

NASA, ESA, and the Hubble Heritage Team (STScI/AURA)

■ **Figure 1–5** The expanding dust cloud of Supernova 1987A is located in the center of the image amidst a backdrop of stars. The bright ring around the central region of the exploded star is composed of material ejected by the star about 20,000 years before the actual explosion took place. The supernova remnant is surrounded by gaseous clouds, whose red color represents the glow of hydrogen gas.

example, is an asterism but isn't a constellation, since it is just part of the constellation Ursa Major (the Big Bear). As we will see further in Chapter 4, some asterisms and constellations are sufficiently close to the celestial north pole in the sky that they are visible at all times of year, as seen from the United States. The Big Dipper is an example. But other asterisms and constellations, farther from celestial north, are visible at night for only part of the year. Let us now survey some of the prominent asterisms and constellations that you can see in each season; see also *Star Party 1.1: Using the Sky Maps*. (Amateur astronomers often hold viewing sessions informally known as “star parties,” during which they observe celestial objects. Likewise, the occasional “Star Party” boxes in this text highlight interesting observations that you can make.)

1.3a The Autumn Sky

As it grows dark on an autumn evening, you will see the Pointers in the Big Dipper – the two end stars – point upward toward Polaris. Known as the “north star,” Polaris is not one of the brightest or nearest stars in the sky, but it is well known because it is close to the direction of the celestial north pole. As we will see in Chapter 4, that means it uniquely appears almost motionless in the sky throughout

(a)

NASA and ESA; J. Hester (Arizona State U) and M. Weisskopf (NASA/Marshall Space Flight Center)

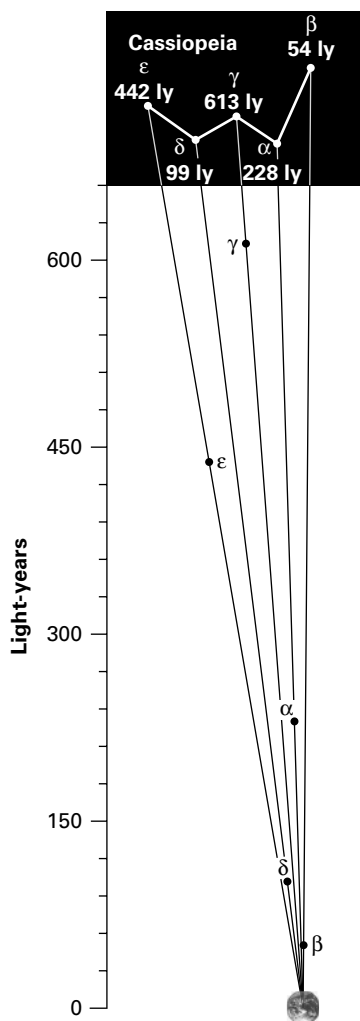
(b)

NASA and ESA; J. Hester (Arizona State U)

■ **Figure 1–6 (a)** The core of the Crab Nebula, the detritus of a star that blew apart as a supernova in 1054 CE. This composite of Hubble Space Telescope images shows gas circulating around a neutron star/pulsar that doesn't show here. **(b)** The color coding reveals the expansion of the nebula; tracing back the expansion agrees with the 1054 CE date of an observed “guest star.”

the night and provides a bearing that can help you get safely out of the woods. Almost an equal distance on the other side of Polaris is a “W”-shaped constellation named Cassiopeia (■ Fig. 1–8). In Greek mythology, Cassiopeia was married to Cepheus, the king of Ethiopia (and the subject of the constellation that neighbors Cassiopeia to the west). Cassiopeia appears sitting on a chair.

As we continue across the sky away from the Pointers, we come to the constellation Andromeda, named for Cassiopeia's daughter in Greek mythology. In Andromeda, on a very dark night you might see a faint, hazy patch of light; this is actually the center of the nearest



■ **Figure 1–7** The stars we see as a constellation are actually at different distances from us. In this case, we see the true relative distances of the stars in the “W” of Cassiopeia, as determined from the Hipparcos spacecraft. The stars’ appearance projected on the sky is shown in the upper part.

large galaxy to our own, and it is known as the Andromeda Galaxy. Although at about 2.4 million light-years away it is one of the nearest galaxies to us, it is much farther away than any of the individual stars that we see in the sky, since they are all in our own Milky Way Galaxy.

