, but, in my experience, doesn't improve the view beyond what you'd get with a broadband filter, and certainly doesn't provide the performance of a narrowband type. Red hydrogen light is dim, and shutting off all other sources of light from an object can make almost anything hard to see.

Which to choose? At 100 dollars or pounds for 1.25-inch filters—2-inch units are approximately twice as expensive—these little pieces of glass don't come cheap. In my opinion, a narrowband filter from Orion U.S., Lumicon, or Baader is the place to start. They provide enough "gain"—contrast enhancement—to make a considerable difference in the appearance of nebulae from the city. The narrow-bands also have the advantage of "working" on the largest number of objects. As a second filter, the OIII is a worthwhile investment. Despite the fact that it dims field stars badly, it is an *amazing* filter. If you're interested in planetary nebulae, especially, the OIII belongs in your eyepiece box. The hbeta? If you never observe from dark—and I mean really dark—sites, you can probably do without the hbeta. If you do get to pristine skies occasionally, are interested in chasing the hard nebulae, have at least a medium aperture scope, and possess a lot of patience and observing skill, the hbeta might be nice to buy "some day."

At least as important as *choosing* the correct light-pollution filter is *using* an LPR filter correctly. A few years ago, I began hearing city observers complaining that their light-pollution filters just didn't work at all. According to these folks, not only did their OIIIs and Ultrablocks not *improve* nebulae, they actually made them look *worse*. I knew this wasn't true, as I've used these filters very successfully in the city with scopes as small as 60-mm.

A little investigating revealed the cause of the problem these people were having: that old devil, *ambient light*. An LPR filter is screwed onto the "telescope end" of your eyepiece and works by reflecting unwanted wavelengths of light away before they can enter the eyepiece. What happens, though, if you allow ambient light from man-made sources to enter the *other* end of the eyepiece? From the "eye end?" It enters the eyepiece, hits the filter screwed onto the scope end, and is reflected right back into your eye. Your eyepiece is flooded with light-pollution. That was what was happening to these observers. No wonder their filters made objects look worse. The secret to avoiding this light-flood is to shield the eye lens end of a filtered eyepiece from ambient light. This can be as simple as cupping your hands on each side of the eyepiece or as elaborate as arranging one of the light shields we'll talk about in the following chapter. In addition to helping your expensive LPR work as designed, protecting yourself from ambient light also allows your eyes to attain a little dark adaptation

Finders

Every amateur telescope needs a finder, the small, low-power telescope mounted on the main tube. A big scope has such a small field of view, relatively speaking, that without the wide-angle finderscope, locating objects—even the Moon—is an exercise in frustration. Finders are less important for the users of self-pointing go-to scopes, but the observer must still be able to aim the scope at alignment stars initially, and will need a decent finder to do that. If go-to alignment is a little off, the finder can also help locate an object outside the main scope's eyepiece field, as a surprising number of DSOs are visible in large finders—even in the city.

For the urban astronomer who doesn't use a computerized telescope, an adequate finder is vital. The problem for the city astronomer in locating DSOs is that there are far fewer stars visible in city skies than there are from the country. Out in the dark hinterlands where you can see down to magnitude 6 or better, finding objects is easy. There are plenty of stars in the sky corresponding to those on your charts. Plenty of "waypoints" to help you "star-hop" from sparkler to sparkler till you arrive at your target object. Reduce the number of stars visible to magnitude 4, however, and there will be some areas of the sky that are nearly "blank" to the naked eye. Virgo is a good example. Between the widespread arms of the Virgin, the "Y" shaped western side of the constellation, is the wondrous Realm of the Galaxies. There are dozens of island universes in this area that the urban astronomer can see with a modest telescope. But how do you find them? There very few visible stars spread across the 15 degrees of sky between Vindemiatrix and Omicron Virginis under city skies. The answer is a nice, big finder.

The average finder shipped with a medium-cost telescope has an aperture of 30 mm (I do notice that even some of the less expensive Chinese telescopes are beginning to be shipped with 50-mm finders, lately). This is sufficient, if not generous, for the country. In the city it is almost useless. Get rid of it as soon as you can, as it will not show enough stars to make finding DSOs anything but frustrating. A 50-mm finder, on the other hand, is just about perfect. Even in poor locations, a 50-mm aperture finderscope can deliver stars down to about magnitude 8, meaning you'll be able to see every star plotted on the popular *Sky Atlas 2000* star charts.

