How do you get to Albireo?

A while back I spent a couple of years teaching physics in Africa, as a volunteer with the US Peace Corps. At one point during my service I had to return to the US for a month, and while I was home I visited with my friend Dan in New York City. We got to talking about the beautiful dark skies in Africa, and the boundless curiosity of my students about things astronomical … and so that afternoon we went into Manhattan and, with Dan's advice, I bought a little telescope to take back with me to Kenya.

Dan was far more excited about my purchase than I was. He'd been an avid amateur astronomer since he was a little kid, something of an achievement when you're growing up in the grimier parts of Yonkers and your eyesight is so bad you can start fires with your glasses. And he was just drooling over some of the things I'd be able to see in Africa.

I didn't really understand it, at first. You see, when I was a kid I'd had a telescope, too, a little two-inch refractor that I had bought with trading stamps. I remembered looking at the Moon; and I knew how to find Jupiter and Saturn. But after that, I had sort of run out of things to look at. Those glorious color pictures of nebulae that you see in the glossy magazines? They're all taken with huge telescopes, after all. I knew my little telescope couldn't show me anything like that, even if I knew where to look. And of course I didn't know where to look, anyway.

But now here was Dan getting all worked up about my new telescope, and the thought that I'd be taking it back to Africa, land of dark skies and southern stars. There were plenty of great things to look at, he insisted. He gave me a star atlas, and a pile of books listing double stars and clusters and galaxies. Could it be that I could really see some of these things with my little telescope?

Well, the books he gave me were a big disappointment. At first, I couldn't make heads or tails of their directions. And even when I did figure them out, they all seemed to assume that I had a telescope with at least a six-inch mirror or lens. There was no way of telling which, of all the objects they listed, I might be able to see with my little three-incher.

Finally, Dan went out with me one night. "Let's look at Albireo," he said.

I'd never heard of Albireo.

"It's just over here," he said. "Point it this way, zip, and there you are."

"Neat!" I said. "A double star! You can actually see both of them!"

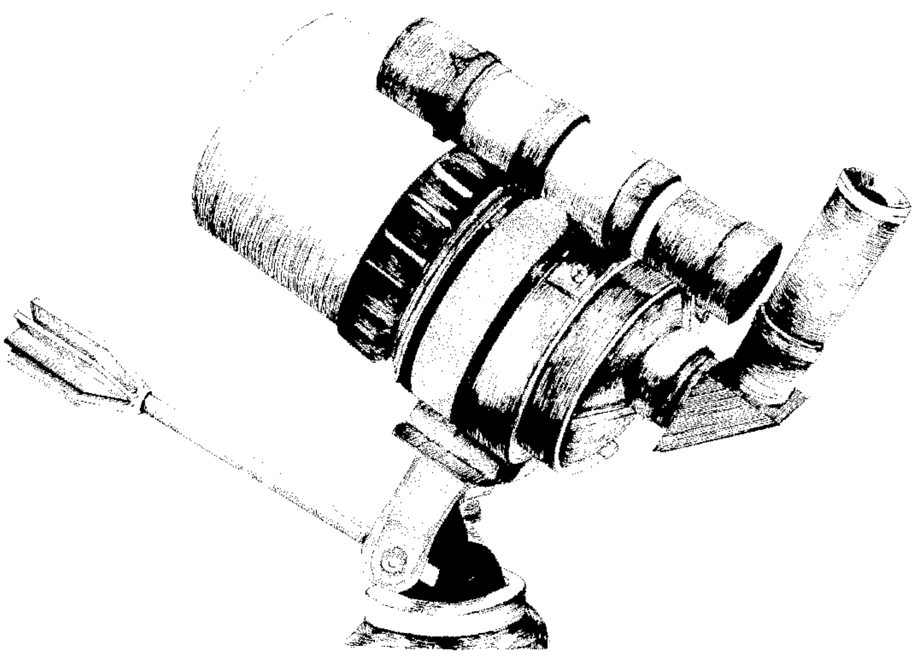
"And look at the colors," he said.

"Wow … one of them's yellow, and the other's blue. What a contrast."

"Isn't that great?" he said. "Now let's go on to the double-double."

And so it went for the next hour.

Eventually it occurred to me that all of the books in the world weren't as good as having a friend next to you to point out what to look for, and how to find it. Unfortunately, I couldn't take Dan back to Africa with me.



I suspect the problem is not that unusual. Every year, thousands of telescopes are sold, used once or twice to look at the Moon, and then they wind up gathering dust in the attic. It's not that people aren't interested – but on any given night there may be 2,000 stars visible to the naked eye, and 1,900 of them are pretty boring to look at in a small telescope. You have to know where to look, to find the interesting double stars and variables, or the nebulae and clusters that are fun to see in a small telescope but invisible to the naked eye.

The standard observer's guides can seem just incomprehensible. Why should you have to fight with technical coordinate systems? All I wanted to do was point the telescope "up" some night and be able to say, "Hey, would you look at this!"

It's for people who are like I was when I was starting out, the casual observers who'd like to have fun with their telescopes without committing themselves to hours of technical details, that we decided to write *Turn Left at Orion.*

— Guy Consolmagno (Easton, Pennsylvania; 1988)

Introduction to the Fourth Edition:

A lot has happened in the quarter century since Dan first showed me Albireo. Back then, we would have to tip-toe when coming in late, so as not to wake up his kids; Dan and Léonie's babies are grown up now, almost as old as we were when we first started working on this book. In 1983, I had given up a research job at MIT to join the Peace Corps; in 1989, I gave up a professorship at Lafayette College to enter the Jesuits, who assigned me to the Vatican Observatory in Rome. For the last 20 years I've been doing full-time research again … and still traveling.

I also still have my 90-mm scope. But now I get to observe with the Vatican Advanced Technology Telescope on Mt. Graham, Arizona – a 1.8-meter reflector whose optics and controls, including the world's first large spin-cast mirror, are test beds for the telescopes of the twenty-first century. And I've gotten to use bigger telescopes, including the 10-meter Keck in Hawaii. Dan, more modestly, has upgraded to a Schmidt–Cassegrain 8" and a 10" Dobsonian.

It's not only our personal lives that have changed. In the last twenty-five years, major developments have occurred in the world of amateur astronomy.

Amateur telescopes have changed: the Dobsonian design has put 8" mirrors in the price range of nearly everyone. Meanwhile, computer-controlled production techniques have made small catadioptrics better than ever, while holding the line on prices. So why settle for a little three-incher any more?

Personal computers, and the astronomy software that runs on them, have changed the way most of us find objects in the nighttime sky. For the first edition, we drew our star charts by hand, in ink; now we are also guided by *Voyager* and *Starry Night* for finding star positions. You can use your PC to look up the positions of comets, asteroids, and the outer planets and print out customized finder charts for your observing location. In fact, you can buy a computer-controlled telescope; just punch in some numbers, and the scope slews itself to the pre-programmed object. With all this convenience, who needs a book?

