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NASA medal recipients



Astronomy

5th Edition

**by Stephen P. Maran, PhD, and
Richard Tresch Fienberg, PhD**

**for
dummies®**
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Astronomy For Dummies®, 5th Edition

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Introduction

Astronomy is the study of the sky, the science of cosmic objects and celestial happenings. It's nothing less than the investigation of the nature of the universe we live in. Astronomers carry out the business of astronomy by using backyard telescopes, huge observatory instruments, radio telescopes that detect celestial radio emissions, and satellites orbiting Earth or positioned in space near Earth or another celestial body, such as the Moon or a planet. Scientists send up telescopes in sounding rockets and on unmanned balloons, some instruments travel far into the solar system aboard deep space probes, and some probes gather samples and return them to Earth.

Astronomy can be a professional or amateur activity. About 30,000 professional astronomers engage in space science worldwide, and there are hundreds of thousands of amateur astronomers around the globe. Many amateurs belong to local or national astronomy clubs in their home countries.

Professional astronomers conduct research on the Sun and the solar system, the Milky Way galaxy, and the universe beyond. They teach in universities, design satellites in government labs or industry, and operate planetariums. They also write books like this one (but maybe not as good). Most hold PhDs. Nowadays, many professional astronomers study abstruse physics of the cosmos or work with automated, remotely controlled telescopes, so they may not even know the constellations.

Amateur astronomers know the constellations! They share an exciting hobby. Some stargaze on their own; many others join astronomy clubs and organizations of every description. The clubs pass on know-how from old hands to new members, share telescopes and equipment, and hold meetings where members tell about their recent observations or hear lectures by local or visiting scientists.

Amateur astronomers also hold observing meetings where everyone brings a telescope (or looks through another person's scope). The amateurs conduct these sessions at regular intervals (typically monthly) or on special occasions (such as the return of a major meteor shower or the appearance of a bright comet). And they save up for really big events, such as a total eclipse of the Sun, when thousands of amateurs and dozens of pros travel across Earth to position themselves in the path of totality and witness one of nature's greatest spectacles.

About This Book

This book explains all you need to know to launch into the great hobby of astronomy. It gives you a leg up on understanding the basic science of the universe as well. The latest space missions will make more sense to you: You'll understand why NASA and many other organizations launch satellites and send probes to planets, comets, and asteroids, and why robot rovers and even a helicopter landed on Mars. You'll know why the *James Webb Space Telescope*, the *Hubble Space Telescope*, and other observatories peer out into space, and you'll gain an understanding of what they see. And when astronomers show up in the news media to report their latest discoveries — from space; from the big telescopes in Arizona, Hawai'i, Chile, and California; or from radio telescopes in New Mexico, South Africa, China, Australia, or other locations around the world — you'll understand the background and appreciate the news. You'll even be able to explain it to your friends.

Read only the parts you want, in any order you want. We explain what you need as you go. Astronomy is fascinating and fun, so keep reading. Before you know it, you'll be pointing out Jupiter, spotting famous constellations and stars, and tracking the *International Space Station* as it whizzes overhead. The neighbors may start calling you “stargazer.” Police officers may ask you what you're doing in the park at night or why you're standing on the roof with binoculars. Tell 'em you're an astronomer. They probably haven't heard that one. (We hope they believe you!)

Foolish Assumptions

We assume you're reading this book because you want to know what's up in the sky or what the scientists in the space program are doing. Or perhaps you've heard that astronomy is a neat hobby, and you want to see whether the rumor is true. Or perhaps you want to find out what equipment you need to explore the night sky.

We suspect you're not a scientist, that you just enjoy looking at the night sky and have fallen under its spell, wanting to see and understand the wonders of the universe.

We figure you want to observe the stars but also want to know what you're seeing. Maybe you even want to make a discovery of your own. You don't have to be a professional astronomer to spot a new comet, and you can even help researchers make progress in understanding the cosmos by signing up for citizen science projects that require only that you examine space images with your personal computer from the comfort of your home. Whatever *your* goal, *our* goal is for this book to help you achieve it.

Icons Used in This Book

Throughout this book, helpful icons highlight particularly useful information — even if they just tell you to not sweat the tough stuff. Here's what each symbol means:



REMEMBER

The string-tied-on-a-finger icon points out information you should file away for future reference.



