CHAPTER EIGHT

Tour 1

A Trio of Fall Globulars

As warm September days pass and cool October nights arrive, the heavens change again in their never-ending cycle. The beauties of summer—Cygnus, Hercules, Sagittarius—are still on view but are descending into the west. If you want to catch the Summer Milky way, now's the time. It will be gone all too soon. Of course, there are many fascinating objects on the rise in the east, too. That's a big attraction for observers at this time of year. You get the best of both worlds. Point your scope west and you can still visit the multitudinous clusters and nebulae of the Milky Way. Head east and, just as in the spring, you'll be looking out of our home spiral into the galactic wilderness beyond. Many of the galaxies of fall, like Andromeda's M31 and company, Pegasus' NGC 7331, and Cetus' brilliant M77, are easily seen by city scopes. Much more spectacular than these galaxies, however, are autumn's fantastic globular star clusters.

Yes, globular clusters. Most observers think of these as summer objects, but their locations out in the galactic halo mean that just as a few—M3 and M53 among the Messiers—dip into the spring, some are also on display in fall skies. One cliché I keep hearing is "all globular clusters look alike, see one and you've seen them all." When I hear this, I can't help but think that the person making this claim hasn't observed many globulars. To the glob-fan, these star clusters are as distinct and individual as human friends, as we'll see tonight.

On this evening's star-hike, we'll visit three memorable globular clusters, M15, M2, and M56, all dramatically different objects, ranging from "blazing" to "subdued." Before we begin, though, I see that Hercules is getting low in the west. I'm sure you'll want to take one last look at his amazing star-ball. Go ahead, point the telescope at M13. I'll wait.

M15

Finally had enough of M13? Let's begin our journey, then. Our first stop is M15 in Pegasus. This is a most attractive object for small scopes, including those sited under badly light-polluted skies. Dark skies and large apertures transition this one from "attractive" to "spectacular," but I've had nice looks at M15 with scopes as small as my 60-mm ETX in the city.

You won't have to spend much time hunting M15. Like all tonight's objects, it's amazingly easy to find. It is bright and prominent with a magnitude of 6.4 and a diameter of 12.3′, and lies only 4° 10′ from prominent Enif, Epsilon Pegasi, The Horse's Nose. To hit M15, as shown in Figure 8.1 draw an imaginary line from Theta Pegasi, which is the star just east of Enif in the Horse's Neck, through Enif, and on for approximately 4°. Position your telescope in this spot and look for a fairly distinct 6th

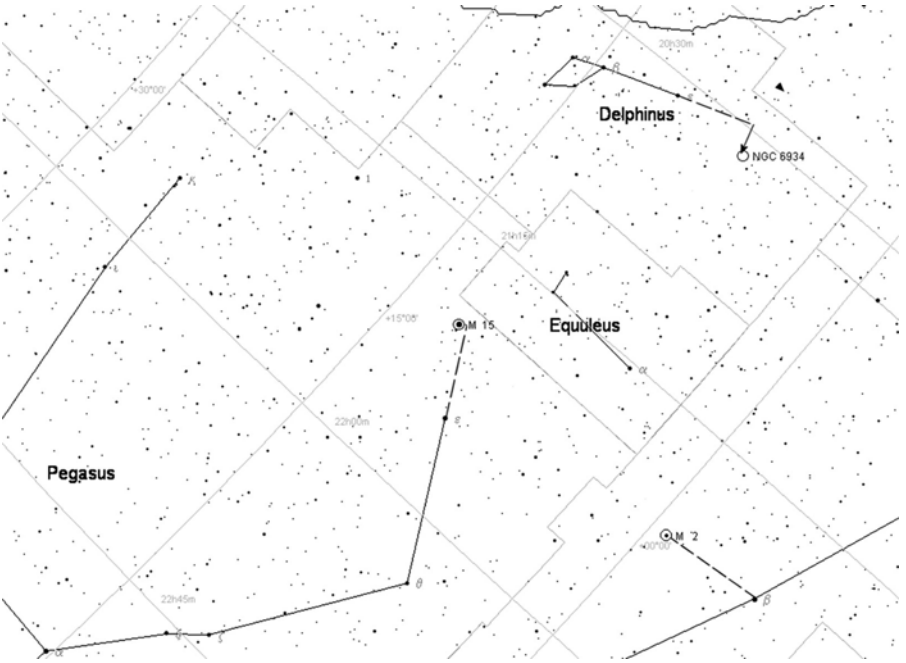

Figure 8.1. Forelegs of Pegasus, the Flying Horse.

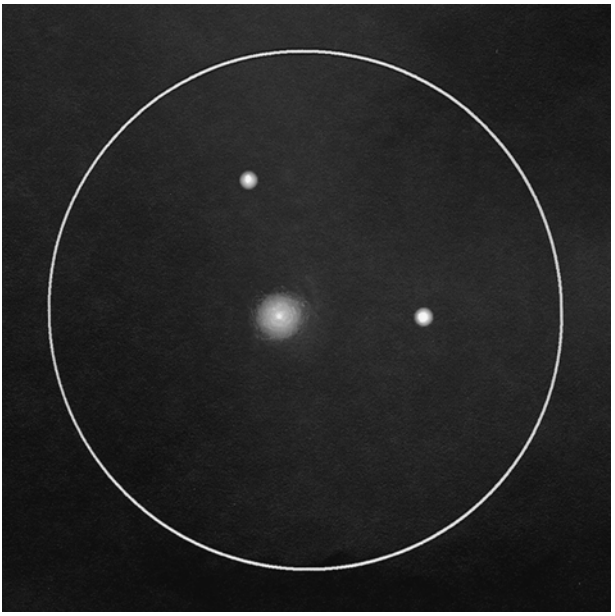

Figure 8.2. Pegasus' compact globular star cluster M15.

magnitude star. M15 is just 16′ to the west-southwest. Center this star in the finder, insert a low-power eyepiece, and take a look. With maybe a little sweeping, M15 should jump into your field.

In the main eyepiece of nearly any telescope you should notice an obviously fuzzy "star" right away. This is M15, which possesses a core that is strangely bright and compact, making the cluster show up well in the brightest skies. Increase your magnification to 100–150×, and settle in for a good, long look. Unfortunately, under the poorest skies with telescopes 6 inches in aperture and smaller, all you may see *is* M15's preternaturally bright core. There will probably also be a little haze surrounding this core, but don't expect to easily resolve stars. Careful application of averted vision and high magnification *may* make a few wink into view now and then, but you will probably need at least 8 inches of aperture to see this as a resolved globular cluster. An 8-inch scope does do that handily:

> In the 8-inch f/5 Newtonian, M15 is beautifully resolved at 166× with a Chinese 6-mm 60° apparent field eyepiece. The cluster stars, which are incredibly tiny and delicate, extend at least 75% of the way out to the eyepiece field edge, quite an accomplishment for this inexpensive telescope, as this short focal length eyepiece features over one-third degree of true field.

Even if your telescope is so small that you're unable to see many or any of this highly compressed cluster's stars, M15 is still worthy of extended observation or even a drawing, as the one I did of this glob in Figure 8.2 shows. I also made a text entry in my log on the same evening:

> M15 is bright and easily found with the 4.25" Newtonian. Far brighter in this aperture than you'd expect. Seems more or less round with perhaps a hint of elongation north/south. The concentrated core is almost star-like, even at higher magnifications. Some hints of mottling, as if the cluster "wants" to resolve, but won't quite do it. I detect, at most, a star or two at the cluster edges, and can only see these with extended observation using averted vision at 200×, which is the limit for this telescope's optics.

M15 was a marvel in the C11 SCT:

> Incredibly beautiful with a 25-mm Plossl in the C11, even though it's not completely dark yet. The core is bright, blazingly bright, and hordes of tiny stars are all around for about 10 arc minutes. It is just about as beautiful in a 12-mm Nagler at 220×. Resolution close to the core is very evident in this eyepiece.

M15 is a Shapley–Sawyer Class IV (4) globular, which makes it "highly concentrated" according to that classification scheme. One thing's sure; its core is amazingly luminous. Why? Current thinking is that a black hole may reside at M15's heart. Professional astronomers have changed their minds on this at least once before, however. Like so many of the objects we observe, M15 remains a mystery, its bizarrely bright center shining across the thousands of dark light years and into our tiny scopes.

M2

Once you're ready to move on from M15—and I hope you give it at least a half hour of your time—we'll set the course of our imaginary starship for destination two, M2. M2 is an impressive globular star cluster that has the misfortune of being located inside the borders of the dim zodiacal constellation Aquarius, The Water Bearer. Due to its position along the zodiac, Aquarius is a familiar name to even the most novice astronomer, but that doesn't mean they've actually seen it. Its pattern, composed of mostly lackluster stars, can definitely be hard to make out in the city.

Is M2 hard to find, then? Not very. M2 itself is bright (magnitude 6.5, 8.0′ in size), making it dramatically apparent in my little ETX refractor in heavy light pollution. It is also conveniently located near one of Aquarius' few respectably bright stars, magnitude 2.95 Beta Aquarii, which is shown in Figure 8.3. Center your finder on Beta, and then move 4° 46′ north, as shown on the chart. A pair of magnitude 6 stars half a degree apart lies a degree north-northeast of M2, and provides a good guide if you get lost in this star-poor area. M2 *may* be visible in a 50-mm finder, depending on your conditions. Even if you can't make out M2 in the finder, with a little luck it should be in the field when you move to the main eyepiece if you've positioned the scope with care. As always, have a good star atlas on hand to supplement the charts in this book.

