CHAPTER 33

Watching the Night Sky

"Many people tend to postpone their enjoyment of the stars because they are constantly with us, but . . . once you come to know [the stars], they never lose their appeal."

—Helen Hogg (A distinguished 20th-century Canadian astronomer, she helped popularize star study for young people.)

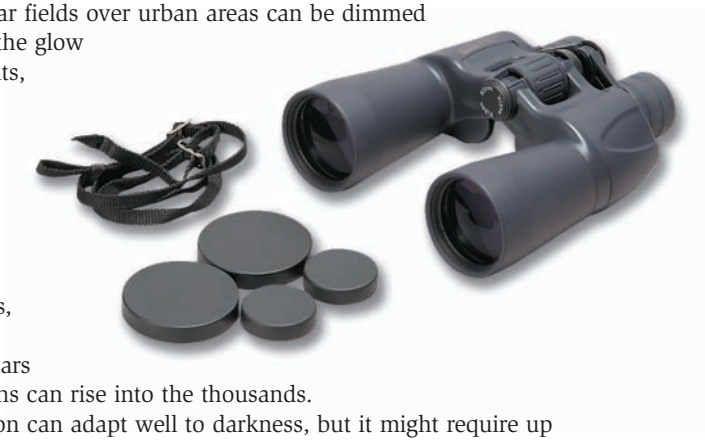
The view of space from planet Earth is an endlessly intriguing panorama of darkness and light, a vision shared through the ages with all of humanity.

One of the great pleasures of camping out and hiking at night is looking into the heavens. Undimmed by the lights of cities, the sky blazes with stars. Constellations parade overhead and the Milky Way forms a shimmering ribbon against the darkness. Travelers in northern latitudes sometimes watch the aurora borealis draping the sky with shadowy, luminous curtains. Watch for a while and you might see a meteor streaking through the darkness.

At first glance the night sky might seem to hold a random scattering of brilliant points of light. Look more carefully, though, and you will notice that some stars are brighter than others. Night after night, they appear in almost the same places. There is order to their locations, and by learning about that order, you will have an effective method for finding directions after sunset. You also can more fully appreciate the legacy of star study that has come down to us through the ages, for the night sky has been a subject of curiosity and fascination since the beginning of time.

Observing the Night

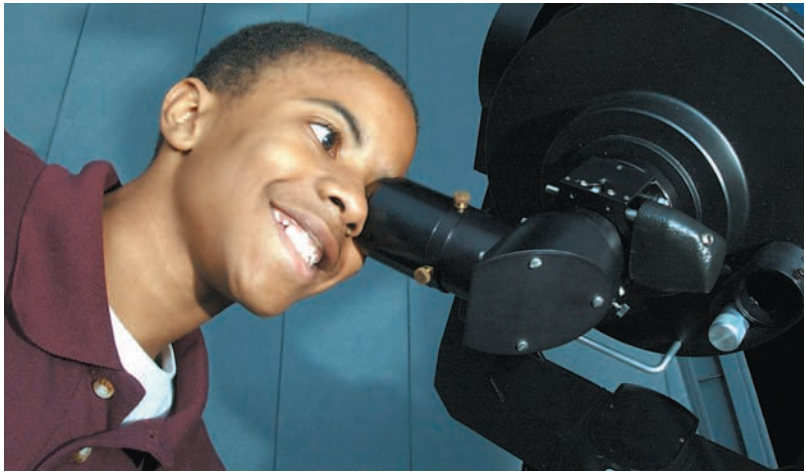
Make the most of watching the night sky by choosing good times and places. Of course, you won't be able to view the stars when they are obscured by clouds, fog, or mist. The brilliance of a full moon washes light across the sky. Lunar craters are most visible during lunar eclipses, which limit the intensity of light. Star fields over urban areas can be dimmed by light pollution—the glow created by streetlights, illuminated parking lots, and other sources of artificial lighting. At best, you will be lucky to make out a couple of hundred stars. Get away from cities, though, and the number of visible stars crowding the heavens can rise into the thousands.



Human vision can adapt well to darkness, but it might require up to 30 minutes to adjust fully. Your pupils will expand to capture more light, and the amount of light-sensitive pigment in your retinas will increase, allowing you to observe much more in the night sky. Your eyes can quickly lose their adaptation if they are exposed to bright white light such as that from a lantern or flashlight. If you want to illuminate a star map or find your way through the darkness, cover the lens of your flashlight with red cellophane held in place with a rubber band.

Good binoculars can take you much deeper into the universe than with eyes unassisted, revealing wonders ranging from moon craters to the colors of planets and shapes of nebulae. Telescopes, too, can increase your understanding and enjoyment of nights spent studying the heavens.

