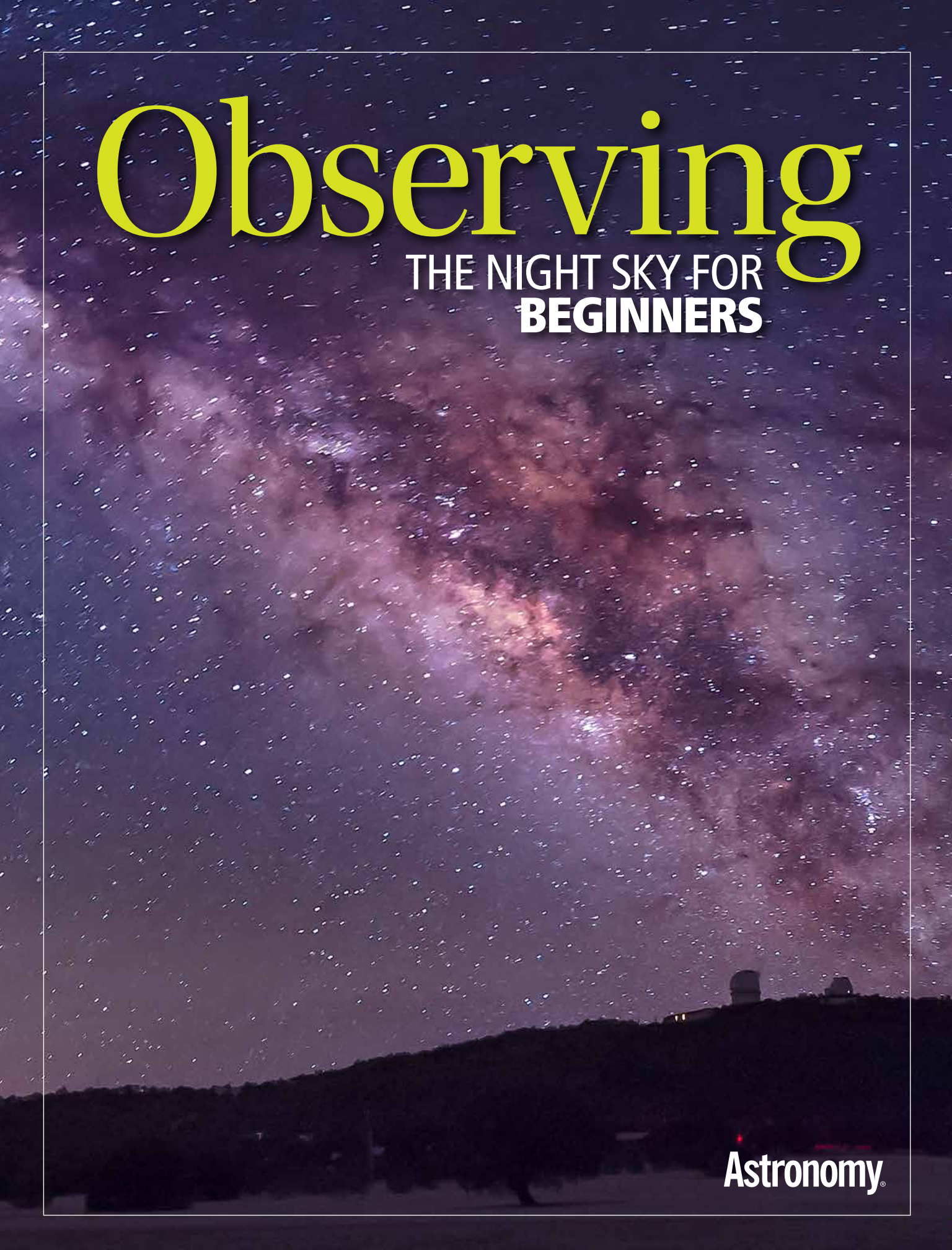
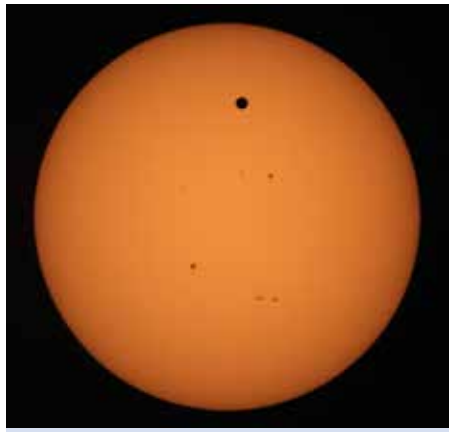

Observing
THE NIGHT SKY FOR
BEGINNERS
Astronomy

The planet named for the goddess of beauty is a stunning sight through any telescope, especially this spring. BY MICHAEL E. BAKICH

See Venus at its best



RODNEY POMMIER

Venus transited (crossed in front of) the Sun from the perspective of earthbound observers June 5, 2012. The next transit of Venus visible from our world won't occur until December 10–11, 2117.

VENUS RANKS AS THE THIRD-brightest object in the sky, outshone only by the Sun and the Moon. At times, the planet's light can cast shadows.

From the earliest times, humans have been captivated by its brilliance. The oldest surviving document regarding the planet is the Venus tablet of Ammisaduqa, which was created before 1600 B.C. This cuneiform tablet records Venus' appearances over two decades, giving the correct time intervals between them.

Observing Venus

Because it's so bright and its appearances in the morning and evening skies last for months, Venus is easy to observe. During its orbit, the planet goes through a pattern of inferior conjunction (when it's between Earth and the Sun), greatest western elongation (when it's at its maximum distance from the Sun in the morning sky), superior conjunction (when it's on the other side of the Sun from Earth), and greatest eastern elongation (when it's at its maximum distance from the Sun in the evening sky).

One more event — greatest brilliancy — occurs approximately 36 days before and after inferior conjunction when the planet lies 39° from the Sun. The geometry of the Sun-Venus-Earth angle at these times makes Venus appear brightest from Earth.

The phases of Venus are of interest to observers, as is another easy-to-see aspect: size change. Mercury looks twice as big near inferior conjunction as it does at superior conjunction. Venus, on the other hand, is more than six times larger.

Daytime observations of Venus are not as difficult as most amateur astronomers imagine. In fact, it's far better to observe Venus during the daytime, or at least in twilight, because the background sky brightness reduces the deleterious effects of the planet's brilliance. And observing Venus in the daytime sky is easy: Simply point your telescope at Venus before daybreak and allow the drive to track it until after sunrise.

The problem with daytime observations is that solar heating of the air (and your telescope) can produce some really bad seeing (atmospheric steadiness). Most locations report the worst daytime seeing in the afternoon. (Yours may not.)