TECHNICAL
STUFF

This nerd (who reminds us of ourselves when we were younger) appears beside discussions that you can skip if you just want to know the basics and start watching the skies. The scientific background can be good to know, but many people happily enjoy their stargazing without knowing about the physics of supernovas, the mathematics of galaxy chasing, and the ins and outs of dark energy.



TIP

This lightbulb puts you right on track to make use of some inside information as you start skywatching or make progress in the hobby.



WARNING

How much trouble can you get into while watching the stars? Not much, if you're careful. But some things you can't be too careful about. This icon alerts you to pay attention so you don't get burned.

Beyond the Book

In addition to the book you're reading right now, be sure to check out the free Cheat Sheet on the web. It offers a historical calendar of notable astronomical events and other useful information. To get this supplement, simply go to www.dummies.com and enter "Astronomy For Dummies" in the Search box.

If you want to test your astronomy knowledge, check out the practice quizzes online. Each chapter has a corresponding quiz consisting of multiple choice and true/false questions. We've also turned the glossary into flashcards that let you test your knowledge of astronomy terms.

To gain access to the online content, all you have to do is register. Just follow these simple steps:

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If you do not receive this email within two hours, please check your spam or junk folder before contacting us through our Technical Support website at <http://support.wiley.com> or by phone at 877-762-2974.

Now you're ready to go! You can come back to the practice material as often as you want — simply log on with the username and password you created during your initial login. No need to enter the access code a second time.

Your registration is good for one year from the day you activate your PIN.

Where to Go from Here

You can start anywhere you want. Wondering about black holes? Start off with Chapter 13 and read all about them. But don't get too close.

Or you may want to begin at Chapter 1 with what's in store for you as you pursue your passion for the stars.

Most chapters include links to additional information and resources. Whether you're looking for the camaraderie of a local astronomy club, the best stargazing apps for your smartphone or tablet, magazines with the latest astronomy news and tips for what to observe in the sky this month, or websites where you can learn more about your favorite space missions, we've got you covered.

Wherever you start, we hope you continue your cosmic exploration and experience the joy, excitement, enlightenment, and enchantment that people have always found in the skies.

1

Getting Started with Astronomy

IN THIS PART . . .

Discover the basic elements of astronomy, check out lists of constellations and bright stars, and get a crash course on gravity.

Find out about the resources available to help you check out the night sky, including organizations, facilities, and equipment.

Get an introduction to celestial and other phenomena that sweep across the night sky, such as meteors, comets, and artificial satellites.

- » Observing the nature of astronomy
- » Focusing on astronomy's language of light
- » Weighing in on gravity
- » Recognizing how objects move through space

Chapter **1**

Seeing the Light: The Art and Science of Astronomy

Step outside on a clear night and look at the sky. If you're a city dweller or live in a cramped suburb, you see dozens, maybe hundreds, of twinkling stars. Depending on the time of the month, you may also see a full Moon and up to five of the eight planets that revolve around the Sun.

A shooting star, or "meteor," may appear overhead. What you actually see is the flash of light caused by a tiny piece of space dust streaking through Earth's upper atmosphere.

Another pinpoint of light moves slowly and steadily across the sky. Is it an artificial satellite, such as the Hubble Space Telescope or International Space Station, or is it just a high-altitude airliner? If you have binoculars, you may be able to see the difference. Airliners have flashing lights, and their shapes may be perceptible.

If you live in the country — on the seashore away from resorts and developments, on the plains, or in the mountains far from any floodlit ski slope — you can see thousands of stars on a clear night. The Milky Way appears as a beautiful pearly

swath across the heavens. What you're seeing is the cumulative glow from millions of faint stars, individually indistinguishable with the naked eye. At a great observation place, such as Cerro Tololo in the Chilean Andes, you can see even more stars. They hang like brilliant lamps in a coal black sky, often not even twinkling, like in Vincent van Gogh's *Starry Night* painting.

When you look at the sky, you practice astronomy — you observe the universe that surrounds you and try to make sense of what you see. For thousands of years, everything people knew about the heavens they deduced by simply observing the sky. Everything that astronomy deals with

- » Is seen from a distance
- » Falls from afar like a meteorite, or is collected and brought to Earth with a spacecraft like a Moon rock
- » Is discovered by studying light and particles of matter that come from objects in space
- » Moves through space under the influence of gravity

This chapter introduces you to these concepts (and more).