When I had M2 firmly centered in the 4.25-inch Newtonian, I found it to be "tantalizing." I couldn't make out any individual stars, not with averted vision, and not with high power. But it was definitely granular, and seemed *ready* to resolve. This impression was much stronger than with M15:

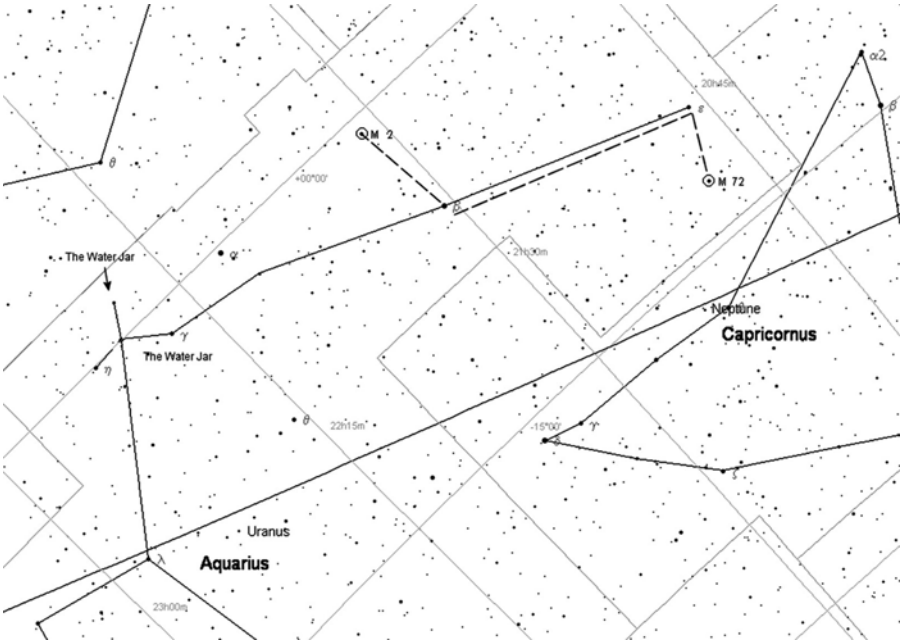

Figure 8.3. Aquarius, the Water Bearer.

> Spectacular is the word! Maybe not a beautiful as M15, but lovely nevertheless. Much less concentrated than M15 but still fairly condensed looking. Loose, grainy, and ready to resolve on a better night.

Well, maybe. I don't believe I've ever had an urban evening that was good enough to allow M2 to be resolved in a 4-inch class telescope. A little more aperture works wonders on this glob, though.

A 6-inch scope *begins* to reveal M2's stars in the city, which is not surprising, since the brightest are at magnitude 13. An 8-inch telescope delivers many more, easily and routinely. Nothing, of course, does more good than dark skies, and I had a mind-blowing view of this cluster one October evening from the dark northern Mississippi skies of the Mid-South Star Gaze. In my 8-inch Schmidt Cassegrain, M2 was revealed as a titanic globe of stars, and took on an almost three-dimensional appearance. At times, I felt as if I were in danger of *falling into the cluster*. M2 is rather strongly elliptical in shape, but it always looks round to me, no matter how large my scope or how dark the skies.

M2's core appears much more normal than that of M15, so it's a surprise to find that this globular actually rated as a *more* condensed II (2) on the Shapley–Sawyer scale. Despite its "looser" class of IV, M15 *looks* more compact because of the unusual brightness of its nuclear region. A presumed distance of 40,000 light years gives M2 a diameter of 175 light years. Estimates of its star-population density range upward from 150,000 stars.

M56

The last featured attraction for tonight is one of the more obscure Messier objects. It's really a "summer" object, I suppose, but it's sedate enough that, hypnotized by the gleaming deep sky marvels of summertime, I usually don't get around to M56 until it's almost too late. Everybody knows and loves Lyra's M57, the Ring Nebula, but relatively few people bother to visit its neighbor, M56. The lack of attention given this globular cluster is due to its fairly dim magnitude, 8.3, its rather loose structure, and the fact that it is relatively distant at 50,000 light years. It's of medium size for a globular, 7', but this comparatively small diameter doesn't seem to help with its visibility in light pollution. It can be hard in small apertures, and doesn't begin to be very interesting until you apply 10–12 inches of telescope mirror to it.

M56 is M57's neighbor both on the Messier list and in the sky. It is easy to locate by drawing an imaginary line from Beta Cygni, the famous double star, Albireo, and bright Gamma Lyrae. You'll find this globular 3° 48′ from Albireo right on the line to Gamma. Work slowly and methodically, because this one will be easy to miss in light-polluted skies. *Very* easy to miss. If you have trouble, there's a magnitude 5.85 star just 25′ past M56 in the direction of Gamma Lyrae.

I found M56 to be a surprising challenge when I was doing the Messier list with my 4.25-inch scope in the city. In fact, it was one of those objects that I had to search for over the course of quite a few evenings, waiting for an especially good night. I was prepared to undertake this kind of a hunt for the dimmer Messier galaxies, but was surprised and a little put out to find a supposedly bright glob so vexing. When it finally appeared in the 4.25-inch scope, I was a little less than bowled-over. Nevertheless, since I'd hunted for this one for so long, I did document it with the drawing in Figure 8.4 and a log entry, just to prove I'd been there:

> Amorphous and quite a bit dimmer than I expected. At 90×, it's nothing more than a vague and undefined glow in the middle of my field. Not even a hint of resolution. Even riding high in the sky, this cluster is undetectable until I use averted vision.

As with M2 and M15, M56 was dramatically improved in larger aperture scopes. In the 12.5-inch Dobsonian, it was much easier to find, and, when found, yielded quite a few stars, and was beginning to look a lot more like the photograph in Plate 43. Moving that scope out to our hardly perfect suburbs actually made M56 into a beautiful object, with many tiny stars resolved across its face. Unfortunately, a dim and loose structure prevents this cluster from being a real showpiece, even from dark desert locations.

M56, a Shapley–Sawyer Class X (10) globular, was one of those objects actually discovered by Charles Messier who first laid eyes on it in 1779. At an estimated distance of 33,000 light years, it stretches across about 85 light years of space. In addition to its loose structure, most of its stars are at around magnitude 14, making the cluster problematical for smaller amateur telescopes when it comes to resolution.

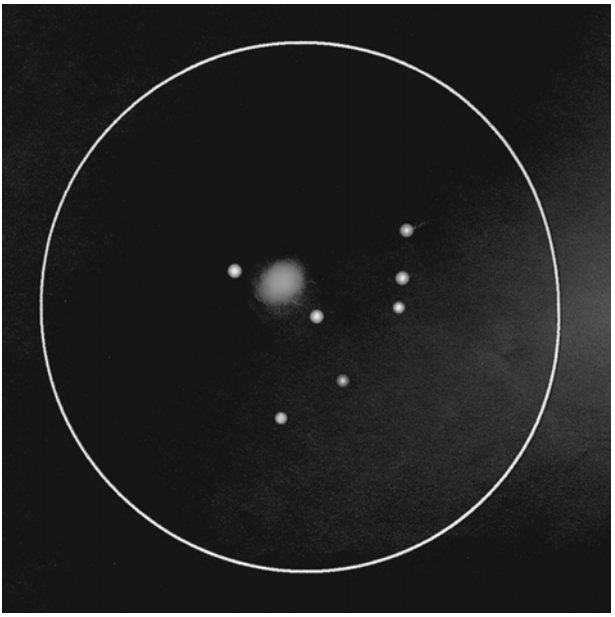

Figure 8.4. Lyra's subdued globular, M56.

A Couple More

NGC 6934

If you hurry, you can still catch the brighter of Delphinus the Dolphin's two globulars, NGC 6934. In this case, "brighter" is a relative term. At magnitude 8.9 and 5.9′ across, this little fuzzy can be difficult. It's easily located by drawing a line from magnitude 3.77 Alpha Delphini through magnitude through Beta, through Epsilon, and on for another 3° 45′. Stop at that point and move a degree and a half east, and you should be on NGC 6934. Despite an unimpressive magnitude figure, it will be readily apparent in an 8-inch scope under most conditions. I know NGC 6934 never fails to show itself with ease in the C11. However, even with 11 or 12 inches of aperture, this cluster is not resolvable in the city, appearing as a small grainy spot. In the 11-inch SCT under dark skies, though, considerable resolution is possible with high magnifications, and this little glob also shows itself to be slightly elliptical in shape.

M72

There are Messiers and *then* there are Messiers. There are the M13s and there are the M56s. Aquarius' "other" globular, M72, is definitely in the M56 category. On most

evenings, this small, loose globular cluster, glowing weakly at magnitude 9.4, is just on the edge of perception in the 4-inch scope and completely invisible in the Short Tube 80-mm refractor. It usually looks better than M56, but not by much. Applying 12 inches of telescope aperture and dark skies to M72 doesn't make it spectacular, either. It's just ho-hum at best, a dim, loose clump of a star cluster. What I find surprising is that Messier cataloged this one and skipped over a much better globular, NGC 288, nearby in Sculptor. Unlike M72, NGC 288 is an easy and impressive object for smaller telescopes.

If you're up to the M72 "challenge" in the city, the easiest way to find it is probably to start at magnitude 2.95 Alpha Aquarii. Proceed 10° south and west to magnitude 2.9 Beta, and then another 11° 33′ in the same direction to magnitude 3.77 Epsilon Aquarii. M72 is 3° 21′ south-southeast of this star. A pair of magnitude 6 stars separated by a little more than 1° lies just to the west of the cluster. Once you've done M72, be sure to look for NGC 288 as well. It's 1° 45′ from the famous Sculptor Galaxy NGC 253, and about 3° from prominent (when its near culmination) Alpha Sculptoris.

Tonight's Double Star: Mesarthim, Gamma Arietis

Aries, despite its status as a constellation of the zodiac, isn't much to look at. It's an unmemorable pattern of medium bright stars. But one of these anonymous looking stars is a very fine double, Mesarthim. This star is famous in astronomical history as "The First Star of Aries," a name it bore because it was once the closest star to the Vernal Equinox, "The First Point of Aries," before the wobble of the Earth's axis moved the Equinox over into neighboring Pisces.

Both the primary and secondary of this pair are usually said to be of equal brightness, both being given magnitude values of 4.8 by most sources, though the westernmost star does look slightly dimmer to me. The separation of the two components is a generous 8", which is easy to resolve for most scopes, but not so large as to make the pair less attractive. For me, widely separated doubles are less interesting, looking like nothing more than unassociated field stars in larger scopes. While both of the stars of this pair are white, the "dimmer" component is sometimes (and rather fancifully, if you ask me) called "gray." Mesarthim is not difficult to locate if you can make out the dim hook-shaped pattern of stars that is Aries, lying to the east of Pegasus and Pisces. Mesarthim, Gamma, is the "end" star at the Western terminus of the pattern, closest to Pegasus.

> It's late now, and I'm starting to tire as the stars of Cygnus and Delphinus disappear into the West. But I see Orion 's rising in all his glory. If tomorrow isn't a workday, and if dew and fatigue don't shut me down, maybe I'll observe a few more marvels. I've already almost had a surfeit of wonders. As I stand under the quiet autumn sky amid dead and fallen leaves, the images of these great and mysterious forests of stars linger and will surely haunt my dreams.