If you observe Venus in the daytime, use a yellow, orange, or red filter. Any of them will enhance the contrast by filtering out the sky's blue light. But remember: The darker the filter you use, the bigger your scope will have to be. It's a simple matter of light throughput.

If you're going to observe Venus at night, limit your viewing to when the planet is at least 20° above the horizon. The air below that level is so thick that image quality will suffer.

Amateur astronomers have reported seeing an irregular terminator, dusty shadings, bright spots, and caps on the cusps, to name the most obvious sightings. Viewed in visible light, there are no permanent features discernible in the clouds of Venus. The atmosphere is in a continuous state of mixing, and any patterns observed quickly dissipate.

The best — really, the only — way to see features in the atmosphere of Venus is through a dark blue (No. 38A) or violet (No. 47) eyepiece filter. Such filters, unfortunately, don't allow much light through. They have transmissions of 17 percent and 3 percent, respectively. So this advice really is for those who have access to a telescope with an aperture of 10 inches or more.

The most-reported sighting using these filters is of an immense C- or Y-shaped feature centered on and symmetrical with the planet's equator. This is a short-lived phenomenon, but it tends to re-form often enough to be considered a "permanent" feature in the clouds of Venus.

PETE LAWRENCE

This sequence shows how the illuminated portion and the apparent size of Venus changed from July 25 to August 15, 2015. The leftmost image shows the planet 12.9 percent illuminated with a diameter of 47.6". In the rightmost image, the illumination has fallen to 0.9 percent, but the size has increased to 57.9".

Venus often pairs with the Moon in the early evening and early morning sky. Both objects are bright, allowing for pictures that incorporate a moderately lit landscape. JOHN CHUMACK

Venus made a retrograde loop through the background stars of eastern Sagittarius from November 7, 2013 (bottom right), to March 14, 2014 (upper left). The photographer captured 28 exposures of the planet and then digitally stacked and aligned them to show Venus' movement during this interval. TUNÇ TEZEL

A tough catch

The orbit of Venus tilts nearly 3.4° to the plane of Earth's orbit. This means that, at inferior conjunction, Venus may stand nearly 9° north or south of the Sun. I've made it a challenge several times to observe Venus at the moment of inferior conjunction. Such a feat is obviously a daytime observation. If your telescope has setting circles, you can attempt this.

First, find the date and time of inferior conjunction and the right ascension and declination of the Sun and Venus at that time. With a solar filter in place, and using your lowest-power eyepiece, center the Sun in the field of view. Finally, offset your telescope by the appropriate amount north or south in declination, and remove the solar filter. And now, the safety note: If you don't see Venus immediately, use extreme care in searching for it. Remember, the Sun is near!

When Venus reaches inferior conjunction June 3, 2020, it will lie only 29' north of the Sun — much too close for a safe observation. The situation improves for the planet's next inferior conjunction. On January 9, 2022, it will lie 4°51' north of the Sun. And on August 13, 2023, conditions will be ideal when Venus stands 7°41' south of our daytime star.

It's worth the wait, though, to spot Venus when it's closest to Earth. It appears huge, but the really cool sighting happens when you see the cusps (points) of the ultra-thin crescent appear to extend beyond 180°.

Go see Venus

Sixty-two percent of people have sisters. But 100 percent of us can look into the sky and observe Earth's sister planet. So, take some time during morning or evening twilight — or even in the daytime — to reacquaint yourself with the third-brightest object in the sky. You won't even need a finder chart!

OBSERVATIONAL TIMELINE

Here are some of the highlights of the last two and a half millennia of observations of Venus.

- **Fourth century B.C.** — Turkish-born Greek astronomer Heraclides Ponticus becomes the first to suggest that Venus (along with Mercury) travels around the Sun, and not around Earth.
- **15th century A.D.** — Persian astronomer Ulugh Beg uses a sextant 60 feet (18.3 meters) in radius to make detailed observations of Venus.
- **1582–1588** — Danish astronomer Tycho Brahe makes daytime measurements of Venus and compares its position to the Sun; at night he compares Venus' position to stars.
- **1610** — Italian astronomer Galileo Galilei becomes the first to observe the phases of Venus, and states that it imitates the Moon. He also sees that when Venus is nearly full it is small, and when he observes Venus as a thin crescent, it is large. These two observations are strong observational evidence for the validity of the Copernican theory, which places the Sun at the center of our solar system.
- **1645** — Italian astronomer Francesco Fontana records dusty shadings on Venus, but it will take more than 100 years before Venus is scientifically shown to possess an atmosphere.
- **1666** — French astronomer Giovanni Domenico Cassini makes the first measurements of Venus' rotation rate: 23 hours 21 minutes.
- **1761** — Russian scientist Mikhail V. Lomonosov observes a transit of Venus. He notices that the planet is surrounded by a luminous halo as it enters and exits the solar disk and correctly concludes that Venus has an atmosphere.
- **1911** — American astronomer Vesto M. Slipher determines by spectral analysis that the rotation rate of Venus is much greater than one day.

Michael E. Bakich *is a contributing editor of* Astronomy *who enjoys observing the inner planets.*

A quick guide to **scopes for kids**

Gifting the right equipment doesn't need to be a daunting task.

by Tom Trusock

The first rule for choosing a telescope for a child is to start him or her off with decent gear. With the recent explosion in imported and inexpensive equipment, you should be able to accomplish this fairly economically.

For a teenager, a gift of binoculars might be a good option, but they aren't the easiest to share. And for young kids, you'll probably have a hard time getting the binoculars pointed in the right direction. Additionally, inexpensive models won't weather much abuse.

I'd also steer clear of go-to and other electronic add-ons. While the bleeps of the computerized world are tempting, inexpensive telescopes with such options tend to try to do too much for their price point. This results in a frustrating evening for adults and children. Typically, I don't even recommend a motorized drive on a first telescope. It's just one more thing to power, one more thing to fiddle with, and one more thing that can fail. Keep things as simple as possible.

Refractor or reflector?

A small refractor with a lens about 3 inches (75 millimeters) in diameter would be a decent choice. Just make sure it comes with a sturdy mount. A setup like this will be portable, require little to no maintenance (in the form of collimation, optical alignment), and be relatively child friendly.

One option to consider is a scope offered by Explore Scientific. Listed under the catchy name **FL-AR80640TN** ($149.99), this 3.15-inch refractor measures a bit more than 2 feet long, and comes with a 25mm eyepiece (which provides a usable magnification of 25x), a red-dot finder, and a decent altitude-azimuth mount (one that operates like a camera tripod). It provides great views of the Moon, planets, and brighter deep-sky objects.

I love refractors, but with telescopes, aperture (the diameter of the main lens or mirror) rules. If you're looking to stay in the same price range as my previous choice, you might consider something like Meade's **LightBridge Mini 114mm Dobsonian Telescope** ($149). This 4½-inch reflector is a counterpart to the refractor I mentioned earlier, although it's not quite as resistant to hard use.