Astronomy: The Science of Observation

Astronomy is the study of the sky, the science of cosmic objects and celestial happenings, and the investigation of the nature of the universe we live in. Professional astronomers carry out the business of astronomy by observing with telescopes that capture visible light from the stars or by tuning in to radio waves that come from space. They use backyard telescopes, huge observatory instruments, and satellites that orbit Earth collecting forms of light (such as ultraviolet radiation) that the atmosphere blocks from reaching the ground. They send up telescopes in sounding rockets (equipped with instruments for making high-altitude scientific observations) and on unmanned balloons. And they send some instruments into the solar system aboard deep-space probes.

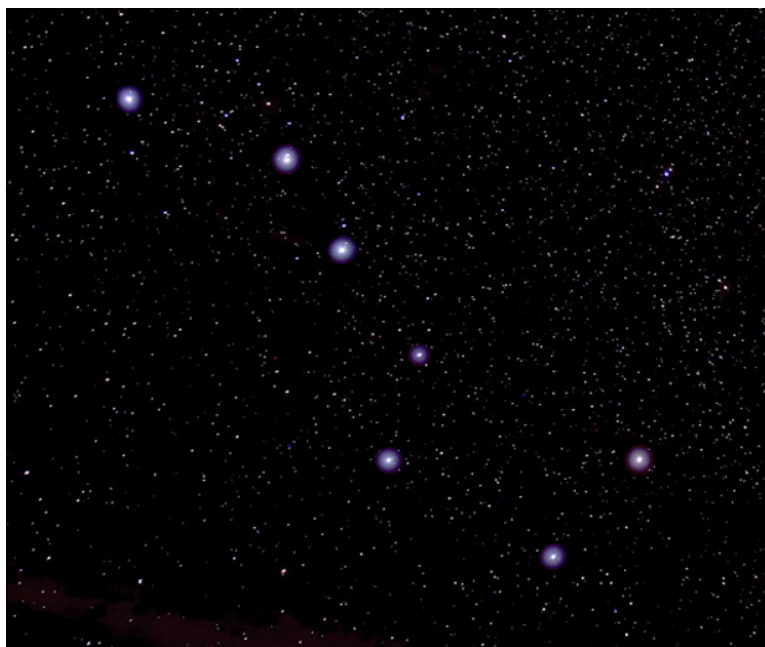
Astronomers also use telescopes positioned in certain regions about 1 million miles from Earth, including the James Webb Space Telescope and the Solar and Heliospheric Observatory.

Professional astronomers study the Sun and the solar system, the Milky Way, and the universe beyond. They teach in universities, design satellites in government labs, and operate planetariums. They also write books (like us, your personal cosmic tour guides). Most have completed years of schooling to earn PhDs. Many

study advanced physics, work with automated, robotic telescopes, or use supercomputers to simulate the history of the universe. They may never have studied the *constellations* (star patterns, such as Ursa Major, the Great Bear, named by ancient stargazers) that amateur or hobbyist astronomers first explore.

You may already be familiar with the Big Dipper, an asterism in Ursa Major. An *asterism* is a named star pattern that's not identical to one of the 88 recognized constellations. An asterism may be wholly within a single constellation or may include stars from more than one constellation. For example, the four corners of the Great Square of Pegasus, a large asterism, are marked by three stars of the constellation Pegasus and a fourth from Andromeda. Figure 1-1 shows the Big Dipper in the night sky. (In the United Kingdom, some people call the Big Dipper the Plough.)

FIGURE 1-1:
The Big Dipper,
one of the most
familiar asterisms
(star patterns) in
the night sky,
comprises the
brightest stars in
the constellation
Ursa Major, the
Great Bear.



Courtesy of Richard Tresch Fienberg

Amateur astronomers, who vastly outnumber professionals, usually know the constellations and use them as guideposts when exploring the sky by eye, with binoculars, and with telescopes. Many amateurs also make useful scientific contributions. They monitor the changing brightness of variable stars; discover asteroids, comets, and exploding stars; and crisscross Earth to enjoy total eclipses of the Sun or catch the shadows cast as asteroids pass in front of bright stars (thereby helping astronomers map the asteroids' shapes). They even join in professional research efforts with their home computers and smartphones (or with

telescopes) through Citizen Science projects, which we describe in Chapter 2 and elsewhere throughout the book.

Many amateur astronomers do educational outreach in their communities, explaining astronomy to school groups and public gatherings.

In this and the next two chapters, we provide you with information on how to observe the skies effectively and enjoyably.