Tour 2

Titan and Crab

One of the wonderful things about being an amateur astronomer is the closeness we develop with nature, and particularly with the endless change of the seasons. The average person may scarcely note summer's metamorphosis into fall until the first chill winds blow, but we sky watchers have been anticipating the end of summer long before the Equinox. As August faded into September and October, we saw the Summer Triangle crawl farther and farther into the west and we said a farewell to the myriad wonders and mysteries of the summer sky. This is, I think, a good time to stop and reflect on the unbelievable sights that have paraded across the heavens and our view for the last several months. How many old friends among the summer deep sky objects did you revisit this year? How many new acquaintances did you make? But summer's dead now, and we turn to the east and to the smoky fall stars.

Autumn almost seems like an intermission before the great winter sky show begins. The dull stars of autumn lack the majesty of the brilliant beacons of wintertime—Betelgeuse, Rigel, Capella and, of course, Sirius. Likewise, the DSOs of autumn, the M72s and M1s are not as splashy as the M42s and M35s to come. But this is not to say that there are no spectacular DSOs on-view before winter sets in. For even the most light-pollution-afflicted observers there are some gems waiting in the fall constellations. They are more subtle and delicate than the sights of summer and winter, but I think this fits the contemplative nature of autumn, a time for goodbyes and a drawing-in in preparation for the cold storms of winter.

In spring our focus is definitely on the deep ranges beyond the Milky Way, to the galaxies sprinkled like wildflowers across the great fields of Virgo. In summer, we return to our home galaxy and to the easy pickings of the plane of the Milky Way. The coming of fall again allows us to delve into the void between island universes. Now Pegasus, the great flying horse, sprawls across the heavens. He is peppered with many, many galaxies, but even the brightest of these present high challenges for city astronomers. At best, the Pegasus galaxies appear as barely perceptible fuzz-spots in smaller apertures. But nearby, easily visible in the worst sky glow, is a titan of a galaxy.

I rarely let a clear autumn night pass without taking at least a quick look at M31, the Great Galaxy in Andromeda. I suppose even the greenest deep sky observers have visited this enormous spiral at least once—it's usually one of the first objects new amateur astronomers seek when taking their initial steps outside the Solar System. Unfortunately, most novice observers make their looks at this great wheel of star brief. All too often, I hear novices dismiss M31 as a "bright smudge"—something to be ticked off on the Messier list and nothing more. Extended observation and a bit of study of both the object itself and its vital statistics, however, will reveal subtle glories in almost any object, and M31 is not an exception.

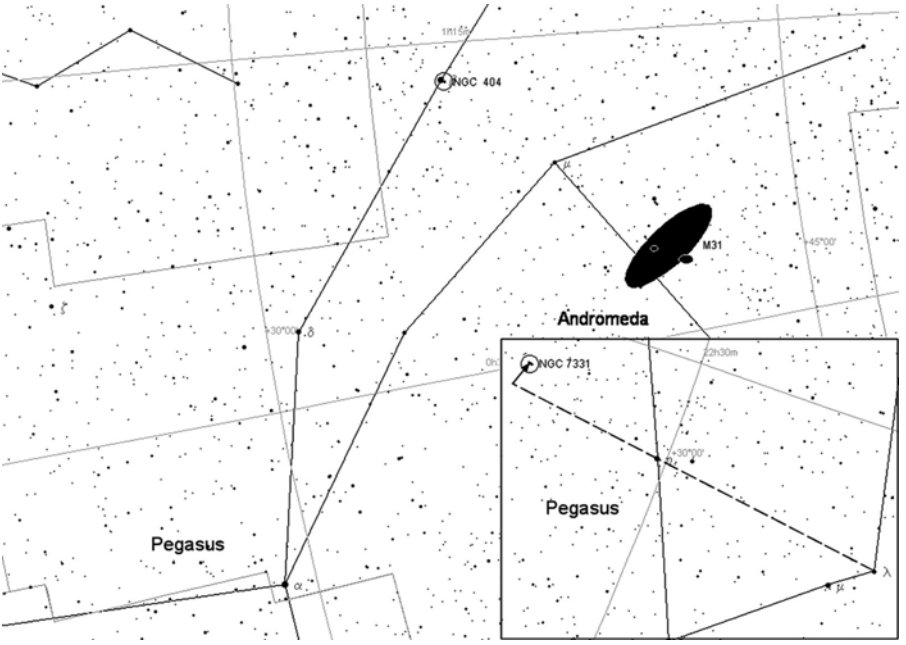

Figure 8.5. Area of the Great Andromeda galaxy.

M31

Summer's journeys have been relatively short hops, usually a mere 20,000 light years or less. Our visit to the more distant of fall's globulars didn't take us much farther. Now we step out into the real dark again. Even the 2.5 million light years to M31 is "backyard" in cosmic terms, but it's far enough that our quest for details in a DSO becomes more difficult—though hardly impossible. Locating M31 is simplicity itself, since it is very large and bright, 178′ × 63′ and magnitude 4.0. Its large size means that its magnitude 4.0 light is very spread out, but it's still bright enough to see with the naked eye from the suburbs, where it appears as a strange nebulous "star." In the city it will be invisible without optical aid, but in binoculars or your finder, it will be easy, and will assume an obviously elongated form.

To find M31, check your star atlas or the chart in Figure 8.5. You'll see that the galaxy lies 1° 21′ west of magnitude 4.5 Nu Andromedae. If Nu is hard or impossible to see in your light-polluted skies, a time honored guide to M31 is the "arrow" formed by the triangle of bright stars composed of Alpha, Beta, and Gamma Cassiopeiae, which should be easy to see in the worst sky glow. Follow this arrow for 15° 16′, and you'll land in the general area of Nu Andromedae. A look through your finder should then reveal M31. When you see the elongated fuzzy of M31 in your finderscope, put it in the crosshairs, insert your lowest power eyepiece into the main scope, and take a look.

How M31 looks at first glance depends on the focal length of your scope more than on its aperture. In a fast, wide-field scope like the Short Tube 80, you'll see a bright, elongated glow with a slightly brighter center. There won't be much, if any, detail visible at first, but M31 will definitely look like a galaxy. With a narrow field scope like an 8-inch SCT, what you'll see is a round glowing ball that represents the nucleus and inner regions of M31. This will be embedded in a fainter haze of nebulosity extending northwest–southeast. You'll have to slew the scope at least one low-power field in each direction to see the full extent of the galaxy visible in the city.

There's no denying that M31 can be disappointing at first blush. I remember drooling over gorgeous long-exposure photographs of this galaxy while I was saving up for my first telescope. Once I'd examined the Moon and Jupiter with my 3-inch Tasco reflector, M31 was the first object I went after. *What a let-down*. The books referred to M31 as "bright," so I expected to be blown away by the sweep of magnificent spiral arms. I found the galaxy easily enough, inserted a low-power eyepiece (I did realize that it would be big), and pressed my hungry eye to the lens. There it was, I'd found it on my first try. I was elated until I started looking in earnest and wondered what was wrong with my new scope.

The blob I was seeing looked nothing like the pictures. All I could make out was a round, fuzzy ball surrounded by a little tenuous haze. I was disappointed enough that I was ready to give up deep sky observing before I'd even gotten started. Luckily, I kept going and found enough "good stuff" to keep me enthused about the deep sky. I was still puzzled by M31, though. Why *didn't* it look like those pictures? I blamed my small scope and forgot about Andromeda.

It took me a couple of years to figure-out why this magnificent galaxy looked so terrible. It wasn't my telescope. No matter what you do or how large a scope you use, M31 will not show spiral structure to the extent that a face-on galaxy like M51 will. It's hard to trace the arms even in photos. This is because of M31's shallow inclination to us. It's viewed almost edge-on, meaning we don't have a good perspective on the arms. Also, like I did the first time I visited here, most novice observers just give this object a quick once-over before moving on. Seeing details in any deep sky object requires more than a 10 second glance. Finally, as always, visually this galaxy will never look exactly like its photos. The eye and the camera are very different sensors. That doesn't mean that M31 always looks *worse* visually, just *different*. The eye actually has an advantage over a camera in that it has a far greater dynamic range than film, meaning it's easier to make out subtle brightness gradations visually.

How do you get beyond the smudge stage with M31? How can you see details in the midst of this fuzzy haze? A good approach is to use a variety of magnifications to scan the whole galaxy, and to use high powers to pull details out of light pollution. After locating M31, start looking for its features with higher power oculars. Begin with perhaps 100×. The trick to making M31 give up detail is patience and perseverance. On many nights in the city, for example, the center of the galaxy is just a round, featureless ball, but on above average evenings at 100× in 6-inch and larger scopes, you may occasionally see M31's "true" nucleus, a tiny star-like point at the center of the fuzzball.

Away from the central region, you'll see the extensive haze that represents the disk and spiral arms of the galaxy. On the best urban evenings, take a look at the Northwest edge of the galaxy. Does this side appear a *little* more sharply delineated than the galaxy's southeast border? If so, you're seeing evidence of one of the dust lanes that

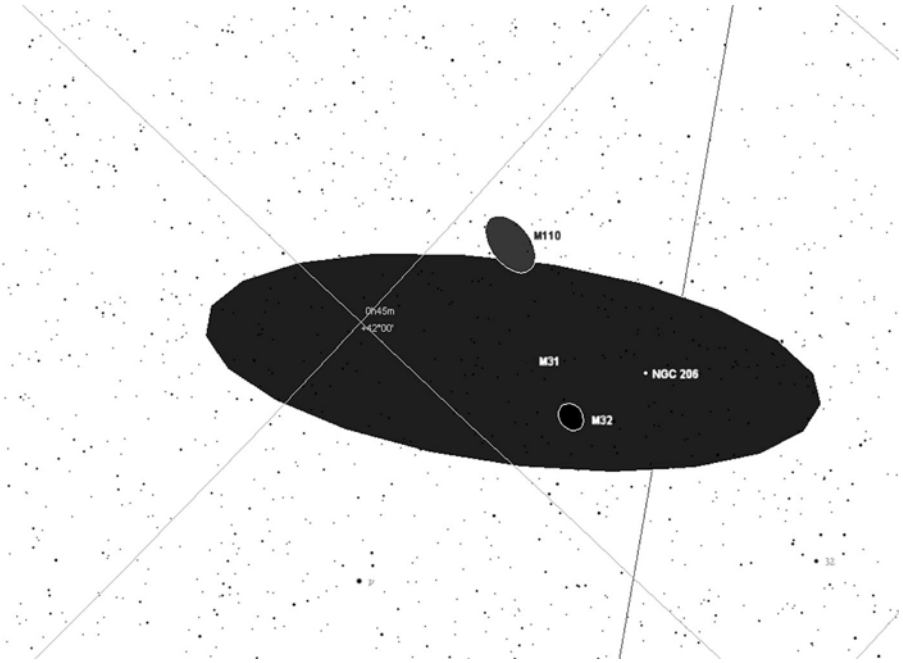

Figure 8.6. Zoomed in on M31.

outline M31's spiral arms. This is not an easy observation to make in the city, but I have done it with a 6-inch reflector when M31 was high in the sky. The secret to seeing the dust lane is to keep trying, especially on transparent late autumn nights after a cold front has passed through.