The "Dobsonian" in the name refers to the mount for this scope. Invented by amateur astronomer John Dobson, it's the simplest type of mount for reflectors. Essentially, you aim the scope by moving it up and down and left and right.

Compared with an inexpensive refractor, a reflector will show better color (no purple fringes) on bright objects like the Moon and Venus. Because of the larger aperture, they provide a brighter image and thus support more pleasing high-power views.

However, because a reflector usually has such a short focal length, it will also require careful collimation for best performance. You'll

Explore Scientific's FL-AR80640TN

Meade's LightBridge Mini 114mm Dobsonian Telescope

also need to supply a table to bring it to a usable height. That can be a drawback if you're trying to keep things simple.

I'd recommend a reflector on a Dobsonian mount, even though it requires a bit more space. The typical configuration is either an 8-inch f/6 or a 6-inch f/8. Both measure about 4 feet long and give the same magnifications whichever eyepieces you use. The 8-inch model will give you a brighter image, though, because its larger mirror captures 78 percent more light.

Both can bring enough celestial wonders into view to keep a budding amateur astronomer busy for a long time. Both also have multiple upgrade paths and are available in reasonably priced starter kits from various sellers. Older children will appreciate the light-gathering power of the 8-inch, while younger ones will like the smaller physical size of the 6-inch.

A few choices

For younger or smaller individuals, a 6-inch telescope still might be pushing it in terms of size. In these cases, I recommend Orion's **SkyQuest XT4.5 Classic Dobsonian Telescope** ($249.99).

A 4½-inch scope offers more than twice the light-gathering ability of a 3-inch while sporting a lightweight and portable package. This telescope weighs just over 17 pounds (8 kilograms), making it easy to pick up and maneuver. The included handle and tension springs will let adults and large children carry the telescope outdoors in one piece, and the navigation knob makes the tube easy to guide to the next target.

As a bonus, Orion includes an eyepiece rack and two decent Plössl eyepieces: 25mm (36x) and 10mm (91x). The focuser is firm yet responsive, and the mount is smooth enough that even tracking with the higher-power eyepiece isn't an issue. The scope provides a nice view of the Moon, the rings of Saturn, the belts of Jupiter, and many bright deep-sky objects. Open star clusters look pleasing through this telescope.

Orion does include a 6x26 finder scope, but I'd replace it with a BB gun or Reflex finder, found online for as little as $15. In my experience, it's much easier for beginners to "put the red dot on that part of the sky" when learning how to star-hop than to interpret the image they see through a finder scope.

Finally, Orion includes a download link to a special version of the company's Starry Night software to help observers plan their evenings. My daughter will attest that it's a fun way to spend a cloudy evening.

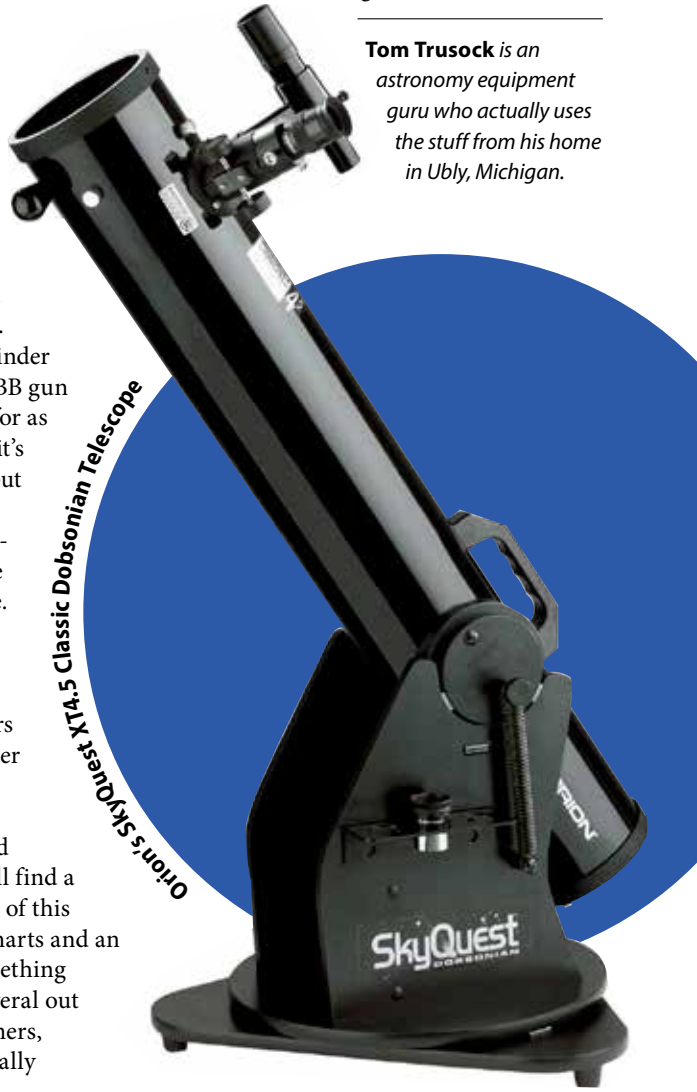
Children also will need a red flashlight and star charts. You'll find a great starter chart in the center of this magazine. Traditional finder charts and an inexpensive lunar map are something else you'll want to acquire. Several out there are geared toward beginners, but you might want to specifically look for star charts that combine the maps with additional information.

Over the years, I've found that everyone enjoys a good story. I recommend *A Walk through the Heavens: A Guide to Stars and Constellations and their Legends* by Milton D. Heifetz and Wil Tirion. It's a simple guide to discovering the constellations and finding your way around the night sky. Plus, it collects many fascinating ancient myths of the heavens.