What You See: The Language of Light

Light brings us information about the planets, moons, and comets in our solar system; the stars, star clusters, and nebulae in our galaxy; and the objects beyond.

In ancient times, skygazers didn't think about the physics and chemistry of the stars; they absorbed and passed down folk tales and myths: the Great Bear, the Demon star, the Man in the Moon, the dragon eating the Sun during a solar eclipse, and more. The tales varied from culture to culture. But many people did discover the patterns of the stars. In Polynesia, skilled navigators sailed across hundreds of miles of open ocean with no landmarks in view, no compass, and certainly no GPS. They navigated by the stars, the Sun, and their knowledge of prevailing winds and currents.

Gazing at the light from a star, the ancients noted its brightness, position in the sky, and color. This information helps people distinguish one sky object from another, and the ancients got to know them like old friends. Now you can, too. Some basics of recognizing and describing what you see in the sky are

- » Distinguishing planets from stars
- » Identifying constellations, individual stars, and other sky objects by name
- » Observing brightness (measured in *magnitudes*)
- » Understanding the concept of a light-year
- » Charting sky positions (measured in special units called *RA* and *Dec*)

They wondered as they wandered: Understanding planets versus stars

The term *planet* comes from the ancient Greek word *planetes*, meaning “wanderer.” The Greeks (and other ancient people) noticed that five spots of light move

with respect to the stars in the sky. Sometimes they go steadily in one direction; at other times they loop back on their own paths. Nobody knew why. And these spots of light don't twinkle like stars do; no one understood that difference, either. Every culture had a name for those five spots of light — what we now call planets. Their English names are Mercury, Venus, Mars, Jupiter, and Saturn. These celestial bodies aren't wandering among the stars; they orbit around the Sun, our solar system's central star.

Today astronomers know that planets can be smaller or bigger than Earth, but they all are much smaller than the Sun. The planets in our solar system are so close to Earth that they have perceptible disks — at least, when viewed through a telescope — so we can see their shapes and sizes. The stars are so far away that even if you view them through a powerful telescope, they show up only as points of light. (For more about the planets in the solar system, flip to Part 2. We cover the planets of stars beyond the Sun in Chapter 14.)

The essential physical difference between stars and planets is that stars are made of gas all the way through and shine by their own light, whereas planets have rock and perhaps ice inside and shine by reflecting light from their host star (in our solar system, that's the Sun). You can read about the planets of our solar system in Chapters 6, 8, and 9; about the Sun in Chapter 10; about other stars in Chapter 11; and about planets around other stars (*exoplanets*) in Chapter 14.

So, why *do* the planets in our solar system sometimes appear to change direction in the sky as they wander across the starry background? They orbit the Sun in concentric circles (actually in slightly out-of-round ellipses), like the lanes of a running track, going counterclockwise if we treat north as “up.” Here on Earth, we're in lane 3; Mercury and Venus run in lanes 1 and 2, whereas Mars, Jupiter, and Saturn scoot along in lanes 4, 5, and 6. Unlike the runners on a track, any of whom might win the race, in the solar system the planets closer to the Sun always orbit faster than the ones farther out, because they're pulled harder by the Sun's gravity (as we explain later in this chapter).

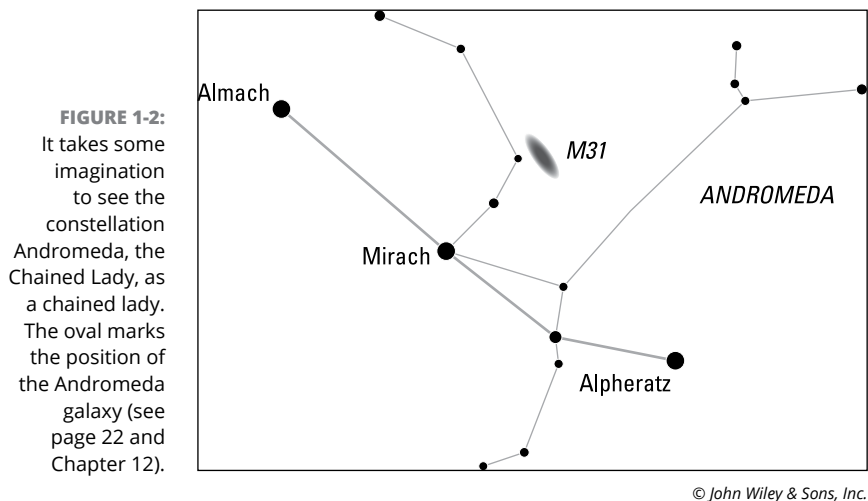
Now, imagine running a race in which the fastest competitor is in lane 1, you're in lane 3, and the slowest runner is in lane 6. If you look at faster runners (analogous to inner planets) as they lap you, or at slower runners (outer planets) as you lap them, they appear to move from your left to your right. But if you look at them when they're on the opposite side of the track (or Sun) from you, they appear to go from right to left as seen against the bleachers in the background (analogous to the stars). Their apparent change of direction is simply a consequence of your changing perspective as everybody runs around the track at different speeds. To see this in action, play around with the University of New Mexico's online simulator at physics.unm.edu/Courses/Rand/applets/retrograde.html.

