CHAPTER SIX

Tour 1

Burning Heart of the Hunting Dogs, M94, M51, and Company

In the city, the advent of the spring observing season is both a delight and a disappointment for the amateur astronomer. A delight because this time of year brings warm weather, making observing a much more pleasant experience. Spring also delivers "new" constellations and signals the return of the great forest of galaxies that stretches from the northernmost Ursa Major to southernmost Hydra. A disappointment because the incredible, delicate riches of the spring deep sky are badly dimmed by the senseless light pollution of our cities.

If you like galaxies, this is an especially frustrating time. They suffer tremendously from light pollution, so badly that it sometimes seems easier to stay inside and watch television, avoiding mosquitoes and aggravation. As we'll see in this chapter, however, there are many lovely galaxies all through Coma and Virgo available for city-bound sky watchers equipped with medium or even small aperture scopes. But before launching ourselves into the awesome Virgo–Coma Cluster, let's travel the northern edge of the spring sky, the Canes Venatici and Ursa Major area. Both constellations offer bright galaxies aplenty, but with a couple of bonuses: a good planetary nebula and a globular star cluster are also on display. Once you get into Virgo, it's almost nothing but galaxies.

M94

Don't think your small scope is capable of showing you galaxies from your bright backyard? Think again. M94 is different. This galaxy has always been one of my first stops when the handle of the Dipper/Plough ascends above the horizon haze and I can again see the two prominent stars that make up Canes Venatici, the Hunting Dogs. Why do I like M94 so much? This sucker is *bright*. Magnitude 8.9 packed into a size of $5' \times 3.5'$ means it stands out well, no matter how bright my skies are. I recall at least one time when searching for this galaxy with my first scope, a 3-inch reflector, that I almost gave up. Instead of the dim blob I expected, M94 looked like a prominent star and I kept passing over it before realizing my error.

M94 is surprisingly easy to find. The only prerequisite for locating it is that you must be able to make out Canes Venatici's rather unspectacular pattern of stars. Referring to your star atlas or the chart in Figure 6.1, look southwest of the Dipper/Plough's handle to Canes Venatici's two lone bright suns, Alpha Canum Venaticorum (Cor Caroli) and Beta Canum Venaticorum (Chara). Cor Caroli, by the way, is one of the finest double stars in the Northern Hemisphere. A pair of bright sapphires (magnitudes 2.89 and 6.0) separated by almost 20″, this binary is a treat in nearly any telescope.

Referencing your chart, note the position of M94 with respect to the constellation's two bright stars, and you'll see that it lies approximately a degree and a half outside the line connecting Alpha and Beta, and is back in the direction of the handle of the Dipper, northeast of the line. Before going to the scope, make sure you have your

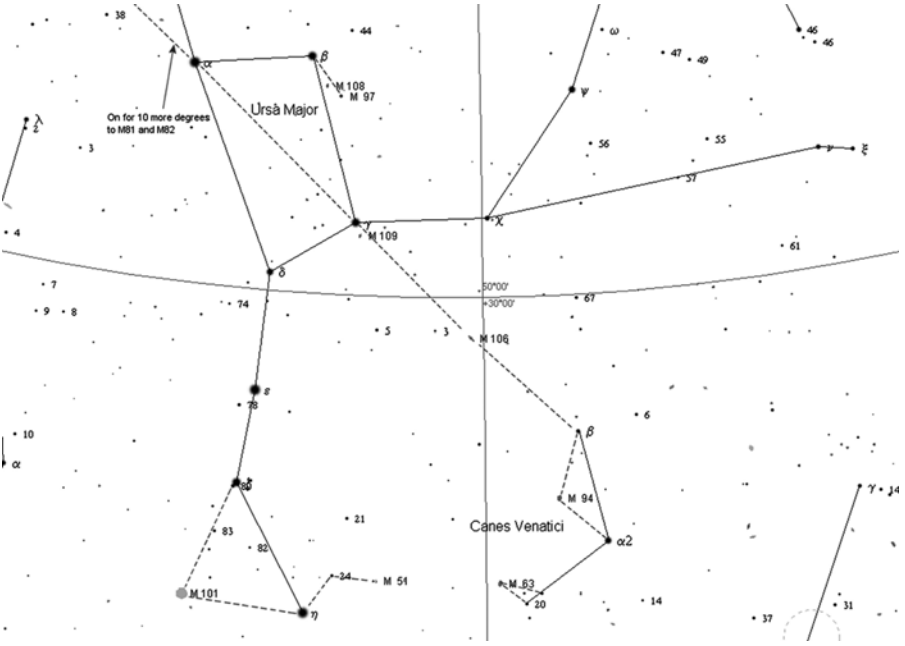

Figure 6.1. Canes Venatici and Ursa Major.

chart oriented correctly, inverted for most finders. Try to fix M94's location against the stars firmly in your mind.

Once you're properly positioned, take a look through the main telescope, starting with an eyepiece that yields a magnification of approximately 50×. What you should see is a nebulous "star" in the field. You may have to sweep the scope around a bit, but if you've positioned it carefully using finder and atlas, it shouldn't take much looking. This star-like object is M94. Let me repeat myself, M94 will look bright, *much* brighter than you'll probably expect a galaxy to be. If you have a hard time deciding whether what's in your field is really the galaxy or just an anonymous star, increase your magnification to 100–125×. That will make its true nature pretty obvious. Averted vision should show a fairly large nebulous envelope around the galaxy's stellar-appearing core.

In my 4.25-inch Newtonian reflector, M94 looked amazingly like a lot of smaller globular star clusters do in small scopes under city lights: bright, round, and surrounded by an easy-to-see mist of "unresolved stars" (really unresolved in this case!).

My log entry for M94 with the 4.25-inch Newtonian reads:

> Almost stellar at low power. At 100× it is impressive in this small aperture. Brightens smoothly toward a brilliant, almost star like, center.

It looked even nicer in the 11-inch Schmidt Cassegrain:

> In the C11, M94 is amazingly, bizarrely bright. Its preternaturally bright nucleus just blazes away. Also visible is a fairly extensive outer envelope of nebulosity. I strain for some hints of its spiral arms, but no other details are visible in this perfectly round galaxy, even at 300×. It is still spectacular for its brightness compared to the way most other galaxies look in the city.

M94, a Hubble Sb type spiral, is thought to be approximately 14 million light-years distant. In long exposure photos taken with professional telescopes, the bright disk is surrounded by tightly wound spiral arms. These arms are not overly easy for the amateur astrophotographer and are nearly impossible visually in the city, even with large apertures. This is due both to their constricted nature and the huge contrast difference between them and the galaxy's core.

Why is this galaxy's nucleus so bright? It is believed that the center of M94 harbors a monstrous black hole that is currently "feeding" on gas found there or perhaps even gobbling stars unfortunate enough to fall within its gravitational grip. While our views of the central portion of our own galaxy are spectacular, those from a planet orbiting one of M94's stars must be indescribable. Their "Sagittarius Region" would blaze forth, with the fires of nuclear annihilation, though most of the glory there would be obscured by dust clouds, just as the seemingly sedate core of our own spiral is hidden.

M51

As a boy, the galaxy I *most* wanted to see was the Whirlpool, M51. I spent a lot of time staring at a photograph of this object taken with the 48-inch Oschin Schmidt Camera at Mount Palomar (Plate 29) and dreaming of what the Whirlpool Galaxy and its

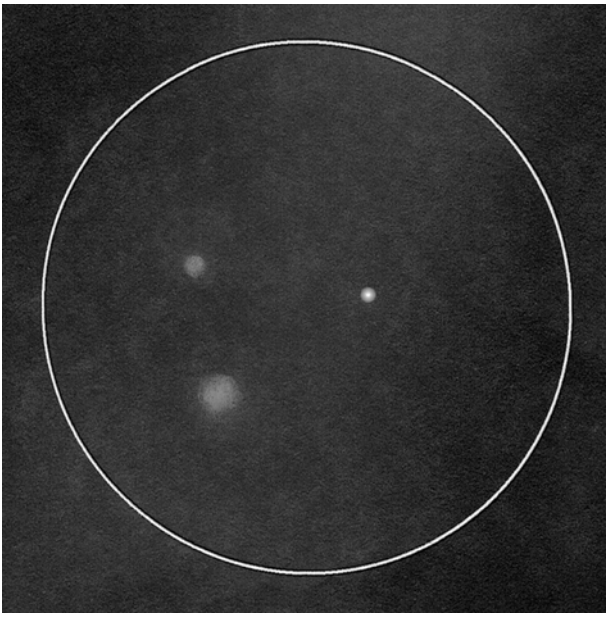

Figure 6.2. M51 with pencil and paper.

small companion, NGC 5195, would look like in my own telescope. Those majestic spiral arms really fired my imagination. Sadly, I was never able to see it at all, much less detect its spiral arms, with my 3-inch or (later) 4.25-inch telescopes. Why? I didn't know *how* to look for it or what it would look like when I found it. In the relatively good, though still light-polluted, skies of my youth this object would, admittedly, not have been overly easy in such small instruments, but would have at least been visible if I'd known how it appears in little telescopes.

M51 looks marvelous in the photos, showing off both its magnificent spiral arms and a bridge of material stretching between it and the passing irregular galaxy, NGC 5195. From a dark observing site it's wonderful visually, too, with the spiral shape being apparent to an experienced observer equipped with a scope as small as 6 inches. Sadly, I have to admit that in the city it is something of a dud. There are two strikes against it. It's large at $11' \times 7'$ minutes in extent, and it's a face-on Sc galaxy, which means its supposedly bright (integrated) magnitude 8.9 light is badly spread-out and diluted.

Does this mean it isn't visible from the average urban site? No. I've seen it with a 6-inch Newtonian reflector from a location less than one mile from a brilliantly illuminated shopping mall (and with a 4-inch scope from a slightly better site). I just don't want you to imagine that M51 will look *anything* like its pictures—or even like its visual appearance from dark sites—in your urban telescope. You will also have to *work* for it, but you can do it, and will at least be able to see the central regions of both M51 and 5195 (Figure 6.2).

If it were a little brighter, M51 would be relatively easy to locate, as bright Eta Ursae Majoris and plenty of other prominent guide stars are visible in your finder in this

area to lead you to it. Since the galaxy is surprisingly dim, though, you must take extra care when positioning your scope. M51 is 3°37′ to the southwest of Eta Ursae Majoris, but a better guide to it is magnitude 4.7 24 Canum Venaticorum, 2°9′ almost directly west of Eta. Hop to 24 from Eta, and, still looking through your finder, you'll see a pair of 7th magnitude stars 47′ apart. M51 lies slightly outside a line drawn between these two, and closer to the easternmost star. Position your scope, and insert a medium-power eyepiece into the focuser. If you're lucky, you should see a painfully dim double glow in the field. That may be all you'll see in smaller scopes, as the brightest star in M51's telescopic field is at 12th magnitude. Nothing? Recheck your positioning with regard to the two 7th magnitude stars, and, importantly, increase your magnification. I frequently found it took at least 100× to reveal M51.

What do you get for all this work?

> This is a very good night, and M51is riding high in the sky. It's easy to see in the 6-inch f/8 Newtonian. For once, I didn't have to guess at to whether I was really seeing it or not! Two round spots of nebulosity, one larger than the other, with no core noted for either object.

An 11-inch SCT makes the galaxies brighter if not much better:

> At 127× in the C11 with a 22-mm Panoptic eyepiece, M51 and its companion look much the same as they do in a smaller scope: a big fuzzball and a little fuzzball. The difference is that they are much easier to see and find in this telescope, and that averted vision brings out quite a bit of barely-perceptible nebulosity beyond the main galaxy's core that's invisible in smaller apertures. M51 also occasionally displays a star-like nucleus, something I don't recall ever seeing in a 6-inch scope from town.

M51, a Hubble Sc class spiral, is floating 35 million light-years out in the darkness. Its accompanying galaxy, little NGC 5195, has, as is obvious from the "bridge" of material connecting the two, recently (in the last few million years, that is) had a close encounter with the larger galaxy. Despite appearances, NGC 5195 does not lie in the same plane as M51—it is in the background and is receding.

M106

M106, is not nearly as famous with deep sky observers as M51, but it is very interesting in its own right. Never looked at it? That's a shame, since it's really much more attractive than M51 in the city. It's easier to find as well. Located in the northwestern part of Canes Venatici, this Sb spiral is large but bright at 17.4′ × 6.6′ and magnitude 8.3. A glance at a chart locates M106 near the center of a line drawn between Gamma Ursae Majoris (one of the Dipper asterism's bowl stars) and Beta Canum Venaticorum. Unlike M51, M106's surface brightness is remarkably high, so you may be able to use a searching power as low as 50× to make the hunt easy.

How does M106 look in small telescopes? Great! For quite a few years I skipped over this cosmic beastie. I didn't hear fellow amateurs mention it often, and it isn't even one of the original Messier objects (numbers 104 and below), so why bother? One evening, after struggling fruitlessly with M51 with the 6-inch scope from a very

poor site, I remembered nearby M106. When I had the galaxy in the field of a 12-mm Plossl, I was very sorry I'd ignored it for so long:

> M106 really is quite bright and is easy to find and identify. Plainly visible with direct vision even with tonight's poor skies. More or less round with some hint of elongation. Compact core visible.

And all this with the lights of my city's shopping mall providing a backdrop. If your scope or eyes or observing site are better than mine, you may be able to see another, smaller galaxy, NGC 4248, 14′ to the west and in the same medium-power field with M106. Unfortunately, at magnitude 12.5, NGC 4248 will be tough (I won't say *impossible*) from most urban locations. There are many, many galaxies scattered across this area of the sky, but most of them will remain invisible in the streetlight glow, I'm afraid.

