PART I GETTING TO KNOW THE SKY

1

Beginning with the Big Dipper

The best way to get a good start on observing is to discover the stars for yourself. Becoming familiar with the sky – on your own terms – is an important first step toward useful observation.

We do need a place and time to start, so let's try your backyard, under an evening sky of late spring or early summer. High in the west will shine the seven bright stars of the Big Dipper, possibly the best known asterism, or group of stars, in the entire sky. Since Roman times they have been part of Ursa Major (UMa), the Great Bear. The Dipper's handle represents the tail of the Bear, while the feet and nose are shown by fainter stars to the south and west of the bowl (Fig. 1.1).

1.1 The Dipper as a road sign

Much as I have tried, I have never seen a bear in the region of Ursa Major, or a plough. The seven stars of the Big Dipper, however, are easy to spot. At any time of night and in any season of the year, the two stars at the end of the Dipper's bowl point towards Polaris, the North Star. All the stars in our sky, the Sun included, circle the celestial poles, and for our lifetimes Polaris will stay within a degree of the true North Celestial Pole. Polaris is the brightest star of another constellation, Ursa Minor or the Little Bear. This Little Dipper is bent back, resembling a spoon bent by a child. Except for Polaris itself and the two stars at the end of the bowl, the Little Dipper's stars are faint.

We can use the Big Dipper to locate several nearby constellations. In northern-hemisphere spring, try the handle, which curves, like an arc of a circle, to the southeast. Start by joining the stars of the handle with an imaginary curved line,

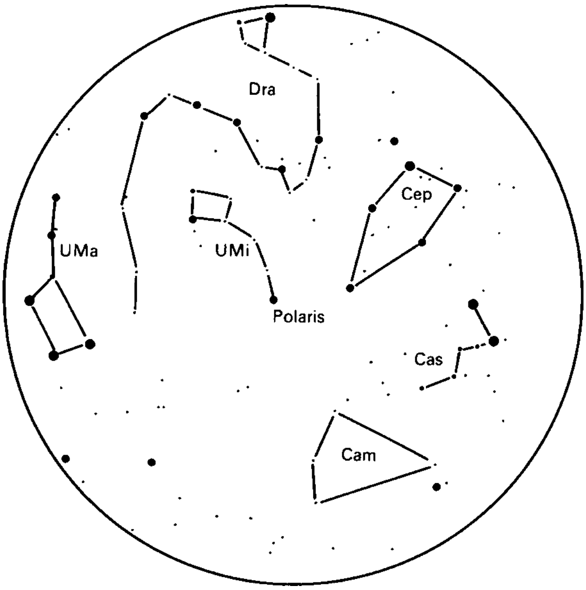

Figure 1.1. North circumpolar stars.

and "arc" to Arcturus, a bright yellow-orange star in the constellation of Bootes (Fig. 1.3). Although this constellation is known mythologically as the Herdsman, it is easier to identify as a kite. Once you have seen Arcturus, why don't you keep your curved line moving in the same direction, for further along you will find Spica, a bright bluish star that is at the head of Virgo the Virgin. Next, draw a line from Gamma in the bowl through Eta, the end star of the handle, and continue across most of the summer sky towards Antares in Scorpius (Fig. 1.4). If you join the the two inner stars of the bowl (Gamma and Delta Ursae Majoris) with a line that continues north, you will eventually reach the summer triangle of Vega, Deneb, and Altair (Fig. 1.4).

In fall, join the two stars at the end of the handle, Eta and Zeta, and continue above the bowl to Capella (Fig. 1.2). In late winter, when the Dipper is high in the sky, a line from Eta through Gamma will lead across the sky in the direction of Procyon. This brings us back to spring, when we also can use the Dipper in a different way. Fill the Dipper's bowl with water, and then poke some holes through the bottom. As the water gushes out, note who is sitting below, comfortably showering himself: it's Leo the Lion! The bright star at the foot of the backward question mark that forms Leo's head is called Regulus (Fig. 1.3).