And why *don't* planets twinkle like stars? Twinkling arises from atmospheric turbulence, which causes rays of light from space to zigzag slightly as they make their way to Earth's surface. The zigs and zags are minuscule, but since stars appear to us as mere points, those tiny diversions cause rapid, erratic variations in a star's apparent position, which we perceive as twinkling. Even though we can't see planets' disks without a telescope, those disks are bigger than the distortions caused by air turbulence. So the zigs and zags of light rays coming from different parts of the disk overlap and cancel each other, and a planet appears to shine steadily.

If you see a Great Bear, start worrying: Naming stars and constellations

We used to tell planetarium audiences who craned their necks to look at stars projected above them, “If you can't see a Great Bear up there, don't worry. Maybe those who *do* see a Great Bear should worry.”

Ancient astronomers divided the sky into imaginary figures, such as Ursa Major (Latin for “Great Bear”); Cygnus, the Swan; Andromeda, the Chained Lady; and Perseus, the Hero. The ancients identified each figure with a pattern of stars. The truth is, to most people, Andromeda doesn't look much like a chained lady at all (see Figure 1-2).



Today astronomers have divided the sky into 88 constellations, which contain all the stars you can see. The International Astronomical Union, which governs the science, set boundaries for the constellations so astronomers can agree on which star is in which constellation. Previously, sky maps drawn by different astronomers often disagreed. Now when you read that the Tarantula nebula is in Dorado (see Chapter 12), you know that, to see this nebula, you must seek it in the Southern Hemisphere constellation Dorado, the Goldfish.

The largest constellation is Hydra, the Water Snake. The smallest is Crux, the Cross, which most people call the Southern Cross. You can see a Northern Cross, too, but you can't find it in a list of constellations; it's an asterism within Cygnus, the Swan. Although astronomers generally agree on the names of the constellations, they don't have a consensus on what each name means. For example, some astronomers call Dorado the Swordfish, but we'd like to skewer that name. One constellation, Serpens, the Serpent, is broken into two sections that aren't connected. The two sections, located on either side of Ophiuchus, the Serpent Bearer, are Serpens Caput (the Serpent's Head) and Serpens Cauda (the Serpent's Tail).

The individual stars in a constellation often have no relation to each other except for their proximity in the sky as visible from Earth. In space, the stars that make up a constellation may be completely unrelated to one another, with some located relatively near Earth and others located at much greater distances in space. But they make a simple pattern for observers on Earth to enjoy.

The brighter stars in a constellation were assigned Greek letters by German astronomer Johann Bayer, who included them in his *Uranometria* star atlas in 1603. In each constellation, the brightest star was (usually) labeled alpha, the first letter of the Greek alphabet. The next brightest star was beta, the second Greek letter, and so on down to omega, the final letter of the 24-character Greek alphabet. (The astronomers used only lowercase Greek letters, so you see them written as α , β , . . . ω .)

So Sirius, the brightest star in the night sky — in Canis Major, the Great Dog — is called Alpha Canis Majoris. (Astronomers traditionally add a suffix to put star names in the Latin genitive case.) Table 1-1 shows the lowercase Greek alphabet, in order, with the names of the letters and their corresponding symbols. (You can see star names with their Latin genitive suffixes in the fourth column of Table 1-2.)



TIP

When you look at a star atlas, you discover that the individual stars in a constellation aren't marked α Canis Majoris, β Canis Majoris, and so on. Usually, the creator of the atlas marks the area of the whole constellation as Canis Major and labels the individual stars α , β , and so on. When you read about a star in a list of objects to observe, say, in an astronomy magazine (see Chapter 2), you probably

won't see it listed in the style of Alpha Canis Majoris or even α Canis Majoris. Instead, to save space, the magazine prints it as α CMa; *CMa* is the three-letter abbreviation for Canis Majoris (and also the abbreviation for Canis Major). We give the abbreviation for each of the constellations in Table 1-2.