Which 50-mm finder? Most of the finders in this aperture range I've seen for sale over the last 5 years have been surprisingly good. Some do produce sharper stars at the edge of the field, but I don't find that overly important for object locating. What's important is a nice wide field—about 4–5° is common and good—and a set of crosshairs that is easy to see and sharply focused. Some observers ask me if they should pay more for an illuminated finder, a finder with a small, red LED attachment that lights up the crosshairs. If you observe from dark sites the illuminator can be nice, as crosshairs tend to disappear under really dark skies. In the city this feature is utterly useless. Our skies are bright enough that crosshairs are easily visible against the sky background.

I've occasionally had calls from disgusted amateurs who've just spent some hard-earned money on a new 50-mm finder (you'll pay around 50 US$ or 50 UKP for an imported 50-mm finder) only to find that it "won't focus." Looking at the current design of 50-mm finders—most finderscopes sold these days are very similar, most being made at the same Chinese factory—there's no obvious way to focus one. The eyepiece is built-in and immobile. Actually, you *can* focus them, although *how* is puzzling since most don't come with instructions of any kind. The secret is unscrewing the objective end. Point the finder at a bright star and unscrew the objective cell a little. You'll find that doing this reveals a locking ring just behind the spot where the objective unscrewed. This can be screwed inward if you need to screw the objective in to achieve sharp focus. But whether you have to screw the objective in or out to focus, you snug this ring up against it to lock it in place when you're finished. Simple and effective.

Are there any 50-mm finders I would rather not have? Yes, non-correct-image right angle finders. Many people don't like looking through a normal "straight-through" finder, which can be a literal pain in the neck. They find one with a built-in 90° star diagonal more comfortable to use. I don't blame them. Craning your neck to look through a straight-through finder when the scope is pointed near the zenith is no fun. The problem is that a normal star diagonal produces an image that is *mirror reversed*. What you see in the finder will never match what's in your star atlas (many computerized star atlases will admittedly allow you to print mirror reversed charts). This makes object location incredibly confusing and frustrating.

If you'd like a right-angle finder, get one advertised as "correct image." These use an amici-type prism to produce views that are not only mirror correct but also right-side-up, making star-hopping a joy. Formerly, one of these finders was an expensive item, but they have recently become available from many dealers in the U.S. and Europe for prices comparable to those of straight through finders. How is that possible? Those ubiquitous Chinese telescope factories again—good quality and rock-bottom prices.

Non-Finder Finders

Over the past 20 years, many observers have begun using zero power sights rather than finder *telescopes* thanks to the genius of the late American amateur astronomer and telescope maker, Steve Kufeld. Steve didn't like the fact that standard finderscopes produce relatively small fields of view and upside-down images. His solution was his Telrad, the "Telescope Reticle Aiming Device" (Plate 10). The principle of operation of the Telrad is similar to that used in the heads-up displays of advanced fighter aircraft: it projects a sighting reticle, a bullseye, into space.

The Telrad is actually a very simple gadget that uses a red LED, a printed transparency, and a couple of batteries to project its reticle onto a piece of glass. When using the Telrad, the observer sights through the glass, and the bullseye reticle seems to float among the stars. For the country observer, the Telrad is a joy. Position the bullseye in the proper place against the stars and you're done. You can purchase clear plastic Telrad overlays for star atlases, and many computer star charting programs will print a Telrad reticle on the maps they produce, making it easy to see where to place the reticle in the sky. This Telrad is a boon for the observer with dark skies, but is not easy for the urban observer to use. I don't recommend one in the city and rarely use a Telrad there myself—not by itself, anyway.

The problem is the lack of guidestars in light-polluted skies. It's hard to place the Telrad bullseye in the right spot among the stars when you can't *see* many stars. Even with a low-power eyepiece in the main scope, you're in for a lot of hunting around. This happens because, unlike a finderscope, a Telrad can't deliver more stars than your eyes alone can reveal—a finderscope's objective easily gathers much more light that your naked eye. The same problem exists for other nontelescopic aiming devices now available for astronomy: not enough stars. If you want to use a Telrad or other zero (or "unit") power finder in the city, fine, but be advised that you'll need to use one as a *supplement* to your finderscope, not as a replacement for it. In combination with a good finderscope, however, a Telrad can really speed up your finding. The Telrad places you in the approximate vicinity of the object, and you can then zero-in on it with the finder without a lot of slewing around. Get a Telrad, but use it with a finder.