For more on binoculars, see the chapter titled "Observing Nature."



Fascinating shapes in space, such as the Eagle Nebula depicted here, can be an artist's inspiration.

What's Out There

The universe teems with nebulae, stars, galaxies, planets, moons, meteors, novas, pulsars, quasars, black holes, and many forms of matter and energy we are just beginning to understand. From space stations and communications satellites to bits of metal debris, objects created by humans also are visible as they orbit through the night. Among the most interesting of the natural phenomena are nebulae, the birthplaces of stars.

Nebulae

The largest known objects in the skies are great swirls of dust and gas called *nebulae,* taking their name from the Latin word for mist or cloud. As materials composing a nebula compress, stars are born. Many nebulae emit no light of their own, but starlight sometimes illuminates them. Others shine on their own as they condense and become superheated. From the Earth, nebulae visible to the naked eye have an appearance similar to that of stars. With binoculars or a telescope, however, they can emerge from the background of space in spectacular displays of color and shape.

Stars

Stars are gigantic thermonuclear reactors adrift in the heavens. Most are much larger than our sun, the star we know the best. Beyond the sun, even the closest stars are many light-years away. (A light-year is the distance that light will travel in a calendar year. At 186,000 miles a second, that's 5,865,696,000,000 miles a year—almost six trillion miles.)

Stars are ranked according to *magnitude*—their brightness relative to one another. The North Star, for example, is the 46th brightest star in the sky, outshone by Sirius, a first-magnitude blue giant and the brightest star visible from Earth. The color of stars indicates their temperatures, with blue burning hottest, followed by white, yellow, orange, and red. Other than the moon, the brightest nonstellar objects in the night sky are the planets Mars, Venus, Jupiter, and Saturn. Between 200 and 300 stars visible on a dark night have names. The names of most stars can be traced to antiquity, coming from Latin, Greek, and Arab language roots. Polaris, for example, the true name of the North Star, is a Latin term for "pole star." Sirius is a Greek word that means "scorching."

Scintillate, Scintillate, Little Star . . .

Rather than shining with a steady glow, stars appear to twinkle. That's because the light coming from them is distorted by turbulence in the Earth's atmosphere. Dust, heat, smoke, and smog all play roles in causing starlight to scintillate—another word for twinkle.

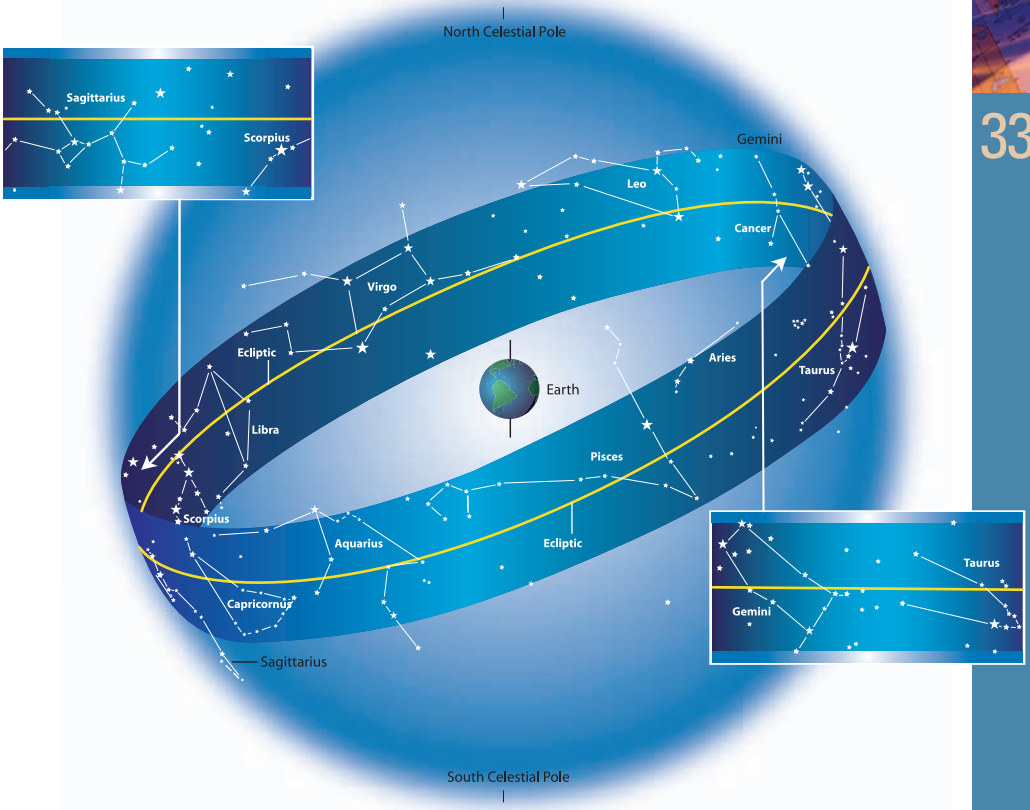
The Hubble Space Telescope's orbit high above the Earth removes it from atmospheric disturbances and allows it to produce crisp, twinkle-free images from the depths of space.