M63

M63 is another galaxy that, while at its best from dark sites, bears up remarkably well from a bright backyard. This is the famous "Sunflower," a name it bears because of the curious appearance of its spiral arms. They are fairly tightly wound and have a splotchy, clumpy appearance. Combine this with the bright inner disk of the galaxy, and, yes, it looks a little like a great cosmic sunflower. While the flower-aspect of M63 is mostly reserved for darker skies, I find myself catching hints of it from time to time with the 11- or 12.5-inch telescopes from the city.

Finding M63 is not a huge challenge. It's 1°29′ from magnitude 4.73 20 Canum Venaticorum, and forms a slightly lopsided triangle with 20 and bright Cor Caroli, which is 5°17′ to the south-southwest. This large (12.6′ × 7.5′), relatively bright (magnitude 8.6) nearly face-on Sb galaxy is apparently a member of the small group of galaxies that includes M51. For best results, view it at about 125×, though it's bright enough to be found at lower powers. Keep coming back to this one, especially on above average nights, and you'll eventually be rewarded with a clear look at its spectacular sunflower aspect. On average nights, your looks at it will probably be more like mine on a typically muggy May's eve':

> From my heavily light-polluted backyard, M63 doesn't reveal any sign of its spiral arms in the 12.5-inch Dobsonian, not at first. The disk is fairly large, about 5′ across, and I can see both a smooth brightening toward its center and the occasional hint of a tiny point-like nucleus. The galaxy is obviously and strongly elongated east/west. As I stare at the Sunflower, using a range of eyepieces from 80× to over 200×, I actually do begin to think I'm seeing hints of spiral structure, but it is incredibly subtle, and may have more to do with what I remember from photos and from observing this object from dark sites than with what I'm actually seeing in the eyepiece tonight.

M81

Heading out of Canes Venatici and over into Ursa Major, we find M81, one of the most beautiful galaxies in the northern sky when seen from a dark—really dark—site. It has

a bright core, a large oval outer envelope of nebulosity, and two gossamer spiral arms. Even from pristine desert skies, M81's arms are subtle, and they are, unsurprisingly, utterly invisible from the city. This is still a nice target, though, and simple to find despite the fact that it's in the seldom-visited northwestern part of the Great Bear, well away from the Dipper/Plough asterism.

To find M81, draw a diagonal line through Gamma Ursae Majoris, Phad, the southwestern bowl star of the dipper (or "blade," if you see a plough here instead) and through Alpha, Dubhe, the star diagonally opposite Phad, which is 10° from Phad. Extend this line *another* 10° into empty (mostly) space and you'll land in the area of M81. You may have to search around for a while, as the nearest prominent star to the galaxy is magnitude 4.56 24 Ursae Majoris, fully 2° to the northwest. Luckily, M81 usually stands out well enough that slow, careful slewing-around will pick it up without too much difficulty. A medium-power eyepiece should reveal M81's softly luminous 24.9′ × 11.4′ disk (that's its size in photos, anyway) glowing cheerfully at magnitude 6.9.

In the field of my C11, M81 on a below average night was still interesting:

> M81 is beginning to sink in the northwest, and is now into some of the worst of the light pollution. Beautiful, but the outer envelope of nebulosity is dramatically reduced in extent from what's visible from a dark site. No hint of spiral arms. Best view is in a 12-mm Nagler at 233×, which reveals a bright core at the center of this galaxy's misty, elongated disk.

While I used the C11 on this particular evening, I've seen M81 with remarkable ease on a good city night with my tiny 60-mm Meade ETX refractor.

M82

If M81 is wonderful from a dark site, M82 is mind-blowing. It is a magnitude 8.4 nearly edge-on galaxy of the Hubble Irregular type. This isn't your average edge-on spiral. Something *bad* has happened to M82. Its magnitude 8.4, 10.5′ × 5.1′ disk is criss-crossed by numerous dark lanes, which give it a "boiling," disturbed appearance. M82 is a strong radio source, indicating that it has indeed been violently disrupted. Years ago, this galaxy was thought to be "exploding," but today's astronomers believe M82's troubles are the result of an encounter with nearby M81 at some time in the distant past.

If you can find M81, you can find M82, as it's only 37′ away, just one medium-power eyepiece field to the northeast. If you've got a good night and the galaxies are at or near culmination, you may even be able to use a low-power eyepiece to see both of them at once in a wide field—a not to be missed treat. Like M81, M82 is routinely visible in small telescopes, as it was one early and chilly spring evening with my 4-inch scope:

> This must be an exceptionally good night, since I'm able to see both M81 and M82 without trouble, and can even put them both in the same field of my lowest power eyepiece, a 25-mm Kellner at 48×. M82 is mostly a featureless cigar, but by sticking with it and boosting my magnification with a Barlow lens, some of its dark lanes/patches do briefly come into view when I use averted vision.

M101

As a young observer I longed to see M101, the Pinwheel Galaxy, almost as much as I craved M51. If anything, M101's wide-flung spiral arms looked even lovelier in pictures than those of the Whirlpool. Unfortunately, just as with M51, I never even had a *hint* of M101 in the field of my 3- or 4-inch telescopes. This giant 22′ diameter face-on, Sc galaxy has a remarkably low surface brightness despite an integrated magnitude value of 7.9. It often doesn't look overly impressive from the darkest sites, even in 8-inch telescopes. Sky conditions must be *just right*, dark, steady and *dry,* for this one to strut its stuff. If you do have those things, though, it is an absolute marvel, filling the field of a medium-low power eyepiece and readily showing spiral arms in 8-inch and larger instruments. These incredible arms are peppered with obvious HII regions, huge patches of nebulosity analogous to our own galaxy's Orion nebula, which stand out dramatically when you view the galaxy through a nebula filter (usually a no–no for galaxies).

Here in the city, M101 is usually a "been there" DSO, one of those objects where the satisfaction comes from having been able to locate it, even if it doesn't look like much when you find it. To be able to brag to your friends that you've at least *been there*. As with all large Sc galaxies in the city, seeing it involves finding a compromise between an eyepiece with a *low enough* power to allow you to fit the galaxy in the field and provide some background sky to "compare" it to, and a *high enough* power to darken the background enough to provide contrast.

M101 is theoretically easy to pin down, as it forms a near equilateral triangle with bright Zeta and Eta Ursae Majoris, Mizar and Alkaid, the last two stars in the Dipper/Plough handle. Just position the scope to the northeast of these stars, as in Figure 6.1, and bingo! Right? I wish it were that simple. This is one you will probably *not* find on the first try—or tenth. It's too big and too dim. But everybody needs a challenge once in a while, so keep coming back, waiting for especially dark nights and for its culmination, and you will finally be rewarded with at least a glimpse of this majestic night-bird:

> Try as I might on this average night, I couldn't seem to find a trace of M101 with the 11-inch SCT. Not a trace. Finally, after using all the tricks: averted vision, dark hood, jiggling the scope, and switching eyepieces several times in a quest for the best magnification, I got a look at the central core. It's just a vague, nebulous ball about 10′ across, but I feel gratified to have defeated this monster again!

The Pinwheel Galaxy, was one of the last objects to be included in Charles Messier's original list of deep sky wonders, and was first seen by his friend Pierre Mechain in 1781. In addition to its scientific significance, M101 is historically interesting for a couple of reasons. It was one of the first of the spiral "nebulae" to be recognized as such. When William Parsons, the Earl of Rosse, the 19th century's most prominent amateur astronomer, turned his giant 72-inch reflector to M101 in 1845, he was able to see its spiral arms, and it became one of many of these curious objects that he recorded with his big telescope.

It is also famous because it is at the heart of a long running controversy over a "missing" Messier object, galaxy M102. There is nothing visible at the original coordinates given for M102 by Messier. While some astronomers, amateur and professional, have identified M102 with a galaxy in Draco, NGC 5866, it appears more likely that

M102 was actually a "reobservation" of M101 with the coordinates written down incorrectly.

M101 is one of a small group of galaxies lying about 24 million light years away from us. This big Sc spiral is approximately 150,000 light years in diameter, making it comparable in size to our own Milky Way. Think about that. Despite the glare of city lights, you've just visited the Milky Way's twin, seeing it as it appeared some 24 million years ago. Sure, it's just a smudge in your little scope, but, as we'll find time and time again as we hike the urban deep sky, your mind will fill in the blanks with wonder. After seeing it with your own eyes from your humble backyard, M101 becomes a real place, a majestic spiral clogged with suns. As you stare at its faint traces in the eyepiece, do you wonder if "someone" is staring back?

M97

Are you up for another challenge, albeit an easier one? Galaxies are great, but after spiral after spiral they all begin to look alike, especially in the city. If you want a break from island universes, Ursa Major harbors a bright DSO that's *not* a galaxy, the legendary Owl Nebula, M97. Surprised to hear the Owl referred to as bright? It really is, though it does have a reputation as one of the harder Messiers—an unwarranted reputation in my opinion. This Vorontsov-Velyaminov Type 3a (irregular disk with very irregular brightness distribution) planetary nebula is large—compared to most of its kind, anyway—at 3.4′ × 3.3′ in size, and you'd think this size, combined with its magnitude of 11.0, would make it tough. It is not. Not at all. In fact, I've seen it from the city with an Oxygen III filter-equipped 60-mm scope, the ETX 60, and it is routinely (though not always) visible without a filter in 8-inch and larger instruments in my messy skies.

You won't have much trouble getting the scope on the right spot for M97. It's 2°16′ south-southeast of an excellent signpost, magnitude 2.37 Merak (Beta Ursae Majoris) in Ursa Major's Bowl/Blade. Using your finder, position the scope on Merak and slowly move 2° due south. You should wind up with a fairly noticeable magnitude 6.63 star in the finder field. Put this star in the finder crosshairs, and, looking through the main scope's eyepiece, carefully move a half-degree (about one medium-power field, depending on your scope's focal length) south and east. When you're done, examine the field very carefully.

Don't see anything? Bump up the power a little and *really* look. With some trying you should see a large, dimly glowing disk staring back at you. If you've got a spectacular urban night, you may even see signs of the two dark spots in the disk, the "eyes," which give it its owl appearance and name. Let me emphasize the value of an OIII if you're after the eyes: without the filter I have never even *suspected* them in the city, not even in the 12.5-inch Dobsonian. With the filter, they're often obvious in that instrument and doable down to about 8 inches when conditions are right. The OIII can also make the difference between seeing and not seeing the nebula itself when conditions are poor or with smaller telescopes on any night. The nebula's central white dwarf star is at magnitude 16.0, so it's *probably* beyond our grasp in the city, even with fairly large apertures.

On this above average evening in the C11 SCT, the sometimes-frustrating Owl is a surprise. With an OIII filter and the 22-mm Panoptic eyepiece, its big disk seems to float

in front of dim field stars. The addition of the OIII brings out definite if not completely concrete hints of the eyes (they always look bigger in the eyepiece than I imagine them to be). They are not overly well defined, but are visible at times, and even occasionally with direct vision.

There's another Messier object in this immediate area, M108, 48′ to the northwest, a dusty almost-edge-on spiral that looks like a smaller version of M82 in small scopes. This magnitude 10.0 galaxy is badly hurt by light-pollution, though, and is most often invisible in all my telescopes.

M3

M97 was OK, but you're tired of the dim? Let's end this tour with a *bang*, M3. This big but bright Globular star cluster, which is found back down in Canes Venatici in the far southern part of that constellation near Coma Berenices, is one of the true treasures of the northern sky. Bright at magnitude 6.3, "medium" in concentration at Shapley-Sawyer Class 6, and large at 18.0′ in diameter, this thing looks good in *any* scope. If you can use a 12-inch or larger instrument on it, you will almost forget you're observing from the city.

You'd think that M3, bright and prominent as it is, would be easy to locate. Surprisingly, this is not always the case. It's in the empty void between Bootes, Canes Venatici, and Coma Berenices, and it is not immediately obvious where to start when

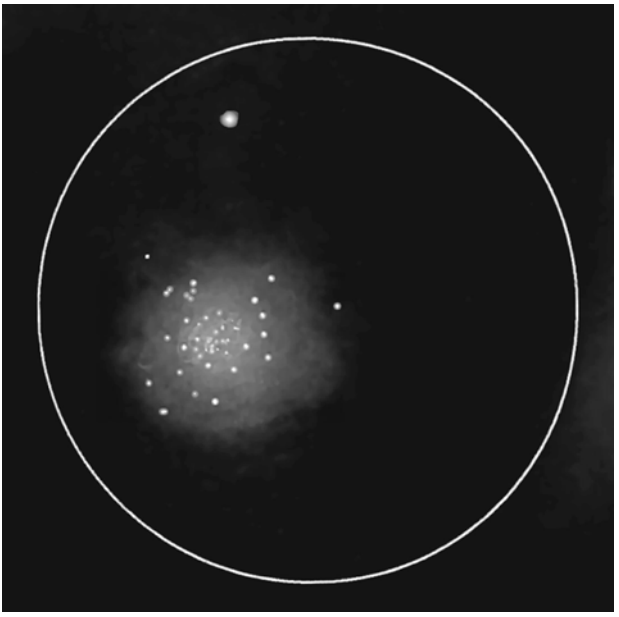

Figure 6.3. The great globular M3.

star-hopping to it. What I do is use brilliant Arcturus (Alpha Bootis) and Rho Bootis, which, at magnitude 3.58 is not as obvious in my skies as blazing Arcturus, but is easy enough to see at any time. M3 forms a near equilateral triangle with these two. If you can't seem to hit it by moving from Arcturus and Rho, another way to approach M3 is by drawing an imaginary line from Rho Bootis to Beta Comae. M3 is two-third of the way along this line in the direction of Beta and just a little to the south of the line. Do whatever you have to do to find M3. It is *breathtaking*. It is an enormous ball of tiny, tiny stars; my drawing in Figure 6.3 doesn't even begin to hint at its majesty. Stars are everywhere, spilling out of the field of a medium-power eyepiece:

> MAN is M3 beautiful! 127× with the C11 reveals many tiny stars from the outer periphery of the cluster and extending inward right across the core. As is often the case with globular clusters, M3 displays hints of color tonight, especially when I lower the magnification. In this case, the general hue is a very subtle blue–green (nearby M13 looks yellow to me). I'm embarrassed to spend so much time on this "easy" object, but it just looks so good!