Eyepieces

Eyepieces that are good in the country are usually good in the city and vice versa. Conditions in the city *are* different, however, and it's a good thing to select oculars with the urban environment in mind. Wherever you observe from, though, you can't go wrong choosing the best eyepieces you can afford. No matter how many times you change telescopes over the years, your eyepieces will still be useful. Unless you are interested in the most expensive ultrawide field eyepieces, choosing "best" rather than "cheapest" does not cost much more. For example, the excellent TeleVue Plossl eyepieces currently cost a little over twice what you'll pay for the average Chinese Plossl. Sometimes imported eyepieces can be good optically, but rarely as good as a TeleVue or other top brand. You can also be assured that name-brand oculars are better mechanically as well as optically, and are well suited for the long-haul. "Twice as much" for a considerable increase in real quality doesn't seem bad when you consider the fact that you may be living with an eyepiece for several decades.

Eyepiece Characteristics

Eyepieces, like telescopes, can be described with just a few numbers. Most important is the eyepiece focal length. Eyepieces (also often called "oculars") are commonly found in focal lengths of 40-mm down to about 6-mm, with 50–55-mm and 5–3-mm models also readily available, if not as popular. An eyepiece's focal length lets you know its magnification potential. The shorter the focal length, the higher the magnification in a given scope. To find an eyepiece's "power," as explained in the telescope section of this book, divide eyepiece focal length into telescope focal length. A 10-mm eyepiece gives you 200× in a 2000-mm focal length scope and 100× in a 1000-mm focal length instrument.

"True field" is the amount of sky you can see with your telescope and eyepiece combination. To find true field, you divide the magnification given by an eyepiece in a particular scope into its "apparent field" value (which should be listed in the manufacturer's specifications for that eyepiece). An eyepiece with a magnification of 200× and an apparent field of 85° yields a true field of 0.42° (85/200 = 0.42), a little less than half a degree of sky.

The aforementioned apparent field figure describes the expanse of field visible to the eye when looking into an eyepiece. Don't confuse this with true field. While the expanse of space visible to your eye may extend across 50° of your field of vision, for example, this may only encompass half a degree of *real* distance in the sky. Eyepieces with large apparent fields are more comfortable to use and more impressive (TeleVue's Al Nagler calls this the "spacewalk experience"). Using an eyepiece with a large apparent field compared to an eyepiece with a small apparent field is like watching a program on a 70-inch projection television rather than a 12-inch portable.

Although there are dozens and dozens of eyepiece brands available to amateur astronomers in the U.S. and Europe, the choice of an ocular is actually fairly simple. There are only four basic families of designs that are widely available and popular at this time, and many of the multitudinous brands advertised in the astronomy magazines are actually, like many of today's scopes, rebadged Chinese eyepieces from the same factories.

Eyepiece Designs

Many eyepiece types have come and gone over the 75 years since amateur astronomy became a popular pursuit, but all that experimenting has finally boiled down to the four basic designs/types shown in Figure 3.1. The simplest, the three element Kellner, is popular with amateurs for one reason: it's cheap. These eyepieces work fairly well in longer focal lengths (20-mm and longer), but are less usable in short focal lengths due to small eye relief—you have to place your eye very close to the lens to see the entire field, a problem for eyeglass wearers. The edge of the field is not very sharp in a Kellner, either, especially with smaller focal ratio scopes. Kellners can do well in large focal ratio instruments like SCTs, however (large focal ratio telescopes are always more forgiving of eyepiece deficiencies than small focal ratio ones). Kellners seem to be on their way out lately. With the advent of dirt-cheap Plossls from the Far East, telescope manufacturers can afford to include "better" eyepieces with their new scopes, and there's little reason for an amateur to buy a Kellner when a Plossl is only a few dollars or pounds more expensive.