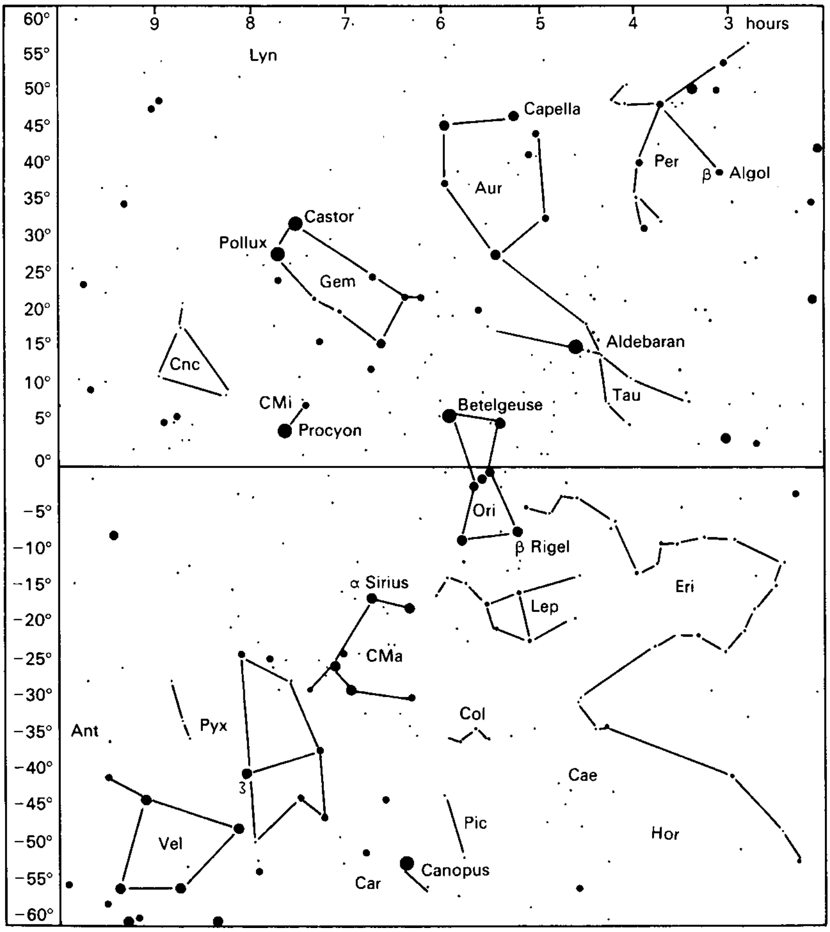

Figure 1.2. The sky, January to March.

1.2 Your own constellations

Thousands of years ago the Egyptians, Greeks, and Romans placed their heroes in the sky. These figures are still with us because they offer an easy and familiar way of finding our bearings. Before you learn the standard constellations, why not make some up for yourself? This way, you can become familiar with the sky on your own terms, requiring no textbooks or charts; at this stage you are better off without them. And what is most surprising of all, when you begin to learn the classical groups you may be surprised at how closely your personal circus resembles that of tradition.