Dust lane visible? Then keep going. NGC 206, shown in the close-up chart of the M31 area in Figure 8.6, is a huge cluster of giant stars located on the outer fringes of one of M31's spiral arms. It is similar to M24, the Milky Way star cloud in Sagittarius. NGC 206 can be found 30′ west and slightly south of Andromeda's nucleus. Hard? Very. Possible from the city? Yes. When the sky is right, look for a subtle brightening less than 4′ across.

Keep pushing your little urban scope and don't give up too easily on any night. Keep cruising this great galaxy, looking for the star-like nucleus, for NGC 206, and for dust lanes. Be sure to attain as much dark adaptation as possible in your location. Even on the worst nights, though, there is always plenty to see in "Andromeda." In the little 4.25-inch scope on a spectacularly *bad* evening, for example, I found that

> Even under these horrid skies, M31 is quite a sight in the 4.25-inch (48× with a 25-mm Kellner). A large, round nuclear area is visible embedded in very faint haze. M32 is bright and obvious, but M110 is not seen. The view is bad, I guess, but I can help feeling a sense of wonder. I'm looking across nearly three million light years to the home of half a trillion suns!

M32

After the central fuzzy-ball inner regions of M31, the most easily seen object in the area is M32. This is a small satellite galaxy orbiting the center of M31, it is Andromeda's equivalent of our own galaxy's Magellanic Clouds. This round magnitude 9.08, fuzzy lies 25′, one medium-power field, southeast of the center of M31. This 8.8′ × 6.5′ elliptical galaxy, like all its kin, doesn't reveal much in the way of details in any telescope. A higher power eyepiece should at least show that M32's center is brighter than its outlying regions, though. Like most small ellipticals, it looks perfectly round to me even though in reality it's a somewhat elongated Hubble Type E2.

M110

M31 possesses another relatively easy-to-observe satellite galaxy, M110 (a.k.a. NGC 205), which is another elliptical. At magnitude 8.93 and 21.9′ by 10.8′, its light is more spread out than that of M32, making it surprisingly hard to see from urban observing sites. It is easy to photograph, however, as the sky fogged photo in Plate 44, taken from a substantially light-polluted suburb shows. M110 is the little fuzzy blob to the right of the main galaxy. I have detected its ghostly glow with the 4.25-inch reflector, but only on truly exceptional nights, and it wasn't easy then. Maybe slightly easier than the star cloud, NGC 206. M110 is on the "opposite" side of M31 from M32. Search for it 35′ west-northwest of M31's center.

When I've applied high power to M110 with a large aperture scope, I've occasionally thought I've caught fleeting hints of complex detail, as if I'm seeing some grainy clumps or dust spots in the haze outlying its nucleus. Quite likely this is just the result of me straining overly hard to turn up details in what is essentially a featureless elliptical galaxy. Actually, it's not *quite* featureless. Some long-exposure images taken with large telescopes do reveal strange dark patches or lanes in M110, and it has been classified as an E6p, "p" for peculiar. Have I actually detected these dust patches or am I just remembering what I've seen in photos? I'm not sure, but never be deterred from attempting an observation because someone tells you it's "impossible" with your scope and your skies.

M31 and its satellites are located at least 2.5 million light years from Earth (some current estimates put them at 2.8 million light years). The big galaxy is classified as a Hubble Type Sb spiral, since its nucleus and arms are of equal prominence. It is 180,000 light years in diameter, and may contain up to 500 billion stars, making it the largest galaxy in the local group, and considerably bigger than the Milky Way. M31 is, unlike the distant red-shifted galaxies in the Virgo Cluster and beyond, approaching the Milky Way, and astronomers believe it is destined to collide and merge with our home spiral in the distant future. The final result of this cosmic collision may be the formation of a monstrous elliptical galaxy that takes the place of our two graceful spirals.

M1

Like M31, M1 held a special attraction for me as a young astronomer. One thing that drew me to it was its "number one" position in Messier's list. Surely, the *first* had to be, if not the best, at least special in *some* way. There were also those beautiful silvery astrophotos of the Crab Nebula. M1 was another of the objects photographed by the 200-inch Hale telescope and made into beautiful black & white prints that circulated widely among the public in the science books and magazines of the late 1950s. In its Palomar print, M1 looks incredibly fascinating. It is a large jagged-edged oval of brightly glowing gas set in a rich star field and overlaid with numerous thin, twisting filaments of gas.

I was also drawn to this nebula, which is a supernova remnant, because I had just been introduced to adult science fiction by Arthur C. Clarke's famous work, "The Star." In this gem of a short story, space travelers come upon the remains of a civilization destroyed by a supernova that turns out to have been seen on Earth as the Christmas Star. I was moved by the story and identified the supernova—unspecified in the tale—with M1's precursor.

Another attractive feature of M1 was its closeness to a bright star, Zeta Tauri, which meant that it was an object I could hope to locate easily in those days when I was learning the sometimes difficult art of star-hopping.

Indeed, M1 is one of a handful of "no-brainer" DSOs when it comes to finding. All that's required is that you be familiar with the bright and famous autumn constellation, Taurus the Bull. The Bull's face, formed by the Hyades star cluster and graced by the tremendous magnitude 1.0 red star, Aldebaran, is a "V" of stars. Each "leg" of this V can be extended for 15° 15′ to a bright star. These two stars, Zeta Tauri and Beta Tauri, are the bull's "horns." The northernmost horn, magnitude 3.0 Zeta Tauri, marks the location of the nebula. Position your scope on Zeta and move just a smidge over 1° south and slightly east and you are *there*. Use at least medium magnification and try to wait for M1 to near the meridian. It's tough in the city, you see.

I was able to land on M1 without much fuss, just as I'd been able to find M31 with ease despite my lack of star hopping experience. That was the only good thing about my encounter with M1. Talk about disappointment. It was even worse than Andromeda. With the 4.25-inch telescope, I could *barely* make out the tiny, dim oval of gray nebulosity seen in my drawing in Figure 8.7. No filaments of glowing gas were to be seen.

I've learned a lot about deep sky observing in the nearly 40 intervening years, but I *still* find M1 to be rather difficult and bland from light-polluted areas. At an integrated magnitude of 8.4 and 8′ across its major axis, M1 has a respectable surface brightness of 11, but looks dimmer, much dimmer than that to me. It is *intrinsically* faint, and, like nebulae of all types, takes a real beating from light pollution. I recently came back to M1 with the 4.25-inch reflector, the very same telescope I'd used on it as a young amateur, to see if I'd been too hasty or hadn't known what I was doing back in the old days:

> If you're observing the Crab from the city with a 4.25-inch telescope, you have to be satisfied just to say you've seen it. I didn't have much trouble picking it up, but only with averted vision. I can't see it with direct vision in this telescope on this evening. The only distinguishing feature beyond its small, pale gray oval is that it is obviously elongated, and even that is not an easy observation to make. A few dim stars are scattered across this lonely field.

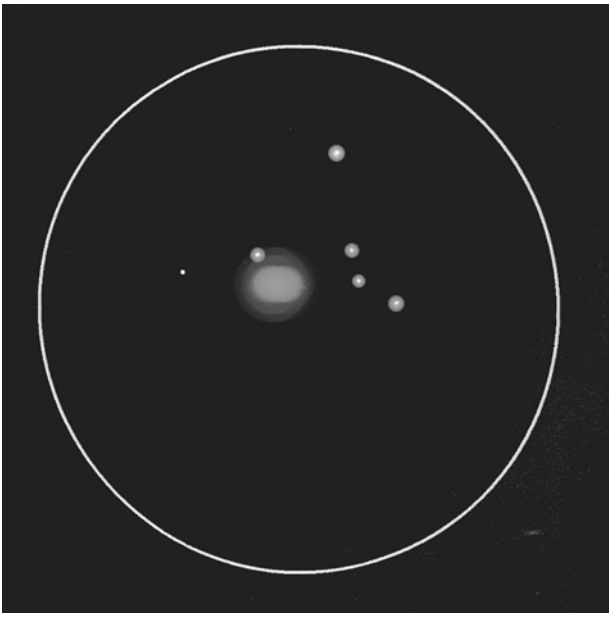

Figure 8.7. M1, the Crab Nebula in a small scope.

Can you do better? Possibly. How? Aperture. I don't notice *much* change in M1 before 12.5 inches. Until you get there, M1 becomes easier to see with each jump in light-gathering power, but remains a featureless oval. In 12.5-inch scopes, though, a couple of things become apparent. With sufficient magnification, the Crab morphs from an oval to something that looks more like the lightning bolt shape that's seen in the image in Plate 45. This aperture class also begins to reveal that the body of the Crab is not smooth, but has a wispy, filamentous character around the edges.

To see the tendrils weaving in and out across the main body of the nebula takes a lot more aperture in the city than 12.5-inch scopes and judicious application of an OIII filter. I have seen the filaments and streamers with my 12.5-inch telescope under dark skies, but the smallest instrument that has revealed them to me in the city has been a 24-inch Dobsonian. Even then, an OIII and some careful observing were required. The Crab looked nothing like its image, but with the OIII in place and at high power, I could see where at least one filament crosses the Crab's body and branches into two. Unfortunately, the OIII suppresses M1's main nebulosity, so getting a true idea of the object, even with a large scope, required me to switch the filter in and out, and increase magnification to over 500×.

Despite the frustrations Old Crabby poses to visual observers, he is still an interesting stop. Perhaps more interesting historically than at the eyepiece, however. Despite its position in the number one spot in his catalog, this object, like surprisingly many of the others, was not *discovered* by Messier. The first person to have seen, or at least recorded it, was the English amateur astronomer John Beavis in 1731. Messier appears

not to have heard of Beavis' observation and may have discovered it independently in 1758. M1 probably *was* the object that spurred Messier to begin his list with the initial intent of cataloging comet-like objects—it certainly looks like a dim comet in a small instrument. Messier's goal, at first, anyway, was to help his fellow comet observers avoid wasting time with funny comet-like patches that didn't move. The first observer to get a *good* look at M1, however, was Lord Rosse, who made a drawing of it in 1844 from his Irish castle. It was Rosse, as a matter of fact, who christened this supernova remnant "The Crab." The filaments, which were visible in his "small" scope, a 36-inch, reminded him of the claws and legs of a horseshoe crab. His eyepiece drawing looks more like a pineapple than a crab to me, but the name stuck.