Like the Kellner, the *Orthoscopic* design has been around for well over a century. These eyepieces are good performers in long and short eyepiece focal lengths, and

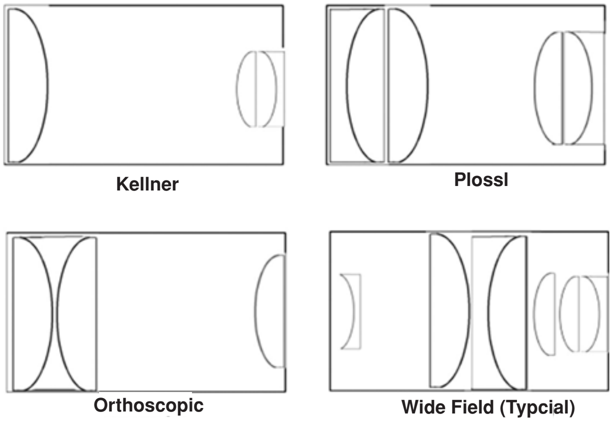

Figure 3.1. Popular eyepieces designs.

have sharp, flat fields. Their main drawback for the deep sky observer is their small apparent fields of view. It's like looking through a keyhole when you are restricted to 40–45° common in Orthoscopics. This doesn't bother planetary observers, of course. In fact, the Orthoscopic remains the eyepiece of choice for observers who don't need wide apparent fields. Its innate sharpness and the fact that it places only a few lens elements in the light path (four), means that the "Ortho" will likely remain a favorite for many years to come.

The Plossl (also known as the "symmetrical") is *the* eyepiece these days. It is without doubt the most popular ocular design with amateurs. Why? It's a good all-round performer, presenting sharp, flat fields across the entire range of focal lengths. It is also, as mentioned above, beloved of far-eastern eyepiece makers and is thus available for very modest prices. It performs equally well on the Solar System and on the deep sky, and, while not a wide field design, delivers a comfortable 50–55° apparent field. The perfect eyepiece? No. Its main drawback is short eye relief in short (less than 10-mm) focal lengths. This four-element eyepiece is now the obvious choice for observers, especially those on a budget.

The *premium wide field* eyepieces, represented by the TeleVue Naglers and Panoptics, the Meade Series 5000 Superwide and Ultrawide eyepieces, and Pentax's XW eyepieces, are a very different experience. Their incredibly expansive apparent fields—ranging from about 70° to 85° or more depending on the exact design of the eyepiece—make for an amazing experience. Looking through one of these expensive eyepieces (expect to pay at *least* 250 US$ or 200 UKP for the *less* expensive models) spoils you. It's hard to go back to peering through the "peephole" of a Kellner or Plossl after the picture window of a Nagler or Ultrawide.

If these eyepieces have a failing other than high prices, it's that they tend to be short on eye relief. TeleVue is working to improve this characteristic in its current designs, and this is a good thing, since it is very frustrating for an eyeglass wearer to own an eyepiece with a huge apparent field, but not be able to see all of it at once. These optically sophisticated eyepieces also put a lot of glass between you and your deep sky object. Some of the Naglers are made up of as many as seven lens elements, and images in a simple Kellner or Plossl may be noticeably brighter despite the advanced coatings used by wide-field eyepiece makers. In general, this brightness penalty is minor and is outweighed by these eyepieces' other advantages.

Eyepiece Considerations for City Lights Astronomers

Bathed in sodium streetlights, our need for long focal length eyepieces is limited. In general, you'll want to stick to the medium focal lengths, usually, with a 25-mm rather than a 35-mm being your low power eyepiece. In fact, I find that my most used eyepiece focal length in light-polluted areas is 12-mm, even with my long focal length SCTs. I'll use a 22-mm for my finding eyepiece, since it offers a fairly wide field that's not saddled with a background that's so bright as to obscure objects, and then switch over to the 12-mm for serious viewing. A good beginning set of eyepieces for the city observer might be a 25–20-mm "finding eyepiece," a 15–12-mm "workhorse," and a 7–6-mm "high power" for the small galaxies and planetary nebulae.