And finally, if you really want to see spectacular astronomical sights you can just log on to the Internet. So, for that matter, who needs a telescope at all?

And yet … there we were last night, peering at double stars with both an 8" Dobsonian and my old 3" Cat. The Dobsonian showed us some glorious sights; it's no wonder they're so popular. Still, for the sheer fun of the hunt, not to mention portability to dark sites, it's hard to beat a three-incher!

With that in mind, we've taken advantage of this new edition to completely revisit our favorites from twenty-five years ago. Everything in this book has been re-observed, with both a small Cat and a Dob. We include a number of additional objects for people with Dobsonians, telescopes larger than we had envisioned in our earlier editions. This includes many new "neighborhood" objects, including objects that are beyond the typical 3" but within the range of a Dob.

And we've added telescope views oriented for how they'd look in a Dob, with more detail and in the mirror image of our original telescope views. To accommodate the extra images, our editors at Cambridge University Press have given us bigger pages for this edition, not to mention a spiral binding. Now your grass stains can extend across the entire page!

We've re-ordered the spreads, and re-written the finding directions … in twenty-five years, light pollution has gotten worse (and my eyes, older) – I find it's harder to see some of those dim stars we used to use for star-hopping.

We've updated the planet and eclipse tables, of course; and we've noted new positions for double stars that have moved in their orbits since the first edition came out.

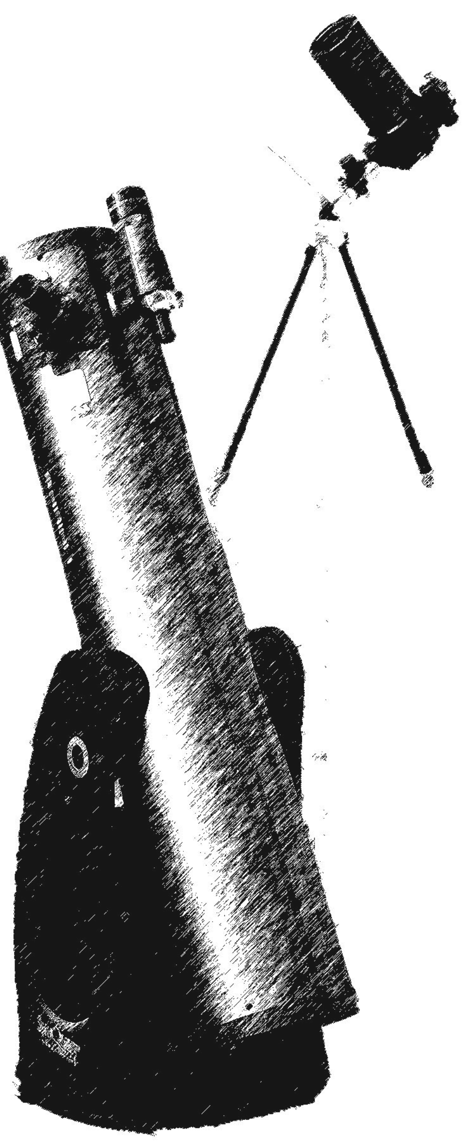
And we've gone back to the southern hemisphere to re-observe and expand our list of deep-sky objects visible only from that part of the world that it would be a crime to miss for anyone living or visiting there.

But our basic philosophy has remained unchanged. We still assume you have a small telescope, a few hours' spare time, and a love of the nighttime sky. *Turn Left at Orion* is still the book I need beside me at the telescope. We're delighted that other folks have found it to be a faithful companion, as well.

— Brother Guy Consolmagno SJ (Castel Gandolfo, Italy; 2011)

How to use this book

This book lists our favorite small-telescope objects, arranged by the months when they're best visible in the evening and the places in the sky where they're located. For all these objects, we assume you have a telescope much like one of ours: either a small scope whose main lens or mirror is only 2.4" to 4" (6 to 10 cm) in diameter; or a modest Dobsonian with an aperture of 8" to 10" (20 to 25 cm). Everything in this book can be seen with such small telescopes under ordinary sky conditions: it's how they looked to us.



The facts of life about small telescopes

How night-sky objects look in a telescope depends on the kind of telescope you have. That, in turn, will determine the sort of objects you will want to observe. We talk at great length later in this chapter about different kinds of telescopes, but it's worth outlining here at the start a few basic telescope facts of life.

A good telescope can magnify the surface of the Moon, reveal details on the small disks of the planets, and split double stars. But just as importantly, it can also gather light and concentrate it at the eyepiece to make faint nebulae bright enough for the human eye to see. A telescope's light-gathering ability, or *aperture*, is key.

Every telescope has a big lens or mirror to gather in starlight and bring it to a focus near the eyepiece. The bigger the lens or mirror, the more light it can capture. All things being equal, then, bigger is better. But in the real world, all things are never equal. Thus there are a variety of different ways to gather that light. For this book we've divided scopes into three classes: binoculars, small telescopes, and Dobsonian telescopes. They each have their strong points and weaknesses.

Binoculars are relatively inexpensive, very portable, and they give you a great field of view. Furthermore, by using both eyes most people can pick out more detail in a faint nebula seen with binoculars than you would using a single telescope of the same aperture. Still, their very portability means that they're usually limited to an aperture of a couple of inches, maximum. And most binoculars don't attach easily to a tripod, making it hard to keep them steady and fixed on faint objects.

At the other extreme, a *Dobsonian* is essentially a big mirror at the bottom of a large lightweight tube, with the eyepiece at the top, all fixed in a simple mount. It has fantastic light-gathering power. But Dobs are very awkward to take on trips, or even just to carry into your back yard for a brief look at the sky. And their simplicity comes at a sometimes subtle cost to their optical quality.

In between are the small telescopes, ranging from the classic refractors (a tube with a lens at each end) to the more sophisticated *catadioptric* designs that combine mirrors and lenses in a compact package. "Cats" are portable and powerful; but to gather as much light as a "Dob" you have to spend about four times the money. Still, a small Cat prowling through dark skies can outperform a big Dob fighting city lights. Note also, as we explain below, Cats and refractors use a star diagonal and that gives them a view of the sky that's the mirror image of what's seen in binoculars or a Dob.

We provide two views for each object in this book: one is the view with a small Cat or refractor, the other the view in a larger Dob. For binoculars, use our finder-scope views as a guide. If you're lucky enough to have an 8" Cat, you'll see the greater detail in our Dob views, but with the orientation of the Cat view.

Finding your way

Once you've got your telescope, where do you point it? Answering that question is what this book is all about.