Don't have a 12-inch scope? Try high magnifications with smaller instruments. That will allow at least some of the cluster's outer suns to wink into view, even in surprisingly small apertures. I've occasionally picked out a cluster star or two with my 80-mm Short Tube refractor, a pretty satisfying feat with such a small scope under such bright skies. Never stop trying until you've squeezed every last photon your telescope, large or small, can deliver from every last DSO.

Tonight's Double Star: *Cor Caroli*, Alpha Canum Venaticorum

Cor Caroli, "The Heart of Charles," as mentioned earlier, is a beautiful double star for even the smallest telescopes. This easy to separate pair is composed of a magnitude 2.9 primary star whose companion, a magnitude 5 bluish-white sun, lies a generous 20 arc seconds away. While the secondary is actually blue in color, the presence of the much brighter primary leads to interesting contrast effects that tend to make the dimmer star take on false shades of purple or "lilac." The star's name, Cor Caroli, was bestowed on it by Sir Edmond Halley (of comet fame) in honor of his monarch, England's Charles II.

> Still haven't had enough? There are many, many wondrous galaxies in this neighborhood, especially in nearby Coma Berenices. Have you seen The Blackeye Galaxy, M64, lately? Doesn't it deserve another look before the season ends? Or galaxy M98 (a hard one)? Or how about M99 the "last" Coma galaxy before you step over the border and into mind-bending Virgo? But if you've had a surfeit of wonder for one night and are ready to quit, don't feel guilty. You can take heart in the fact that these lovely galaxies and their kin will be back tomorrow night and next year. We'll also be back, standing, like Newton, on the shores of a great, dark cosmic ocean, picking-up a bright pebble here and there that our fellow men ignore.

Tour 2

Lion's Den

The spring constellations don't inspire awe based on their appearances. Virgo, Canes Venatici, Bootes, Coma Berenices, and the rest all hold beautiful treasures, but the stars that outline their "stick figures," the traditional patterns of spring constellations, are relatively dim and unmemorable. With one glorious exception. As spring begins in the Northern Hemisphere, Leo the Lion sprawls across the eastern horizon at sundown, a monarch surveying his realm. He's unmistakable, with the backwards question mark or sickle that forms his "mane" being identifiable to even casual sky watchers. He's almost the Orion of springtime.

Leo's not just interesting as a constellation figure; his rising heralds the return of the galaxies. In the spring, the change in seasons shifts our evening point of view from the Milky Way, which is well placed in the night skies of summer and winter, to the wild realms outside our friendly home spiral galaxy. In winter and summer we're looking inward toward the plane of the Milky Way, and its inhabitants, star clusters and nebulae, dominate our evenings. In spring, however, we're looking upward and outward into the darkness of intergalactic space beyond (the North Galactic Pole is found in Coma Berenices). So, what you can expect in spring is galaxies, lots of them. The immense body of our own galaxy is out of the way and its huge clouds of dust and hordes of stars no longer obscure the outside universe. Oh, you can see a few galaxies from the city in summer and winter, but nothing like the riches presented for small scopes in springtime.

When it comes to galaxies, nothing beats the Coma–Virgo cluster. The heart of this great agglomeration of island universes lies only about 60 million light years away (our own spiral is actually an outlying member of the Virgo cluster), and many showpiece galaxies can be found in the Coma Berenices–Virgo area of the sky. Amateur astronomers who enjoy galaxy hunting and observing eagerly await the return of this great cloud every year. I enjoy observing DSOs of all types, and don't really have a favorite variety, but when a new year begins I always find myself longing for the *real* depths of space. I'm ready to step off into the intergalactic void represented by Virgo and the numberless galaxies sprinkled across her like grains of sand. But it seems to take forever for the coy Maiden to reappear in our skies after a hard winter.

Luckily, Virgo is not the only spectacular expanse of galaxies on display in the spring. Long before the Virgin comes back, I'm observing galaxy after galaxy in Leo, who precedes Virgo and is well up over the horizon on late February evenings. The lion is nowhere near as rich in DSOs as Virgo and Coma, but he has enough galaxies to keep me working night after awe-filled night, even from the worst of the light pollution and with the smallest telescopes.

Which is not to say that springtime galaxy observing is always easy or rewarding. Unfortunately, the coming of Leo coincides with the return of stormy weather in many parts of the Northern Hemisphere. As was mentioned earlier, what we need for easy galaxy observing is, in addition to dark skies, *dry* skies. It seems ironic that the best

season for touring the dim and distant destinations outside our host galaxy should also be the season when they are hardest for many of us to see.

I've often headed out into a pleasantly warm night, visions of spirals in my head, only to be at least partially stymied by the humid hazes and "isolated thundershowers" that so often mar spring evenings in the Southeastern United States. Sometimes it gets so bad that I find myself thinking that trying to do deep sky observing from my light-polluted backyard is foolish at best. Then, when I'm about to give up and pack my poor, photon-starved telescope away, I begin to have successes that seem almost miraculous considering my usually horrible spring conditions.

One recent April evening I found myself hungry for the deep sky, and especially for galaxies. A quick look outside revealed that conditions were only fair at best. "What the heck," I thought, "if I can't see any galaxies I'll look at Jupiter." Outside with my little 4.25-inch Newtonian reflector—I didn't think there was much reason to bother with one of my larger scopes—I immediately turned to Leo, who, in his accustomed way, was dominating the eastern horizon. Some of his prominent stars were hard to make out in the haze, though, and I supposed I might not see a single spiral.

I pressed on anyway, and after a few minutes hunting, there was M66 peeping in and out. With a little slewing around and averted vision, I found I could see the neighboring spiral, M65, too. M105 was even easier. The sky was far from dark, but still the galaxies were there, perhaps helped slightly by my steady spring seeing. Most veteran deep sky observers know dark, dry skies are critical for optimum observing, but fewer are aware that seeing—atmospheric steadiness—is almost as important for dim-fuzzy-hunting as it is for planet watching. Under steady seeing conditions, extended objects like galaxies and nebulae are stable and not "smeared out" and stars are "smaller" and look brighter.

One thing is sure, after that hazy night I never assumed anything about sky conditions again. Unless you're completely clouded out, always give the sky a try; you might well be as surprised as I was on this "bad" night when galaxy after galaxy landed in my field. After this evening of productive galaxy viewing with a minimalist telescope, the galaxies of Leo never seemed dim and daunting again. Instead, Leo became a very friendly and familiar old lion for me.

Sad to say, this nice lion suffers from several annoying afflictions: lice in his mane, fleas on his stomach, and ticks on his hindquarters. What makes him a very *interesting* lion, though, is the fact that all these bugs are in reality *galaxies*. Referring to these majestic star systems as vermin may seem a little cavalier, but Leo's spirals do conveniently divide themselves into three rather distinct groups, one in his mane (the sickle or "backwards question-mark"), one in his stomach (the area between the stars 52 and 53 Leonis), and one in his hindquarters (the triangle of formed by the prominent stars Theta, Delta, and Beta Leonis).

M65 and M66

M65 and M66 are Leo's best in my opinion, cutting through urban haze with amazing ease. They are not hard to find, either. These two giant spirals are located in the hindquarters asterism about 2° 30′ southeast of Theta Leonis (Figure 6.4). Another guide is magnitude 5.3 73 Leonis, which should be visible in a 50-mm finder, even

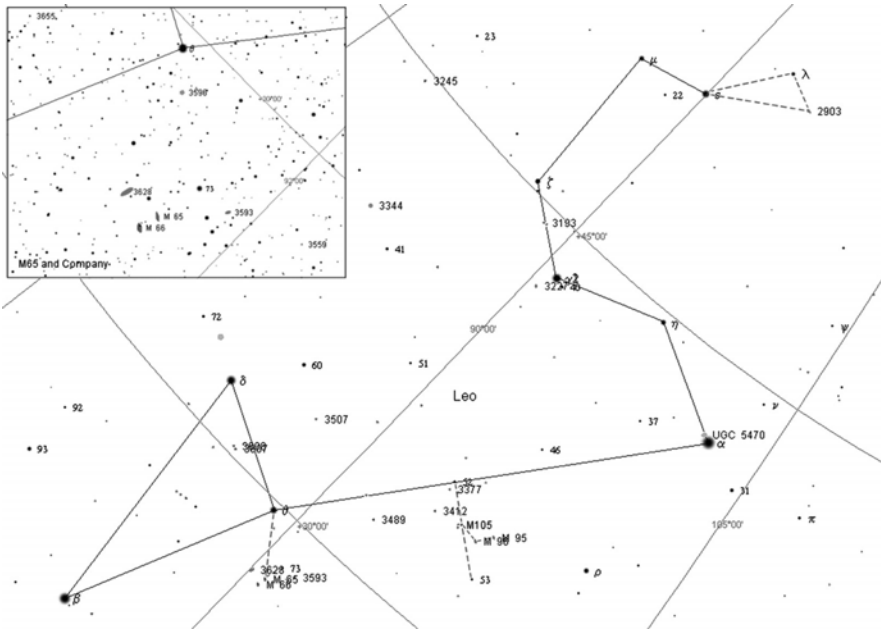

Figure 6.4. Lion's Den.

on badly compromised evenings. M66 is a mere 46′ east of this star. Put 73 on the western edge of the field of a low-power eyepiece and you may see M66 gleaming on your eyepiece's eastern field edge if your telescope can deliver 46′ of sky in one bite. Depending on your sky, you may have to use relatively high magnification to see it easily, but, even then, only a little hunting around in the area of 73 Leonis will turn up the galaxy. Once you have M66 centered, M65 is easy, since it's only 20′ further east. In lower power eyepieces, M65 and M66 should be easily visible in the same field in most scopes if your sky background is dark enough (use a wide-field eyepiece of medium focal length, if possible).

I'm always amazed at just how easy it is to find this pair in the city. If I can't hit them immediately by working from memory, a quick look at a chart like the one in Figure 6.4 makes quick work of the pair. I'm also continuously surprised at how obvious they are. I've often scoffed when I've read descriptions of galaxies that refer to them as "bright"—any galaxy is *inherently* a dim object—but these two are so prominent in my often terrible spring backyard conditions that I guess they really *should* be called bright. To me they both appear more prominent than even their fairly impressive (integrated) visual magnitude values of 10.2 (M65) and 9.6 (M66) suggest.

Once you've found these two, what exactly is there to see? Depending on your eyes and your experience, you may find your first glimpse of them in the city a little disappointing. Two smudges of light, each 3—4′ across. Nothing more. As always, a good, long look can make a difference in the details you can pick out, and it doesn't necessarily take a large scope. In my 4.25-inch Newtonian after extended observation I recorded that they were:

> Lovely and awe-inspiring. A wonderful sight even in this aperture. M66 is the brighter of the two with some hint of a core visible. M65 is dim, but easily seen.

My log entry for this evening also goes on to say that both galaxies are obviously elongated, rather than being just two round blobs, which, unfortunately, is all you see of many galaxies from the city.

Sometimes, throwing more aperture at a DSO helps a lot in the city. Sometimes it doesn't. On a comparable evening—clear, but with haze and high humidity—M65 and M66 looked about the same in my Nexstar 11 SCT as they did in the 4.25-inch Newtonian. They were easier to see and brighter, but gave up no more detail than in the little telescope:

> These galaxies, and especially M66, are fairly impressive in the C11. No core noted for M65, it's an oval smudge of light. M66 is brighter, but looks much the same. The real attraction under these conditions is that both can be seen in the same field of a 22-mm Panoptic eyepiece at 127×.

Actually, even under dark skies, most observers, even those with large instruments, don't see much more than a subtle brightening toward the middles of these spirals. They do look larger from the country, with more of their nebulous outer envelopes visible, but even under the best skies they seem reluctant to give up their subtle spiral arms to visual observers.

M65 and M66 (Plate 29) are large and normal-appearing spiral galaxies, both lying about 35 million light years away. These two are actually neighbors in space, and not just superimposed along our line of sight, but gravitational interaction does not appear to have caused any disruption to their elegant spirals. M65 is classified Sa, while M66 shows signs of a vaguely defined central bulge and therefore is an Sb.

NGC 3628

Let's say you're having one of those often-rare good nights in the spring, dry and relatively dark. You can then try for a "triple play." NGC 3628 lies 30′ north of M66. Although its magnitude value of 10.3 is not much dimmer than that of the other two galaxies, it's considerably larger, about 12′ in extent in photographs. This makes it a good deal more difficult to find, and I haven't seen it from the city in a scope smaller than 8 inches—and that on an exceptional night. Under city lights, a 10–12-inch scope makes seeing this one easier if not *always* trivial. Most of the time, even with the larger scopes, I just barely make it out, as in this log entry from one sultry and smoky June evening:

> This third member of the "Leo Trio" is substantially harder to see than either M65 or M66 in the C11. It's a dim smudge that fades in and out as the seeing changes. Some hint of its strong elongation, but that is just on the edge of perception tonight. Mostly, it looks like a small, dim, round haze. Best seen at 100×.