So, don't buy a 35-mm eyepiece. And get a 12-mm instead of a 20-mm as a medium power ocular, right? Maybe not. There is one instance where you might want longer focal length eyepieces. If you need good eye relief, rather than paying a premium for a shorter focal length eyepiece designed with this characteristic in mind (like the Tele-Vue Radians and the Vixen Lanthanums), just "barlow" a longer focal length eyepiece. Barlow lenses, shown in Plate 11, in their simplest form are single element negative lenses. Place one ahead of your eyepiece and it increases your magnification (typically by two or three times depending on the barlow's design). Long focal length eyepieces typically have better eye relief than shorter ones, so you can gain a comfort advantage by using an inexpensive 25-mm eyepiece barlowed to 12.5-mm (2× its original magnification) rather than an expensive 12.5-mm LER "Long Eye Relief" model.

Some novice amateurs are skeptical of barlows. How can you double your set of eyepieces with an inexpensive barlow? There *must* be a catch. Actually, no, not this time. A good barlow—and all of those I've tried from major manufacturers are outstandingly good these days—doesn't have any drawbacks. A modern two- or three-lens element barlow doesn't hurt your image quality. In fact, if you use simple eyepiece designs with a small focal ratio telescope, a barlow can actually *improve* image sharpness at the field edge. A barlow is a must-have accessory.

Premium Wide Fields or Not?

Should you pay the big money for a Meade, Pentax, or TeleVue wide-field eyepiece? If you can afford it, yes, in my opinion. These eyepieces are painfully expensive for most of us, but, as mentioned earlier, you will be able to use one for the rest of your observing life. In addition to their comfortable and impressively wide apparent and, therefore, true fields of view, they offer a real advantage in the city: their wide fields make it very easy to star-hop to objects in the main eyepiece. In some areas of the sky even my 50-mm finder doesn't pull enough "signposts" out of the glow to allow me to easily find deep sky targets. The area of the Virgo-Coma galaxy cluster is an example. What do I do? I pop in my 12-mm Nagler or 22-mm Panoptic (depending on the focal length of the scope I'm using). These eyepieces provide enough magnification to darken the field dramatically, but display a wide enough swath of true field allow me to jump from star to star with the aid of detailed charts on my way to galaxy after galaxy. I'd rather have one or two premium eyepieces than a whole boxful of cheap Plossls—especially in the city.

Roadmaps to the Sky: Atlases and Charts

In city or country, you need detailed sky maps to find anything. Forget the simple all-sky charts found monthly in the astronomy magazines. They don't show enough stars to allow you to locate anything beyond the brightest objects. An adequately detailed atlas is actually often far more important for the urban astronomer than for the country observer. If you've got dark skies, you can often just get in the neighborhood of an object. The target will be visible in the finder, making it simple to place it in the field of the main scope's eyepiece. In the city, all but the brightest DSOs will be invisible in finders, even large ones, so you'll need to be "on the money" every time. Only detailed charts, printed or computer-generated, can help you do that.

Print Atlases

There are quite a few print star atlases available to the amateur. Although computer charting is popular among astronomers now, traditional paper atlases don't seem ready to disappear. There are actually more of them on sale than ever. As far as I'm concerned, the perfect atlas for the urban observer has yet to appear. My dream atlas would be composed of several series of charts, with each series covering the entire sky. There'd be one group with a limiting magnitude of 3, one for 4, and maybe one for 5. Each of these series would be linked to a detailed group of charts showing stars down to magnitude 8 or 9 and thousands of DSOs (remember, the higher the magnitude number, the dimmer the star). An Australian atlas, *The Herald Bobroff AstroAtlas*, which has just come back into print after being gone for a while, almost fulfills these requirements, but its series of charts are not quite what I want either in magnitude limits or completeness. Since my dreamed-of *Urban Star Atlas* has yet to be produced, we'll have to settle for the next best thing.

Take a look at *Herald Bobroff* if you can find a copy—it's an interesting atlas—but I still consider "the next best thing" to be *Sky Atlas 2000* by Wil Tirion and Roger Sinnott (Plate 12). This large format set of charts covers the sky down to magnitude 8.5 for stars and features many thousands of DSOs. It's about as perfect as it gets for the city. Nearly every star you can see in light-polluted areas through a 50-mm finder is plotted, and the selection of DSOs is quite appropriate for what is doable in the urban environment. *SA 2000* comes in several editions: an unbound Desk version with white sky/black stars, an unbound Field version with black sky/white stars, and a larger format Deluxe edition that is spiral bound and features color and a white sky. *SA 2000* is the basic atlas for the urban observer in my opinion.