There are two classes of night-sky objects. The *Moon* and *planets* move about in the sky relative to the stars; fortunately they are bright enough that it's easy to find them. *Seasonal objects* – double stars, clusters, nebulae, and galaxies – stay fixed in the same relative positions to each other, rising and setting together each night, slightly faster than the Sun, thus changing location slowly as the seasons change.

The Moon and planets: Finding the **Moon** is never a problem; in fact, it is the only astronomical object that is safe and easy to observe directly even in broad daylight. (Indeed, unless you're up in the wee hours of the morning, daytime is the only time you can see the third quarter Moon. Try it!)

The Moon changes its appearance quite a bit as it goes through its phases, and for each phase there are certain things on the Moon that are particularly fun to look for. We've included pictures and discussions for seven different phases of the Moon, plus a table showing when to expect lunar eclipses, and what to look for during them.

Planets are small bright disks of light in the telescope. In a Dobsonian, with a Barlow lens, they can be spectacular to look at! But even a pair of binoculars will be able to show you the phases of Venus and the moons of Jupiter.

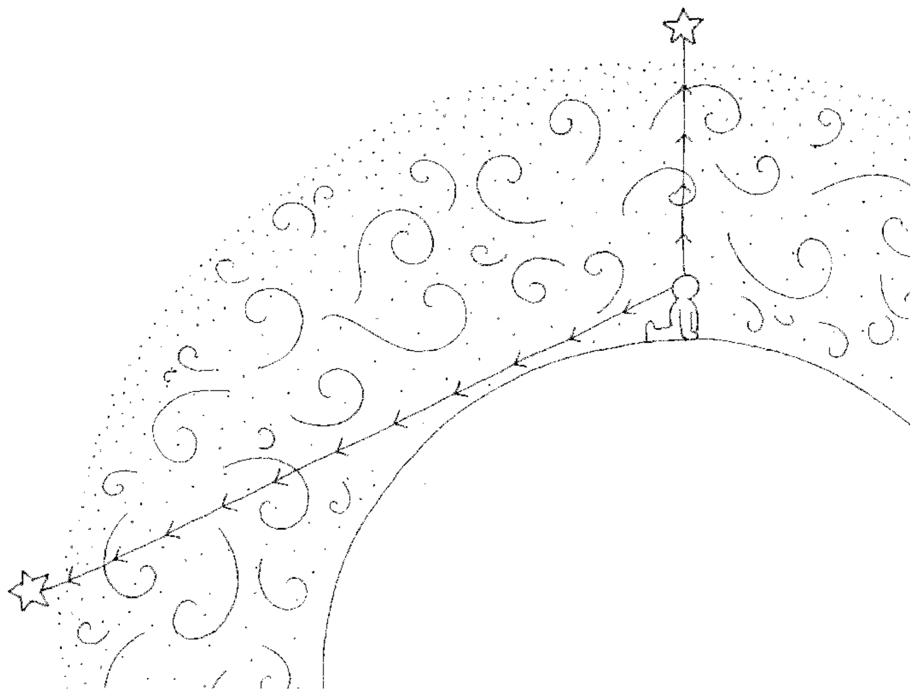
The positions of the planets, relative to the other stars, change from year to year; but if you know in general where to look for them, they're very easy to find.

Cambridge University Press
978-0-521-15397-3 - Turn Left at Orion: Hundreds of Night Sky Objects to See in a Home Telescope – And How to Find Them: Fourth Edition
Guy Consolmagno and Dan M. Davis
Excerpt
More information

They're generally as bright as the brightest stars. We give a table of when to look for each planet, and we describe little things you might look for when you observe them.

The seasonal objects: The stars, and all the *deep-sky objects* we talk about in this section, stay in fixed positions relative to one another. But which of those stars will be visible during the evening changes with the seasons; objects that are easy to see in March will be long gone by September.

How do you know, on any given night, what objects are up? That's what the **What, where and when** chart at the back of the book is all about. For a given month, and the time when you'll be observing, it lists each of the constellations where seasonal objects are located; the direction you should turn to look for that constellation (e.g. W = west); and if you should be looking low, towards the horizon (e.g. "W – "), or high up (e.g. "W + "). Constellations marked with only a "++" symbol are right overhead. Then you can turn to the seasonal pages to check out the objects visible in each constellation available that night.



When you look directly overhead, you don't have to look through as much dirty, turbulent air as you do when you look at something low in the sky. Try to avoid looking at things near the horizon.

If you live in the north, stars to the south never do rise very high; there's nothing you can do about that. (Southern-hemisphere residents have the same problem with northern stars, of course.) But stars along the other horizons will appear higher in the sky during different seasons, or at different times of the night.

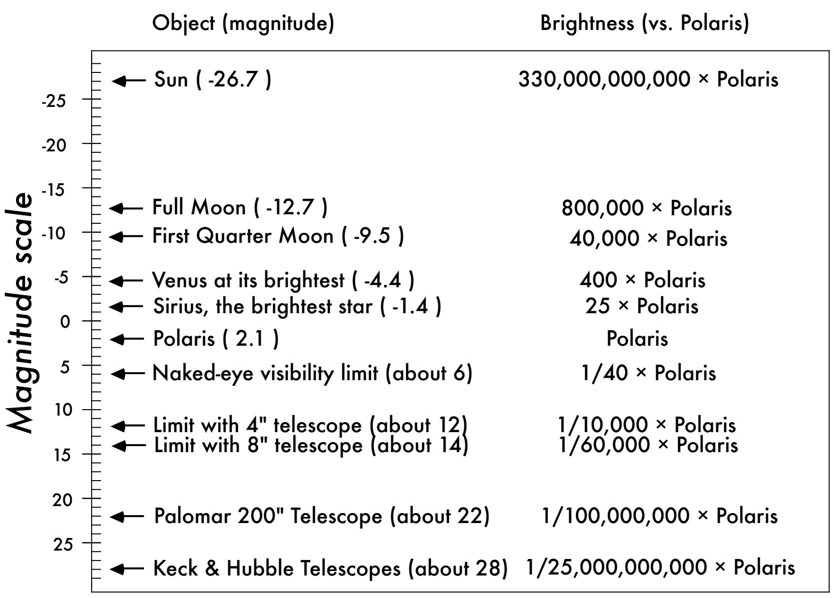
But note, you don't need to memorize the constellations in order to use this book. Constellations are merely names that astronomers give to certain somewhat arbitrarily defined regions of the sky. The names are useful for labeling the things we'll be looking at; otherwise, don't worry about them. If you do want to know the constellations, there are a number of good books available (our personal favorite is H. A. Rey's *The Stars*) but for telescope observing, all you need is an idea of where to find the brightest stars, to use them as guideposts.