Much of M1's fame among professional astronomers is due to the remains of its progenitor, a rapidly spinning neutron star, the battered core that is all that's left of the giant sun that died in the supernova. Since it shines dimly at magnitude 16 in the middle of the Crab's comparatively bright nebulosity, city observers, even those with large scopes, don't have a prayer of spotting it, I'm afraid. This neutron star is composed of "degenerate" matter that has been so compressed by the supernova explosion that the whole star is really best thought of as a single giant neutron. As it spins, the interaction of the star with its magnetic field causes a radio beam to be emitted and rotate lighthouse fashion across the stars. This "pulsar" was one of the first stars to be identified, not long after the initial discovery of these of radio wave-emitting neutron stars by Cambridge University's Jocelyn Bell in 1967.

My romantic association of the Crab with the Christmas star is demonstrably false, as studies have shown that it is undoubtedly the remains of the supernova observed by Chinese astronomers beginning on July 4, 1054. It was also seen by native peoples in the Americas, but seems not to have been noticed in Europe (maybe it was a cloudy summer). For once, the distance to a DSO is well known, with M1 having been determined to be 6300 light years distant. This makes its constantly expanding cloud currently 10 light years in diameter.

Other Area Attractions

NGC 404

At a relatively dim magnitude of 11.23 and a relatively large size of 3.4′ across its major axis, this oval-shaped galaxy should be a *challenge*, but not the *huge challenge* it often is for small urban telescopes. The difficulty lies in its close proximity to the gloriously bright star Beta Andromedae, which is only 6′ 46″ away, shining at magnitude 2.0. The galaxy is easy to find, but rarely easy to see in the glare of its "companion" star. NGC 404 is, however, regularly visible in an 8-inch scope, and I have seen it from my city observing sites with a 6-inch scope at times. The secret to conquering it is to use a high enough magnification to enable you to put Beta Andromedae just outside the field and NGC 404 toward the field center. Try 150× to begin with. Some observers claim a broad-band light-pollution reduction filter can dim the star a little while preserving the galaxy enough to make this an easier observation.

NGC 7331

Moving into western Pegasus, to the prominent triangle of Eta, Mu, and Beta Pegasi, the stars that make up the Flying Horse's forelegs, we find NGC 7331, a magnitude 10.33 Hubble Sab spiral that is often referred to as "Andromeda Junior." To find it, draw a line from Mu, through Eta, and into space for another 4° 20′. NGC 7331 lies at the terminus of this line. There are no bright stars in the area, so be careful and refer to a detailed star chart generated with *Cartes du Ciel* or *Skytools 2*. Its "Andromeda Junior" nickname reflects the fact that its inclination to us is similar to that of M31, and, in small to medium-sized scopes, it does look like a perfect miniature of the Great Andromeda Galaxy.

Under dark skies, scopes 12 inches in aperture and larger reveal considerably looser spiral structure in NGC 7331 than is seen in M31, making one spiral arm stand-out dramatically from the disk, but this feature is invisible in the city. In light pollution the galaxy is an object most suited for scopes 8 inches and larger in aperture. In an 8-inch scope on a dry night, NGC 7331 is visible as a clearly elongated fuzz-spot that shows off a bright core and not much else.

You'll occasionally hear NGC 7331 referred to among amateur astronomers as a member of the "Deer Lick Group" of galaxies. There are many dim NGC galaxies occupying the same field as this object, and I suppose they represent deer licking at the cosmic salt of NGC 7331. These tiny cosmic lint balls are at daunting magnitudes dimmer than 14 and are likely invisible in the city in any but the largest scopes. I have seen them with some effort in my C11 under dark skies, but never from any site near the city.

Just 29′ south-southeast of the Deer Lick is the legendary galaxy group Stephan's Quintet. Sadly for us, these five tiny galaxies are dim and close together and will probably take something on the order of a 20-inch instrument on an exceptional night in the city to see. Even in the country, they, like the Deer, are often barely detectable as minute magnitude 14 and dimmer smudges in my 11-inch Schmidt Cassegrain.

Tonight's Double Star: Almaak, Gamma Andromedae

Almaak is another almost perfect double star for the urban observer. It features a combined magnitude of 2.3, making it the third most luminous star in its constellation, and its separation is a wide 10″, meaning that it's easy for most scopes to resolve despite the secondary star's relatively dim magnitude of 5.5. The magnitude 2.3 primary is a burnished gold; while the secondary is a deep blue, hearkening back to summer's magnificent Albireo.

Gamma Andromedae is not just a double star, it's a triple. The blue secondary star has a companion of its own. Unfortunately, this companion lies a scant 0.4″ from its parent star. It's not overly dim at magnitude 6.3, but the extreme closeness means you'll need steady seeing and big aperture and luck to see it. Almaak is easily found,

being the end star on the easternmost of the two chains of stars that form Andromeda's main figure.

> After a long, satisfying view of M31, I find it difficult to pull myself back across the light years and return to the now-insignificant problems and worries of a minor planet orbiting a puny G2 star on the outskirts of an average spiral galaxy. It's time to pack my wonderful telescope away for the night, but I know that when earthly problems and worries again loom large, the wondrous voyages of amateur astronomy will bring them back into proper perspective.

Tour 3

The Cassiopeia Clusters

I seem to do some of my best astronomy thinking in the early morning—or even while I'm asleep. So, I wasn't surprised to awaken one day with the idea for a project I could execute from my light-polluted home in my city's Garden (historic) District. I would observe as many open clusters in Cassiopeia as a 12.5-inch telescope would show me. I've always enjoyed drifting through the Milky Way in the Cassiopeia area, but the last time I'd taken a detailed look at this part of the sky—many years previously—my only telescope had been my 4.25-inch *f*/11 reflector. I was interested in seeing what a larger telescope could pull out of my bright skies.

I was also curious as to whether the clusters I'd observed in the past would look much different through a larger instrument. I know I've stressed the practicality of smaller telescopes for urban observers, but, as I mentioned in Part I of this book, a 12-inch aperture Dobsonian, is not a huge hassle to set up. If you have a private ground-level observing area, an instrument in this class may be just the telescope for you. There is no question that my "big" dob allows me to penetrate my site's depressing sodium streetlight haze more deeply than I can with a smaller instrument.

But don't hesitate to undertake this tour even if you're equipped with a considerably smaller telescope. A 6-inch reflector or 4-inch refractor may show a little less than what I saw if your skies are as bad as mine, but may show you *more* if your sky glow is less pronounced—or your eyes or observing skills are better than mine.

A look at *Sky Atlas 2000* and a session with *Skytools 2* and *Cartes du Ciel* revealed there'd be approximately 40 clusters in the area that would be bright enough to provide interesting targets for my 12.5-inch scope. A little more narrowing-down to the "best of the best" (I tended to eliminate large and sparse groups) left me with an observing list containing 17 objects. After some time spent familiarizing myself with the locations and characteristics of my of destinations, all that remained was to wait for clear skies, which took a while, since we were experiencing one of our typically stormy Gulf of Mexico Coast Octobers.

When that rare beautiful night finally arrived, I was more than ready to begin my tour of the Celestial Queen. I didn't expect to finish in one evening, and I hope you don't either if you decide to follow me. I wasn't interested in merely ticking objects off a list; I wanted to spend some time in these stellar nurseries, to try to absorb some true sense of them.

Most of these galactic clusters are easy to find, being located near Cassiopeia's "W" asterism. If you run into trouble with the objects situated away from the main star pattern, make sure your finder is up to snuff. Throughout this book I've mentioned 50-mm finders again and again. A 50-mm finderscope reveals enough stars to make locating dim objects easy. If your finder is smaller than this, you're making things unduly hard on yourself. Actually, I'm toying with the idea of adapting my 80-mm *f*/5 Short Tube Refractor as a "super finder." As long as it offers a wide enough field, your finder really cannot have too much aperture.

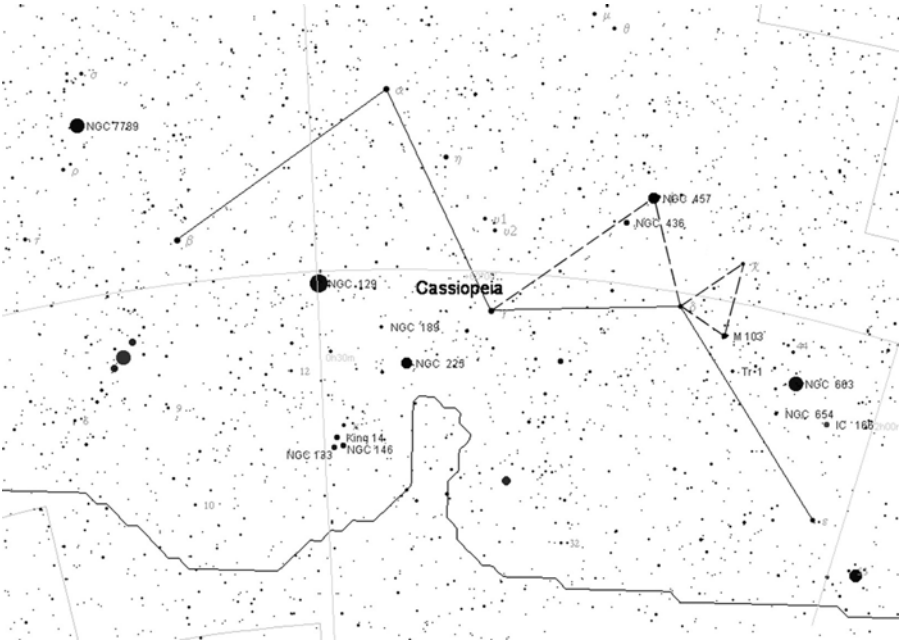

Figure 8.8. Cassiopeia, the Star Queen.

It's a crisp and clear October evening, the kind that is so beautiful you can't stand to stay inside. An occasional breeze brings a hint of coming winter's chill. All around is the cozy scent of burning leaves, reminding us of countless autumns past. Overhead, the stars of fall glimmer. In the far northeast Cassiopeia, Queen of the Sky, rides ever higher as the great spinning wheel of heaven keeps on rolling. This would be a fine, fine night for naked eye or binocular stargazing, even here under city lights, but my wonderful telescope stands ready. With a detailed star atlas or Figure 8.8 in hand, let's set off to see what can be seen in the domain of the Star Queen.