Other options? Many "brighter" atlases that only show stars down to magnitude 6, are available. Leave these alone. You need a chart that includes all the stars you can see in your finder. There are more detailed atlases, too. *Uranometria 2000* by Wil Tirion, Barry Rappaport and George Lovi, reaches magnitude 9.5. Roger Sinnott and Michael Perryman's *The Millennium Star Atlas* goes all the way to magnitude 11. Both of these "super atlases" are incredibly beautiful works, even if they might seem to be overkill for the urban observer. Why pay the high prices these books command when you won't be able to see the thousands of PGC and UGC galaxies they plot? That's what I used to think, anyway. Then I discovered how useful the super atlases could be for star-hopping through the main eyepiece. When an atlas shows most of the stars visible in a medium power eyepiece in your main scope, it's pretty easy to move from object to object without ever using a finder. You'll still want good, old *SA 2000* as your main tool, though.

Computer Planetariums and Atlases

Despite the continuing presence of print atlases, there is no doubt that computer star mapping programs are becoming more popular with astronomers every year, and are taking over many of the duties traditionally reserved for books. Some amateur astronomers are reluctant to make the switch since they don't have a laptop computer to use at the telescope. But owning a laptop is not necessary to gain the benefits of computerized charting, since all current programs will print hard-copy charts that are very close to the quality of the best printed atlases.

Computer charting programs are particularly well suited to urban observing since you can easily tailor their displays to urban conditions. Your limiting magnitude is 4? It's simple to tell a computer program to plot *only* stars of magnitude 4 or brighter. Want to display all the stars visible in your finder? Again, easy. It's also a snap to create highly detailed and correctly oriented eyepiece field-sized maps to allow you to star hop with your main scope. As far as resources go, current computer atlases contain far more detail than even the best printed atlases. The program *Skymap Pro*, for example, contains stars down to magnitude 15, while *Millennium* leaves off at 11. Deep sky objects? *Millennium* has a respectable 10,000, but Skymap easily overwhelms it with 200,000.

Introductory Planetariums

The astronomy programs available now have divided themselves into two broad general classes: planetariums and planners. Planetariums, especially inexpensive entry-level ones, are what most of us gravitate toward when choosing a first astronomy program. Their operation is easy to understand; the program creates a representation of the night sky on your monitor screen. Buttons or menus allow you to change the time of day/date, direction of view, zoom in and out, and perform a few other functions. Entry level programs typically plot stars down to magnitude 9 or 10 and display all the Messier DSOs and a selection of the brighter NGCs. This level of detail is adequate for a beginning observer, but you'll soon be left wanting more. Even in light pollution you're likely to soon begin detecting little galaxies, for example, beyond the range of a beginning planetarium. Also, introductory level programs tend to concentrate more on presenting a "pretty" depiction of the sky than on creating printed charts that will be usable and legible under a dim read light. Still, for the money (about 30 pounds or dollars on average), one of these will get you started using the computer with the scope. Current examples of beginning planetarium programs are *Starry Night Backyard* and *The Sky Student Edition*.

Advanced Planetariums: Deep Sky Software

Moving beyond the most simple and inexpensive planetariums, we come to the programs that have made astronomy software so popular with deep sky observers. These advanced planetariums (often referred to as deep sky programs) do the same basic job as the simple ones—they build a night sky on your computer screen—but in far more detail. The average advanced program will plot *millions* of stars—usually the entire Hubble Guide Star Catalog down to magnitude 15 and dimmer. The latest releases go far beyond the Messier for DSOs, many featuring up to one *million* nebulae, clusters, and galaxies.

Urban observers won't be able to see even a tiny fraction of this million fuzzies, but the advanced programs have other advantages in addition to object totals. They include numerous tools for the observer that simpler programs lack. You can, for example, rotate and flip onscreen or printed charts to *exactly* match the view your scope produces at the eyepiece. These programs can even draw circles on the screen (and on printouts) representing the sizes of the fields of the exact eyepieces used in *your* scope. This makes it easy to produce eyepiece-field size finder charts. It is now very common for this level of software to also allow you to control a go-to scope from the computer. Click on an object onscreen and the telescope moves to it. These features come at a slightly higher price than the introductory programs, with advanced planetariums selling for 100–150 dollars or pounds.