Note that the brightness of a star, its *magnitude*, is defined in a somewhat counter-intuitive way that goes back to the ancient Greeks: the brighter a star, the lower the numerical value of its magnitude. The common rule is that a star of the *first magnitude* is about 2½ times brighter than a *second-magnitude* star, which is about 2½ times brighter than a *third-magnitude* star, and so forth. The very brightest stars can be zeroth magnitude, or even have a negative magnitude! The star Vega has a magnitude of 0; Sirius, the brightest star of all, has a negative magnitude, –1.4. There are only about 20 stars that are first magnitude or brighter. On a dark night, the typical human eye can see down to about sixth magnitude without a telescope.

We start off each season by describing the location of our **guideposts**, a selection of the brightest and easiest stars to find in the evening skies. Most of our readers are in the northern hemisphere, so we have set our guidepost charts to be appropriate for what you will see at about 10 p.m. in the USA, Canada, Europe, China, Japan … anywhere between latitudes 30° and 60° N. Most of these objects will also be visible from Australia, New Zealand, Africa, or South America, but their positions will all be shifted northwards.

Stars set in the west, just like the Sun, so if you're planning a long observing session you should start by observing the western objects first, before they get too low in the sky. The closer to the horizon an object sits, the more the atmosphere obscures and distorts it, so you want to catch things when they're as high up in the sky as possible. (However, Dobs and Cats with alt-azimuth mounts – see page 19 – have trouble aiming straight up, so try to catch such objects sometime before or after they get to that point.)

Most objects are visible in more than one season. Just because the Orion Nebula is at its best in December doesn't mean you should risk missing it in March. Some of the nicest



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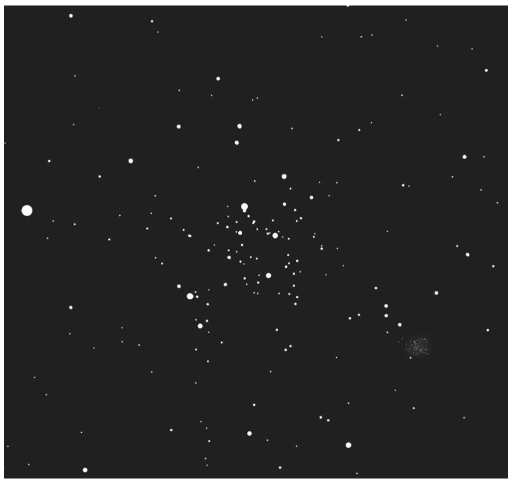
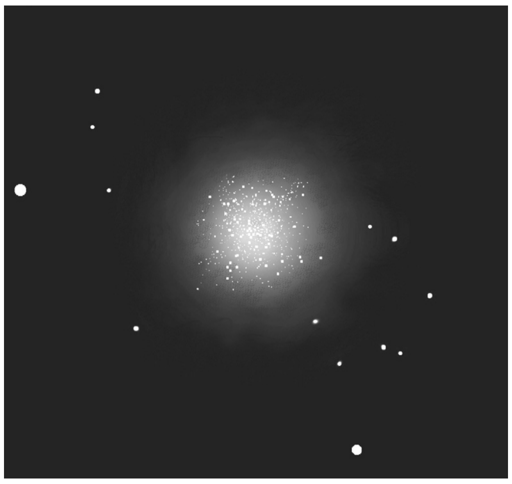

Open cluster: M35


Galaxies: the Leo Trio


Globular cluster: M13


Diffuse nebula: the Swan Nebula

objects from the previous season that are still visible in the western sky are listed in a table at the beginning of each season.

You'll be able to see objects around your hemisphere's celestial pole at some time during any night, year round; but objects around the opposite pole will always be hidden. Northerners will always be able to find the Little Dipper but never see the Southern Cross; southerners always get the Cross but never the Dipper. Thus we have sorted the northernmost and southernmost objects into separate chapters.

Also, remember that when we talk about "January skies," for instance, we're referring to what you'd see then at around 10:00 p.m., standard time. If you are up at 4 in the morning the sky will look quite different. The general rule of thumb is to advance one season for every six hours, so spring stars will be visible in the wee hours of winter, summer stars in early spring morning hours, and so forth.

Who are these guys?

For each object, we give its **name** and we describe the **type** of object it is:

An *open cluster* is a group of stars, often quite young (by astronomical standards), that are clumped together. Viewing an open cluster can be like looking at a handful of delicate, twinkling jewels. Sometimes they are set against a background of hazy light from the unresolved members of the cluster. On a good dark night, this effect can be breathtaking. We discuss open clusters in more detail when we talk about the clusters in Auriga, on page 71.

Galaxies, globular clusters, and the various types of nebulae will all look like little clouds of light in your telescope. A *galaxy* consists of billions of stars in an immense assemblage, similar to our own Milky Way but millions of light years distant from us. It is astonishing to realize that the little smudge of light you see in the telescope is actually another "island universe" so far away that the light we see from any of the galaxies that we talk about (except the Magellanic Clouds) left it before human beings walked the Earth. We discuss galaxies in greater detail on page 109, with the Virgo galaxies.

A *globular cluster* is a group of up to a million stars within our own galaxy, bound together forever in a densely packed, spherical swarm of stars. On a good crisp dark night, you can begin to make out individual stars in some of them. These stars may be among the oldest in our galaxy, perhaps in the Universe. On page 115 (M3 in Canes Venatici) we go into the topic of globular clusters in greater detail.

Diffuse nebulae are clouds of gas and dust from which young stars are formed. Though they are best seen on very dark nights, these delicate wisps of light can be among the most spectacular things to look at in a small telescope. See page 55 (the Orion Nebula) for more information on these nebulae.

Planetary nebulae have nothing to do with planets; they are the hollow shells of gas emitted by some aging stars. They tend to be small but bright; some, like the Dumbbell and the Ring Nebulae, have distinctive shapes. We talk about them in greater detail on page 99 (the Ghost of Jupiter, in Hydra).

If the dying star explodes into a supernova, it leaves behind a much less structured gas cloud. M1, the Crab Nebula, is a *supernova remnant*; see page 67.