In long exposure images, NGC 3628 is bizarrely spectacular, showing signs of gravitational disruption. It's seen edge-on and shows a warped equatorial dust lane. It is assumed by astronomers that this disturbed appearance must have been caused by NGC 3628's interaction with nearby M65 or M66 or both. It's puzzling, though, why

the other two galaxies look so placid and normal. Like M65 and M66, NGC 3628 doesn't reveal anything much to visual observers other than its basic form. A large scope under country skies shows it as a pretty and bright band of light, but the lovely dust lane and nuclear bulge remain invisible.

The Rest of Leo

Mane Lice

NGC 2903

This Hubble Type Sb spiral shines at magnitude 9.1, but is large at 12.6′ along its major axis, so I expected it would be difficult from the backyard. Not at all. Not in the C11 or my 12.5″ Newtonian, anyway. That this object was always visible in these scopes, even under poor conditions, indicates that it should often be visible in much smaller instruments. I have seen it (barely) in an 8-inch scope, but have not been able to hit it on a night good enough to show it up with less aperture. NGC 2903 can be located by moving 3° 53′ southwest of bright, magnitude 2.98 Epsilon Leonis, the "last" or easternmost star in the mane/sickle. The galaxy forms a tall and slightly skewed triangle with Epsilon and magnitude 4.3 Lambda Leonis, which is 1° 28′ northwest of the galaxy.

My log for a typical spring evening (I recorded fair seeing and some haze) reports that NGC 2903 was

> Visible but not starkly apparent in the C11. Its large disk tends to wink in and out of view as I switch between averted and direct vision. Averted vision seems to show a tiny nucleus at 127×, but I'm not sure of this. Higher powers darken the field but don't help much with the galaxy.

NGC 3190 and NGC 3193

This pair is even easier to find that NGC 2903, since they are located almost directly in the center of a line drawn between two bright sickle stars, Gamma and Zeta Leonis. Although these galaxies are relatively small at 5.5′ and 3.5′ in size, respectively, they are forbiddingly dim at magnitudes 11.9 and 12.4. I have only been able to pick them out with any certitude with 12-inch and larger instruments. You, of course, may have better luck, better eyes, or better skies than I have, so be sure to look for them. If you *can* find them, you're in for a treat. Since NGC 3190 and NGC 3193 are a mere 5′47″ apart, they'll appear in the same field in a fairly high-power eyepiece. That's not all: NGC 3190, is one of the *most* attractive of the dimmer galaxies in Leo, as I mentioned in my observation of the two using the 12.5-inch Newtonian:

> This little pair is a real surprise. NGC 3190 is bright, definitely elongated, and shows a small, stellar core. It really "looks like a galaxy," and not just another smudge. NGC 3193, in the same field, is a typical round elliptical, a fuzzy ball. It does, like its neighbor, show off a nucleus, though. A third galaxy, NGC 3185, should also be present in the field, but I've never seen it from light-polluted home.

Tummy Fleas

M105

M105 has long been one of my favorites, though I'm not entirely sure why. It's a Class E1 elliptical galaxy, so there's no hope of seeing detail of any kind beyond a bright nucleus—all elliptical galaxies are featureless balls of stars without dust lanes or spiral arms to make them really interesting. Maybe it's because this one is very bright and not alone. M105 forms a beautiful little group with NGC 3384 and NGC 3389, both of which are only about 10′ away.

Unlike most of the other galaxies in Leo, M105 and company can be a bit tricky to find, as the only bright stars in the area are 52 and 53 Leonis at magnitudes 5.48 and 5.34, 1° 38′ and 2° 4′ away, respectively. Both stars will likely often be invisible to the naked eye in bright skies. They will appear easily enough in a finderscope, though. Once you've got them located, simply move your telescope to a position midway along a line between the two. You may have to sweep around with the telescope to pick up M105, but it's hard to miss. On any acceptable evening, the galaxy should appear modestly bright in a medium-power eyepiece.

M105, at an integrated magnitude of 9.6 and a size of 4.8′ across, is simply not a challenge at all once you're able to locate it. I've seen it without effort in my 60-mm ETX on clear evenings. The other two are harder, much harder, with magnitude 10.0 NGC 3384, an E7 elliptical, being available to 8-inch scopes regularly and 6-inch scopes on above average nights (with high magnification). The third member of this grouping, NGC 3389, a magnitude 12.0 Sc face-on spiral, is, like other examples of this class and orientation, a "toughie," and usually takes 10–12-inch telescopes for positive identification from urban sites. On poorer nights, it is completely undetectable, even in the 12.5-inch scope. Since the M105 group is a favorite spot in Leo for me, I've drawn it numerous times. My sketch in Figure 6.5 reflects its appearance on a better than average evening. M105 is an old friend now, and I've been coming back to it ever since I rediscovered it with the 12.5″ Dobsonian one fine April evening:

> This trio was quite a treat. I remembered the appearance of M105 fairly well, though I probably hadn't looked at it in years, but I didn't recall the other two galaxies in the field. M105 is bright and round with a stellar nucleus. NGC 3384 looks larger and dimmer than M105 and shows some elongation. NGC 3389 is smaller and a little difficult in the 12.5-inch scope—it was dim enough that I couldn't be sure exactly what its shape was and whether or not it displayed a core. This is an immensely beautiful field—three nice galaxies for the price of one!

M95 and M96

These galaxies are the runners-up in Leo when it comes to attractiveness. Were it not for M65 and M66, they would be the runaway winners without doubt. They are a little more difficult to locate, but not overly hard to find once you're in their general area. If you can find M105, locating M95 and M96 is a snap. Go for M96 first, as it's closest to M105. Move carefully and slowly 48′ south-southeast of M105 and examine the

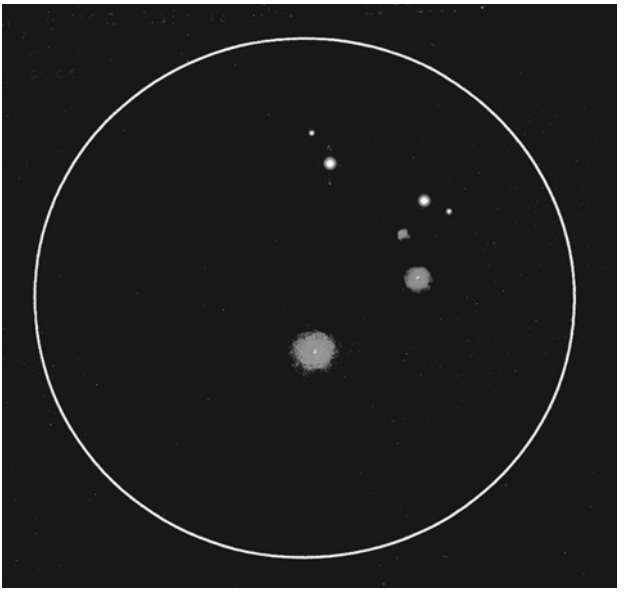

Figure 6.5. M105 and Company.

field obsessively. At an integrated magnitude of 9.3 and a surface brightness of 13.1, M96 will pale when compared to bright M105, but should be visible on most evenings in a 6-inch aperture instrument (as always, depending on the quality of your skies). When you've had a good look at—or for—M96, move on to M95. Its magnitude of 9.7 and size of $6' \times 4'$ result in an integrated magnitude of nearly 14, so this object is, not surprisingly, dimmer-appearing than M96. To locate it, eyepiece hop $41'$ due east from M96.

Given their close proximity, you'd think these two would make a nice "double galaxy" in a wide-field eyepiece. From dark country skies they certainly do, but in the city you'll need to increase your magnification substantially in order to see either of them. To be successful with this pair, I needed 220× in the C11, and even the field of a 12-mm Nagler wasn't quite large enough to include both galaxies at this magnification. Don't let the above put you off. M95 and M96 are extremely nice despite their relative dimness, being more interesting than many other galaxies in Leo, and shouldn't pose many problems for a 6-inch scope if you work slowly and methodically. They were, in fact, interesting enough to move me to document them in a drawing (Figure 6.6). My log entry notes them as a doable if not easy catch for the 8-inch scope (I was barely able to see them in the 4-inch scope on most nights):

> Conditions are not good and are getting worse as the night wears on, but I didn't have much trouble with this pair. In the 8-inch f/5, M96 is large and fairly prominent. It is obviously elongated and shows a stellar core. M95 is considerably harder and requires averted vision at times, but I can see that it is also elongated and also that it doesn't possess an obvious nuclear region.

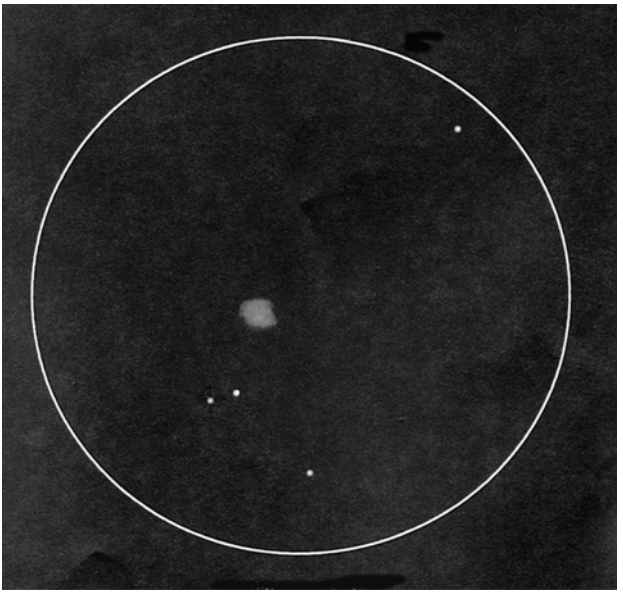

Figure 6.6. M95.

Hind Quarter Ticks

NGC 3521

M65, M66, and NGC 3628 obviously steal the show in the eastern part of the lion, but they aren't the only deep sky wonders to be seen in this area. NGC 3521 is exceptionally beautiful, and I'm surprised that more observers don't talk about it. At magnitude 9.7 and 9.5′ across its major axis, it's easy enough to see in 8-inch and larger telescopes under above average city conditions. In the eyepiece, this SB spiral looks so much like a dimmer twin of M63, the Sunflower, that I've christened it "*Sunflower Junior*."

Sunflower Junior lives in the eastern section of the Lion, but isn't co-located with M65 and M66 in the triangular hindquarter region. It's in a nondescript area to the south—a full 15° 36′ from Theta Leonis. Forget using any of Leo's bright stars to track down Junior. If you don't have go-to or setting circles to aid you, your best bet is probably magnitude 4.47 Phi Leonis. You should be able to locate Phi with your finder with fair ease, as there aren't many other even marginally prominent stars in the region. To find the galaxy, you'll need to move 4° 31′ to the west of the star. If this doesn't work for you, try starting from the slightly dimmer star, magnitude 4.74 61 Leonis. The trip from 61 is shorter, with the galaxy lying 2° 38′ to the north-northeast.

In long exposure photographs, NGC 3521 really does show a clumpy, many-armed appearance reminiscent of that of the Messier object. Visually, it's remarkable, if a little frustrating:

On this not-so-good night, I was surprised to find NGC 3521 without much of a struggle. At 220× in the C11, it is large, obviously elongated with a stellar core, and its disk seems to occasionally give up fleeting hints of detail, as if a multitude of spiral arms is just on the edge of detection. This detail is on the bare threshold of visibility, however, and I can't hold it or even formulate a good idea of what I'm seeing.

Tonight's Double Star: Algieba

Algieba, Gamma Leonis, is one of the Lion's most prominent stars. It is also one of the finest doubles in the northern sky. This binary pair is composed of a magnitude 2.2 primary star and its magnitude 3.5 companion. They are fairly close together at 4.4″ apart, but, being roughly comparable in brightness, they are not hard for small telescopes to split. At higher powers, the two resemble yellow cat's eyes glowing in the darkness. You can locate Algieba by moving up Leo's sickle from Alpha Leonis, brilliant Regulus. Your target is the second sickle star after Regulus.

What have I taken away from my many nights of galaxy hunting in Leo? Other than the pure exhilaration of viewing these far-away night-dwellers with my own eyes through my own beloved telescopes, they have helped teach me that deep sky observing under city lights is a skill. By trying hard on difficult objects, like the dimmer galaxies in the Leo group, I've trained myself to be a better observer. The next time I have a go at Leo, it's always easier to find my way and find my galaxies. Under dark skies I conquer galaxy after galaxy with laughable ease with a non-go-to non-DSC equipped telescope. I've also learned to be very hesitant about calling an object "impossible" from the city. I succeeded more often than I failed, even on the worst nights, and was rewarded with unforgettable encounters with these distant giants.

Tour 3

The Tresses of Berenice

If Leo is the toe-in-the-water constellation when it comes to galaxies, Coma Berenices is where you step off into the deep end of the pool. This is where the great Coma–Virgo Cluster of Galaxies begins. The southern part of Coma, especially, is almost as island-universe-rich as the depths of Virgo. It's just as interesting, too—or maybe even moreso. Virgo's galaxy fields are impressive, but seem to me to be dominated by less interesting Hubble Types. In my mind, the prototypical Virgo galaxy is a monstrous, round elliptical. Bright? You'd better believe it, but without a trace of the details we strain to see in our city-limited scopes. Coma is a different story. Beautiful (if challenging) face-on Sc spirals mingle with razor-thin edge-ons. Everywhere I turn it seems I find another showpiece.