Galaxies

Many points of light we see in the sky are galaxies, great collections of stars and nebulae. Evidence from the Hubble Space Telescope suggests there might be at least 50 billion galaxies. Some are elliptical galaxies without defined shape. Others are spirals. Our solar system is part of a spiral-shaped galaxy called the Milky Way, which is composed of several hundred billion stars. It is gorgeous to the naked eye, especially on summer evenings. Seen through binoculars, it explodes with stars, nebulae, and, beyond the Milky Way, countless other galaxies. Train your binoculars on the area of sky just above the spout of the teapot-shaped constellation Sagittarius, and you will be looking into the radiant heart of our galaxy.

"What is inconceivable about the universe is that it should be at all conceivable."

—Albert Einstein, Nobel Prize–winning physicist



The Constellations

For thousands of years, people gazing at the stars have imagined them forming the shapes of people, animals, and items important to their cultures. Many of the names they gave these connect-the-dot shapes, or constellations, are with us today. Just as the starlight we see coming from stars is an echo of the stellar past, our understanding of constellations represents some of our oldest continuous knowledge, a mix of human history, lore, and belief reaching deep into the mists of time.

The word constellation comes from *con,* meaning "together," and *stella,* meaning "star." The constellations we most often identify today were formally acknowledged in 1929 by the International Astronomical Union (IAU) as a step in standardizing the mapping of the night sky. In all, 88 recognized constellations cover the heavens, with no star appearing in more than one constellation. There are 48 constellations in the southern sky and 28 in the northern sky. Another dozen constellations can be found along or near the ecliptic—the celestial pathway apparently taken across the sky by the sun, the moon, and the planets. (In fact, it is the rotation of the Earth that causes heavenly bodies to appear to move.) The 12 constellations found along the ecliptic are also known as the signs of the zodiac.

The celestial locations of constellations are determined by the time of the year and by an observer's position on the globe. Eighteen of the 88 recognized constellations cannot be viewed from the continental United States. Someone in South America, however, could see those constellations, but might not be able to view the Big Dipper or the North Star.

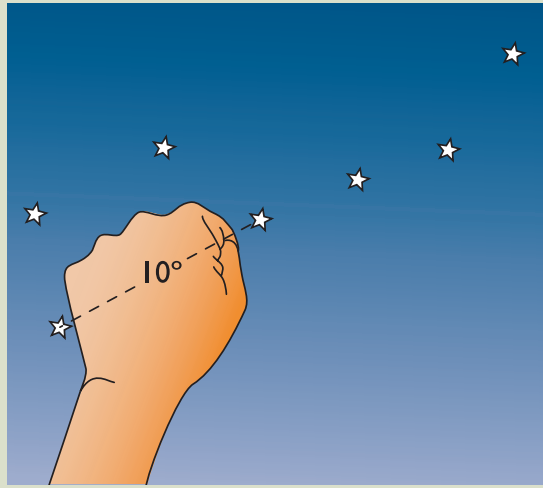
Navigating the Heavens

When giving someone directions for traveling overland to a certain location, you might use landmarks as references. "Go two miles down the Wabash Trace to the Nishnabotna River," you might say. "Waubonsie campsite is a half mile farther by the big oak tree on the left side of the trail."

You can navigate your way around the heavens that way, too, but instead of rivers, trails, and trees for landmarks, use a few easy-to-find constellations as skymarks to guide your eye to destinations overhead. Two of the most recognizable and useful constellations are the Big Dipper and Orion.