Pass on what you know

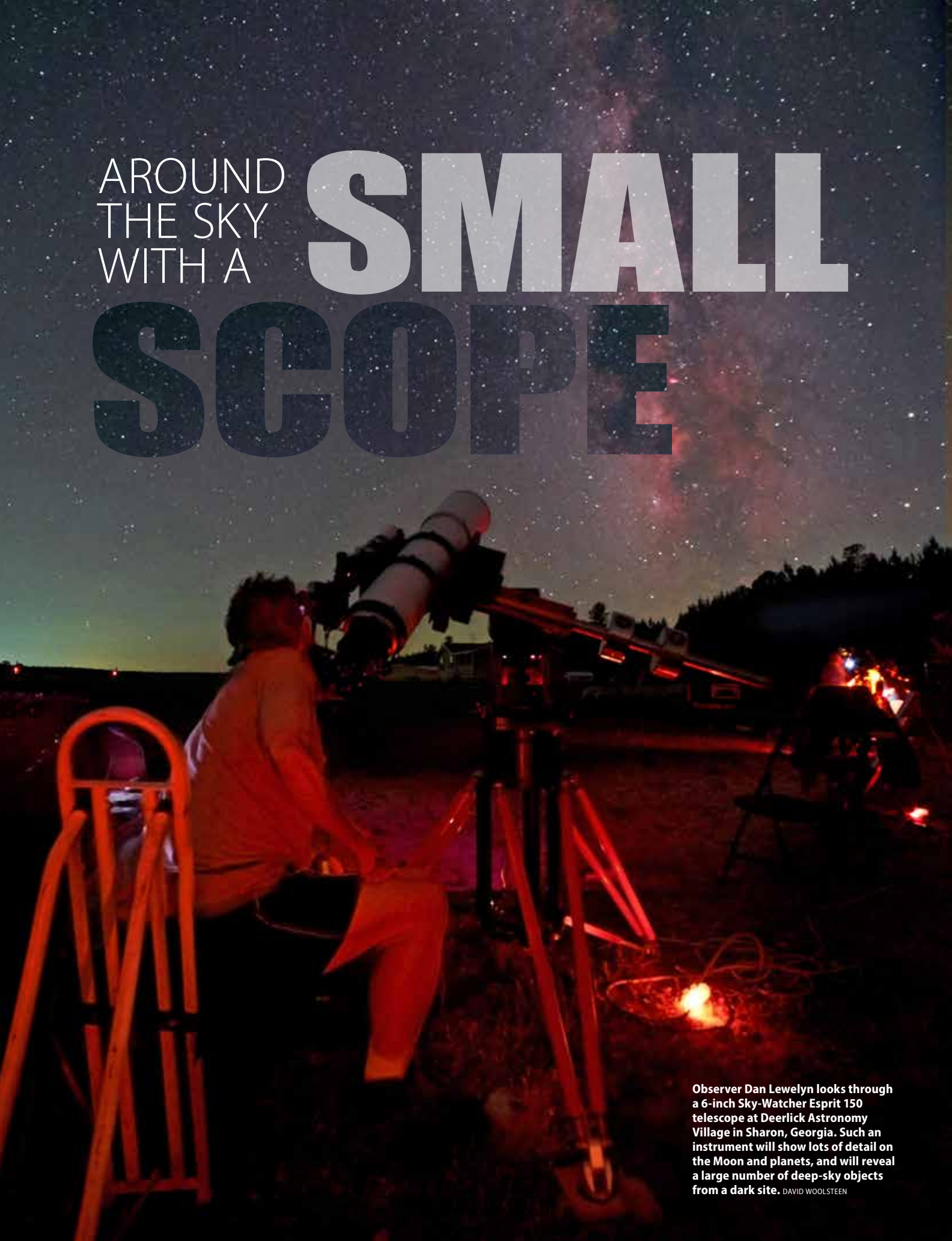
Gear is fun, and a kid-friendly telescope is a great start toward getting children involved in the hobby. Keep in mind, however, that the most precious gift you can give a child is one that doesn't cost a dime: your time. Nothing will replace it, and nothing will stir interest faster. We spend a lot of effort trying to protect and promote our night skies. Isn't it time to start involving its inheritors?

Tom Trusock *is an astronomy equipment guru who actually uses the stuff from his home in Ubly, Michigan.*



Orion's SkyQuest XT4.5 Classic Dobsonian Telescope

AROUND THE SKY WITH A SMALL SCOPE



Observer Dan Lewelyn looks through a 6-inch Sky-Watcher Esprit 150 telescope at Deerlick Astronomy Village in Sharon, Georgia. Such an instrument will show lots of detail on the Moon and planets, and will reveal a large number of deep-sky objects from a dark site. DAVID WOOLSTEEN

Think you need a huge telescope to get anything out of astronomy? Think again.

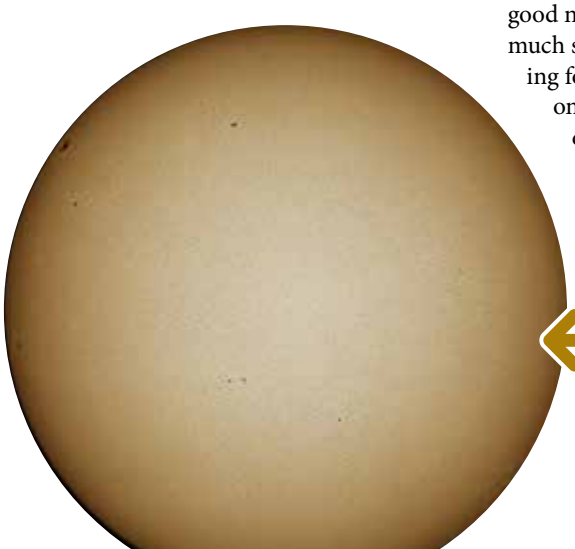
by Glenn Chaple

DO YOU OWN A SMALL TELESCOPE?

By "small," I mean a refractor with an aperture of 3 inches or less or a reflector whose mirror measures under 4½ inches. If not (or if you do, but rarely use it because you believe the sky belongs to water heater-sized telescopes), you're missing out on some eye-popping cosmic adventures. Read on!

During the 1960s, in what were my salad years as a backyard astronomer, I simply couldn't afford one of those 6-inch or greater equatorially mounted "beasties." My maiden celestial voyages were with a secondhand 3-inch f/10 reflector purchased from a high school friend for $15.

I started out with the usual easy fare: the Moon, naked-eye planets, and a smattering of bright double stars and deep-sky objects. Over time, my eyes became sensitive to faint light, and I found myself seeing things I never dreamed possible with so small a scope. In the summer of 1978, I plunked it down in front of a large crowd at a Stellafane Convention talk session and sang the praises of the little scope that could. Let me take you on a similar small-scope spin around the universe.



As long as you have an approved solar filter that fits over the front of your telescope, you can view the Sun. Look for sunspots and sunspot groups, which can be huge sometimes. PETE LAWRENCE

The Moon

What better place to start a cosmic journey than with our neighbor, the Moon? The practical upper magnification limit for a small telescope is 120x to 150x. With just one-third that power, you can view the Moon in its entirety and get a ringside seat to a lunar eclipse. Between 75x and 100x, hundreds of craters, from monsters like Clavius — large enough to contain the state of Connecticut — to pits a few miles in diameter, come into view. Lofty mountain ranges add to the breathtaking sight.

Now and then, the Moon will pass in front of (occult) a bright star or one of the planets. Stellar occultations are well within reach of small scopes (any magnification will suffice). Even when you know what to expect, it's still a surprise when the star suddenly blinks out of sight or reappears at the Moon's dark edge. An occultation of a planet is much more gradual, and a higher magnification (75x to 100x) will enhance the dramatic sight of the Moon "swallowing" an entire world.