TABLE 1-1

The Greek Alphabet

Letter	Name
α	Alpha
β	Beta
γ	Gamma
δ	Delta
ϵ	Epsilon
ζ	Zeta
η	Eta
θ	Theta
ι	Iota
κ	Kappa
λ	Lambda
μ	Mu
ν	Nu
ξ	Xi
\omicron	Omicron
π	Pi
ρ	Rho
σ	Sigma
τ	Tau
υ	Upsilon
ϕ	Phi
χ	Chi
ψ	Psi
ω	Omega

TABLE 1-2**The Constellations and Their Brightest Stars**

Name	Abbreviation	Meaning	Brightest Star	Magnitude
Andromeda	And	Chained Lady	Alpheratz	2.1
Antlia	Ant	Air Pump	Alpha Antliae	4.3
Apus	Aps	Bird of Paradise	Alpha Apodis	3.8
Aquarius	Aqr	Water Bearer	Sadalsuud (Beta Aquarii)	2.9
Aquila	Aql	Eagle	Altair	0.8
Ara	Ara	Altar	Beta Arae	2.9
Aries	Ari	Ram	Hamal	2.0
Auriga	Aur	Charioteer	Capella	0.1
Boötes	Boo	Herdsman	Arcturus	0.0
Caelum	Cae	Chisel	Alpha Caeli	4.5
Camelopardalis	Cam	Giraffe	Beta Camelopardalis	4.0
Cancer	Cnc	Crab	Tarf (Beta Cancri)	3.5
Canes Venatici	CVn	Hunting Dogs	Cor Caroli	2.9
Canis Major	CMa	Great Dog	Sirius	−1.5
Canis Minor	CMi	Little Dog	Procyon	0.4
Capricornus	Cap	Sea Goat	Deneb Algedi (Delta Capricorni)	2.9
Carina	Car	Ship's Keel	Canopus	−0.7
Cassiopeia	Cas	Queen	Schedar	2.2
Centaurus	Cen	Centaur	Rigil Kentaurus	0.0
Cepheus	Cep	King	Alderamin	2.4
Cetus	Cet	Whale	Diphda (Beta Ceti)	2.0
Chamaeleon	Cha	Chameleon	Alpha Chamaeleontis	4.1
Circinus	Cir	Compasses	Alpha Circini	3.2
Columba	Col	Dove	Phact	2.6
Coma Berenices	Com	Berenice's Hair	Beta Comae Berenices	4.3
Corona Australis	CrA	Southern Crown	Meridiana	4.1
Corona Borealis	CrB	Northern Crown	Alphecca	2.2

(continued)

TABLE 1-2 *(continued)*

Name	Abbreviation	Meaning	Brightest Star	Magnitude
Corvus	Crv	Crow	Gienah (Gamma Corvi)	2.6
Crater	Crt	Cup	Delta Crateris	3.6
Crux	Cru	(Southern) Cross	Acrux	0.8
Cygnus	Cyg	Swan	Deneb	1.3
Delphinus	Del	Dolphin	Rotanev (Beta Delphini)	3.6
Dorado	Dor	Goldfish	Alpha Doradus	3.3
Draco	Dra	Dragon	Eltanin (Gamma Draconis)	2.2
Equuleus	Equ	Little Horse	Kitalpha	3.9
Eridanus	Eri	River	Achernar	0.5
Fornax	For	Furnace	Dalim	3.9
Gemini	Gem	Twins	Pollux (Beta Geminorum)	1.1
Grus	Gru	Crane	Alnair	1.7
Hercules	Her	Hercules	Kornephoros (Beta Herculis)	2.8
Horologium	Hor	Clock	Alpha Horologii	3.9
Hydra	Hya	Water Snake	Alphard	2.0
Hydrus	Hyi	Little Water Snake	Beta Hydri	2.8
Indus	Ind	Indian	Alpha Indi	3.1
Lacerta	Lac	Lizard	Alpha Lacertae	3.8
Leo	Leo	Lion	Regulus	1.4
Leo Minor	LMi	Little Lion	Praecipua (46 Leonis Minoris)	3.8
Lepus	Lep	Hare	Arneb	2.6
Libra	Lib	Scales	Zubeneschamali (Beta Librae)	2.6
Lupus	Lup	Wolf	Alpha Lupi	2.3
Lynx	Lyn	Lynx	Alpha Lyncis	3.1
Lyra	Lyr	Lyre	Vega	0.0
Mensa	Men	Table	Alpha Mensae	5.1
Microscopium	Mic	Microscope	Gamma Microscopii	4.7
Monoceros	Mon	Unicorn	Beta Monocerotis	3.7