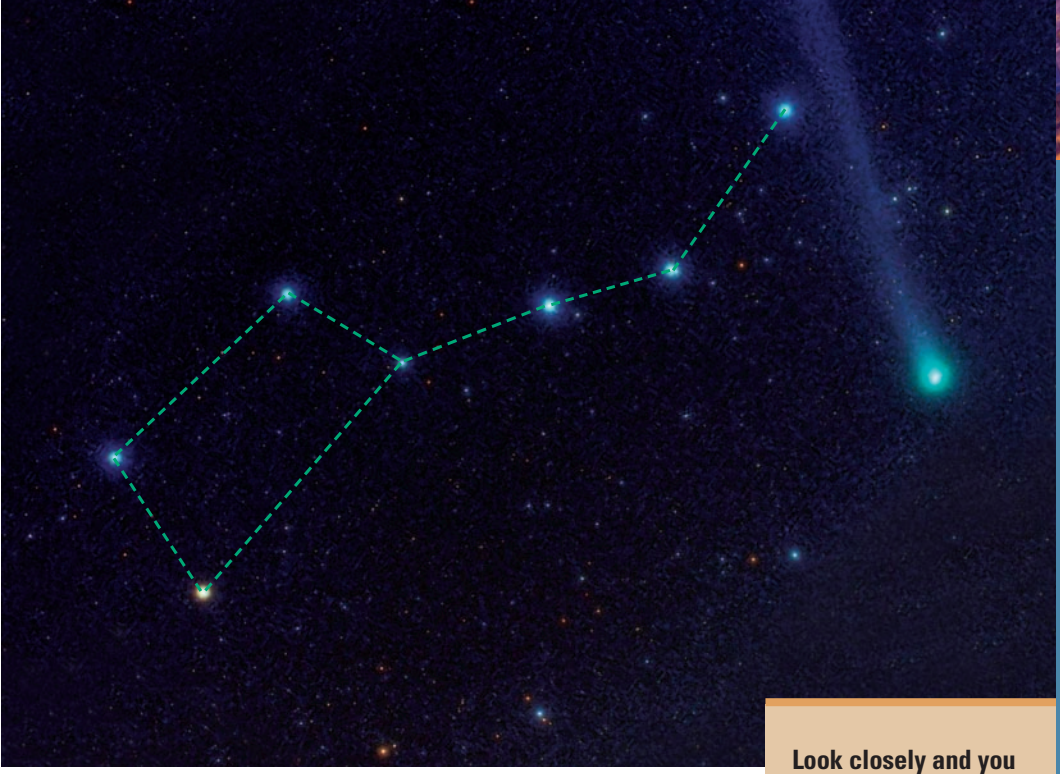
The 10-Degree Fist

Astronomers map the heavens with a grid of coordinates much like terrestrial measurements of latitude and longitude. An arc drawn across the sky from the eastern horizon to the western (or from the southern to the northern) encompasses 180 degrees—half of a complete circle. The measurement of that arc from the horizon to a point directly overhead is 90 degrees. The highest point directly overhead is known as the *zenith.*



A convenient way to measure celestial distances in degrees is to extend your arm and then sight over your hand. Viewed against the sky, your little finger represents a width of about 1 degree. Three fingers held up as if in a Scout sign are about 5 degrees in width, and your fist has a relative width of about 10 degrees. Measure 15 degrees in the sky by spreading apart your index and little fingers, and 25 degrees with the span from the tip of your little finger to the tip of your thumb.

Try a few measurements to get the idea. For example, the stars forming the rim of the Big Dipper's cup are 10 degrees apart. Viewed at arm's length, your fist should just fit between them. The width of the Big Dipper is 25 degrees; that's about two and a half fist widths, or about as wide as the span from the tip of your little finger to the tip of your thumb. The 90-degree arc from the horizon to the zenith (the point directly above an observer) can be measured with nine fist widths stacked one atop the next.



Comet Hyakutake, shown to the right of the Big Dipper, had a close encounter with Earth in 1996, when it passed within 9.3 million miles of the planet.

Look closely and you might see that the middle star of the Big Dipper's handle actually is two stars. Ancient Arab astronomers called them Mizar and Alcor. Some American Indians thought of the larger star as a horse, the smaller as its rider.

The Big Dipper

Perhaps the most familiar of all star patterns seen from North America is Ursa Major, which contains the Big Dipper. On spring and summer evenings it seems to fill the northern sky. Depending on your latitude, it might maintain its dominance in the winter heavens, too, or might disappear in part or in whole beyond the northern horizon.

Legend holds that Ursa Major, the mythical big bear, is guarding the northern territories. The state flag of Alaska features the Big Dipper, showing it along with the North Star.

A skill practiced by generations of Scouts is the ability to use the Big Dipper to find the North Star:

> To find the North Star, train your eyes on the pointer stars of the Big Dipper—the two stars farthest from the handle. Imagine a line connecting them and extending upward to a point about five times the span between the two pointers. You should see the North Star at that point. The Earth's North Pole lies directly under the North Star.
>
> —*The Boy Scout Handbook,* 11th edition, Boy Scouts of America, 1999

Northern sky

Like the sun and moon, most stars seem to move from east to west across the sky, an illusion caused by the fact that the Earth is rotating in the opposite direction beneath them. Because it is aligned with the Earth's axis, the North Star does not appear to move at all. Watch through the night and you will see Cassiopeia and the Big Dipper rotating around the northern sky with the North Star apparently motionless between them.