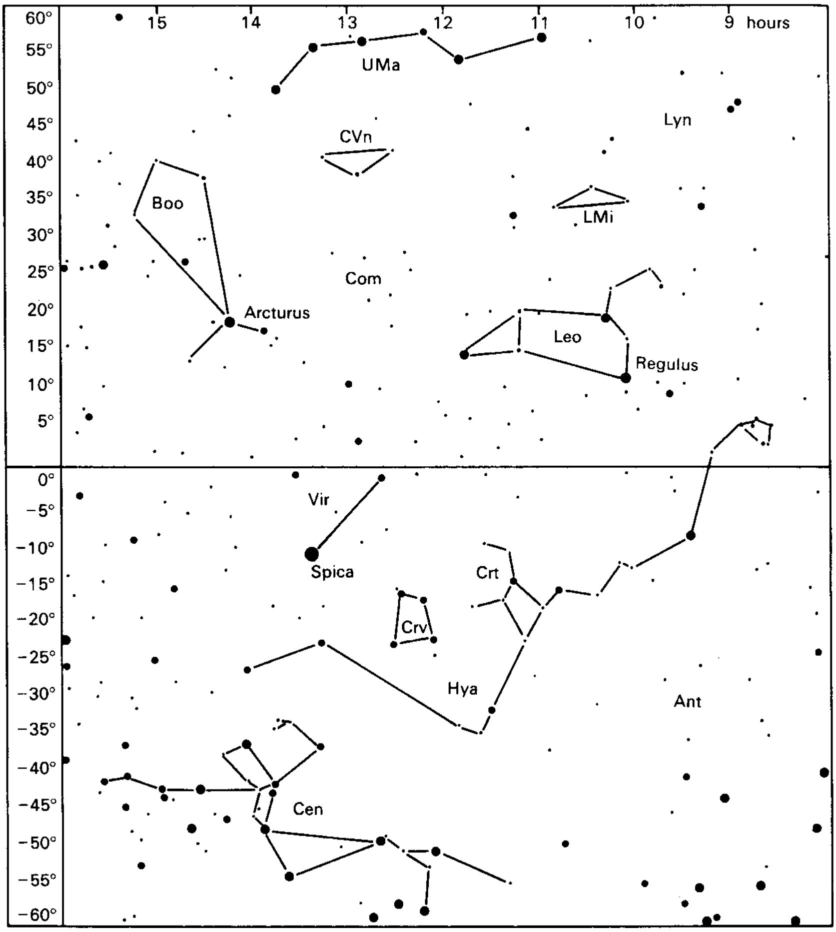

Figure 1.3. The sky, April to June.

After a night or two of this you should be ready to begin your voyage to the constellations. You will now need a good star chart or atlas. Learning the sky by going from one constellation to another is a process that requires patience and will occupy the starlight nights of at least four seasons. The stars of spring with the Lion and the Crab give way as the year progresses to the Swan and the Harp of summer, and with the cooling air of autumn comes Pegasus, the mighty flying horse, and Andromeda, the princess in chains. Finally, the two hunting dogs of Orion romp through the snowy sky of winter. Then, on late winter nights you can look towards the east and see the

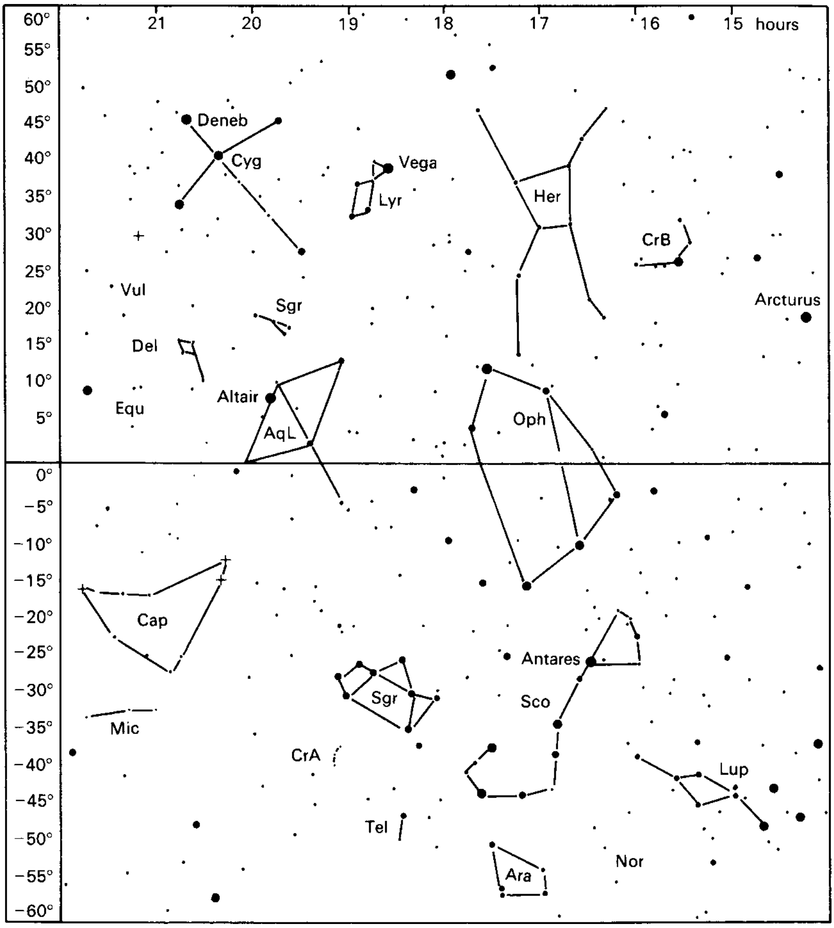

Figure 1.4. The sky, July to September.

spring stars on display once more as another orbit of your life comes full circle. As you proceed, you may find that learning the constellations is like making new friends who will be there to greet you on schedule at their appointed times.