If you're a beginner, you've probably at least heard fellow amateurs talk about the wonders of Coma Berenices, and have seen the beautiful images of the constellation's many galaxies that appear in the spring issues of the astronomy magazines, but you may not actually have seen the constellation itself. While it's very beautiful, it's quite subdued in an urban setting, since the brightest star in the constellation, Beta Comae, shines weakly at magnitude 4.26 (as you may know, due to Bayer's "mistakes" and changes in the layout of the constellations over the years, "Alpha" is not always the brightest star in a constellation). And what's a "Coma Berenices," anyway? It's the *hair of Berenice*.

Berenice, in legend if not necessarily fact, was the beautiful golden-haired wife of King Ptolemy of Egypt. Apparently their marriage was a happy one, and Berenice pined for him when he was called away to war. She prayed mightily to Aphrodite (the Ptolemys were the Greek rulers of Egypt) for his safe return, swearing she would cut her long and lustrous hair as a sacrifice if he were returned safely to her. When Ptolemy returned home, Berenice dutifully had herself shorn. She must have been inconsolable over the loss of her beautiful locks despite being reunited with her hubby. A court astrologer took pity, however, and pointing at a lovely splash of stars in the spring sky, he informed her that in honor of her sacrifice and devotion, the gods had immortalized her tresses in the night sky.

A pretty story, but most people with some familiarity with the sky, if not Coma, would guess that the constellation in question looks nothing like the glimmering hair of pretty Berenice. That's usually the case when it comes to constellations and mythology—Bootes looks like a kite, not a herdsman, Virgo doesn't look much like a Virgin, and Canes Venatici is two dully shining stars rather than a pair of sprightly hunting dogs. This is one time, though, when a constellation actually resembles its namesake. True, Coma Berenices' basic pattern, located just south of Canes Venatici, is unremarkable. It's just an "L" shape of stars consisting of Alpha, Beta, and Gamma Comae. Unremarkable save for one thing: Berenices hair really *is* entangled in the constellation's pedestrian stars.

What saves Coma Berenices from obscurity as a constellation is Melotte 111. This is a huge cluster of stars 5° in diameter located in the Western half of the constellation,

just South of Gamma. From rural skies, the beauty of Mel 111 is incomparable. With an integrated magnitude of 1.8, and its brightest stars hovering around magnitude 5, it's even detectable in the city on a nice night when Coma is riding high in the sky. Because of Mel 111, Coma Berenices puts nearby Canes Venatici to shame, and is more readily identifiable even than sprawling Virgo, whose only claim to fame is her bright sapphire, Spica. While Mel 111 is often completely invisible to the naked eye under city lights, a pair of binoculars easily brings its myriad stars out of the gray sky background. Before going on to this area's hard-core objects, take a few minutes to admire this cluster with a pair of 10 × 50 binoculars.

Learning constellation lore is fun and Mel 111 is lovely, but I know you're here for the *meat*, the deep sky objects (DSOs) mingled with our lady's shining hair. There's no lack of them, and I could go far beyond what's outlined here, but these are the best of the best. Where to start? Make it easy on yourself in two ways: start with a Messier and begin with the less galaxy-crowded northern half of the constellation.

M64

M64, an integrated magnitude 8.5 Sb spiral galaxy, is the perfect place to begin our leisurely stroll through Coma's galaxy fields. Under dark skies you'll see galaxies almost anywhere in Coma Berenices where you point a medium-aperture scope, just as in Virgo, and playing "which galaxy is which" gets confusing in a hurry. The area of M64, located to the north of the Coma–Virgo border, back in the direction of the constellation's "L" shape, is, thankfully, a less crowded and confusing part of the sky. In fact, M64 is alone in its surrounding patch of the heavens for the urban astronomer.

Finding M64 is incredibly easy. It is about two-third of the way along a line drawn between magnitude 5.6 40 Comae and magnitude 4.9 35 Comae. With your atlas or Figure 6.7 properly oriented, both of these stars should be easy to locate with a large aperture finder—like Virgo, this part of Coma is relatively barren in light-polluted skies, so there aren't hordes of stars to confuse a galaxy hunter. Bright enough to appear fairly obvious at 50×, M64 will initially appear as a dimly glowing oval of light a minute or two of arc across.

Were it merely an oval of light in our telescopes, M64 would be just another spring galaxy to be glanced at quickly before moving on—for those of you who can bring yourselves to be blase' about these great cosmic creatures. But there's one curious feature of M64 that puts it in the "must see" class. M64 has a nickname, you see, The *Blackeye*. This is due to a large patch or lane of dust located just outside the galaxy's nuclear regions (See Plate 30) In photos, this looks more like a curving arc than the spot or "eye" we see visually in small to medium size telescopes. How easy is the galaxy and its eye? M64, whose true dimensions in photographs are 10.3′ ×5.0′ across, is not a challenge for most urban observers. With sufficient magnification even a 60-mm can hope to pick it up in the worst light pollution a mid-sized city can throw at it. How about the dust patch, the eye? That is a different story, as I found out with my 6-inch *f*/8:

> M64 is easy as pie in the 6-inch at 96× with a cheap 12-mm Kellner eyepiece. Certainly not overwhelming, though. Compact (but not stellar) core surrounded by sharply defined oval haze oriented roughly northeast-southwest. I convinced myself I saw evidence of

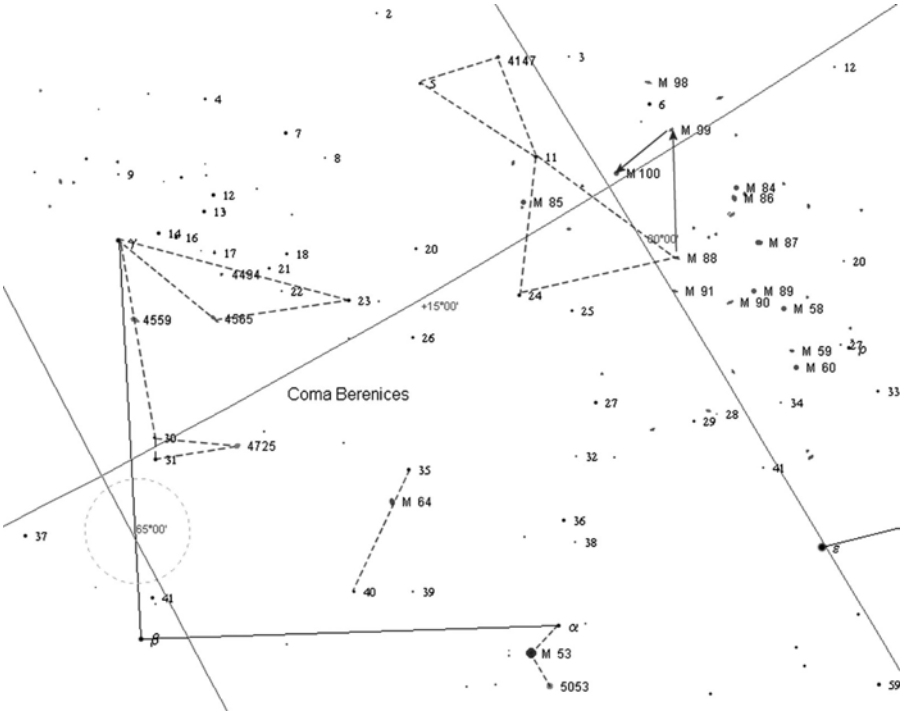

Figure 6.7. Coma Berenices.

the black eye, but, in truth, I'm not sure if I saw it or not. It's incredibly subtle in this aperture in the light pollution, and I think steady seeing in addition to dry, transparent skies would be a big help.

As is usually (though not always) the case with galaxies in the city, going to the C11 SCT helped. A lot:

The famous "black eye" of M64 is immediately and dramatically obvious. On this above-average night, the galaxy itself is at least 3′ across, and the black eye appears as a notably darker area next to a bright patch directly adjacent to the stellar-appearing nucleus. Though the eye is easy enough to see, I found that I had to use averted vision to get a good look at it most of the time, and even then could not always "hold" it. This is not an easy feature for a city scope, even an 11-inch scope. I used 220×, but something closer to 300× might yield better results.

M64, the Blackeye (I've also heard this object referred to as The Sleeping Beauty Galaxy—don't ask me why), is a large and healthy spiral, a member of the Coma Supercluster of galaxies, and lies around 19 million light years from Earth. "Healthy" as in "not disrupted." But M64 is not *quite* your normal galaxy. It appears to be composed of an inner and an outer disk of stars that are rotating *counter to each other*. The interaction between these two disks is probably responsible for the vigorous star formation we see taking place and also, perhaps, for the weird eyespot. It's speculated

that the whole shebang may be the result of M64 having devoured a smaller, but still sizable, companion galaxy many millions of years ago.

NGC 4565

M64 is a "showpiece," but it's not *the* showpiece of Coma. That honor must go to NGC 4565. In medium-aperture scopes, it is one of the most beautiful objects in the entire sky. This near-edge-on magnitude 9.6 Sb spiral is composed of a bright, round central region 2 or 3′ in extent superimposed on the thin disk of the galaxy that extends for an amazing 15′ of arc (Plate 31) This domed-disk look gives NGC 4565 its nickname, "The Flying Saucer Galaxy."

Getting there is easy, if not quite as easy a trip as M64. Your guides to this one are magnitude 4.4 Gamma Comae, and magnitude 4.8 23 Comae, which lies 6° from the brighter star. NGC 4565 is almost exactly halfway along this line, and 1° 45′ northeast of it. In other words, Gamma and 23 form the base and NGC 4565 the apex of a shallow triangle. Another way to pin down NGC 4565 is by looking for magnitude 5.3 17 Comae. NGC 4565 forms a right triangle with this star and Gamma, and is 1° 39′ north-northeast of 17. Actually, when it comes to locating the galaxy, you have an advantage over those astronomers blessed with darker skies. For them, this area is a riot. It's just *brimming* with the stars of Melotte 111. For you, under the sodium streetlights, 23 will stand out pretty prominently.

If you've seen this one from the country, you'll remember it as astonishingly big and surprisingly bright, even in 4-inch instruments. But the question is always, "How much galaxy can I see in the city?" Aperture is a tremendous help. In urban 4–6-inch instruments, hunting NGC 4565 can spell frustration, with the galaxy sometimes being completely invisible. In an 8-inch scope, it *can* be fairly easy to see, but much of its dark-sky glory has been stripped away. Instead of being a bright edge-on streak, NGC 4565 may be reduced to just another Virgo–Coma Fuzzy Ball. If you're looking for the famous Flying Saucer, you may even pass over it, as you're expecting a distinctive spindle-shape, rather than just a round nuclear region. On very good nights with an 8-inch scope, or on average nights with a 10-inch or larger scope, the saucer shape can be easy, however (Figure 6.8):

> Plenty of skyglow tonight, though I would rate this late spring evening as drier than average. With direct vision at 127×, NGC 4565 first appears as a nebulous round blob about 1′ or less in diameter with a tiny, bright, star-like nucleus. A little averted vision quickly reveals the edge-on disk that forms the Saucer. With continued examination, I'm confident that I'm seeing at least 5′ of disk on either side of the core—pretty impressive for a C11 in light-pollution hell!

Note that while I was able to detect the saucer's disk with the 8-inch scope on good nights, I was never able to convince myself that I saw real evidence of NGC 4565's equatorial dust lane, the equivalent of the "Great Rift" that cuts through our own Milky Way's plane, and which is so obvious in photographs of the Flying Saucer. I tried for it with all of my might and all my telescopes from the wide-field 60-mm up to the 12.5″ Dobsonian at a variety of magnifications, but failed miserably. Which doesn't mean you might not succeed, or that I might not bag it on a special night.

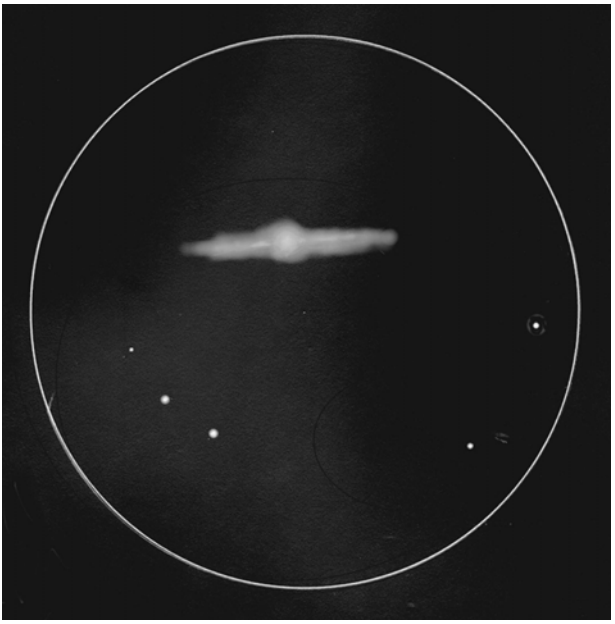

Figure 6.8. The magnificent Flying Saucer Galaxy.

What a sight NGC 4565 must be from close-up. It's the largest edge-on spiral as seen in our telescopes, and, depending on whose distance estimates you use, it is also large in reality, ranging up to a diameter of 125,000 light years, considerably larger than the Milky Way, which is probably no bigger than 90–100,000 light years in diameter. This object, missed by Messier, was first plucked out of the void by William Herschel in 1785, and has been a source of wonder and joy for sky watchers ever since.

M53

Just like dear, old Mother Earth, the Milky Way Galaxy has an axis of rotation and, thus, a North Pole and a South Pole. Looking in the direction of its North Galactic Pole, which is located not far from the unassuming star 31 Comae, you're looking up and out of the galaxy's disk, 90° from the Milky Way's plane. You're peering into deep space, so it's no wonder there are so many galaxies in this area. You'll look in vain for bright nebulae and open clusters as you scan north–south from Coma to Virgo. Globular clusters are a different matter, however. While they congregate along the galactic plane in places like Sagittarius and Ophiuchus, their orbits around the Milky Way's center and our perspective can bring them into view even in the midst of the Realm of the Galaxies.