In astronomical measurements, the North Star can be found 28 degrees from the closest star of the Big Dipper. Use your hand at arm's length to estimate that distance across the sky. (Not only is it the North Star, it also is the last star in the handle of the Little Dipper, a portion of the constellation Ursa Minor, or the Little Bear. The cup of the Little Dipper appears to be pouring into the Big Dipper's bowl.)

With the Big Dipper as a primary skymark, similar degree measurements can lead you to other stars and constellations spangled across the northern skies:

1. Follow the arc of the Big Dipper's handle 30 degrees across the sky to the first-magnitude star Arcturus in the constellation Boötes (the bear driver).
2. Continue along the same arc another 30 degrees to Spica, a star almost as bright as Arcturus and a primary feature in the zodiac constellation Virgo (the virgin).
3. Return to the Big Dipper and trace the line through its pointer stars to the North Star. Extend the line almost the same distance again to reach Cassiopeia (named for an ancient Ethiopian queen), a constellation shaped like the letter W with its top opening toward Polaris and the Dippers.
4. Punch a hole in the ladle of the Big Dipper and go straight down to Regulus, which is also Leo the Lion's front paw.

Orion and the Southern Skies

A winter constellation south of the ecliptic is Orion, known in Greek mythology as the Great Hunter. Two bright stars mark his shoulders. Three small ones form his head and two more his legs. There are three stars in Orion's belt; the three stars hanging from the belt are his sword.

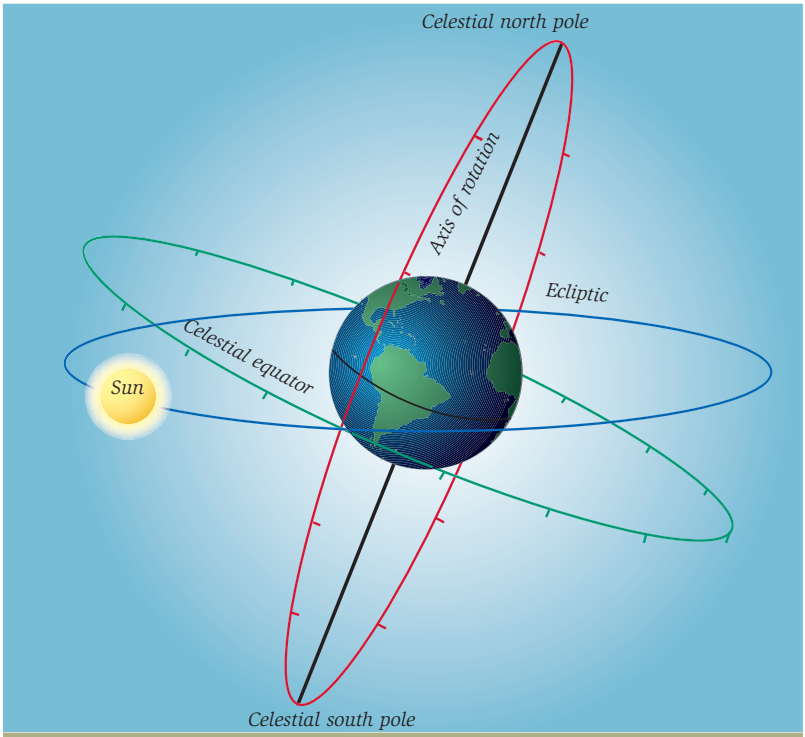
Orion is a constellation composed of wonders. Betelgeuse (pronounced *beetle-juice*), a first-magnitude red giant star emitting 60,000 times more light than our sun, forms the hunter's upper shoulder. Rigel, burning with white light and the brightest of Orion's stars, marks one of the feet. At the middle of the sword is the Orion Nebula—stellar dust and gasses compressing to form new stars. With a pair of binoculars you can begin to unlock the nebula's secrets.

As a skymark, Orion is unparalleled for locating constellations and stars in the winter. Facing south, extend a line to your left through Orion's belt, and at a distance of 20 degrees you will come to Sirius situated in the head of the constellation Canis Major, the Great Dog. Follow the line from the belt 20 degrees to the right of Orion to the first-magnitude red giant star Aldebaran, the eye in the V-shaped head of the constellation Taurus, the Bull. Stay the course for another 15 degrees past Taurus to a tight, faint

Southern sky

cluster of stars called the Pleiades, or Seven Sisters. With good eyesight you might make out six of them. Through binoculars, you might discover that the Pleiades actually are several hundred stars.