NGC 457

I suppose that the logical way to conduct a tour of Cassiopeia is to start at one end of her "W" and work your way down the constellation stick-figure, but my wife, Dorothy, was very interested in getting a look at NGC 457, the E.T. (or Owl) cluster, so I started there, working my way northeast from his location. ET is compact and bright at 13′ across his long axis and magnitude 7.0, and fits the field of a medium/low-power eyepiece very comfortably. This cluster is spectacular in even tiny instruments.

E.T. is located 2° South of Delta Cassiopeiae, forming an isosceles triangle with Delta and Gamma, and is visible with ease in a finder, appearing as a small "line"

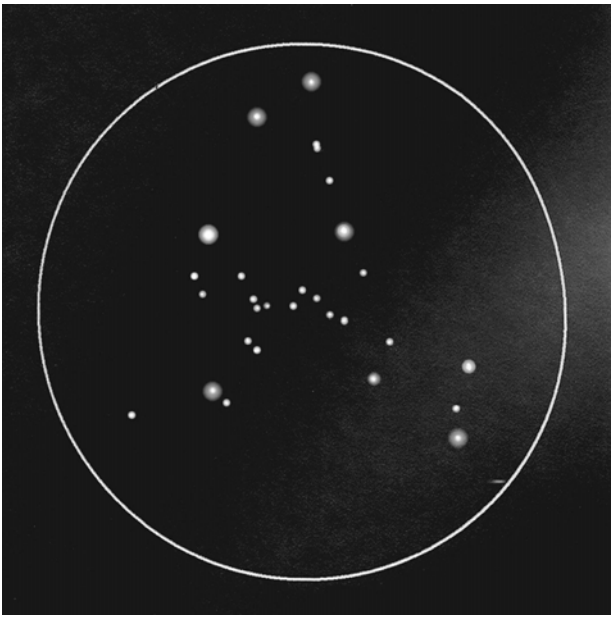

Figure 8.9. E.T., aka "The Owl Cluster."

of stars at low magnifications. When you have NGC 457 in the field of your main scope, play "connect the dots" with the suns in this sparkling cluster to form a stick figure. Soon enough, you'll begin to see a little extraterrestrial, hand raised in greeting (Figure 8.9 is my attempt to sketch the little guy). One of his eyes stands out brightly against the rest of the cluster. This is magnitude 6.99 Phi Cassiopeiae. While most of the rest of the stars in your eyepiece do belong to NGC 457, Phi, the most brilliant star in the field, is actually a foreground object not physically associated with the group. The view through my 12.5″ was amazingly good, but even a Short Tube 80 reveals much of NGC 457's lustrous body. About 40–45 cluster members are easily visible in the 12.5-inch scope. A red star in ET's left armpit is very distinctive.

NGC 436

Our next destination is NGC 436, which is located only 49′, maybe one low-power field depending on your scope and eyepiece, to the northwest of NGC 457, back in the direction of Gamma Cassiopeiae. In the 12.5-inch scope, this 6′ diameter, magnitude 8.8 open cluster is similar in appearance to one of Cassiopeia's most spectacular objects, M103, as seen by a 6-inch telescope (i.e., very beautiful). Approximately 25 magnitude 11 and fainter stars are easily seen. The cluster is quite compact, and looked best at 90× in the 12.5-inch scope with a wide-field Konig design eyepiece.

M103

Continuing on, move 3° to the north-northeast to find the next port of call, M103. It forms a near equilateral triangle with bright Chi and Delta Cassiopeiae. Lovely! When you've got this group of newborns in the eyepiece, you'll see a handful of brilliant blue gems with a striking orange star positioned near the center of this magnitude 7.4 cluster. At least 25 stars were visible across the cluster's 6.0′ extent in my light-polluted skies, with the stars arranged a vaguely triangular shape. With 12.5 inches of aperture, M103 almost seems to display a 3-D effect (I again used 90× to good effect).

Trumpler 1

Moving northeast for another 41′ brings the relatively bland Trumpler 1 into view. It was small, less than 5′ in diameter in my 12.5-inch scope at medium magnification, but relatively bright at magnitude 8.1, so it was easy to locate and distinguish from the area's star-rich background. I would guess it could be a little dim in an 8-inch scope, though. 10 stars are arranged in a square asterism that defines the cluster. "TR1" is worth a visit because of one prominent red star in the middle of the grouping. Due to its small size, this cluster was best seen in a 12-mm Nagler eyepiece yielding 127×, and a little more power would probably have improved it even more.

NGC 654

Continue on a northeasterly course (turning a little bit more to the east, now) and you'll arrive at another stopping place along the star trail, NGC 654, a little over 1° away from TR1. Like Trumpler 1, NGC 654 is small, 5′ in size, but it is considerably brighter than the previous cluster at an integrated magnitude of 6.5. In a medium-aperture scope, 25 stars are visible in this sassy group. One striking yellow sun stands out from the crowd at 127× in the 12-mm Nagler eyepiece's spaceship-porthole field. A pleasing view indeed.

NGC 663

From NGC 654, change compass heading and move 1° southeast for the next stop-over, NGC 663, a big 16′ wide magnitude 7.1 association. To pin it down, move 40′ to the east of the midpoint of a line drawn between Epsilon and Delta Cassiopeiae. NGC 663 is beautiful in any scope on any respectable city night. Forty bright luminaries and many fainter cluster members are visible in 8-inch and larger telescopes. A 27-mm Erfle eyepiece (56×) did a good job on this one for me with the 12.5-inch scope.

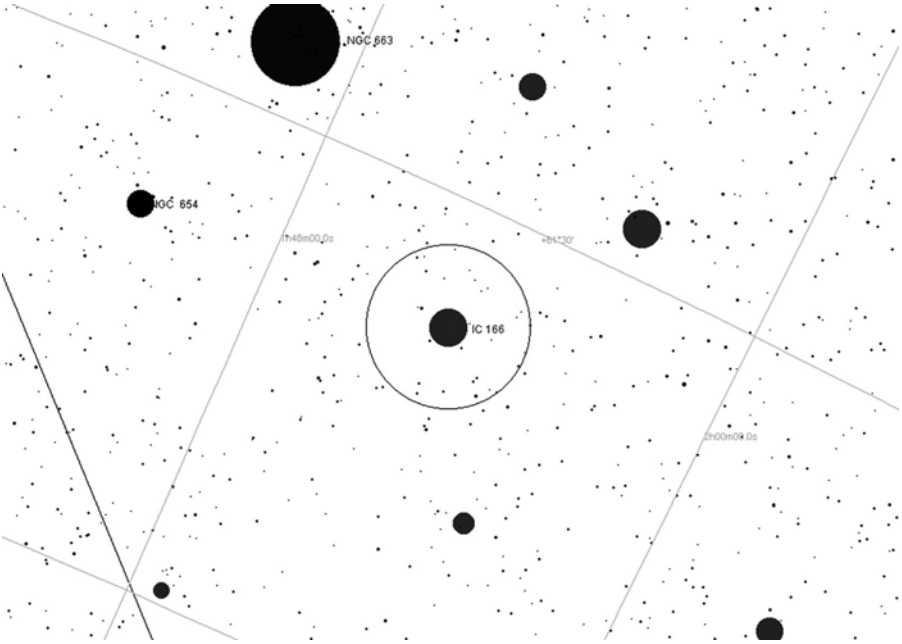

Figure 8.10. Detailed finder chart for IC 166.

IC 166

Switching directions again and heading back northeast for 52′ takes you to the area of the only object in this tour that I found at all difficult with the 12.5-inch Dobsonian. It's small at 5′, but challengingly dim at magnitude11.7, and I had a rather hard time locating IC 166. It is extremely easy to miss in the midst of Cassiopeia's busy star fields (most of the IC clusters were discovered photographically as vague clumpings in rich star fields on photographic plates). I was finally able track it down, but only by using a computer generated small-area finder chart like the one in Figure 8.10, which shows field stars down to approximately magnitude 13. Once I found it, this cluster was hardly spectacular, with a few faint members winking in and out. IC 166 is reputed to contain nebulosity, but I certainly didn't see any. This cluster may look better and be much easier to find if your skies are darker than mine, so don't let me scare you off from it. This object is not shown in *Sky Atlas 2000*.

M52

You have now arrived at the eastern terminus of tonight's guided tour, so take a breath and hop all the way to the western end of the Queen's W to spectacular M52 (Plate 46). Draw a line through Alpha to Beta Cassiopeiae and on for another 6°, carefully position

your scope on this spot, and M52 should literally hop out of the eyepiece at you. It is readily apparent even in a large-aperture finder under most city conditions. Another way of looking at its position is that it forms an isosceles triangle with Zeta and Iota Cephei in the neighboring constellation, Cepheus.

M52 is a spectacular object, as you'd guess from its membership in the Messier catalog. Measuring 13′ across and glowing strongly at magnitude 6.9, it is very compact and pretty, and is made most beautiful by the presence of a prominent ruby nestled among its sapphires. This bright star located on the southwestern edge of the cluster is, as is often the case with these stellar stand-outs, not an actual member of the group. M52 is very rich, and more than 50 cluster members were readily visible in my heavily light-polluted skies with the Dobsonian. If ever the phrase "like diamond dust on black velvet" described a cluster, it is M52.

NGC 7789

Another large hop, 6° 25′ this time, to the south-southeast brings up a group I thought was even nicer than M52, and which is rivaled only by NGC 457 for the title of "most beautiful star cluster in Cassiopeia." NGC 7789 (Plate 47) is another bright and easy catch at 16' in extent and magnitude 6.7. Look for it halfway between magnitude 5 Sigma Cassiopeiae and magnitude 4.5 Rho. Just outstanding! A showpiece even when dimmed by heavy sky glow. Very rich, it resembles a loose globular like M71 in Sagitta. A goodly number of magnitude 10 stars and many, many magnitude 12 and fainter cluster members we visible in my medium-aperture telescope.

NGC 129

At 5° 30′ northeast of NGC 7789 on the other side of Cassiopeia's W is NGC 129, which lies near the center of a line drawn between Beta and Gamma Cassiopeiae. 21′ diameter and glowing at magnitude 6.5, you'd think this one would look much like NGC 7789, but it's nowhere near as rich or condensed. It tends to the large and sparse, but is made impressive by the inclusion of bright DL Cassiopeiae in the field, a sixth magnitude star that is not a cluster member. The cluster was attractive in my 12.5-inch scope with a 27-mm Erfle eyepiece at 56×, but 90× brought out some fainter cluster members. Use a fairly high-power wide-field eyepiece on this one, if possible.