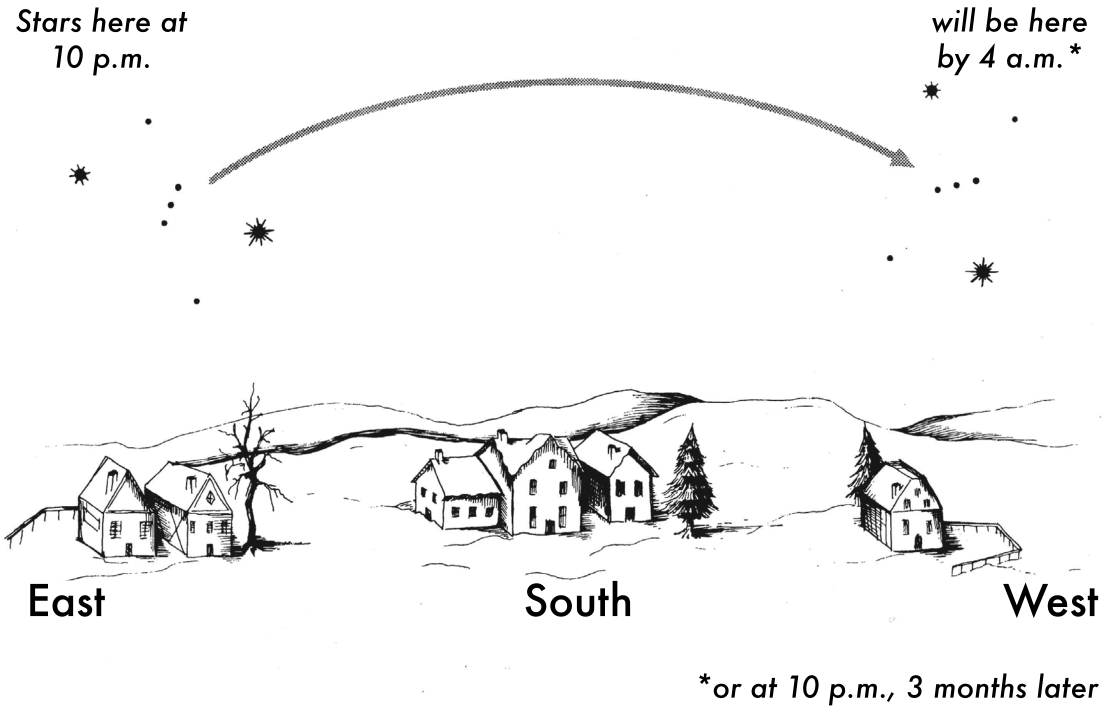
A *double star* looks like one star to the naked eye, but in a telescope it turns out to be two (or more) stars. That can be a surprising and impressive sight, especially if the stars have different colors. They're also generally easy to locate, even when the sky is hazy and bright.

Variables are stars that vary their brightness. We describe how to find a few that can change brightness dramatically in a matter of an hour or less.

Next we give the **official designation** of these objects. Catalogs and catalog numbers can seem to be just as confusing as constellations, at first. But these are the methods that everyone uses to identify objects in the sky, so you may as well get to know them. Sometimes it's fun to compare what you see in your telescope with the glossy color pictures that appear in astronomy magazines, where these objects are often identified only by their catalog number.

Brighter stars are designated by Greek letters or Arabic numerals, followed by the Latin name of their constellation (in the genitive case, for the benefit of Latin scholars). The Greek letters are assigned to the brighter stars in the (very approximate) order of their brightness within their constellation. For example, Sirius is also known as *Alpha Canis Majoris* (or *Alpha CMa* for short) since it's the brightest star in Canis Major, the Big Dog. The next brightest are *Beta*, *Gamma*, and so on. Fainter naked-eye stars are known by their *Flamsteed number,* e.g. *61 Cygni,* assigned by position west to east across the constellation.

Subsequent catalogs have followed for fainter stars. The most common are the *Yale Bright Star Catalog* (numbers beginning with HR, after its predecessor, the *Harvard Revised Catalogue*); the *Henry Draper Catalogue* (numbers beginning with HD); and the *Hipparchos/Tycho Catalogue* (HIP numbers) assembled for the European Hipparchos spacecraft which measured parallax distances to thousands of stars.



The stars and deep-sky objects stay in fixed positions relative to one another. But which of those stars will be visible during the evening changes with the seasons; objects that are easy to see in March will be long gone by September. Thus we refer to these objects as seasonal. *Some objects are visible in more than one season. When we talk about "January skies" we're referring to what you'd see in January at around 10:00 p.m. local standard time. If you are up at four in the morning the sky will look quite different. The general rule of thumb is to advance one season for every six hours, so spring stars will be visible on winter mornings, summer stars on spring mornings, and so forth.*

Double stars also have catalog numbers. Friedrich Struve and Sherburne Burnham were two nineteenth-century double-star hunters; doubles that filled their catalogs now bear their names. Struve variables are traditionally marked with the Greek letter Σ followed by a number. (Friedrich's son Otto also made a catalog of doubles; his stars are denoted with the letters OΣ.)

Variable stars are given letters. The first known in each constellation were lettered R through Z; as more were discovered, a double-lettering system was introduced: e.g. *VZ Cancri.*

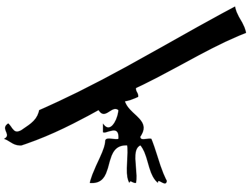
For clusters, galaxies, and nebulae, two catalogs most used in this book are the *Messier Catalog* (with numbers like *M13*) and the *New General Catalog* (with numbers like *NGC 2362*). Charles Messier was a comet-hunter in the 1700s who had no use for galaxies and nebulae. He kept finding them over and over again, and would get confused because many of them looked like comets to him. So he made a list of them, to let him know what *not* to look at while he was searching for comets. In the process he wound up finding and cataloging most of the prettiest objects in the sky. But he managed to number them in a totally haphazard order. The *New General Catalog,* assembled in the 1880s from the observations of William and John Herschel, numbers objects from west to east across the sky. Objects that you see in the same area of the sky have similar NGC numbers.

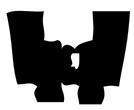
Ratings and tips

For each object you'll see a little box where we provide a *rating*, and list the *sky conditions, eyepiece power,* and the *best months* of the year to look for them. We also note the objects where a *nebula filter* might help the view. And we point out some of the reasons why this particular object is worth a look.

The rating is our own highly subjective judgement of how impressive each object looks. Since each kind of telescope will see the object in a different way, we repeat the ratings three times, with the appropriate symbols for Dobsonians, small telescopes, and binoculars. Obviously some objects are better seen in a large telescope with lots of light-gathering power, and so they'll rate a higher number of Dobsonians than binoculars. But there are also those objects, like the Beehive Cluster, that actually look better in binoculars than in Dobsonians.

A few of these objects can be utterly breathtaking on a clear, crisp, dark, moonless night. The Great Globular Cluster in Hercules, M13, is an example. And even if the sky is hazy, they're big enough or bright enough to be well worth seeing. Such an object, and in general any object that is the best example of its type, gets a *four telescope* rating. (The Orion Nebula and the Large Magellanic Cloud rate *five telescopes*. If they are visible in your sky, they are not to be missed on any night.)





Objects that are still quite impressive but which don't quite make "best of class" get a *three telescope* rating. An example is the globular cluster M3; it's quite a lovely object, but its charms are more subtle than M13's.

Below them are *two telescope* objects. They may be harder to find than the three telescope objects; or they may be quite easy to find, but not necessarily as exciting to look at as the other examples of their type. For instance, the open clusters M46 and M47 are pleasant enough objects in a small scope, but they're located in an obscure part of the sky with few nearby stars to help guide you to their locations. The open clusters M6 and M7 are big and loose, and easy to find, rating high for binoculars, but they look less impressive in a bigger telescope: only two Dobs.