With the Big Dipper and Orion as your initial skymarks, you will be well on your way to becoming familiar with many of the features of the night sky. In seasons when those constellations are not visible or are partially obscured by the horizon, use other constellations as skymarks, especially Cassiopeia in the northern heavens and Scorpius in the southern. The star maps in this chapter can help you determine directions and distances in degrees for identifying constellations and stars relative to skymarks you already know.

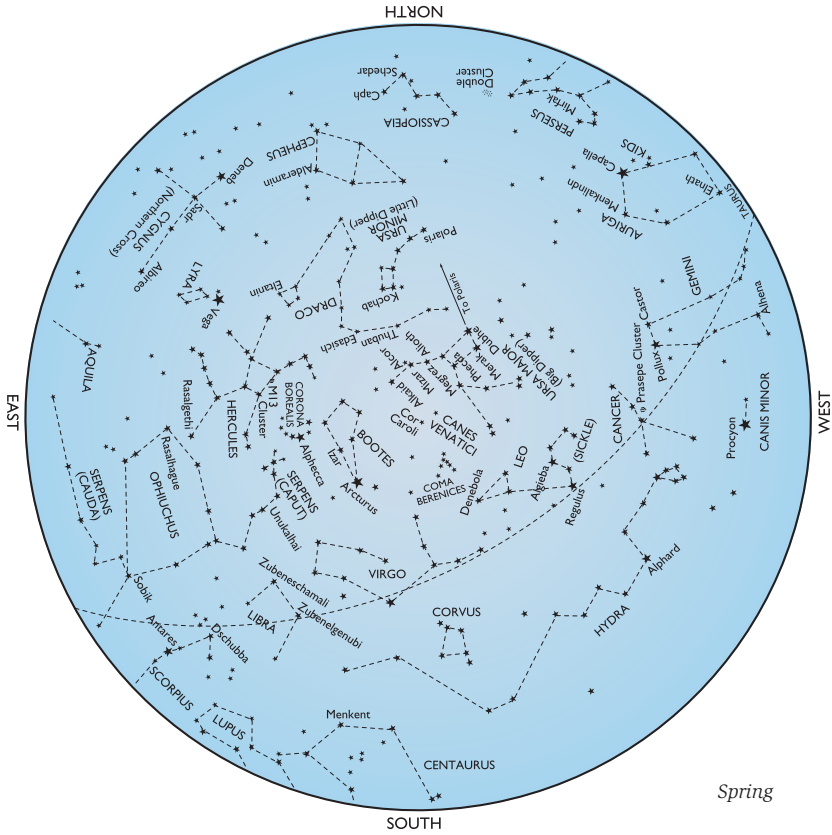


Mapping the Sky

Just as every spot on Earth can be mapped with degrees, minutes, and seconds that form a global grid of longitude and latitude, celestial coordinates are a means astronomers use to pinpoint the locations of objects in the sky.

Imagine yourself in the center of a round birdcage. The bars of the cage encircle you in the same manner that the lines of a sky map encircle you as you look up toward the heavens. The key terms of a sky map include these:

- Right ascension is similar to longitude on a map of the Earth. As with longitude, measurements of right ascension can be noted in degrees. Right ascension also can be measured in hours, minutes, and seconds, based on the fact that every 60 minutes the stars appear to move across an arc of about 15 degrees.
- Declination is similar to latitude on a ground map. Just as latitude measures the distance north or south of the Earth's equator to a point on the ground, declination measures the distance north or south of the celestial equator to a point in the sky.
- The celestial equator, located directly above the Earth's equator, bisects star maps and separates constellations into those of the northern sky and those of the southern.
- The *ecliptic* is the apparent path taken across the sky by the sun, the moon, the planets, and the 12 constellations of the zodiac.