1.3 Southern Cross

Just as the Big Dipper points the way to so many northern hemisphere constellations, Crux, the Southern Cross, guides you to constellations around

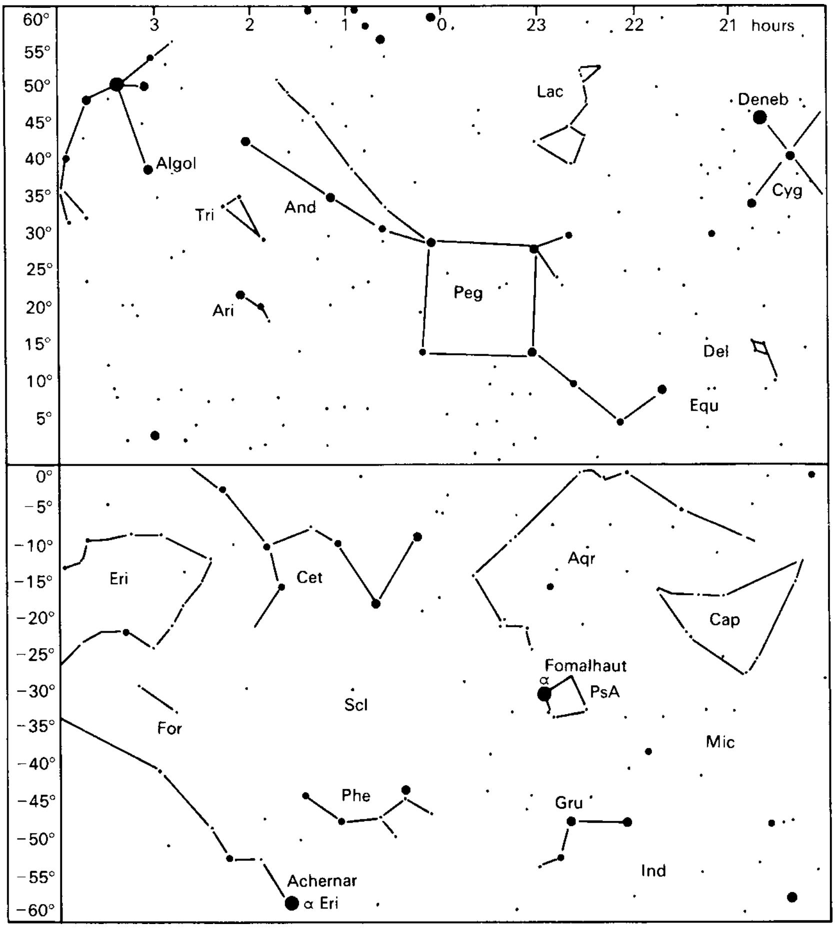

Figure 1.5. The sky, October to December.

the south pole. When it is high in the southern-hemisphere autumn sky, follow the short arm towards Centaurus, and the long arm toward the pole and its faint constellations of Musca and Octans. Canopus and the delights of Carina also grace the fall sky.

The southern sky is a busy place, with more bright stars than northern-hemisphere observers are used to. The Milky Way is magnificent, particularly in the southern part of Carina, where stars and clouds of gas combine to paint a pretty celestial picture. Our two nearest galaxies, the Large and Small Magellanic Clouds, are also visible only from southern latitudes, the Large Cloud in fall, the Small Cloud in spring.

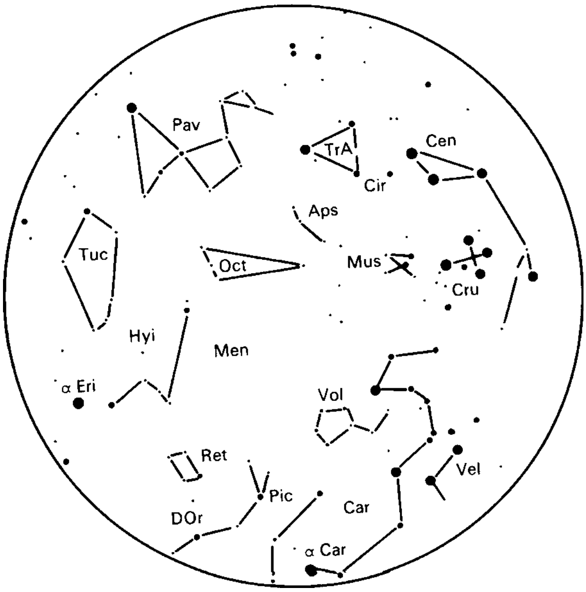

Figure 1.6. South circumpolar stars.