The Sun

Danger ahead! A direct unfiltered view of the Sun through even the smallest scope can result in permanent eye damage. The good news? A small scope won't collect as much sunlight as its big brothers, allowing for safe projection of the Sun's image onto a sheet of white cardboard. For a direct view, you can buy an aperture filter that clamps to the front end of the telescope. Those designed for small scopes cost less than ones made for bigger instruments.

The Moon offers hundreds of features plus a constantly changing face to observers with small telescopes. You can view the entire Moon with low-power eyepieces or zoom in to individual craters or mountains if you use higher magnifications. JIM THOMPSON

Like the Moon, the Sun doesn't require high magnification. At 30x to 50x, you'll see the entire disk — perfect for viewing solar eclipses. You'll also pick out sunspots and bright cloudlike plages, or unusually bright areas, near the solar limb. Under steady seeing, 100x will reveal granulation — the mottled texture of the Sun's turbulent surface.

The solar system

Now that Pluto has been demoted from planetary status, I can confidently state that a small telescope will embrace all the planets. A magnification of just 30x is enough to monitor the changing phases of Venus, follow the night-to-night dance of Jupiter's four bright moons, and admire Saturn's fabled rings. Mercury will appear

as a tiny "half moon" when at a favorable elongation, or as a tiny black dot during one of its rare transits of the Sun. Mars will show a definite ochre-colored disk, and you'll see Uranus and Neptune, billions of miles away, as greenish and bluish starlike points, respectively.

A boost in magnification (100x to 150x) picks up dark surface features and the polar caps on Mars around the planet's closest approaches to Earth. You can see Jupiter's Great Red Spot, discern detail in the cloud bands, and watch shadow transits of its moons. The Cassini Division in Saturn's rings comes into view, as well as a handful of its brightest moons. The disk of Uranus is tiny, but obvious.

Once you're familiar with the planets, you can move on to asteroids and comets. But first, I'd like to recount a pair of exceedingly rare celestial events that demonstrate the capability of small telescopes. The first happened in April 1976, when Mars occulted the 3rd-magnitude star Epsilon (ε) Geminorum. Using a 4½-inch reflector and a magnification of 150x, I watched with bated breath as Mars closed in on the star. At the moment of contact, there wasn't the "blink-out" that you get with a lunar occultation. Instead, the star slowly faded from view as its light passed through the thin martian atmosphere.

The second one occurred in the summer of 1994, when the world watched as a chain of fragments once belonging to Comet Shoemaker-Levy 9 plowed into Jupiter. In their wake was a series of dark, short-lived "scars" in the jovian atmosphere. I didn't need to look at Hubble images to see them. They were plainly visible through my 3-inch scope at 120x.

Infrequent visitors such as Comet Lovejoy (C/2014 Q2) sometimes brighten enough for a view through a small telescope to reveal streamers, the gaseous coma that surrounds the comet's head, and vivid color. DAMIAN PEACH

And so are many asteroids and comets. Dozens of asteroids reach 11th magnitude or brighter during opposition, putting them within reach of a small backyard scope on dark nights. Finder charts for bright, currently visible asteroids often appear in *Astronomy*. And while most comets are too faint to pick up with small scopes, the ones that count — naked-eye spectacles like comets West and Hale-Bopp — show remarkably well with relatively little aperture and magnification. Again, you can count on *Astronomy* for a heads-up on an impending visit by a noteworthy comet.

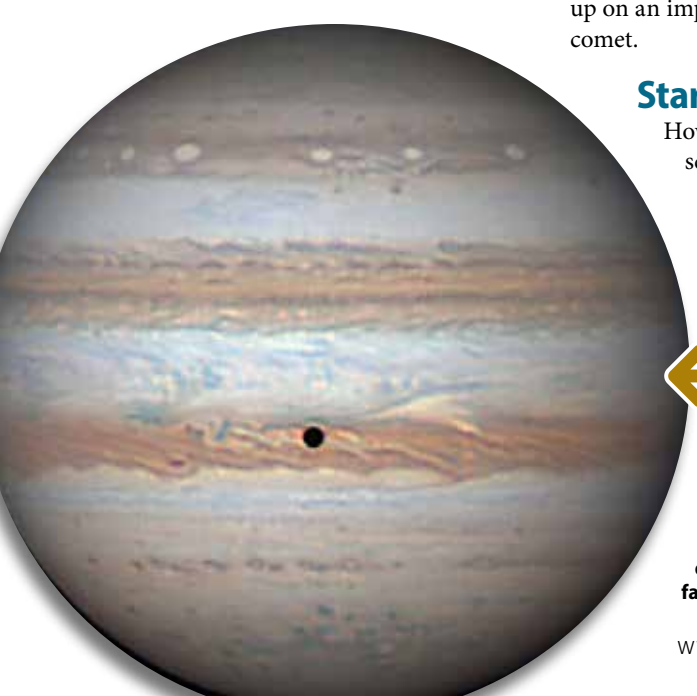
Stars

How many stars can a small scope capture? With my 3-inch reflector, I routinely spot those at magnitude 11. Nearly 2 million stars are as bright or brighter than that. We can only see half of them at one time, but I'll settle for a million.

A surprising number of stars are actually part of double- and multiple-star systems. Although they look like single luminaries to the unaided eye, you can split hundreds like Albireo (Beta [β] Cygni), brilliant Castor (Alpha [α] Geminorum), and the magnificent triple Beta Monocerotis through a 3-inch scope.

One of the most rewarding activities for amateur astronomers is monitoring stars that change their brightnesses over time. Again, you can study hundreds of such variable stars, from pulsing red giants to explosive dwarf novae, with a small scope. During my first year as a member of the American Association of Variable Star Observers, I made more than a thousand brightness estimates of variables with nothing more than my 3-inch reflector.

Did you know you can see a black hole through a small scope? Actually you can't, not even with a cannon-sized telescope. But you can see a star that's being cannibalized by its black hole companion. If you train your scope on the 4th-magnitude star Eta (η) Cygni and wait a minute or two as the stars drift through the field of view, a somewhat faint double star will appear. The brighter of the pair, designated as HDE 226868, is the star being devoured.



Jupiter shows more detail than any solar system object other than the Moon. Even through a small telescope, you will see the two large equatorial bands, the Great Red Spot (when it faces Earth), and occasionally, the shadow of one of the planet's four large moons falling on its clouds. DAMIAN PEACH

The Trifid Nebula (M20) in the constellation Sagittarius the Archer is one of the showpiece deep-sky objects. Although a small scope won't bring out the color evident in this image, you'll see an area rich in details, well worth a long look. THOMAS V. DAVIS

Gazing at this ordinary-looking star and knowing what's going on is enough to give an observer goose bumps!