If there's an easier DSO to find than magnitude 7.6 M53, I've never seen it. Well, maybe the Orion Nebula is a *little* easier to hunt down, but not much. M53 is located

56′ north and slightly east of brilliant Diadem, Alpha Comae. Position the scope in the general vicinity and you'll likely find M53 staring back at you without any hunting at all. If your telescope can deliver a 1° field, put Alpha on the Northern field edge and M53 will "automatically" be visible on the other side of the eyepiece field (once you see it, move Alpha out of the field to reduce the glare, of course). I found the cluster trivially easy to spot even with my 60-mm ETX during typically hazy spring weather here on the Gulf of Mexico coast.

How *good* is it? In the 60-mm, as you'd expect, it was just a little round ball of nebulous light. In the city, a 4-inch scope makes it bigger, but doesn't resolve any stars. Even in the county, this can be a tough nut for a 4 incher to crack. At 6 inches, things get better in a hurry:

> Bright and easy to locate. Round with a grainy, diffuse core at 96× in my 6-inch f/8 Newtonian reflector. As I continue to stare at M53, I'm surprised to see stars start popping out at the "edges" in this medium-difficult object.

Encouraged by this 6-inch scope observation, I threw more aperture and more magnification at M53:

> Very pleasant in the 12.5-inch Dobsonian at 150×. Two fairly bright stars in the field about 15′ from the cluster's center. As the sky darkens, M53 becomes a real mind-blower! Microscopically tiny stars wink in everywhere, including across the core, and M53 assumes a weird "splayed" appearance, looking like a cosmic jellyfish floating among the stars. This impression is heightened by the fact that the core is not overly bright or concentrated.

Swimming alone in the star-poor reaches of Coma's deep ocean, M53 (Plate 32) evokes a sense of lonely isolation, and this feeling does actually reflect the truth of things. M53 is one of the more distant globular clusters known, being, it's estimated, 70,000 light years from Earth. Like other globular star clusters, it is in a huge long-period orbit that will eventually carry it back closer to "home." But for now, M53 sails along distant shores in splendid isolation. This Shapley–Sawyer Class 5 globular's brightest stars are at around magnitude 13.8, which is why it's hard to resolve any stars with small telescopes at anything but high magnifications and under dark skies.

The Coma "What Else"

NGC 5053

What other good stuff is to be seen in Coma Berenices? Plenty. If you like galaxies and have a medium-sized telescope, Coma can provide countless hours of enjoyment, even if you must observe from considerable light pollution. We're into the Realm of the Galaxies here, of course, but there are at least two other objects worthy of our attention. The logical next stop is another globular, NGC 5053.

M53 floats far from home, but not completely alone from our perspective. There is another globular very closer at hand, NGC 5053. It's considerably nearer to Earth than M53, being approximately 53,000 light years from us, but it's along our line of sight to M53 and appears only about 1° from that cluster in the sky. A quick look at its specs: magnitude 9.8, 9′ in diameter, and a Shapley–Sawyer Class of XI (11), and it's

obvious that small scope owners are in for a real battle. It's distant, it's relatively dim, it's fairly large, and it's very weakly concentrated, meaning the 4-inch owner probably can't hope to see even an unresolved core. The surface brightness of this object is a distressing magnitude 14.3. Finding is not the problem, seeing is. It's in the same field as M53 with a wide-field eyepiece at low power—but you probably will never see it at very low power in the city. On a good spring night with the C11, I tried my hardest with this one, and was rewarded with at least a look at its dim reaches:

> Some of NGC 5053's small stars occasionally swim into view in the C11 at 127×, and, as the cluster rises toward culmination, I can see quite a few members at one time or another. This cluster is unexpectedly difficult. My impression is that this looks like a very dim, large, and flattened open cluster rather than a globular. No central condensation at all.

I keep trying for NGC 5053 with my smaller telescopes, but so far have been unsuccessful with it from the city. Actually, this globular really didn't look impressive or interesting from the pristine dark skies of the Texas Star Party at Prude Ranch in Fort Davis with the 12.5-inch scope.

M88

Ouch! How about something just a little easier? Now we turn our attention to the heart of the matter, the Coma galaxies near the Virgo border. This is a rich and confusing area, so take a deep breath and get a detailed finder chart ready. Don't be too apprehensive, though. The four Messier galaxies we'll visit are distinctive and bright, so you shouldn't have too much trouble identifying them. Luckily, they reside just outside the really galaxy-congested areas to the South.

M88 provides a good jumping-off point if you decide to eyepiece-hop through the region (the galaxies in this area are close together enough to make this practical). It's an Sc spiral of the reasonable magnitude of 9.6, and appears relatively bright in the eyepiece. Unfortunately, if you don't have a go-to scope, it can be something of a bear to find. The best way to this one is by using two Mel 111 stars, magnitude 4.7 11 Comae and magnitude 5.0 24 Comae as your markers. The galaxy forms a near equilateral triangle with the stars, and is positioned due east of them. When you're in the correct spot, it should show itself in fairly small apertures, though you may need to run up the magnification as high as you dare. Work carefully while hunting this galaxy, referring to your atlas frequently. It's easy to mistake M91 for M88, though M91 is obviously a good bit farther east on the charts. To avoid this case of mistaken identity, print out a detailed eyepiece-tailored finder chart with *Cartes du Ciel* or your astronomy program of choice.

As frustrating as M88 can be to find and positively identify, it has one thing in its favor, it doesn't require extreme aperture for a good look. I know I got a good view of it with my Chinese-made 8-inch $f/5$ Newtonian.

> This is a superior night in the city, and M88 is nice and bright at 167× in the 8-inch f/5. What I see is a prominent core region. This area is large, about a minute of arc across, and is elongated north–south. I also see hints of a small nucleus, but not a trace of spiral arms.

Naturally, I always want to see more detail, and when I came back to this one on a similarly good night with the 12.5″ Dobsonian, I was able to see a faint outlying haze in addition to the bright oval central region the 8-inch scope revealed. This haze appeared as two faint extensions on either side of the nucleus, and I'm confident that this averted-vision view was showing me traces of this spiral's lustrous arms.

M99

Next up is M99, a fairly considerable jump, 3°12′ due west, for the eyepiece-hopper, but easily doable if you keep track of the prominent field stars sprinkled along the way. Unfortunately, M99 isn't easy to see on an average city night. Not in the 8-inch scope. Or really even in the 11 and 12.5-inch telescopes. Why? At magnitude 9.9, it's not much dimmer than easy M88. It's that same old bugaboo we often run up against with galaxies: it's a face-on Sc spiral. As they get dimmer, they get much harder. The only saving grace here is that it's relatively small at 5.3′ × 4.6′ in size, which made it at least detectable in the C11:

> On this good night, M99 is fairly easily visible in the C11. "Easily visible" in that I can make it out as a dim and somewhat formless glow in the field of a 220× eyepiece. Increasing my power to 300× and above gives an impression of elongation, but it's hard to hold the galaxy steady enough in my gaze to be sure.

Naturally, all I was seeing was M99's inner regions. There was not a hint of its delicate spiral arms.

M100

A short hop of 1° 42′ north-northeast brings us to another face-on Sc spiral, M100, nicknamed the "Catharine Wheel Galaxy." If you're not eyepiece hopping from M99, your best landmarks to M100 are 11 and 6 Comae, both of which glimmer at approximately 5th magnitude. The Galaxy is approximately 2° from either star and 1° east of a line drawn between them. M100, at 7.5′ × 6.1′, is larger than M99, and only slightly brighter at Magnitude 9.4, so it should be a little harder to see due to its more spread-out light. In fact, many observers do comment that M100 is more difficult than M99. Not me, though. This galaxy was not only easier than I expected in the 11-inch scope, it seemed to show more detail than M99:

> M100 surprised me—I figured I'd really have to fight the seeing and light pollution to get a look at it, even in a C11. But there it was, showing about 45″–1′ of its inner core. Not only that. Averted vision clearly showed faint haze extending out at least another minute or two of arc. Looked substantially better than M99 this evening.

Under dark skies, there's a very attractive near-edge-on galaxy in the same medium-power field as M100, NGC 4312. Despite this "bonus galaxy" being prominent in an 8-inch scope from dark skies, however, I don't believe I've ever seen it from the city with any of my scopes. From the country, in large-aperture scopes, M100 itself becomes a marvel, with its far-flung arms actually seeming to mimic the sparkling of a fireworks Catharine wheel.

M85

The next Messier on our path is a good meat-and-potatoes galaxy in almost any but the smallest instruments. From M100, move the telescope 2° 26′ north. To find it directly, position your telescope 3/4 of the way along a line drawn between 24 and 11 Comae. The galaxy lies closest to 11, and is 1° 10′ from the star. Once there, the galaxy appears as a little smudge of light at an integrated magnitude of 9.1. In images it's 7.4 arc minutes across its long axis and about 5.9′ in "width," but in the city be content if you can make out an arc minute of galaxy at best. Despite its true elongated shape (this is a lenticular S0 type galaxy), amateur telescopes of almost any size and under any skies just deliver a round fuzzy:

> M85 is prominent enough to be visible with direct vision in the 6-inch f/8 Dobsonian—though I wouldn't exactly call it bright! Moving South in Coma puts me into increasing light pollution at this site. Round with a condensed but not star-like nucleus. A bright field star is present 1′ outside the galaxy's core.

Like M100, the field of M85 harbors a "companion" galaxy, NGC 4394, but, like M100's buddy, this magnitude 10.9 sprite seems to be invisible in the city—in my telescopes, at least. As always, though, I keep trying.

That wasn't so hard, was it? Yes, southern Coma is clogged with DSOs, but as long as you keep your wits about you and your charts at hand, navigation can be easy and even fun. Relax. We're done with this challenging part of the constellation, now.

NGC 4725

For the next two objects we jump back to the northwestern area, the same part of Coma we visited for NGC 4565. At 2° 3′ south of 31 Comae, we find NGC 4725, an oval, magnitude 9.40 phantom glowing bravely despite a size bordering on the large, 10.4′ × 7.2′ of arc in images. This DSO can be slightly tricky to find, since there aren't any bright stars in its immediate area. One tip-off is a prominent (in a 50-mm finder) magnitude 6 star, HR 4864, that is 45′ farther south than the galaxy and almost on a line running from 31 and through NGC 4725.

In the C11, this near face-on SAB galaxy appears as a prominent oval haze 2′ in size. I noted a bright core and strong elongation east–west. Observers with darker skies than mine often report seeing details near the nucleus in NGC 4725, possibly evidence of this barred spiral's arms. I've never seen or suspected that in the city, however.

NGC 4559

This amorphous galaxy is easier than NGC 4725 when it comes to locating, but harder to observe. It's in the Western part of Coma, 2° from Gamma, and about 2/3 of the way along a line drawn between 31 Comae and Gamma Comae, almost directly north of NGC 4565. This is another big one, a strongly elongated SBc barred spiral that

stretches 11.0′ × 4.9′ and glows weakly at magnitude 10.5. I didn't expect much, not even with the 12.5″ Dobsonian, so I wasn't disappointed:

> A challenging patch of nebulosity. A small triangle of bright field stars makes this a more difficult object than it would probably otherwise be. Definitely not easy. I think I see a shapeless or maybe oval (?) form a few minutes across.

NGC 4147

Let's finish our evening's walk with an object that's definitely not a showpiece, but which is something of a surprise and considerably more entertaining than NGC 4559. Coma Berenices contains two globular clusters, right? Sure, everybody knows that! Wrong. There are *three*. The third is little NGC 4147, a 4′ smudge glimmering dimly at magnitude 10.3. This faint fuzzy is in the barren southwestern area of the constellation, well to the west of the galaxy packed Virgo border, but it's not *too* difficult to find, since it forms a triangle with 5 and 11 Comae, and is only 2° from either star.

I stuck to larger aperture for this Class VI globular, the 11-inch Schmidt Cassegrain, since I hoped to tease a star or two out of it at high magnifications. It will no doubt be visible in smaller telescopes given its fairly small size despite its seemingly punishing magnitude (for a DSO in the city). I *was* pleased with its appearance, though, try as I might, I could not make any stars appear on this particular evening:

> A little blob of a glob that stands out amazingly well at 127× in the C11. It was very obvious the second I put my eye to the eyepiece after the go-to slew finished. It's a bright core with an envelope of dim nebulosity extending 1′ outward on all sides. Going to magnifications of 300 × −500× did not resolve any stars, but did cause the cluster to take on a grainy appearance, as if it were on the edge of resolution. I'll definitely come back to this one.

I realized from the beginning that it would probably take very dark skies and at least the 12.5-inch scope to pick *any* stars out of NGC 4147, but I'll keep trying, hoping to be proven wrong. That is the essence of City Lights deep sky astronomy.

Tonight's Double Star: 24 Comae

24 Comae is wide and easy with a separation of 20.4 arc seconds between its two stars. What makes this pair notable is that the color contrast between the magnitude 5.2 primary and the magnitude 6.7 secondary results in a case of "false color" for the dimmer star. In reality, the primary is a strong orange and the secondary is white, but, as is often the case with this color combination, your eye and brain insist that the dimmer star must be an amazing emerald green. There are no green stars, but you'll find that hard to believe after observing this interesting double.

The subdued combined magnitude of the pair, 5.2, and its presence among the hordes of cluster stars in Melotte 11 make 24 somewhat difficult to find without go-to or setting circles. Luckily, the star forms a near right triangle with Alpha and Beta, so

it's not hard to position the scope on the right spot. The large separation between the primary and secondary stars means you can use a low-power eyepiece, which should turn up this pair of gems with ease.