If you have ever seen the constellation of Sagittarius on a July evening under a dark sky, you probably noticed the Milky Way in its background, bright as a cloud. From the southern hemisphere, Sagittarius is virtually overhead, shining so brightly I have seen it cast a shadow. The reason the Milky Way is so bright in that part of the sky is that Sagittarius marks the central hub of our Milky Way galaxy.

2

Magnitude, color, and distance

What is the first thing you notice about the stars? Quite likely, it is their differing brightnesses. Although this appears obvious, it is the single most important concept with which you should become familiar before you can be a variable-star observer.

2.1 Magnitude

Why do stars differ in brightness? Is it because they are at different distances from us, so that the farther stars appear fainter, like the glow from lamps at the far end of the street? Or are the stars themselves of different brightnesses? As you have likely guessed, both are correct. Sirius, a blue star off the southeast corner of Orion the Hunter, is normally the brightest star in the night sky, not so much because it is actually large and bright, but because it is close. At a mere 8 light years away, Sirius is one of our nearest neighbors. However, there exists a star only a little farther away; Wolf 359 is a "red dwarf" star whose intrinsic brightness is so low that it cannot be seen with the unaided eye. Famed in *Star Trek* legend as the site of a Borg battle, Wolf 359 is a red dwarf star. Meanwhile, the brightest star in Cygnus the Swan, Deneb, is well over 1000 light years away from us, and is one of the intrinsically brightest stars in the sky. S Doradus is even brighter, but it appears to us as a faint star because it is so far away, actually in a neighboring galaxy.

To reconcile these two factors, astronomers have created two independent systems of describing brightness or "magnitude." It is possible that the earliest magnitude scale dates back to the ancient Hebrew custom of locating three stars in a sky dark enough to be certain that the Sun has set, thereby confirming that the Sabbath or festival has ended. The brightest stars and planets, it was understood in those ancient times, could conceivably be viewed just before sunset, and waiting for the faintest stars to appear meant waiting too long. So a crude brightness scale was devised; when three stars of the middle brightness level were seen, that marked the end of Sabbath.

Our current magnitude system dates from the nineteenth-century astronomer Norman Pogson. A star's "apparent magnitude" is a number that indicates its brightness as it shines in our sky. A star of the 2nd magnitude, like Polaris, is about 2.5 times fainter than a 1st magnitude object, like Aldebaran. Similarly, a 3rd magnitude star would be 2.5 times fainter than Polaris, and so on. Thus a 3rd magnitude star would be more than 6 times fainter than Aldebaran, a magnitude 4 star would be more than 15 times fainter, a magnitude 5 star 39 times fainter, and a magnitude 6 star would be 100 times fainter. This scale can, of course, apply for stars brighter than first magnitude too. Vega, a star about 2.5 times brighter than Aldebaran, is about magnitude 0, while brilliant Sirius shines at around magnitude −1.4.

While this system is useful in assigning star brightnesses as they appear to us on Earth, it does not tell us how intrinsically bright a star really is. For this purpose, we can use another system of "absolute magnitudes." Imagine a sky in which every object is at precisely the same distance from us, and let that distance be 33 light years. At this distance, the Sun would appear almost as bright as a star of the 5th magnitude. S Doradus would be extremely bright at magnitude −20, mighty Sirius would be extremely diminished, to magnitude 4. Such a sky would be odd, indeed, for eyes used to the stars as we see them. It would not be filled, as ours is, with stars that have unfairly taken places too close to the front of the room, and appear brighter than they deserve!

The Dipper Project

Which of the seven stars in the Dipper is the brightest? Is it one of the three in the handle, or is it in the bowl? Which one is the faintest? (That should be easy.) And finally, what is the order in between? Do this exercise carefully; have your friends do so as well and keep them trying until you are fairly certain of the order. But watch out! You may be surprised to find that during a hazy or moonlit night the order appears to change.

2.2 Color

Stars show different colors. Look carefully at a bright blue star and a bright red one. In August, try Vega and Antares, in December, Rigel and Betelgeuse, and in April, Arcturus and Spica. These are not like traffic lights; starlight is much more subtle. Vega is not blue but has a bluish tinge, Antares is reddish,