NGC 189

Now, hop 1° 31′ northeast to magnitude 8.8 NGC 189. This open cluster is located 1° south of the midpoint of a line drawn between magnitude 5.5 12 Cassiopeia and Gamma Cass. NGC 189, a little thing, less than 5′ in diameter, is distinguishable from the starry background, but there's not much there, really. About 10 stars, of magnitude 11 and dimmer were detectable in the 12.5-inch scope.

NGC 225

Another degree away on this northern path is the much nicer NGC 225, which is 50′ to the north of NGC 189. What a very nice surprise this little cluster was. A big 12′, magnitude 7.0 nest of suns, it really breaks through the light pollution in medium-aperture scopes. Here, 15 stars are arranged in a pattern most observers call a "W". To me, though, it looked just like a tiny, perfect Sagittarius Teapot.

NGC 133, NGC 146, and King 14

2° west of NGC 225 is the end of the road for this evening's ramble, the area of three small clusters I thought were both pretty and unique: NGC 133 (mag 9.4, 7′), NGC 146 (mag 9.1, 7′), and KING 14 (mag 8.5, 7′). These open clusters are located near Kappa Cassiopeiae in an area 30′ northwest of the star. This is a rich locale, and, while the three clusters do stand-out fairly well from the background star fields, it is somewhat difficult to decide where each cluster begins and ends. A very nice sight since all three objects are visible in one low-power eyepiece field (they are all about 12–15′ apart). Use your lowest-powered, widest-field ocular. There is some feeling, by the way, that NGC 133 may be an asterism rather than an actual star cluster.

Tonight's Double Star: Achird, Eta Cassiopeiae

Achird, Eta Cassiopeiae, is an intensely lovely double star. The brighter of the pair, a golden yellow magnitude 3.4 sun, is accompanied by a considerably dimmer red companion, which glows balefully at magnitude 7.5. The separation between the two is a respectable 12″, but the large difference in magnitudes makes this one a little tougher than you'd think for the smallest scopes. I see the secondary as a deep red, but many observers swear it's *purple*. This is likely due to a color-contrast effect similar to the one that turn's mighty ruby Antares' dim white companion a shocking emerald.

Locating Achird is easy thanks to its proximity to Cassiopeia's "W" asterism. It is about one-third of the way along a line drawn between two of the W stars, Alpha Cassiopeiae and Gamma Cassiopeiae. Go about 1/3 of the way along this line from Alpha toward Gamma and stop, and you'll immediately notice Eta shining bravely about half a degree to the east-southeast.

If you think Achird is tough to split with your small telescope, come back in a decade or two and it will be a little easier. This is an actual binary pair; the stars are orbiting a common center of gravity, and their separation is increasing slowly due to the companion's elliptical orbit. Unlike Achird, many of the double stars we observe are not "true" binaries; many are simply optical illusions created by our viewpoint. Sometimes two members of a pair are just along our line of sight and are not physically connected. The status of a double as a true binary star or "merely" an optical double

must be determined by long observation of the stars' motions or by spectroscopic study.

Was I a little tired of open star clusters when I finished this observing project? Maybe a little. But my sense of wonder was restored when I stopped and thought about the implications of what I had seen. Using an inexpensive medium-aperture telescope to scan this medium-size constellation from my bright backyard, I'd visited open cluster after open cluster—and barely grazed the surface of what can be seen there. The huge nests of newborn stars I saw on this night represent one tiny area of the Milky Way. Now do you begin to realize how big our galaxy is? I did, and was awed.

Tour 4

Deep Water Constellations

Late autumn always seems magical to me, and not just because the year-end holidays are on their way. Some of my fondest observing memories are of clear boyhood November nights under the stars. Back in the 1960s, before the unchecked and mutant growth of strip malls and automobile dealerships, a young observer with a *very* modest telescope could voyage almost endlessly thorough the deep sky. The combination of crisp, cold nights, the almost unbelievably bright stars of the Winter Milky Way, and my beloved 4.25-inch Newtonian made for many unforgettable observing runs, the memories of which are still dear to me today.

Face south as winter comes in, and you'll see the autumn constellations on perfect display. These "watery" star figures, Aquarius, Capricornus, and Cetus, about to give way to the winter star figures, are perfectly placed for early evening viewing. There are some subtle and beautiful and often ignored deep sky objects in the area, and we'll visit a pair of the water area's prime constellations, Capricornus and Cetus tonight, but let's start with a star pattern that's located just to their South and *not* associated with water.

NGC 253

I hesitate to use the phrase "off-the-beaten-path" when talking about this constellation, since just about every observing guide at least mentions the wonders of this area, but a Northern Hemisphere bias on the part of some authors gives Sculptor the short shrift. Yes, Sculptor *is* located at a southerly declination, and is, I guess, just about at the limit of what's practical for many northern U.S. and European observers to observe. However, even from northerly latitudes, there's a true showpiece visible here, a galaxy so wonderful I could easily spend an entire night admiring it. Get your telescope ready and come along with me—you're in for an incredible experience.

I suppose there's no use trying to convince you that M31 is *not* the greatest galaxy visible from the Northern Hemisphere, but I'm here to tell you that Sculptor's NGC 253 is a close second. This huge spiral, located near the south galactic pole, was a revelation for me the first time I located it, since it was not only bright, but showed considerable details in my 4.25-inch scope—something galaxies are simply not supposed to do when viewed by small scopes from light-polluted neighborhoods.

How do you find NGC 253? It's easy. All you'll need is a clear southern horizon and a decent star atlas or Figure 8.11. By mid evening on a cold, clear November night, Sculptor is transiting the meridian and NGC 253 is well placed for viewing. Though Sculptor is a somewhat faint and lackluster constellation, it's fairly easy to spot, since there's not much else in the area. Sculptor's stars aren't overly prominent, but they stand out well in their isolation. Predictably, the constellation doesn't look anything like a sculptor or a sculptor's tool. About the only thing I can compare it to is

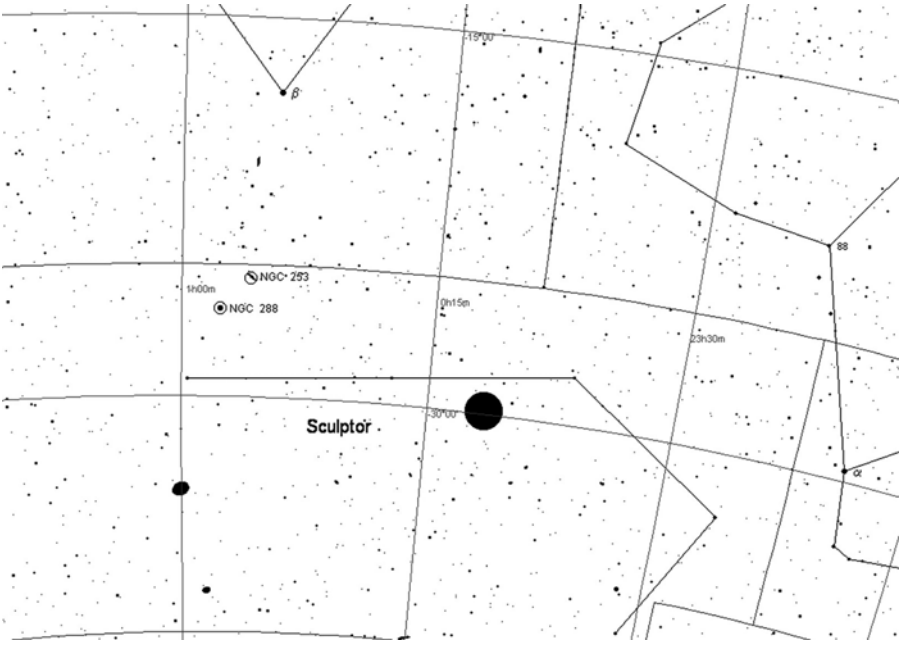

Figure 8.11. Sculptor and the area of the South Galactic pole.

a backwards letter 'j' lying on its side. A good guide to Sculptor (and NGC 253) is the magnitude 2.0 star Beta Ceti. NGC 253 itself is big at 27.7′ × 6.8′, but it's also bright for a galaxy at an impressive integrated magnitude of 7.72, so looking for it should cause a minimum of heartburn.

Draw a line almost due south from Beta Ceti for 12° and you'll come upon the magnitude 4.3 star, Alpha Sculptoris, which is easily visible in a finder in the barren reaches near the south galactic pole (which lies a few degrees northwest of Alpha). A little over halfway along this line, about 7° 15′ from Beta Ceti toward Alpha, turn and go 1° 20′ west of the line, and you'll find our quarry, as shown in the chart. A triangle of sixth and seventh magnitude stars just east of the galaxy also provides a good guide. You may be able to pick NGC 253 up in a 50-mm or larger finder on special nights. The sky-cleansing effects of passing cold fronts will help.

Were you surprised by your first look at NGC 253? I know I was. The fact that the galaxy is very large and fairly low in the sky even from my southerly latitude led me to expect very little. But I was *amazed* when I found this DSO. NGC 253 *is* large, but it's also bright. In my little 4.25-inch $f/11$ reflector, the galaxy's mottled appearance, tremendous dark lanes and bright patches were easily discernable. Once in a while, I even felt a hint of this giant's subtle spiral structure Averted *imagination?* Even in those days, the neighborhood where I grew up didn't feature the skies of the Texas Star Party.

I've viewed this DSO many times since, but it's always a treat and a reminder of why I got started in amateur astronomy to begin with: to see and try to understand the

marvelous and mysterious. A recent observation with the same 4.25-inch Newtonian from my now badly light-polluted city showed that the little scope could still deliver a lot of galaxy from today's worse skies:

> I passed over NGC 253 several times before I realized that I needed to push the magnification as low as it would go—for a change—-to help make this wonder stand out. I had to get enough dark space around the galaxy to be able to pop it out of the sky. When I had it in a 32-mm Plossl, it appeared as a smoky cigar shape. Extended observation brought out hints of dark patches.

This fine galaxy bears the distinction of being discovered by one of our most dedicated—and most overlooked—amateur astronomers, Caroline Herschel, the sister of William. Ms Herschel discovered this jewel during one of her tireless comet searches in 1783. Though Caroline is understandably overshadowed by her remarkable brother, her glorious and productive career makes a story I'd like to see told more often.