Deep space

The Messier catalog is a listing of 109 nebulae, star clusters, and galaxies compiled by the 18th-century French comet hunter Charles Messier. To view them all is a rite of passage for the dedicated backyard astronomer. In the mid-1970s, I accomplished the feat with my 3-inch reflector, adding an equal number of non-Messier deep-sky objects.

Just because deep-sky objects are far away doesn't mean you need high magnifications to see them. The bright inner portion of the Andromeda Galaxy (M31) has the same apparent width as several Full Moons. My best view of this great galaxy was with a 4-inch rich-field scope and a magnifying power of just 16x.

Clusters like the Beehive (M44) in the constellation Cancer and the Pleiades (M45) in Taurus are quite attractive through a small scope and at low power. The Omega Nebula in Sagittarius (M17) and the Orion Nebula (M42) are intriguing sights through a 2.4-inch refractor and a magnification of just 60x. Sure, most galaxies appear as ultrafaint, fuzzy patches. It's when you realize that each is actually an enormous swarm of billions of stars tens of millions of light-years away that you experience another goose bumps moment.

Just how far can you "see" with a small telescope? With a 4-inch rich-field reflector, I once glimpsed (barely, and by using averted vision) the quasar 3C 273, some 2.5 billion light-years away. The photons tickling my retina originated at a time when the dominant form of life on Earth was single-celled. Now that's a goose bumps moment to the nth power!

Do it because it feels good

In a nutshell, you need to make a small-aperture scope an integral part of your observing regimen. If you don't already own one, you should. Just a few hundred dollars will get you a nice 2.4-inch refractor or 4½-inch reflector. Such an instrument is portable and easy to use, and its eye on the universe is large, indeed!

Glenn Chaple, *a contributing editor and columnist for* Astronomy, *enjoys the challenges and rewards of observing with small scopes.*

BY PHIL HARRINGTON

Wonders of the Big Dog

Canis Major holds the sky's brightest star and one of the most beautiful open clusters.

The bright star cluster M41 in Canis Major is one of the most sparkling star groups when viewed with a good pair of binoculars. ANTHONY AYIOMAMITIS

A blaze of brilliant stars decorates the January sky, ushering in 2018. Brightest of all is **Sirius** (Alpha [α] Canis Majoris) in Canis Major, the Big Dog. Aptly nicknamed the Dog Star, Sirius stands obediently by its master, Orion the Hunter.

Swing your binoculars Sirius' way, and it puts on an astonishing show. If you can, catch it as it is just rising above the southeastern horizon. Since you look through more of Earth's atmosphere when viewing near the horizon, temperature layers and intertwining wind currents play havoc with Sirius' light, bending and refracting it into a firestorm of rapidly changing colors. When our atmosphere is especially turbulent, resulting in "poor seeing," Sirius' color shifts are stroboscopic.

As it rises higher in the sky, the colorful show slowly calms down to reveal that the star's true color is a radiant white. Winter skies often remain turbulent through the night, with upper-level winds still creating mayhem with distant starlight. The brighter the star, the greater the twinkling effect. In the case of Sirius, the effect can be almost hypnotic.

Sirius shines at magnitude –1.4. But while it appears bright in our sky, it is not an especially luminous star. True, it does radiate 26 times more energy than our Sun, but it is not nearly as powerful as, say, Rigel, seen 27° to the northwest. No,

The brightest star in the sky, Sirius, harbors a dim companion called Sirius B just 4" away (below left). It is quite a challenge to see visually. DAMIAN PEACH

Sirius appears so bright primarily because of its distance from our solar system. Sirius lies only 8.6 light-years away, while Rigel is almost exactly 100 times more distant. Were they to swap places, Sirius would shine at only 9th magnitude. Rigel, however, would blaze at a staggering magnitude –10.

Sirius is accompanied by a white dwarf companion star known as **Sirius B**, or the Pup. Trying to spot Sirius B is one of backyard astronomy's greatest challenges. The problem is not that Sirius B is so faint. In fact, it shines at magnitude 8.5, which is within reach of most binoculars. No, the problem is Sirius. The same effect that causes stars to twinkle — scintillation — also blurs the view by scattering their light. Sirius so completely overwhelms the observer's eye that poor Sirius B, some 10,000 times fainter, is usually obliterated. The two are separated by only 4", which also confounds observers.

Shift Sirius toward the top (north) of the field and then take a look near the bottom (south) for a clump of faint stars. That's the open cluster **M41**. I think of it as the "Dog Tag Cluster" for its position near Canis Major's "neck."

Many astro history buffs credit the Greek scientist Aristotle (384 B.C.–322 B.C.) with discovering M41. That credit is based on his description in *Meteorologica* (325 B.C.) in which he writes, "one of the stars of the Dog has a tail, though a dim one; if you looked hard at it, the light used to become dim, but to a less intent glance it became brighter."

The first person to associate this statement with M41 was John Ellard Gore (1845–1910) in an article he authored in the August 1902 issue of *The Observatory*. Others have since adopted the same interpretation, although some suggest it actually points to a trail of faint stars farther south, near Wezen (Delta [δ] Canis Majoris). There is no way to know for sure.

From Aristotle's words, however, there seems little doubt that whatever he saw, he used averted vision to see it more distinctly. You can, too. But to see M41 with the unaided eye, it takes especially dark, transparent skies.

It's much easier through binoculars. Swing your binoculars toward the cluster, and you will immediately see a compact collection of stellar pinpoints. Some 80 stars call M41 home, with 16 of them breaking the 9th-magnitude "binocular barrier." The rest blend together to create a soft glow.

The brightest star in M41, designated **HD 49091**, lies nearly dead center in the pack. A type K3 orange giant, it shines at magnitude 6.9 and puts on a fine show through binoculars. Try defocusing the image ever so slightly to accentuate the color. How many other red and orange stars can you count in M41?

Also try your luck at resolving a double star found northwest of the cluster's center. Known as **h2341**, its component stars shine at magnitudes 8.3 and 9.1 and are separated by 45". That's wide enough to be resolved at 10x, but their faintness will likely require you to use a tripod or other support to steady the view. Then, by using Aristotle's technique of averted vision, they may just pop into view.

I'd love to hear about your binocular adventures and conquests. Contact me through my website, philharrington.net.

Until next month, remember that two eyes are better than one.

Phil Harrington is a longtime contributor to Astronomy *and the author of many books.*

Become an observer in 10 simple steps

Amateur astronomy is fun and easy. Follow these tips and you'll be viewing the universe in no time. **by Michael E. Bakich**

Astronomy remains a vibrant science because something's always making news. When you're an amateur astronomer, not only can you read about what's going on, but you can also participate. In essence, the sky is calling. But how do you start observing the sky? What do you need to know?