Finally, some objects are, quite frankly, not at all spectacular. As an example, the Crab Nebula (M1) is famous, being a young supernova remnant, but it's very faint and hard to see in a small telescope. You may have a hard time finding such objects if the night is not really dark or steady. They're for the completist, the "stamp collector" who wants to see everything at least once, and push the telescope to its limits. In their own way, of course, these objects often turn out to be the most fun to look for, simply because they are so challenging to find. But they might seem pretty boring to the neighbors who can't understand why you're not inside watching TV on a cold winter's night. These objects we rate as *one telescope* sights.

Matching the telescope to the weather

Sky conditions control just how good your observing will be on any given night, and so they will determine what you can plan on seeing. The ideal, of course, is to be alone on a mountain top, hundreds of miles from any city lights, on a still, cloudless, moonless night. But you really don't need such perfect conditions to have fun stargazing. We've seen most of the objects in this book even amid suburban lights.

Any night when the stars are out, it's worth trying. True, the visibility of the fainter objects can be obscured by thin clouds, especially when they reflect the light of a nearly full Moon (or the glow of city light pollution); but that is not necessarily all bad news. Some things, like colorful double stars, actually look better with a little background sky brightness to make the colors stand out. And objects that require the highest magnification – double stars again, or planets – demand really steady skies which often occur when there is a thin cloud cover. (The clearest nights are often those associated with a cold front passing through, when the air tends to be turbulent … not to mention hard on the observer's hands and feet!)

On the other hand, the fainter objects on our list can stand no competition from other sources of light. They are listed as *dark sky* – wait for when the Moon is not up. To see them at their best, take your telescope along on your next camping trip. Not only will the dim ones become visible, but even the bright nebulae will look like brand new objects when the sky conditions are just right.

How to look, when to look

As we mentioned above, telescopes have two different functions: to make small things look bigger, or to make faint things brighter. You control which of those roles it's doing by the eyepiece you choose. In **eyepiece power** you're trading off magnification against brightness and field of view. In general, your longer eyepiece is low power, giving more light and a greater field of view, while the shorter eyepiece gives you greater magnification. For more detail, see the section *Know your telescope*.

Extended objects like open clusters need low power to fit in the field of view; dim objects like galaxies need low power to concentrate their light. Small, bright objects like planets and double stars can take a high-power eyepiece. Planetary nebulae are small, but dim; the compromise is to observe them at medium power. Some objects, like the Orion Nebula, are interesting under both low and high power. Since the lower-power eyepiece shows you more of the sky, the best technique is to find an object with low power, and then – when appropriate – observe it at a higher power.

Low power makes faint objects brighter; unfortunately, it can also make a murky suburban sky brighter as well. Sometimes, once you've found a faint object in low power, you can increase its contrast against the sky by switching to a higher power eyepiece. A more elegant (but more expensive) way to increase this contrast is by

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Guy Consolmagno and Dan M. Davis
Excerpt
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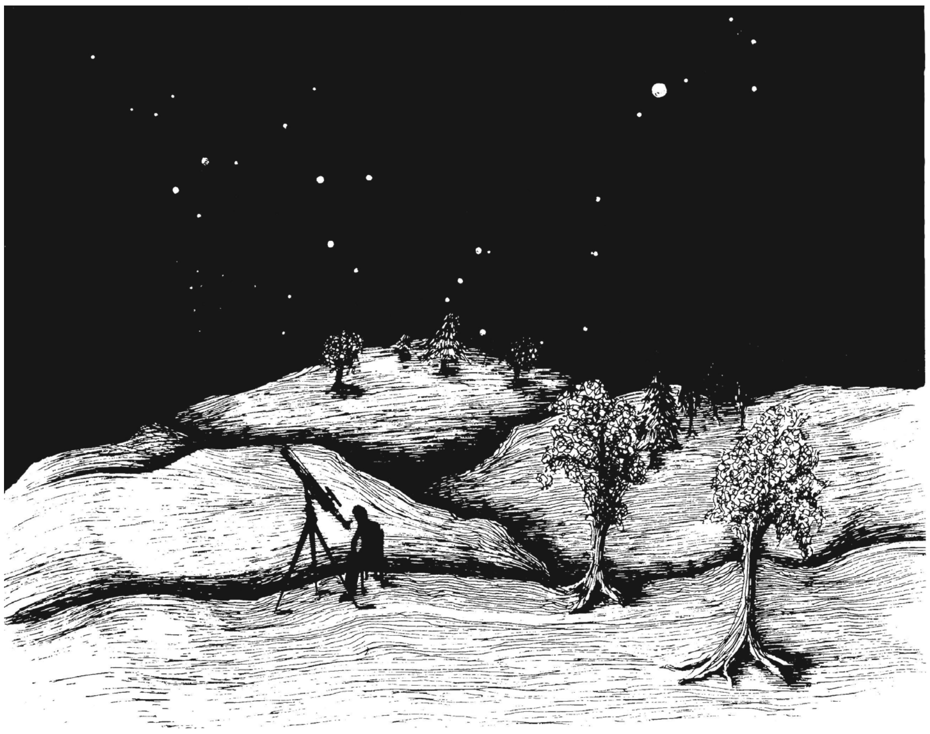

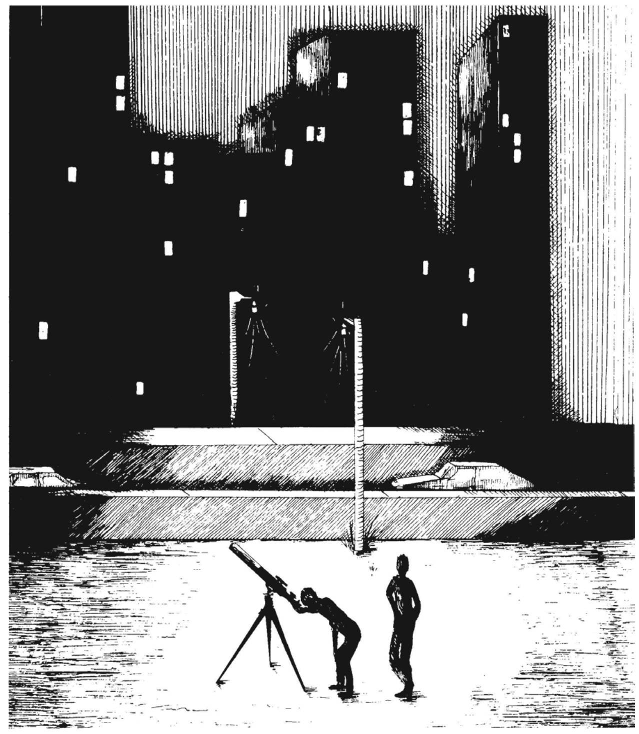

The ideal observing conditions are to be alone on a mountain top, hundreds of miles from city lights, on a cool, crisp, moonless night. Be sure to bring your telescope along when you go camping! You shouldn't wait for perfect conditions, however. Most of the objects we describe in this book can be seen from the suburbs; many of them, even within a city. The roof of an apartment building can make a fine place for an informal observatory.

using an appropriate **filter**. A specially colored filter that cuts out the yellow light put out by sodium street lamps can make a remarkable difference in what you can see through your telescope even when you're fighting light pollution. Even better, a filter that lets through only the greenish light emitted by some nebulae can really bring out detail in otherwise faint objects. But these filters only work for certain objects, mostly diffuse nebulae and planetary nebulae. We indicate when a nebula filter might be appropriate. (Of course, you don't want to use colored filters if you're trying to pick out the colors of a double star.)