Southwest in the sky from Andromeda, but still high overhead, are four stars that appear to make a square known as the Great Square of Pegasus. One of the corners of this asterism is actually in the constellation Andromeda.

If it is really dark outside (which probably means that you are far from a city and also that the Moon is not full or almost full), you will see the hazy band of light known as the “Milky Way” crossing the sky high overhead, passing right through Cassiopeia. This dim band with ragged edges, which marks the plane of our disk-shaped galaxy (see Chapter 16), has many dark patches that make rifts in its brightness.

Moving southeast from Cassiopeia, along the Milky Way, we come to the constellation Perseus; he was the Greek hero who slew the Medusa. (He flew off on Pegasus, the winged horse, who is conveniently nearby in the sky, and saw Andromeda, whom he saved.) On the edge of Perseus nearest to Cassiopeia, with a small telescope or binoculars we can see two hazy patches of light that are really clusters of hundreds of stars called “open clusters,” a type of grouping we will discuss in Chapter 11. This “double cluster in Perseus,” also known as η and χ (the Greek letter “chi”) Persei, provides two of the open clusters that are easiest to see with small telescopes. (They will appear in Figure 11–35.) In 1603, Johann Bayer assigned Greek letters to the brightest stars and lowercase Latin letters to less-bright stars (■ Fig. 1–9), but in this case the system was applied to name the two clusters as well.

Along the Milky Way in the other direction from Cassiopeia (whose “W” is relatively easy to find), we come to a cross of bright stars directly overhead. This “Northern Cross” is an asterism marking part of the constellation Cygnus, the Swan (■ Fig. 1–10). In this

★ Star Party 1.1 Using the Sky Maps

Because of Earth’s motion around the Sun over the course of a year, the parts of the sky that are “up” after dark change slightly each day. A given star rises (and crosses the meridian, or highest point of its arc across the sky) about 4 minutes earlier each day. (Note that stars relatively close to the visible celestial pole don’t rise or set, but they still cross the meridian about 4 minutes earlier each day.) By the time a season has gone by, the sky has apparently slipped a quarter of the way around at sunset as Earth has moved a quarter of the way around the Sun in its yearly orbit. Some constellations are lost in the afternoon and evening glare, while others have become visible just before dawn.

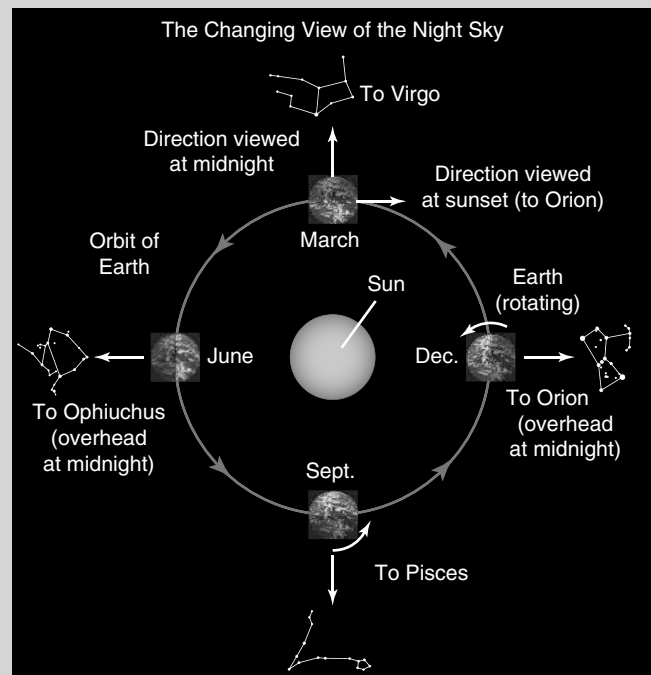
In December of each year, the constellation Orion crosses the meridian at midnight. Three months later, in March, when Earth has moved through one-quarter of its orbit around the Sun, the constellation Virgo crosses the meridian at midnight, when Orion is setting. Orion crosses the meridian at sunset (that is, 6 hours earlier than in December – consistent with $4 \text{ minutes/day} \times 90 \text{ days} = 360 \text{ minutes} = 6 \text{ hours}$). Another three months later, in June, Orion crosses the meridian an additional 6 hours earlier – that is, at noon. Hence, it isn’t then visible at night. Instead, the constellation Ophiuchus crosses the meridian at midnight.