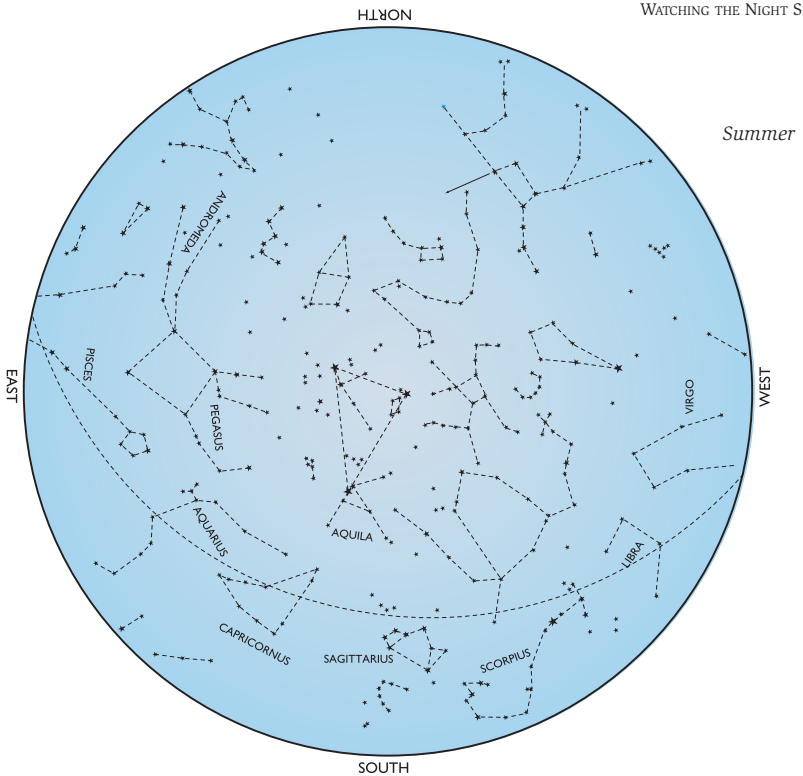
Spring

The angle of the Earth's axis in relation to its orbit around the sun creates the seasons, extends the hours of summer daylight, and shortens our winter days.

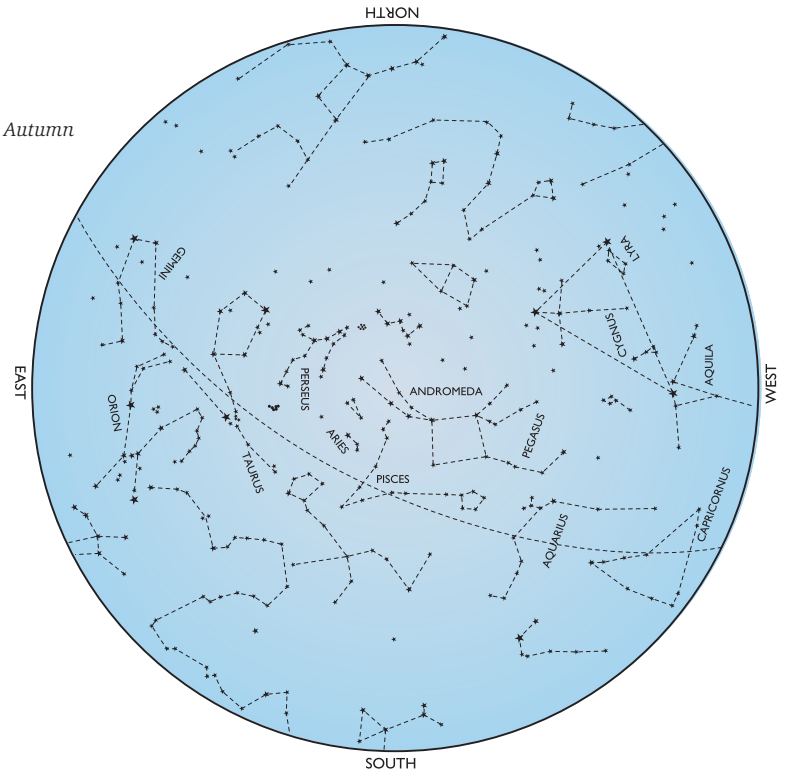
Star Maps

The rotation of the Earth creates the illusion that the stars we are seeing wheel across the night sky. Likewise, the annual progression of the Earth around the sun affects which stars we can observe on a given night, for we are always looking out from the dark side of the Earth—the side away from the sun. That puts us in position to view the heavens in one direction on summer nights and in the opposite direction on a winter's evening. Some constellations can't be seen at all during certain seasons, as they rise at midday and their light is obscured by sunlight. Orion is one that dominates the sky in the winter but is invisible throughout the summer.