The indication for *best seen* lists the specific months of the year when these objects can be found relatively high in the sky, from the end of twilight until about ten o'clock, at about 45° north – roughly, anywhere between Florida and Scotland. (For the southern-hemisphere chapter we assume you're at 35° south, roughly the latitude of Sydney, Cape Town, Buenos Aires, and Santiago.) Of course, as mentioned above, staying up later can gain you a few extra months to preview your favorites.

Where to look, what to look for

The first map for each object is a **naked-eye chart**. These charts generally show stars down to third magnitude. As we mentioned above, magnitude is the measure of a star's brightness, and smaller numbers mean brighter stars. On the best night, the human eye can see down to about sixth magnitude without a telescope; with the glow of city lights, however, seeing even a third-magnitude star can be a challenge.

The next chart shows the **finderscope view**. The little arrow pointing to the west indicates the way that stars appear to drift in the finderscope. (Since most finderscopes have very low power, this westward drift of the stars will seem very slow.)

Finderscopes come in all sizes and orientations. We have assumed that your finderscope turns your image upside down, but does *not* give a mirror image of the sky (see below); check to see how yours behaves, and use our charts accordingly. (Before sunset, aim your telescope at a distant street sign or car license plate: is it upside down? Is it mirror imaged?) Likewise, the field of view of finderscopes can vary, but they usually show about 5° to 6° of the sky. The circle we draw in our views assumes a 6° field, and the whole finderscope-view box is generally 12° square.

On the right-hand page we show the **telescope view:** what the object should look like through your eyepiece. Usually we give two views, one as seen in a small telescope through a star diagonal (see below) and the other as seen in a Dobsonian or other Newtonian telescope. Notice that one is the mirror image of the other, as we will explain shortly.

These pictures are based on our own observations with small telescopes. The idea is that if you can match up what you see with what's in our picture, then you'll

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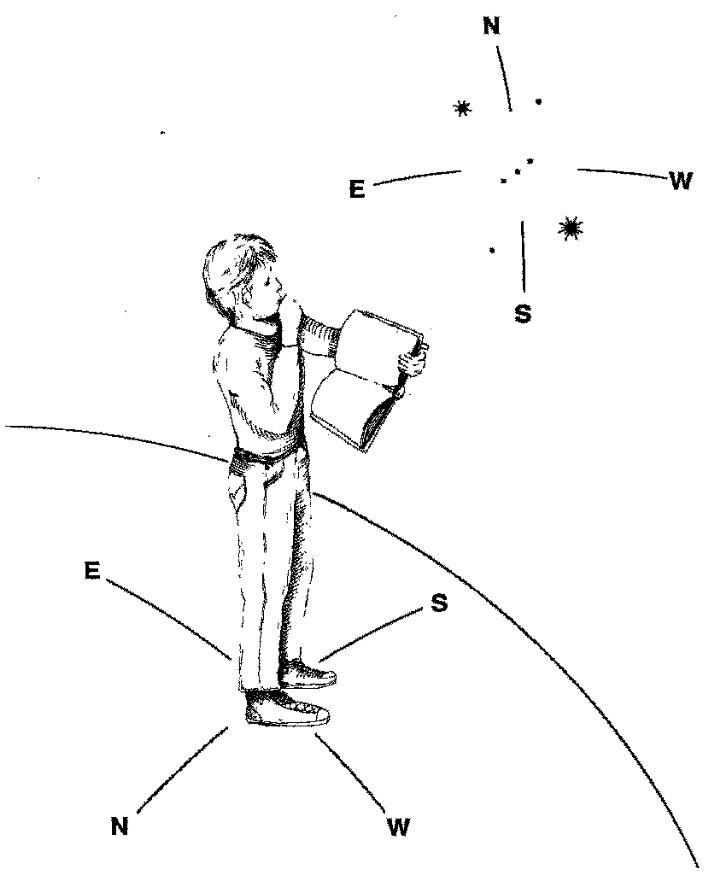


Standing on the Earth, looking out from inside the globe of the sky, the directions east and west appear to be reversed from what we're used to on ordinary maps.

know that you are actually looking at the same object we're talking about. What we have drawn is what a typical person is likely to notice, and we don't always show all of the fainter stars in the field of view. These pictures are not meant to serve as technical star charts – don't try to use them in celestial navigation! (For more detail see page 244.)

Note that we treat double stars somewhat differently. These stars are relatively bright and usually easy enough to see (if not split) with the naked eye. For that reason, you don't need the same kind of elaborate directions to find them as you do for the fainter clusters and nebulae. Within each season we have gathered the best of the doubles into occasional double-star spreads with a more detailed finder chart pointing out the locations of the best examples in the area. Then each double is pictured in a close-up circle: a circle of two thin lines represents a view ten arc minutes across, while a thick/thin pair of circles denotes a closer, higher-powered view, only five arc minutes in diameter. These close-up views assume a Dobsonian orientation. Their purpose is merely to give you an idea of the relative distance and brightness of the companion, and if there are any other stars in the field of view. These pages also include a little table describing the individual double stars, their colors and brightness, and how close together (in *arc seconds*) they appear to be.

(What are arc minutes and arc seconds? They are the way we indicate the size of a very small angle. The arc of the sky from horizon to zenith is an angle of 90°. Each degree can be divided further into 60 minutes of arc, usually written 60' (the full Moon is about 30' across) and each minute can be further divided into 60 seconds of arc, or 60". Thus one arc second is 1/3,600 of a degree – as tiny a separation as you'll ever be able to make out in a small telescope.)

The low-power eyepiece view assumes a power of between 35× to 40×; this is what you'd use for large clusters of stars and a few big galaxies. The medium-power eyepiece drawing assumes roughly a 75× view. The high-power eyepiece drawing gives a view magnified about 150×. And because larger telescopes like Dobs can handle even higher power, in a few of the Dobsonian fields we include an inset with a very high-power view of 300×. To get this kind of magnification, you either need a very short focal length eyepiece or an additional lens called a Barlow. (We talk about Barlow lenses with other *Accessories* on page 22.)