Because of this seasonal difference, inside the front and back covers of this book we have included four Sky Maps, one of which is best for the date and time at which you are observing. Suitable combinations of date and time are marked. Note also that if you make your observations later at night, it is equivalent to observing later in the year. Two hours later at night is the same as shifting later by one month.

Hold the map above your head while you are facing north or south, as marked on each map, and notice where your zenith is in the sky and on the map. The horizon for your latitude is also marked. Try to identify a pattern in the brightest stars that you can see. Finding the Big Dipper, and using it to locate the pole star, often helps you to orient yourself. Don't let any bright planets confuse your search for the bright stars – knowing that planets usually appear to shine steadily instead of twinkling like stars (see Chapter 4) may assist you in locating the planets.

You might also (or instead) want to use one of the numerous smartphone apps that show the positions of constellations and planets in the sky. Many of these even provide interesting information about the objects, if you touch the appropriate places on the screen.

Come back and look at Sections 1.3a–d at the appropriate time of year – even after you have finished with this course.



direction, spacecraft detect x-rays whose brightness varies with time, and astronomers have deduced in part from that information that a black hole is located there. Also in Cygnus is a particularly dark region of the Milky Way, called the Northern Coalsack. Dust in space

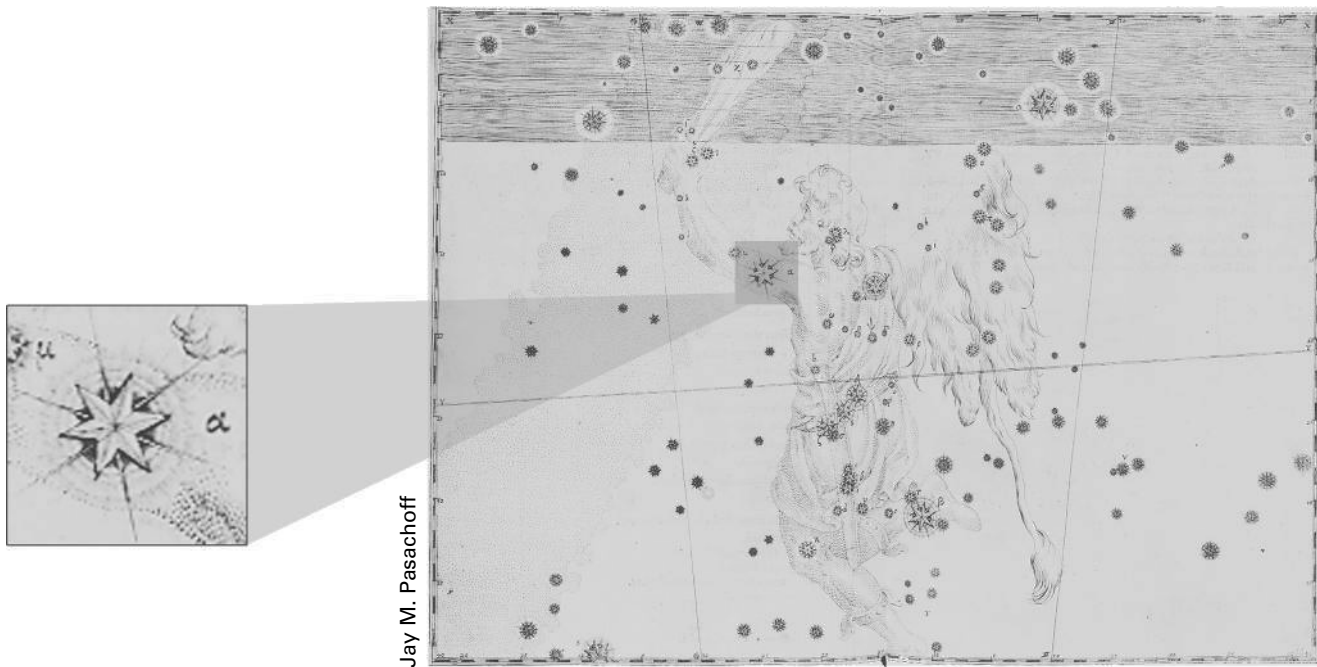
in that direction prevents us from seeing as many stars as we see in other directions of the Milky Way.