1 Learn the sky in a general sense

And I mean general: Earth rotates once a day and orbits the Sun once each year. The first motion causes sky objects to move from east to west, and the second causes different constellations to appear in each season's sky.

Next, learn why the sky is the celestial sphere. It has a north pole, an equator, and a south pole. Two sky coordinates exist: Right ascension is like earthly longitude, and declination mimics latitude.

Read up on Moon phases. The Moon first becomes visible as a thin crescent low in the western evening sky. Each night thereafter, it appears to grow and move eastward until Full Moon, after which its lit part shrinks to invisibility. When you again spot the thin crescent low in the west, roughly 30 days have passed. You'll want to know the Moon's phase because its light can prevent you from seeing faint objects.

The Moon offers beginning observers hundreds of easy-to-see targets. It's also bright, so you can view it from any location through any size telescope. Anthony Ayiomamitis

Finally, become familiar with bright seasonal constellations. Start with just a couple per season: Taurus the Bull and Orion the Hunter in winter; Scorpius the Scorpion and Cygnus the Swan in summer; and so on. Don't worry about the faint ones. If you haven't heard of them — for example, Lacerta and Serpens — there's probably a good reason why.

2 Immerse yourself in the subject

You've made a good start. In each issue, *Astronomy* features a combination of science- and hobby-related articles. "The Sky this Month" is an up-to-date guide to the current sky. But there's so much more out there. Your public library and bookshops offer many observing guides. Except for where you'll find the planets, such texts don't go out of date.

3 Try (equipment) before you buy

You wouldn't buy a car without first getting behind the wheel, so don't purchase a telescope without first viewing through it. Some astronomy shops will set up equipment for you, and a few even will walk you through its operation.

Another way to test-drive a scope is to attend an observing session or a regional star party hosted by an astronomy club. Take your time, visit manufacturer websites, ask lots of questions, and you'll soon enjoy a lifetime of viewing pleasure through your very own scope.

You won't see galaxies under a light-polluted sky. That means you'll have to pack up your scope and accessories and head to a dark site. Choose it carefully. Richard Best

4 Pick your observing site carefully

If you'll be content with the Sun, the Moon, planets, and double stars, pretty much any location will do. To see faint, diffuse objects like nebulae and galaxies, however, you'll need a dark site.

Some things to consider are how light-polluted the location is, the driving distance, how portable your telescope is, safety (do you get cell phone service?), and weather factors. The last point includes how generally clear the sky is and how steady the air is.

5 Double your observing time with the Sun

Night isn't the only time you can sky watch. The Sun beckons beginning observers because it's big, bright, and full of features that change daily. Put safety first by using a filter, and even a small scope will deliver high-quality views.

After several years of quiescence, when few sunspots appeared across its face, our nearby star has begun offering observers lots to see again. Be sure to get a filter that fits correctly over the front end of your telescope. A good solar filter — many retailers sell such accessories — will not transmit harmful ultraviolet or infrared radiation. It will also drop the brightness of the Sun to a viewable level.

Star trails in the southwestern sky hover over attendees of the Albufeira Star Party held at Lagoa de Albufeira, Sesimbra, Portugal. Miguel Claro

6 Comfort is everything

Comfort means a lot more than just staying warm during the winter. In particular, I see many observers who use various gyrations while looking through an eyepiece. The one my late observing buddy Jeff Medkeff labeled the "monkey squat" is pretty hard on the back and requires keeping all kinds of muscles tense to hold your eye at the eyepiece.

So, sit. I find that when I am seated comfortably at the eyepiece, I spend more time observing (and see a great deal more) than I do while standing. Many amateurs use adjustable chairs sold specifically for observing. You will want an observing chair.

7 Photography is rewarding but time-consuming

Here's the good news: You can take pictures of astronomical objects. Here's the other side: Astroimaging takes practice, and there is a learning curve. The higher the quality of the final image, the steeper the curve. Remember that producing a high-quality picture involves two stages. First you acquire the data through your camera, and then you process that image with appropriate software.

Lots of resources exist to help you learn the art of astrophotography. Read all you can, take lots of images, and eventually you'll proudly show off your results to family and friends.

8 Keep a log

You will want to remember what you've seen. A simple log contains the date and time of your observation, what object(s) you looked at, and a brief description, like, "Saw spiral arms!" or "Really blue, but no details visible."

More-detailed logs might contain information about the telescope you used, what eyepiece(s) and magnification(s), sky conditions (percent of cloud cover, amount of light pollution, steadiness of stars), and the faintest star you could see with your naked eye. Observers call that quantity the sky's "limiting magnitude."

9 Become a social astronomer

Visit a planetarium. Attend a star party. Observe with other amateur astronomers. Get on the Internet and chat in one of Astronomy.com's forums.

Without question, the best step you can take is to join a local astronomy club. Attend its meetings and observing sessions. This will place you with a group of like-minded individuals who can either answer your questions or help you figure out where to get them answered.

Most astronomy clubs have members who look for opportunities to share information about the hobby we all love. Get involved, volunteer to help out at events, and before long you'll be the one answering the questions.

10 Observe everything!

I've heard it a million times. "I'm a lunar observer," or "I only observe galaxies." Really? Are these amateur astronomers in fact saying they'd pass up watching a total lunar eclipse, a bright comet, or a rich meteor shower?

While your telescope may be best suited for a particular type of celestial object, you can view any object through any scope. So why not view them all?

The Moon has hundreds of targets on its ever-changing face, and even a small instrument will show most of them. The planets spend lots of time in the early evening sky. A short drive each month during the dark of the Moon may yield dozens of galaxies. While you take them all in, you'll surely marvel at the magnificent universe above and the richness of the hobby you have chosen.

Michael E. Bakich *is a senior editor of* Astronomy *who followed the same steps he writes about to become an observer years ago.*

Use this map to aim your telescope in the general area of the features shown.

NASA'S SCIENTIFIC VISUALIZATION STUDIO

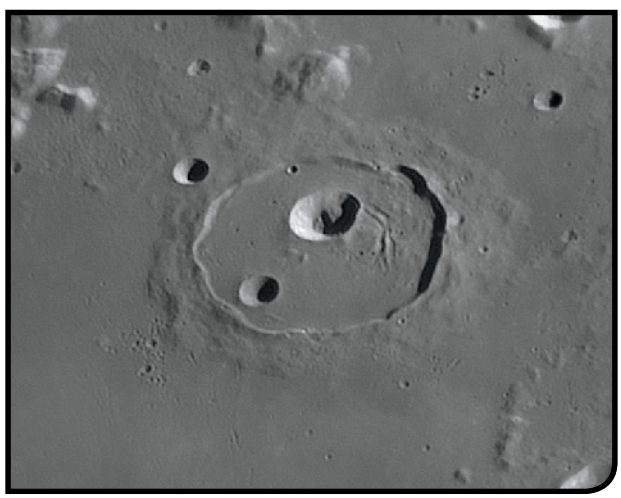
Explore the MOON AT FIRST QUARTER

If you're just starting out, our natural satellite makes a tempting target in the evening sky.