> Even just hitting the highlights of Coma Berenices leaves me breathless. There's so much here to study and admire. And I'm not alone. Today, so long after the fabled king and queen have returned to dust, sky watchers everywhere still gaze in awestruck wonder at Berenices' shining and immortal tresses.

Tour 4

In the Arms of the Maiden

Virgo is scary. I don't mean the goddess, the Greek goddess Persephone who's sometimes identified with Virgo. *She* seems to have been something of a shrinking violet, acquiescing to Hades with only minimal protest, and eating those pomegranate seeds willingly enough. It was her Mother, Demeter, you had to look out for, unless you like cold weather. When I say "scary," I'm talking Virgo the *constellation* and Virgo the *cluster of galaxies*.

When I first began observing the deep sky many years ago, I was eager to navigate the Great Virgo Supercluster. Where else can the urban astronomer confront galaxy after galaxy, many of which are bright Messiers? There are *eleven* Messier galaxies within Virgo's borders. After a few nights with the Maiden, however, I turned-tail and *ran*. I didn't dare the area Hubble called the "Realm of the Nebulae" again for several years. Because I couldn't find any of Virgo's objects in my moderately light-polluted skies? No. Because I found *too many of them*. Even my 4.25-inch reflector delivered faint fuzzy upon faint fuzzy. I was seeing many galaxies, but had no idea *which* galaxies I was seeing, became hopelessly confused and withdrew.

Obviously, I finally made my way back to Virgo and found success there, both in the city and the country. What made the difference? Having the proper tools and a *plan*. Nowhere in the sky is it more critical to have a detailed star atlas. Virgo features a few bright stars like her lustrous magnitude 1.0 sapphire, Spica, but is, overall, a subdued constellation. The area where most of the galaxies reside, within the "arms" of the "Y" in the western part of Virgo, lacks prominent guide stars. During my first attempts at the constellation, I was using the time-honored *Norton's Star Atlas,* which only shows stars down to magnitude 6, and it was almost worthless for the task. In *Norton's*, the area of interest between Virgo's arms has the prominent galaxies marked, yes, but far too few stars are shown to help the star-hopping galaxy hunter pick his steps. Even if there had been more stars indicated, I probably wouldn't have seen them in my paltry 25-mm finderscope. Equipping myself with Becvar's *Skalnate Pleso Atlas* (the forerunner of *Sky Atlas 2000*) and a 50-mm finder made all the difference in the world.

I also had a plan. The secret to navigating Virgo, as laid out in Chapter 3, is to *eyepiece hop* from galaxy to galaxy. Virgo is so crammed with objects that it is eyepiece-hopping heaven. You'll use *Sky Atlas 2000* or another similarly detailed atlas to plan your general itinerary, but your mainstay will be computer-generated charts similar to the one in Figure 6.9. As mentioned earlier, any modern computer-aided-astronomy program can produce roadmaps like this, but if you're a penny-pincher like me, you'll use the free *Cartes du Ciel*. If you don't have access to a computer, a few pages photocopied from *Uranometria 2000* and marked by hand with appropriate eyepiece field circles will work as well. If you are using a PC, zoom-in on the area between the arms, click on the first galaxy of interest, plot an eyepiece circle that corresponds to your setup, and move to the adjacent object on your list. You're making *stepping stones* through the sky—that's what these field circles are. You will also want to adjust the stellar

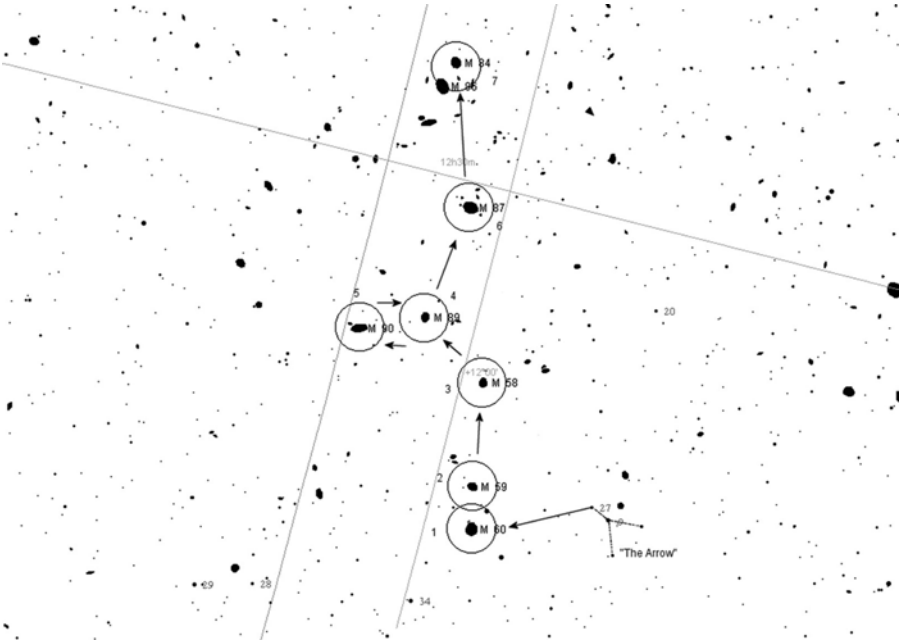

Figure 6.9. Virgo Star Hop.

magnitude settings of the program in order to have only those stars that are likely to be visible with your telescope and eyepiece combination displayed and printed on your charts.

Not sure how deep your telescope and eyepiece will go? Pick an area around an easily identifiable landmark star, maybe Rho Virginis, and print out a series of charts of the star's area overlaid with eyepiece circles that match your ocular and scope setup. Make several charts, each going dimmer in magnitude, point the scope at the area, and see which chart matches up best with what you see in the eyepiece you plan to use while hopping.

Which eyepieces are most appropriate for conquering the Virgin? Review the accessory section earlier in this book, but, if you're on a budget, some of the new imported Chinese wide-field eyepieces are very inexpensive and sport generous apparent fields of view. Newer ones sometimes give you as much as 80° of apparent field, which is perfect for eyepiece hopping. You will also want to stick with an eyepiece that gives you medium magnification—125× was optimum for my skies. If you can't find one of the inexpensive 2-inch wide-field eyepieces with a short enough focal length to give you powers in this range with your telescope, consider a 2-inch Barlow. Imported ones of good quality are now available to go along with the imported 2-inch format eyepieces.

How about scopes? What's needed for success in the Realm of the Nebulae? As we found in our wanderings through Leo and Coma, galaxies are dim. That's just the way it is. On a very superior night in the city, you should be able to do any of the following

with a 6-inch scope. On poorer nights, or from really badly light-polluted areas, though, any or all of these *may* be invisible in an 8-inch scope. When I was making my "test runs" for this tour, I chose to throw all the aperture I had at Virgo—12.5 inches. On all but the very worst, haziest nights, the 12.5-inch Dobsonian would reliably bring back all of these galaxies, and would often show me the fainter "companion" galaxies that frequently reside in the same fields as the target objects in this crowded area.

The tour that follows is necessarily only a sample of Virgo, and a small one. It doesn't exhaust the Messiers in Virgo, and many of the multitudinous NGC galaxies marked on your charts will also be visible in light-polluted skies. This selection will show you the technique for eyepiece hopping and will whet your appetite for more of the Great Virgo Cluster.

Before getting started, I want you to know a little more about the area you'll be traversing. It's not mere hyperbole when I refer to the *Realm of the Galaxies* (as we now know Hubble's "Nebulae" to be) as "awesome," "mind bending," or by some equally extreme adjective. This crowd of galaxies deserves all that and more. The Virgo Cluster is a great grouping of island universes that stretches from north to south across our spring skies. By conservative estimates, it contains at least 2000 galaxies ranging from inconsequential dwarfs like our own galaxy's Magellanic Clouds to monstrous heavyweights like the frightening M87, a great elliptical galaxy residing near the cluster's heart and containing, at a conservative estimate, *100 times* the mass of our own (large) Milky Way. The center of the Virgo Cluster is roughly 65 million light years away, and is itself is a component of a larger structure, the Local Supercluster of galaxies, that also encompasses Coma's many members.

The Jumping-Off Point

In addition to good charts, finders, and eyepieces, there's one other critical need for wending your way through all these island universes: a convenient jumping-off point. That is, a star or asterism near your first target that will get you going and to which you can easily return or backtrack to if you get lost. As mentioned in the initial discussion of *eyepiece hopping* in Chapter 3, we'll use a little "Y" of stars in northern Virgo. When I talk about a "Y" in this case, I don't mean the great form of the constellation, but the little grouping of stars centered on Rho Virginis as shown in Figure 6.9. This asterism stands out well in a 50-mm finder and you shouldn't have much trouble getting there from epsilon Virginis. Position that "Y" in your finder, and lets go to town—to downtown Virgo.

M60

Our first stop is M60, a nice, bright magnitude 8.8 Messier elliptical. It's a good place to begin our quest, even if featureless ellipticals like this one are the least interesting galaxies to view under any conditions. If you're properly positioned on the Little Y, finding M60 is a pure joy. Think of the Y as an arrow pointing the way to the galaxies

of Virgo. Starting from the "tip" of the arrow, 27 Virginis, move your scope 1° 14′ north and just slightly to the east.

Once you're on the field, you should immediately see at least one dim specter of a galaxy. If you're lucky, you may notice another faint fuzzy. There's a dimmer object, the small, magnitude 11.9 spiral, NGC 4647, there, too, but identifying M60 is not a problem; it is the obviously larger, brighter galaxy. Under fair seeing and transparency on a March night, the 12.5-inch reflector didn't make M60 overly exciting, but it was nice to be successfully started on my way across the Virgin:

> M60 is bright and unmistakable with direct vision in the 12-mm eyepiece. It's about 2′ in diameter tonight, and looks perfectly round with subtle hints of a small, bright core. No hint of NGC 4647 this evening. Two bright field stars make this an attractive area.

Since this is an elliptical, there's little more than this to expect from any telescope under any conditions. With dark skies and large scopes, M60 gets bigger, but is just a bigger featureless ball. Although this is a not-quite-round E2, it's going to be very difficult to make out such a small amount of elongation visually in any instrument.

M60, the easternmost of the Virgo Messiers, may not look impressive, but its stats reveal this as *one big sucker*. At 60 million light years out, its 7.2′ × 5.9′ disk corresponds to a true size of 120,000 light years across. Its mass is estimated at around 60 billion Suns. In photos, the little accompanying galaxy, NGC 4647, appears disturbed, and it is thought that it has had an ancient encounter with M60. In the heart of Virgo, interactions like this are common and often result in the smaller spirals being "devoured" by the great ellipticals, who just get fatter and fatter as the ages pass.

M59

So, you thought M60 was an easy find? The hop to M59 is even more effortless. It is 25′ to the west from M60, so all you have to do is gently nudge your scope, moving slowly west while continuing to look through the main scope's eyepiece. Like M60's field, M59's field also contains two bright stars. These make the field more distinctive, but the galaxy doesn't need any help. It is one of the more interesting and attractive objects on tonight's journey. When you stop your scope, a magnitude 9.6 oval of light should be obvious. While this is an elliptical, it's an $E5$ elliptical, a strongly oval thing well toward the lens shapes of the "late" elliptical galaxies and the S0 lenticulars.

In the eyepiece of a 6-inch $f/8$ reflector, M59 is lovely, if not overwhelming:

> M59 is strongly elongated, a little oval puff of smoke. No core, no outer envelope. Looks like a fingerprint smudge on black velvet. Despite this lack of details, this galaxy is one of the more unusual sights in Virgo. An odd little spot, sharply defined, and standing out from the background incredibly well.

M59 is another "giant" elliptical, if not quite as large as neighboring M60. It's 90,000 light years in extent along its major axis, approximately. As always, when we're talking about the sizes and distances of even relatively nearby galaxies, the watchword is "approximately," though astronomers are pinning down the true cosmic distances more closely every day. Like most elliptical galaxies, M59 is accompanied

by an unbelievably huge retinue of globular star clusters, 2000+ in this instance. The Milky Way, in comparison, owns an unimpressive 150 known globs.

M58

Let's press on! When you tire of admiring M59's ghostly oval flying saucer shape, it's on to M58, a bright barred spiral (an SBc). Getting there requires only a small jump, as the galaxy is 1° 3′ west of M59. In the field with the galaxy is a noticeable magnitude 8 star. The galaxy itself has a magnitude of 10.8, so it is on the dim side. At least it's small at 5.0′ × 3.8′, so telescopes of 8 inches and above in aperture should make quick work of it. I have noted that on poorer nights it can range from "invisible," to "almost there," to "hard" with my 8-inch $f/5$. Boosting the magnification to the 200× level always seems to bring it into view eventually. In a 10–12-inch scope, it's no problem whatsoever, even when it's hanging over the skyline in the early spring:

> I was hoping to see something other than another round smudge, and, at 200×, I believe I have. As the sky darkened to astronomical twilight, this galaxy grew to over 2′ in size in the 12.5-inch scope, and, in addition to a bright core and an outer envelope of nebulosity, I thought I could barely detect clumps or condensation in the nebulosity that might be signs of its spiral arms. At lower power, this is just another featureless Virgo ghost.

If you hope to see anything beyond the smudge level, be prepared to spend a lot of time and effort on M58. Out in the dark country, 8-inch telescopes have a chance of seeing indications of this galaxy's central bar, but this feature is considerably easier in larger telescopes, in which the galaxy begins to take on a spindle shape. You'd never know it to look at it, but this is one of the brightest galaxies in the Virgo Cluster. Our ability to see this large galaxy in the city is helped greatly by its bright nucleus. While not as obviously active as the nuclei of "peculiar," disturbed Seyfert galaxies like M94, M58's nucleus' high-luminosity does indicate that something similar may be going on in this galaxy.