Slightly to the west is another bright star, Vega, in the constellation Lyra (the Lyre). And farther westward, we come to the constellation



VegaStarClairPhotography <https://vegastarcaptivityphotography.wordpress.com/>

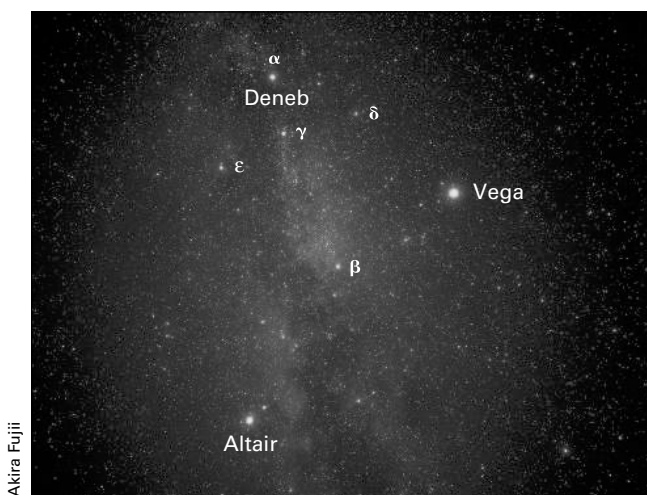
■ Figure 1–8 The constellation Cassiopeia is easily found in the sky from its distinctive “W” shape. During this exposure, a meteor from the Perseid meteor shower (August 11 or 12 each year) flashed by.



■ **Figure 1–9** Johann Bayer, in 1603, used Greek letters to mark the brightest stars in constellations; he also used lowercase Latin letters. Here we see Orion, the great hunter. The inset shows the red supergiant Betelgeuse, α Orionis (that is, alpha of Orion), marking Orion’s shoulder.

Hercules, named for the mythological Greek hero who performed twelve great labors, of which the most famous was bringing back the golden apples. In Hercules is an older, larger type of star cluster called a “globular cluster,” another type of grouping we will discuss

in Chapter 11. It is known as M13, the great globular cluster in Hercules. It resembles a fuzzy mothball whether glimpsed with the naked eye or seen with small telescopes; larger telescopes have better clarity and gather more light, and so can reveal the individual stars.



■ **Figure 1–10** The Northern Cross, composed of the brightest stars in the constellation Cygnus, the Swan. Deneb, also called alpha (α) Cygni, gamma (γ) Cygni, and beta (β) Cygni make the long bar; epsilon, gamma, and delta Cygni make the crossbar. The bright star Vega, alpha in Lyra, is nearby. Also marked is the bright star Altair, alpha in Aquila, the Eagle. These stars lie in the Milky Way, which shows clearly on the image.

1.3b The Winter Sky

As autumn proceeds and winter approaches, the constellations we have discussed appear closer and closer to the western horizon for the same hour of the night. By early evening on January 1, Cygnus is setting in the western sky, while Cassiopeia and Perseus are overhead.

To the south of the Milky Way, near Perseus, we can now see a group of six stars close together in the sky (■ Fig. 1–11). The tight grouping tends to catch your attention as you scan the sky. It is the Pleiades (pronounced “pleé-a-deez”), traditionally the Seven Sisters of Greek mythology, the daughters of Atlas. (We can usually see six stars with the unaided eye now, so either one of the stars has faded over the millennia or it was never visible and the association with the Pleiades myth was loose.) These stars are another example of an open cluster of stars. Binoculars or a small telescope will reveal dozens of stars there, whereas a large telescope will ordinarily show too small a region of sky for you to see the Pleiades well. So a bigger telescope isn’t always better.

Farther toward the east, rising earlier every evening, is the constellation Orion, the Hunter (■ Fig. 1–12). Orion is perhaps the easiest constellation of all to pick out in the sky, for three bright stars close together in a line make up its belt. Orion is warding off Taurus, the Bull, whose head is marked by a large “V” of stars. A reddish star, Betelgeuse (“beé tl-juice” is an acceptable pronunciation, though some say “behtl-jouz”),



■ **Figure 1-11** The Pleiades, the Seven Sisters, in the constellation Taurus, the Bull. It is a star cluster, and long exposures like this one show dust around the stars reflecting starlight, preferentially the bluish colors. When the Pleiades and the Hyades, another star cluster, rose just before dawn, ancient peoples in some parts of the world knew that the rainy season was about to begin.

marks Orion's armpit, and symmetrically on the other side of his belt, the bright bluish star Rigel ("ryé jel") marks his heel. Betelgeuse is an example of a "red supergiant" star; it is more than a billion kilometers across, far bigger itself than Earth's orbit around the Sun!