Note again that we've included an arrow to show the direction that stars will drift. As the Earth spins, the stars will drift out of your field of view; the higher the power you are using, the faster the drift will appear. Though this drift can be annoying – you have to keep readjusting your telescope – it can also be useful, since it indicates which direction is west.

In the text, we describe where to look and how to recognize the object. And we comment about some of the things worth looking for in the telescope field – colors, problems that might crop up, nearby objects of interest. For double stars, we also give a table describing the different components of the system. Finally, we describe briefly the present state of astronomical knowledge about each object, a guide to what you're looking at.

East is east, and west is west…except in a telescope

What about the orientations of these pictures? Why do we seem to confuse south and north, or east and west?

There are several things going on. First, we're all used to looking at road maps or geographical atlases: maps of things on the ground under our feet. There, traditionally, north is up and east is to the right. However, when we look at the sky our orientation is just backwards from looking at the ground. Instead of being outside the globe of the Earth, looking down, we're inside the globe of the sky, looking up. It's like looking at the barber's name painted on a window; from inside the barber shop, the lettering looks backwards. In the same way, a sky chart keeping north up must mirror east and west: west is to the right and east is to the left.

Next, many finderscopes are simple two-lens telescopes. This means that, among other things, they turn everything upside down. (Binoculars and opera glasses have to have extra lenses or prisms to correct for this effect.) So instead of north at the top, we'd see south at the top and north at the bottom, with east and west likewise reversed. But nowadays some finderscopes do have an extra lens or prism to turn the image rightside up again. Some evening before it gets dark, check out your finder by aiming it at a nearby street sign and see what kind of orientation it gives you.

We've chosen to orient the finder views with south at the top: this matches the view of what a typical simple two-lens finder will show to most of our readers (living in the northern hemisphere) when looking at most of the objects in this book as they arc across the southern sky. It also matches what southern hemisphere observers will see when looking south at all the glorious objects around the south pole. For our northern circumpolar objects, however, we twist the finder view to have "north" at the top. (Southern hemisphere observers looking at objects in the north will have to turn their book upside down. Sorry!) But, of course, once you're pointed up at the sky, what's "up" is likely to be any direction: as the night progresses its apparent orientation will twist around as it moves across the sky.

Finally, most refractors and catadioptric telescopes sold nowadays have an attachment called a *star diagonal,* a little prism or mirror that bends the light around a corner so you can look at objects up in the sky without breaking your back. This means, however, that what you see in your telescope is a mirror image of your finderscope view. It's also a mirror image of almost any photograph you'll find in a magazine or book. The orientation as seen through a star diagonal is what we use in our "small telescope with a star diagonal" views.

But Dobsonian telescopes do not use star diagonals. (A Dobsonian is the most common example nowadays of what is classically called a Newtonian design. What we say here applies to all Newtonian telescopes.) So it does not have that extra mirror image affect. But it does show the object upside-down from what you expect, which means that to push an object into the center of the field of view can often mean moving the telescope in just the opposite direction of what you might expect. (One trick is to "drag the object;" in other words, push or pull the telescope in the direction you want to push or pull the object in order to center it in your field.) Since a Dobsonian usually has at least twice the aperture (and thus at least four times the light-gathering area) of a small scope, the Dob view will also include more stars, fainter stars, and larger areas of nebulosity. We try to show just how much more, in our drawings.

Notice, finally, that many spotter scopes sold for terrestrial use nowadays come with a 45° angle prism called an *erecting prism*. This does *not* give a mirror-imaged view. Don't confuse these devices with true star diagonals; they're handy for bird-watching, but they'll still give you a crick in your neck when you try to use them to look at stars overhead. If you can, see if your telescope dealer will replace this with a true 90° findercope. The view you get through an erecting prism will be better represented by the Dobsonian view, at least in terms of the orientation of the stars, though not of course in the detail you'll actually see … unless you have a very large spotter scope indeed.

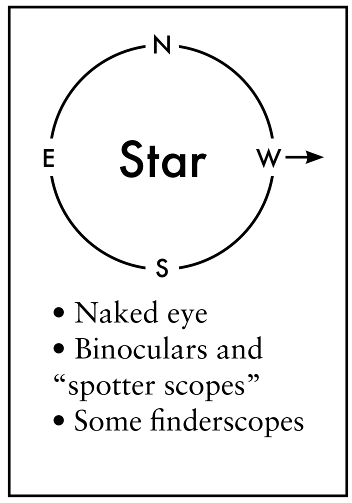
Knowing your telescope

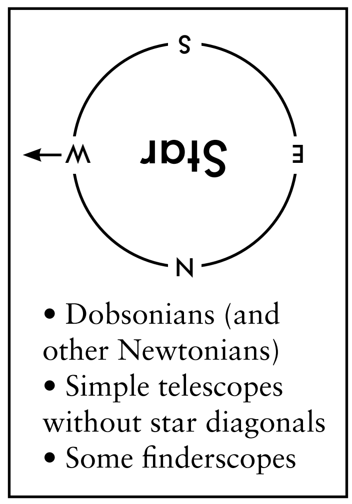
If you're just starting to observe, you may find the next sections of this chapter, on knowing and using your telescope, to be handy. We explain how your telescope works, and how that affects your choices of what to observe, what lenses and accessories to use, and why objects look different from one telescope to another. You can read it over while you're waiting for sunset.

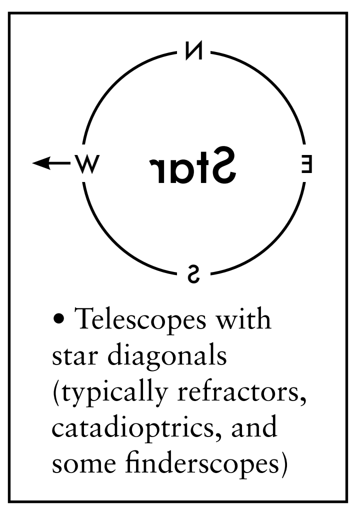
At the end of the book, Dan suggests some more advanced books you might like to look into to become a more knowledgeable observer. We also describe there some of the details about how we put this book together. And we provide **tables** of all the objects we've talked about, with their coordinates and technical details.

But, except for these first and last chapters, the rest of this book is meant to be used outdoors. Get it dog-eared and dewy. After a year of observing, you'll be able to tell your favorite objects by the number of grass-stains on their pages!

At www.cambridge.org/turnleft you can find flipped, mirrored, and inverted versions of all our star charts.







A star field as it appears to the naked eye; upside down, as it appears in a Dobsonian; and mirror imaged, as it appears in most telescopes with a star diagonal. To determine your telescope's orientation, try reading the lettering on a distant sign.

The arrows show the directions that stars appear to drift, moving east to west, across the field of view.