M89

When you're ready, jump out into space again, 49′ to the northwest. The next field contains the magnitude 9.8 E0 elliptical M89. Like most smaller ellipticals (it's 5′ × 4.6′ in size), M89 shows up very well and is no challenge at all. In addition to the glowing ember that's M89, there are a few stars of 8th to 9th magnitude in the field, and quite a few dimmer ones, making for an attractive vista in my 12.5-inch Dobsonian. In that telescope, the galaxy looked good, if somewhat bland in typical elliptical fashion:

> Very bright with a stellar nucleus. A round featureless envelope of nebulosity surrounds this center, extending out about 1′ tonight. Bumped the magnification up to over 200×, but no additional detail beyond a little more nebulosity is seen—not that I expected much more than a round fuzzball from an E0.

Everywhere you go in Virgo, you find "Es." The presence of so many elliptical type galaxies may be due to the generally high density of galaxies in the Virgo cluster.

These plentiful ellipticals may be the final result of the collisions and interactions that must occur continuously within central Virgo. Like many elliptical galaxies, M89 is a radio source, and possesses a jet of matter flowing out from its nucleus and extending over 100,000 light years into space. This activity may be a sign that M89 is suffering "indigestion" after having recently swallowed a smaller companion.

M90

Once you're on M89, M90 is close at hand. Sweep—slowly, very slowly—40′ northeast and you'll be on M90's home field. Now, it is a good time to talk about identifying fields and landing on the *right* galaxies. When you've got two objects as close together as M89 and M90, a mere 40′ apart, a situation that you'll run into constantly in Virgo, there's always the chance of misidentification. Work slowly when you move onto your next target, looking intently at everything that passes through your field. Once you think you are on the correct object, use your finder chart to try to identify patterns of field stars.

There are almost always enough stars in any given area to allow you to positively identify your target. To make this as easy as possible, print out a whole series of charts with only one galaxy per page, showing stars right down to the limit of your scope's ability. Use these in conjunction with your "main" eyepiece hopping charts to help ensure you're on the "right" galaxy. Another help in positively identifying objects is remaining constantly aware of directions in your eyepiece and on your chart. If you've got two objects in the field of your eyepiece, reference your chart and determine what their compass positions should be relative to each other.

How do you tell if you're *really* on M90 and not M89? That's easy—if you know which direction is which in your eyepiece field. M90 is the more *northerly* of the two. Another easy tip-off is the way this one looks. It is nothing like the E0 type M89. M90 is an Sb spiral, and it *looks it*, showing obvious elongation, even with modest telescopes.

What did M90 look like once I was sure I was on it? It is large at 9.5′ × 4.5′, but even at magnitude 9.5, it, like the rest of the Messiers in Virgo, is not usually a challenge for a medium-aperture telescope:

> M90 is a large elongated galaxy in photos, but tonight, with my 12.5, it appears considerably smaller than either M58 or M89, and barely subtends 1′. Still, though, its oval shape is detectable, if not as easy as I've seen it in the past. Small, bright, prominent nucleus. By any standards, this is a dim DSO tonight. Don't know that I'd have seen it in an 8-inch scope.

In long-exposure photographs, M90 is much more interesting than it is visually in the hazy air and light pollution of my backyard, showing off a prominent central bar and several dusty patches in its images. This is one of the bigger spiral galaxies in Virgo, but it's not very massive. It also seems that this is a very sedate galaxy despite its Virgo cluster address, showing no signs of an active nucleus and little or no evident star formation in the spiral arms. These characteristics lead some astronomers to wonder if this might be a "transitional" form between spiral galaxies and the weird lenticulars, which, like ellipticals, have no star formation going on. Maybe. In most long-exposure photographs, plenty of dust is visible across the galaxy's disk, something ellipticals and lenticulars lack.

M87

Probably the easiest way to get to M87 is to *back up*. Instead of making a big jump to The Monster Galaxy from M90, go *back* to M89. From there, it's a straight, if still sizable leap in the dark to M87. Move 1° 12′, two medium-wide eyepiece fields, as shown in the chart in Figure 6.9. On all but the brightest and haziest nights there should be no doubt when you get to M87. It's a big, bright elliptical at magnitude 8.6 and 7′ in diameter. Like the rest of its elliptical kin, its large size doesn't make it difficult to find—it stands out like a neon sign:

> This monstrous galaxy is beautifully bright in the C11 SCT. Looks just like M13 does in my 80-mm refractor at low power—a round, unresolved, and smooth ball of light. There's a bonus object here, too, the faint smudge of galaxy NGC 4476 12.5′ from M87. This small spiral galaxy is just a fuzzy mote, but is easy to see. A *Skytools* chart shows four other small galaxies brighter than magnitude 14 in this field, but I don't see any of them. As for M87, I don't see a nucleus, just a smooth brightening to its center.

I keep referring to M87 (Plate 33) as a "monster" or "monstrous." Why? This thing is *bizarre* and is of a size and majesty that's difficult for the human mind to encompass. M87 stands alone and apart from its 2000 fellow residents of the Virgo cluster. It's the *biggest*, *brightest* (intrinsically), and *strangest* of them all. At least 100 times the mass of our not-exactly-small Milky Way, and blazing with the fire of a *trillion* Suns, M87, sits near the center of the Virgo cluster, a fat old spider in its web, gobbling any of the unwary inhabitants that pass too close to its massive form. And it sings. It warbles a mindless song across the dark light years in its guise of radio source *Virgo A*. M87's radio voice is the result of violent processes taking place in its nucleus. In addition, M87 spits fire across 5,000 light years with a jet of tortured matter that is so luminous that it has even been detected by very large amateur telescopes from very dark skies at very high magnifications. The only engine we know of that can generate these titanic energies is a truly massive black hole.

M84 and M86

M84 and M86 are both classified as lenticular S0 galaxies, lens-shaped featureless bodies that don't reveal any details beyond their basic shapes, no matter how big you go telescope-wise or how dark you go sky-wise. The wondrous thing here is that you've got two bright galaxies (magnitude 9.1 and 6.7′ × 6.0′ in size, and magnitude 8.9 and 9.8′ × 6.3′ across, respectively) only 16′ apart.

These two galaxies, shining like bright cat's eyes in the darkness—the pair has long been known to amateurs as "The Eyes"—are also, amazingly and amusingly, accompanied by a "nose" and a "mouth." The nose is formed by small, round magnitude 12.0 NGC 4387, and the mouth is made by the appropriately edge-on magnitude 11.0 NGC 4388. When you've got the conditions and aperture required to see the fairly challenging nose and mouth in addition to the easy eyes, these distant, wondrous objects taken on the positively comical appearance of a 1970s "have a nice day" happy face (Plate 34). This is a great field even if *all* you can see is The Eyes, however (sketched in Figure 6.10):

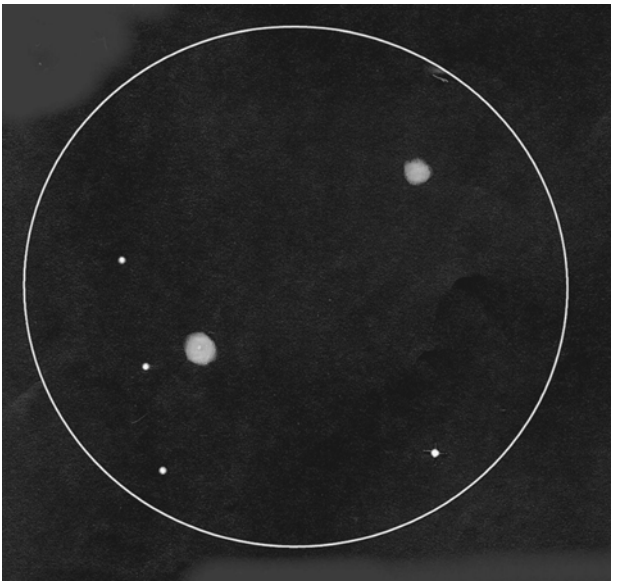

Figure 6.10. M84 and M86, The Eyes.

The eyes both appear round, with M84 being the larger and brighter of the two. M84 also displays a tiny, obvious core—M86 does not. Both are beautifully framed in the field of the 12-mm Nagler in my 12.5-inch Dobsonian Newtonian. Tonight I'm only seeing the two bright galaxies in this usually packed field—Nose and Mouth are invisible.

Tonight's Double Star: Gamma Virginis , Porrima

Just as there are more and less challenging galaxies, there are more and less challenging double stars. Magnitude 3.5 Porrima is certainly bright and easy to find—it marks the spot where Virgo's Y shaped arms join her body—but it can be a little tough to resolve. The primary and secondary are both the same magnitude, 3.5, and that usually makes for an easy split—the toughest doubles are those with a primary and secondary star of very unequal magnitudes. However, these two stars are currently (1995) near their minimum separation. Their 169-year mutual orbit has brought them to within a difficult 0.4″ of each other, meaning that a 10-inch scope at high power is required to give even a hint of resolution.

Even when the pair was 3.5″ apart years ago, Gamma Vir was usually not quite split by my 4.25-inch scope, appearing like a little "figure 8" with the two yellowish-white stars' airy disks in contact. Despite this difficulty, Porrima is a great double star to observe as a long-term project, especially if you own a medium-aperture instrument.

It actually *does something*. Over the next several years, the separation between these two gems will begin to increase and the change will be detectable visually.

> "Packed field" is right. M84 and M86 reside very near the core of the Virgo cluster, and there are galaxies everywhere. Under a suitably dark country sky, this is one of the most rewarding spots in the heavens. In a 12.5-inch telescope from magnitude 6 naked-eye conditions, I can count at least seven other galaxies in this half-degree field in addition to the two lenticulars. This vista—or even just the two bright galaxies—evokes genuine awe. The combined light of how many trillions of suns is visible at once in my eyepiece? It makes me feel small and pitiful, and makes all the works of man seem insignificant. Then I take heart. The stars blaze on unknowingly, but we are able to take-in their majesty and use it to fuel our dreams.

Special Bonus Object

The Inhumanly Distant 3C 273

Cosmic distances are not easily grasped by the human mind. Even the paltry 1.8 billion miles from Earth to the planet Pluto is hard to come to grips with. Get beyond the home galaxy, out in the deep waters of intergalactic space, and the stated distances to the island universes lurking there become essentially meaningless. What's the difference between 20 million light years and 60 million light years when 2 billion miles seems incomprehensible? But the next step on the cosmic distance ladder, to the mysterious quasars, helps put everything in perspective. 60 million light years doesn't seem far away at all and seems easy to visualize when you contemplate an object nearly 3 *billion* light years distant.

3C 273, the 273rd object in the Cambridge catalog of quasars, "Quasi Stellar Radio Sources," is 2.6 billion light years away and is probably the most distant object you and your telescope can hope to view from the city. Surprisingly, considering how far away it is, it is trivial to see, shining at magnitude 12.8. A magnitude figure dimmer than 12 may make you a bit skittish after finding out that 10th magnitude galaxies are sometimes difficult to see with urban scopes, but the quasar is a star-like point, so it is not nearly as hard as a 12th magnitude extended object. 3C 273 is doable with an urban 6-inch telescope at high magnification, and is quite easy with 8-inch and larger instruments.

No, seeing is not the problem with 3C 273. It's the brightest of these odd objects. Unfortunately, finding and identifying it *are* difficult at best. The easiest way to locate this quasar is with a go-to-equipped telescope. Even then, be prepared to use a detailed finder chart generated with a computer program to help you to decide which "star" in your field is really 3C 273. If your go-to telescope has a "precision pointing" mode, this is the time to use it. The closer you can put the quasar to the center of your field after a go-to slew, the easier identification will be. Digital setting circle users certainly have an advantage over star hoppers, but even with DSCs you'll have to do considerable searching, as it's unlikely that your circles are good enough to put objects dead center in the field every time.

If you have neither go-to nor digital-setting circles, be prepared to work hard for this object. Even experienced observers should be prepared to spend a half hour to an

hour looking for it the first time. Your starting position is within the arms of Virgo, to the east of the galaxies we've visited on this tour. The quasar forms a right angle with Eta and Gamma Virginis, being about 3° 30′ north of Eta and 4° 45′ west of Gamma. There are no bright stars in the area, so the way to find 3C 273 will be to work slowly with a series of detailed charts, matching the field stars shown on them to what you see in your finder and main scope.

Once found, what exactly will you see? Not a whole lot. In any scope. Even the Hubble Space Telescope has trouble picking out details in quasars. You'll see nothing more than a somewhat distinctive looking blue star-like point. It's not much to look at, no, but I hope you'll be content with the wonder evoked by the significance of 3C 273. You're seeing an object so old that when light set out from it, life, simple life, was barely establishing a foothold on our home planet.

Quasars were discovered in the late 1950s when astronomers began noticing odd radio sources. These were soon linked to dim star-like objects. When these "Quasi Stellar" objects were observed with spectroscopes, their spectra revealed Fraunhofer lines hugely shifted toward the red end of the spectrum, indicating the quasars are receding at huge velocities. This huge Doppler shift also means they are very distant, some of them near the edge of the observable universe.

Over the years, the best guess as to what quasars are has been that they are the visible signs of extremely massive black holes at the centers of young galaxies. These black holes must be feeding off torrents of in-falling matter, and are almost unimaginably bright. Quasars, then, are the ancient and far more active cousins of the active galactic nuclei seen in familiar objects like galaxy M94. The Hubble Space Telescope has revealed what appears to the haze of "host" galaxies around some QUASARS, seeming to prove this theory to be correct, but there is still much that is unknown about these ancient objects.