The technical details of NGC 253 paint a picture of a large and fairly nearby Sc spiral. Sc is a provisional designation, as the galaxy's almost edge-on inclination makes it hard to be certain of its exact Hubble type. NGC 253 is the brightest member of the Sculptor Group of galaxies, which is estimated to lie about 8.1 million light years away (or slightly more distant than the M81/82 group). This is a big and healthy spiral with a mass of around 150 billion Suns. At times, its mottled appearance, well seen in Plate 48, makes it superficially resemble "disturbed" galaxies like as M82, but a look at a long exposure photo makes clear that this is a *dusty*, but otherwise normal and untroubled member of the cosmic zoo.

NGC 288

Did you hop over to NGC 288 from M72 earlier? If not, let's go there now. This magnitude 8.1, 13.8' diameter globular star cluster lies south and east of NGC 253, back on the line from Beta Ceti to Alpha Sculptoris, 1° 45′ from NGC 253, or only a couple of low-power fields away. Slew southeast and this star cluster should appear in your field almost effortlessly. How it will appear when you've got it will depend both on the condition of your skies and your *latitude*. From home, 30° north, I am able to pick stars out of NGC 288 with little difficulty with the 8-inch *f*/5, though I did have to run the magnification up to 200× to darken the background sufficiently. From southern latitudes, this cluster must be magnificent indeed.

M77

Sculptor conquered, let's dive into the watery realm of Cetus the Sea Monster. Cetus is a huge constellation and his star pattern is not always easy for me to make out in the southern sky-ocean. Not only are my city skies badly light polluted, some of the worst sky glow is to the south—the Gulf of Mexico is filled with brilliantly lit oil rigs. Unfortunately for me, there are many more interesting objects

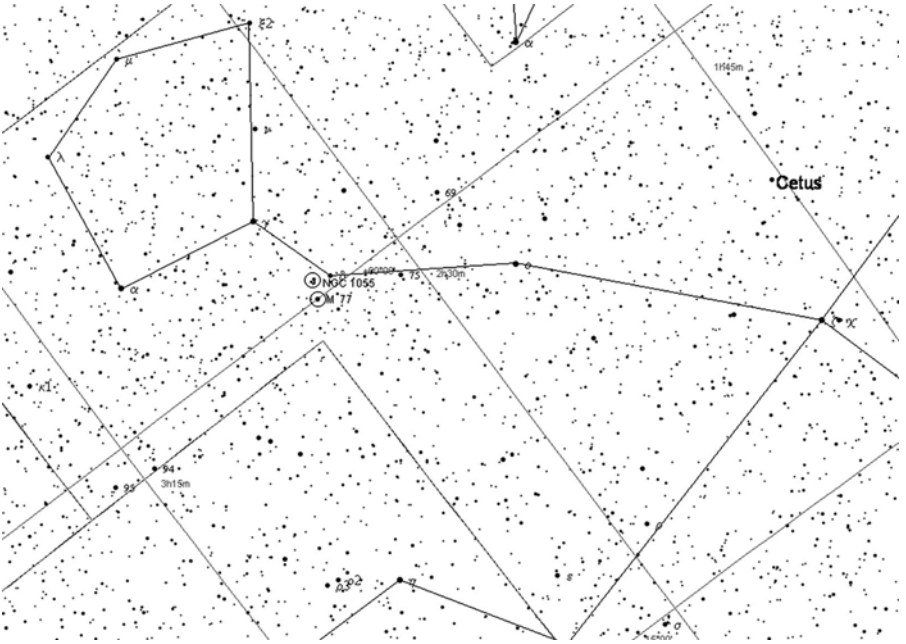

Figure 8.12. Chart of Cetus the whale—sea monster.

along the southern horizon than there are along my comparatively dark northern horizon.

The whole area from Cetus through Sculptor is clogged with galaxies. This is the southern celestial hemisphere equivalent of the Coma Berenices area. Here, you're looking out of the galaxy in the direction of the South Galactic Pole rather than the north galactic pole. Unfortunately, there's no equivalent of the bright Virgo cluster here. There are many distant giants lurking, but most of them are invisible in small city telescopes. M77 is one of the few exceptions. It's not only prominent in gray skies, it's easily located. Take a good look at Figure 8.12 and position your scope on magnitude 4.08 Delta Ceti, to the west of Cetus' "head." Then, slowly move the telescope 1° south and just slightly east, keeping an eye out for a suspiciously fuzzy star entering the field.

M77 is a real standout among the dim southern spirals, a galaxy so prominent and easy that it bears a Messier catalog number. This face-on Sb spiral is not intensely bright at magnitude at 9.64, but it's not overly large at $7.0' \times 5.9'$, so even if your scope won't show anything else in this area other than stars you *will* see M77. I found it with ease in my ETX 60-mm refractor, which showed it as a slightly fuzzy "star." In a 3–4-inch telescope M77 is unmistakably nonstellar, consisting of a bright core and a small disk of faint haze. Visually or photographically, even in images taken with sensitive CCD cameras like Plate 49, M77's tightly wound spiral arms are hard to make out. What's amazing is the galaxy's overwhelmingly bright core. M77 is classified as a "peculiar" Seyfert galaxy with an active nucleus like Canes Venatici's M94. Bottom line? A black hole is probably feeding on unlucky stars at M77's center.

NGC 1055

While you're in the area, try for a "bonus" galaxy, NGC 1055, which is situated half a degree northwest of M77. An edge-on spiral at a visual magnitude of 10.60, it is not too much dimmer than M77, but is considerably harder to spot due to its lack of a bright central region. On nights when the southern horizon is not too bright with light pollution, I can see this one with some difficulty with the C11 SCT.

M30

M77 is a rather strange looking galaxy and M30 is an odd looking globular. At a magnitude of 7.5 and a diameter of 11′, this globular star cluster is Capricornus' only claim to fame other than its position among the zodiacal constellations. With the exception of some frighteningly dim galaxies, there's not a whole lot else to see in this area, even for large amateur scopes from dark sites, but M30 is a huge treat.

I am able to find this cluster with ease in almost any instrument by using magnitude 3.77 Zeta Capricorni, located on the Eastern side of Capricornus' kite/triangle shape (the Seagoat looks even less like its namesake than most constellation figures). From Zeta, slew 3° 20′ east and slightly north. The cluster shows up well, and is somewhat resolvable in light pollution with 6-inch telescopes. This is demonstrated in my 6-inch

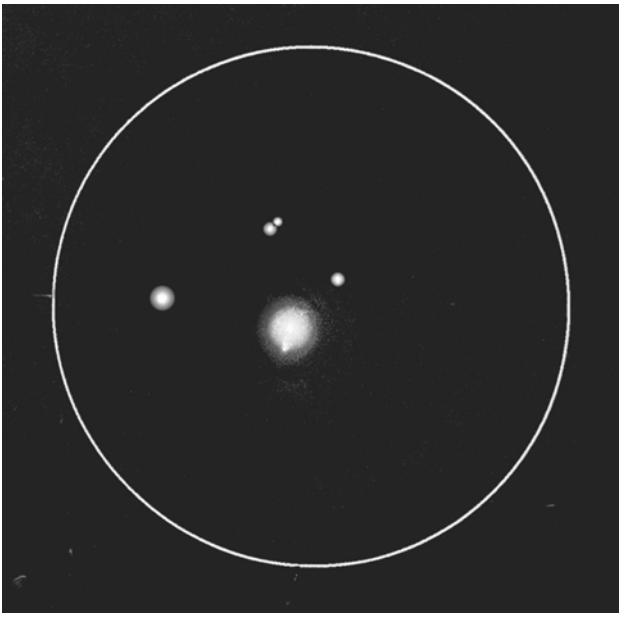

Figure 8.13. M30, the lop-sided globular cluster.

scope drawing in Figure 8.13, which shows some stars despite this glob's fairly tight rating of V (5) on the Shapley–Sawyer scale. I tried to capture the cluster's offbeat, off-balance appearance in the drawing. What makes M30 look odd is the three "lanes" of stars on its northern edge. These give it a strange off-center appearance. Even when not fully resolved, these star chains lend a weird, clumpy, half-circle aspect to this fine globular.

M30 is one of Charles Messier's original discoveries; he saw it for the first time in 1764. At 26,000 light years away, it is approximately 90 light years in diameter, assuming that that distance figure is correct, which it probably isn't. The brightest stars in M30, bloated red giants at the ends of their lives, are at magnitude 12.0, enabling fairly small scopes to retrieve some suns from its misty globe despite streetlights. Although it's a fairly normal looking globular, despite the odd star chains mentioned above, M30 is one of those clusters thought by astronomers to have undergone "core collapse." Although the cluster's center looks normal compared to M15's blazing center, it is believed that at least half of M30's huge mass is concentrated in an area a "mere" 20 light years in diameter. The "why" for this phenomenon is still unknown.

Tonight's Double Star: Kaffaljidhma, Gamma Ceti

Gamma Ceti is a lovely if somewhat challenging double residing back in the dim water constellation, Cetus. While sometimes resolvable with a 4-inch scope under excellent conditions, it can be a trial for an 8-inch scope under average or poor seeing to show as two separate stars. This is because its primary and secondary are of unequal brightness at magnitudes 3.5 and 7.3, respectively, and quite close at a 2.8″ separation. Nevertheless, this is one of the most popular "harder" doubles in the sky, maybe because observers are attracted by the contrasting colors of the primary and secondary. The main star is a very pale yellow, while the companion is an icy blue.

Gamma is no harder to find than anything else in dim Cetus, and the fact that it's one of the "stick figure" pattern stars helps. Gamma is the star that connects Cetus' "head," the northern part of the constellation, to the rest of the Sea Monster's sprawling body.

> NGC 253 is wonderful in the city, but my most cherished memory of this object comes from one year's Mid South Regional Star Gaze, held deep in the dark pine forests of northern Mississippi. It was fairly early on the first night of the star party, but observers were already starting to drift away from the field. I was a little tired from the trip and the initial setup of equipment myself, but looking due south I noticed the bright beacon of Beta Ceti and remembered what lay in that part of the sky. I soon had my C8 SCT pointing at NGC 253—beauty itself in a wide-field Nagler eyepiece. Alone but for a friend or two, I just looked and looked and looked. At first my thoughts turned to boyhood views of this distant kingdom of stars, but before long I began to wonder what this galaxy must look like from the southern hemisphere. Thinking of southern climes suddenly led my tired but wondering mind to see this far-away star-swirl as a laden Spanish Galleon, bursting with gold, and sailing before the wind on a sea of endless night.