Name	Abbreviation	Meaning	Brightest Star	Magnitude
Musca	Mus	Fly	Alpha Muscae	2.7
Norma	Nor	Level and Square	Gamma Normae	4.0
Octans	Oct	Octant	Nu Octantis	3.8
Ophiuchus	Oph	Serpent Bearer	Rasalhague	2.1
Orion	Ori	Hunter	Rigel (Beta Orionis)	0.1
Pavo	Pav	Peacock	Peacock	1.9
Pegasus	Peg	Winged Horse	Enif (Epsilon Pegasi)	2.4
Perseus	Per	Hero	Mirfak	1.8
Phoenix	Phe	Phoenix	Ankaa	2.4
Pictor	Pic	Easel	Alpha Pictoris	3.2
Pisces	Psc	Fishes	Kullat Nunu (Eta Piscium)	3.6
Pisces Austrinus	PsA	Southern Fish	Fomalhaut	1.2
Puppis	Pup	Ship's Stern	Naos (Zeta Puppis)	2.3
Pyxis	Pyx	Compass	Alpha Pyxidis	3.7
Reticulum	Ret	Reticle	Alpha Reticuli	3.4
Sagitta	Sge	Arrow	Gamma Sagittae	3.5
Sagittarius	Sgr	Archer	Kaus Australis (Epsilon Sagittarii)	1.9
Scorpius	Sco	Scorpion	Antares	1.0
Sculptor	Scl	Sculptor	Alpha Sculptoris	4.3
Scutum	Sct	Shield	Alpha Scuti	3.9
Serpens	Ser	Serpent	Unukalhai	2.7
Sextans	Sex	Sextant	Alpha Sextantis	4.5
Taurus	Tau	Bull	Aldebaran	0.9
Telescopium	Tel	Telescope	Alpha Telescopii	3.5
Triangulum	Tri	Triangle	Beta Trianguli	3.0
Triangulum Australe	TrA	Southern Triangle	Atria	1.9
Tucana	Tuc	Toucan	Alpha Tucanae	2.9

(continued)

TABLE 1-2 *(continued)*

Name	Abbreviation	Meaning	Brightest Star	Magnitude
Ursa Major	UMa	Great Bear	Alioth (Epsilon Ursae Majoris)	1.8
Ursa Minor	UMi	Little Bear	Polaris	2.0
Vela	Vel	Sails	Suhail al Muhlif (Gamma Velorum)	1.8
Virgo	Vir	Virgin	Spica	1.0
Volans	Vol	Flying Fish	Gamma Volantis	3.8
Vulpecula	Vul	Fox	Anser	4.4

Astronomers didn't coin special names such as Sirius for every star in Canis Major, so they named them with Greek letters or other symbols. In fact, some constellations don't have a single named star. (Don't fall for those advertisements that offer to name a star for a fee. The International Astronomical Union doesn't recognize purchased star names.) In other constellations, astronomers assigned Greek letters, but they could see more stars than the 24 Greek letters. Therefore, astronomers gave some stars Arabic numbers or letters from the Roman alphabet, or numbers in professional catalogs. So you see star names such as 61 Cygni, b Vulpeculae, HR 1516, and even RU Lupi. (We're not making this up.) But as with any other stars, you can recognize them by their positions in the sky (as tabulated in star catalogs), their brightness, their color, or other properties, if not their names.

When you look at the constellations today, you see many exceptions to the rule that the Greek-letter star names correspond to the respective brightness of the stars in a constellation. The exceptions exist because

- » The letter names were based on inaccurate naked-eye observations of brightness.
- » Over the centuries, star atlas authors changed constellation boundaries, moving some stars from one constellation into another that included previously named stars.
- » Some astronomers mapped out small and Southern Hemisphere constellations long after the Greek period, and they didn't always follow the lettering practice.
- » The brightness of some stars has changed over the centuries since the ancient Greeks charted them.