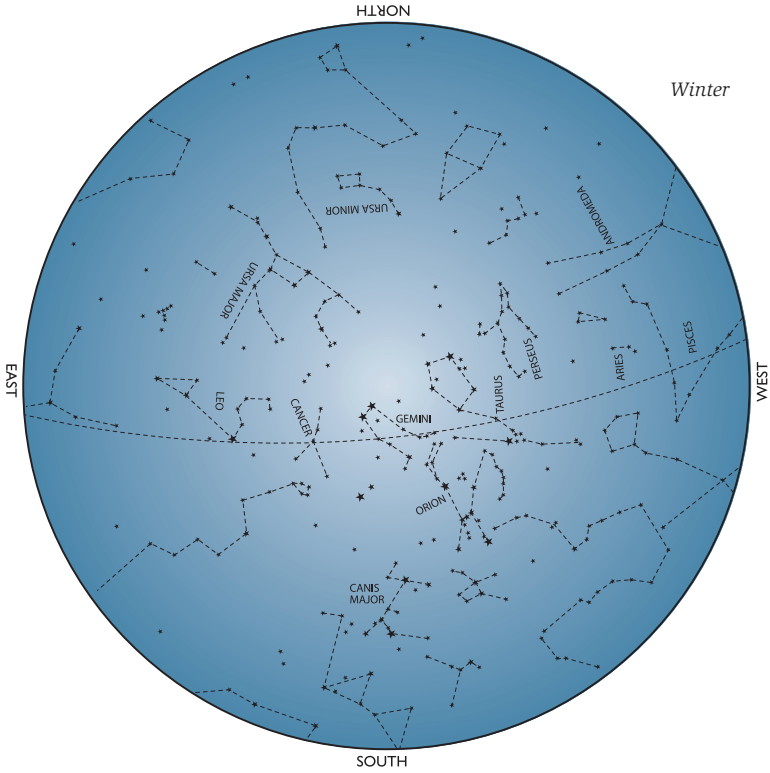
To accommodate these variations in location and time, constellation maps give the dates and hours when they best represent what you will see in the sky. The maps in the *Fieldbook* assume a viewer is in the Northern Hemisphere and is viewing the heavens between 9 P.M. and midnight.



Summer

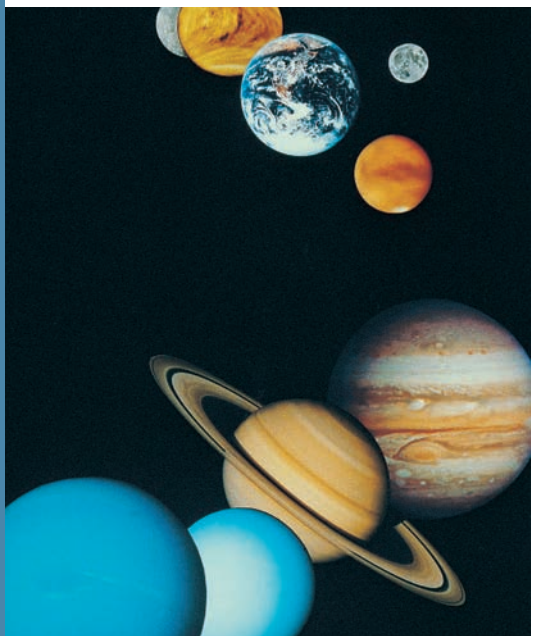


Autumn



The Planets

From earliest times, star watchers have noticed that five particular points of light did not behave like all the others. Rather than holding their positions in constellations, these five moved about among the stars. The ancient Greeks called them wanderers.



Today we know that these wanderers are planets that, like the Earth, revolve around the sun. Those visible with the naked eye are Mercury, Venus, Mars, Jupiter, and Saturn. All look like bright stars except Mercury, which, as the closest to the sun, makes faint appearances near the western horizon just after sunset. The remaining planets—Uranus, Neptune, and Pluto—can be seen only with the aid of a telescope. A small telescope enables you to view Saturn's rings, Jupiter's red spot (a giant storm), and the moons of other planets.

The Moon

Other than the sun, no heavenly body has more impact on Scout outings than the moon. Revolving around the Earth once in about 28 days, the moon waxes as more of its surface is lit by the sun, and wanes as less of its surface is lit by the sun. (If the right side of the moon, as you face it, is reflecting light, the moon is waxing. When the right side is dark, the moon is waning.)

A moonlit night can be bright enough for you to observe wildlife and to move about in camp without a flashlight. A mountain travel team might schedule a trip so that they will have a full moon to illuminate their route on a summit attempt that begins long before sunrise. Sailors and sea kayakers know that the ebb and flow of tides is caused by the pull of the moon's gravity upon the Earth's oceans.

With the help of binoculars or a telescope, you can make out craters on the moon created by the impact of meteorites. A map of the moon can guide you from one terrain feature to another, and to the locations of lunar landing zones—as yet the only places beyond the Earth where human footprints can be found.

"The surface of the Earth is the shore of the cosmic ocean. From it we have learned most of what we know. Recently, we have waded a little out to sea, enough to dampen our toes or, at most, wet our ankles. The water seems inviting. The ocean calls."

—Carl Sagan, *Cosmos,* 1977 (An astronomer and teacher, he stimulated public interest in science and space through his books and television series.)