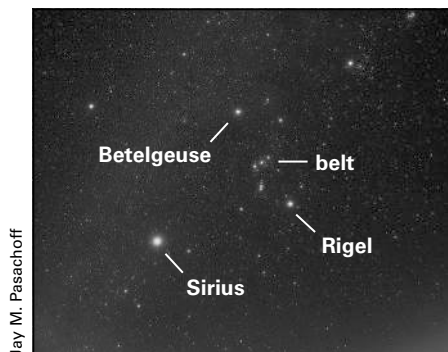
Orion's sword extends down from his belt. A telescope, or a photograph, reveals a beautiful region known as the Orion Nebula. Its general shape can be seen in even a smallish telescope; however, only photographs that have detected much light clearly reveal the vivid colors – though whether it is reddish or greenish in an image depends on what kind of film is used. It is a site where new stars are forming right now, as you read these words.

Rising after Orion is Sirius, the brightest star in the sky. Orion's belt points directly to it. Sirius appears blue-white, which indicates that its surface is very hot. Sirius is so much brighter than the other stars that it stands out to the naked eye. It is part of the constellation Canis Major, the Big Dog. (You can remember that it is near Orion by thinking of it as Orion's dog.)

Back toward the top of the sky, between the Pleiades and Orion's belt, is a group of stars that forms the "V"-shaped head of Taurus. This open cluster is known as the Hyades ("hý a-deez"). The stars of the Hyades mark the bull's face, while the stars of the Pleiades ride on the bull's shoulder. In a Greek myth, Jupiter turned himself into a bull to carry Europa over the sea to what is now called Europe.

1.3c The Spring Sky

We can tell that spring is approaching when the Hyades and Orion get closer and closer to the western horizon each evening, and finally are no longer visible shortly after sunset. Now Castor and Pollux, a pair of equally bright stars, are nicely placed for viewing in the



■ **Figure 1-12** The constellation Orion, marked by reddish Betelgeuse, bluish Rigel, and a belt of three stars in the middle. The Orion Nebula is the reddish object below the belt. It is M42 on the Winter Sky Map at the end of the book. Sirius, the brightest star in the sky, is to the lower left of Orion in this view.

western sky. Castor and Pollux were the twins in the Greek pantheon of gods. The constellation is called Gemini, the twins.

On spring evenings, the Big Bear (Ursa Major) is overhead, and anything in the Big Dipper – which is part of the Big Bear – would spill out. Leo, the Lion, is just to the south of the overhead point, called the zenith (follow the Pointers backward). Leo looks like a backward question mark, with the bright star Regulus, the lion's heart, at its base. The rest of Leo, to the east of Regulus, is marked by a bright triangle of stars. Some people visualize a sickle-shaped head and a triangular tail.

If we follow the arc made by the stars in the handle of the Big Dipper, we come to a bright reddish star, Arcturus, an example of a "red giant." It is in the kite-shaped constellation Boötes, the Herdsman.

Sirius sets right after sunset in the spring; however, a prominent but somewhat fainter star, Spica, is rising in the southeast in the constellation Virgo, the Virgin. It is farther along the arc of the Big Dipper through Arcturus. Vega, a star that is between Sirius and Spica in brightness, is rising in the northeast. And the constellation Hercules, with its notable globular cluster M13, is rising in the east in the evening at this time of year.

1.3d The Summer Sky

Summer, of course, is a comfortable time to watch the stars because of the generally warm weather. Spica is over toward the southwest in the evening. A bright red supergiant, Antares, is in the constellation Scorpius, the Scorpion, to the south. ("Antares" means "compared with Ares," another name for Mars, because Antares is also reddish.)

Hercules and Cygnus are high overhead, and the star Vega is prominent near the zenith. Cassiopeia is in the northeast. The center of our Galaxy is in the dense part of the Milky Way that we see in the constellation Sagittarius, the Archer, in the south (■ Fig. 1-13).

Around August 12 every summer is a wonderful time to observe the sky, because that is when the Perseid meteor shower occurs. (Meteors, or "shooting stars," are not stars at all, as we will discuss in