Specific programs that have proven popular with today's serious amateurs in and out of the city are *Skymap Pro*, *Megastar*, *Guide*, *The Sky* 6, and *Cartes du Ciel*. *Cartes* is particularly noteworthy in that it is *freeware*. While it is very capable, offering the same kinds of features as the other programs in this class, the author, Patrick Chevalley, has chosen to distribute it for free over the Internet (see Appendix 1 for the *Cartes du Ciel* URL). Why give away such a wonderful program? Patrick is committed to amateur astronomy, and says he'd rather see amateurs spend their money on eyepieces than computer software.

Planners

The most useful type of astronomy program for the urban observer isn't really a planetarium at all. It's a database. Yes, that sounds dry and uninteresting, but you'd be surprised how much computerized astronomical databases—the planners—can do for you, and how much fun they can make doing it. Like the advanced planetariums, they usually contain the Hubble Guide Star Catalog and up to a million DSOs. The difference between them and the planetariums is that they allow you to *manage* all this data in order to help you plan observing sessions (see Plate 13 for a typical planner display).

Only want to observe galaxies brighter than magnitude 10 that are on the meridian at 8 pm for your location? These programs will easily produce a sorted observing list containing *only* the objects that meet that criterion. The lists created by planners will contain all the details you need to find and study objects—coordinates in Right Ascension and declination, descriptions, magnitudes, and much more. You don't have to give up charts, either. Most planners will produce very usable charts at the same level of detail as the advanced planetariums. The charting "modules" of the planners *usually* don't have quite as many features—especially navigation buttons—as full-blown planetariums, but they are still quite capable. Some of the most recent planning programs incorporate advanced features like go-to telescope control and image libraries. Planners are the future of advanced astronomy software in the city or the country.

Two programs currently rule the roost when it comes to planning/database software for the PC: *Skytools 2* and *Deepsky Astronomy Software* (DAS). Both are similar in the number of stars and objects they contain (millions) and features (many), but each has its own strengths. *Skytools 2* provides a very user-friendly interface and has a "photo-realistic" charting mode whose displays can rival those of hyper-realistic planetarium programs like Starry Night. *Deepsky's* strength is in pictures. The program includes a supplemental DVD disk that is filled with over 400,000 images of DSOs. That means most objects you can click on in the database or on a chart will have a photo associated with them—very helpful in identifying faint fuzzies. The program is also available in a CD-only edition, which includes a CD with a smaller but still useful number of objects—11,000. Don't have or want a PC? *AstroPlanner* is a planning program for the Apple Macintosh that is inexpensive and quite capable. Its charting capabilities are somewhat less advanced than the PC software, but usable, and it offers some interesting features like helping go-to scope users in choosing "good" alignment stars.

Miscellaneous Accessories

Scope, eyepieces, charts? Anything else? Yes, you'll need a few other items to make your observing life fun and comfortable.

Red Flashlights (Torches)

Sure, the sky glow in the city is almost bright enough to allow you to read your charts without further assistance. Almost. You'll need a decent red light to enable you to read your star maps without ruining what night vision you're able to attain in your bright environment. Some users make do with a standard white light covered with red paper or plastic. That doesn't work very well. Usually, the light produced is not very red and is much too bright. My favorite type of astronomy light is one that uses red LEDs. These little devices are very inexpensive from astronomy dealers, produce pure red light, and have controls that allow you to adjust the brightness. Most use two LEDs, and can produce enough light for almost any purpose. Some even allow you to switch-in a pair of blue LEDs when needed—as when walking back to the house at 3 a.m.

Tables

You'll need somewhere to put all these accessories. I favor a simple lightweight folding camp table. These can be found in sporting goods stores. If you don't bring too many items outside with you, a card table can also work well.

Observing Chairs

Might as well be comfortable. If you own a refractor or an SCT, you may even be able to do all your observing while seated. Being comfortable, you'll find, can really increase your stamina and allow you to do very productive observing far into the night. Quite a few custom made "observing chairs" are available from astro-dealers, but I find what works best for me is a simple and inexpensive drummer's throne (stool) from the local music store.

You can—and probably will—keep on buying, but what we've accumulated so far will serve you well when we begin our walking tour of the cosmos. But before getting started let's talk about *how* to observe in the city.