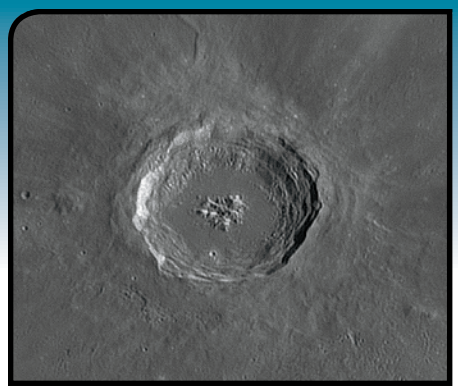
BY MICHAEL E. BAKICH

THE MOON OFFERS LOTS OF VISUAL TREATS when viewed through a telescope — even a small one. With that in mind, let's focus on First Quarter. This phase is easy to observe because it rises around noon and sets at midnight (one hour later if daylight saving time is in effect), so it's visible throughout the evening. If you head outdoors at sunset, just look due south.

1 Vallis Alpes is a cleft that bisects the Montes Alpes range. The valley is narrow at both ends and wider along its middle. Look carefully for small details here. Can you see that the southern face is straighter than the northern side, which is slightly bowed and uneven? The more rugged edges of the valley lie at the narrow west-southwest end that cuts through the mountain range. ALL PHOTOS BY DAMIAN PEACH, UNLESS NOTED

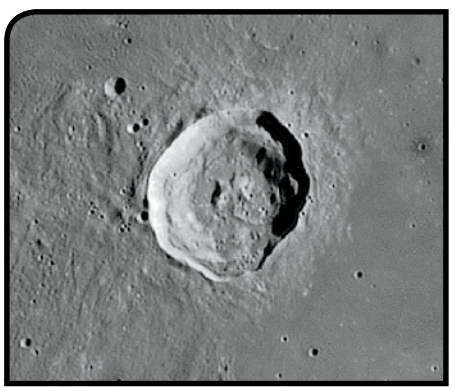


2 Cassini Crater lies at the eastern end of Mare Imbrium. The flooded floor of the crater shows many impacts. The largest crater that sits entirely within the rim is Cassini A, just northeast of center. A hilly ridge runs from it to the southeast. Near the southwest rim is the smaller crater Cassini B.



3 Aristillus is a prominent crater with a bright ray system. Use a low-power eyepiece and you'll see it extending for more than 370 miles (600 km). Then switch to high power and look carefully for the faint remains of a ghost crater off Aristillus' top left edge. It's almost buried by ancient lava flows.

4 Autolycus is a small impact crater just to the south of the more prominent Aristillus Crater. It has a faint impact-ray system extending outward, and some of the material crosses the floor of nearby Archimedes Crater.



5 Manilius Crater formed through an impact on the northeast edge of Mare Vaporum. It has a well-defined rim with a sloping inner surface that runs down to the ring-shaped mound along the base. The small interior crater is more reflective than the surroundings, and it appears bright when the Sun is overhead.

6 Hipparchus is the degraded remnant of a lunar crater near the Moon's center. This ancient feature has been modified by subsequent impacts. Horrocks Crater lies entirely within its northeast rim. Halley Crater is attached to the south rim, and Hind Crater lies to the southeast. To the north-northeast is the bowl-shaped Pickering Crater, and lava-flooded Saunder Crater lies off the northeast rim.

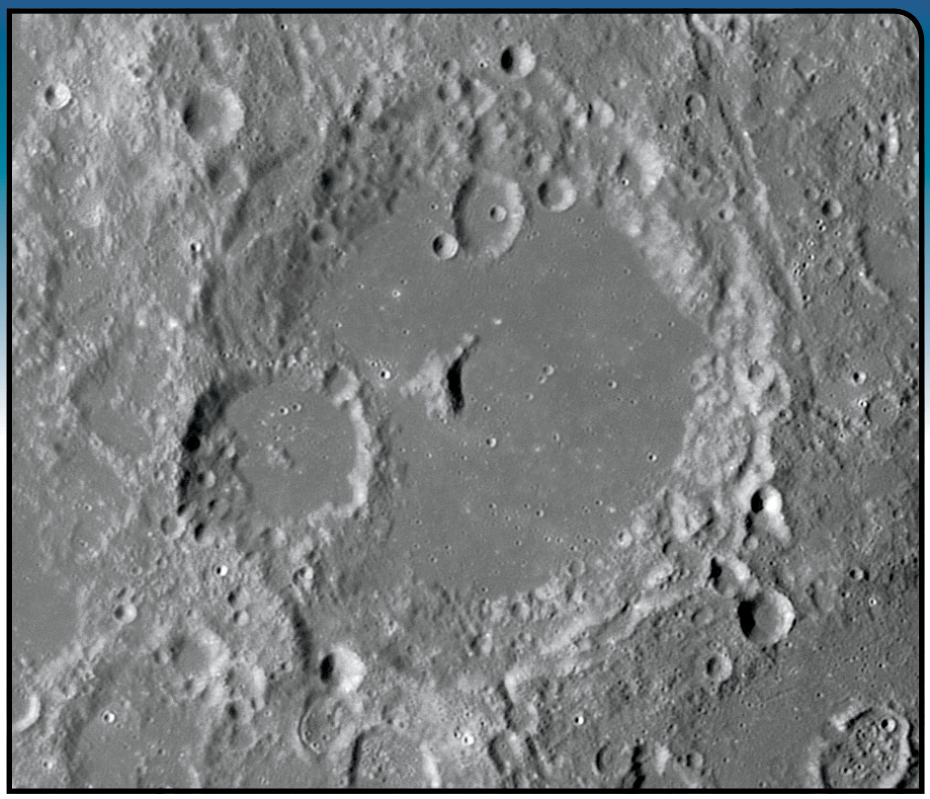
Why this phase?

First Quarter falls within the best times for viewing the Moon, when shadows are longer and lunar features stand out in sharp relief. The area where this is most evident lies along the terminator, the line dividing the light and dark portions of the Moon's surface. At First Quarter, the terminator shows where sunrise is occurring.

Along the terminator, you'll spot dots of light where mountaintops are high enough to catch sunlight but the surrounding lower terrain is still shrouded in shadow. On the floors of large craters, you can follow "wall shadows" cast by the sides of craters hundreds of feet high. All of these features change in real time, so in just a few hours, the differences can be striking.

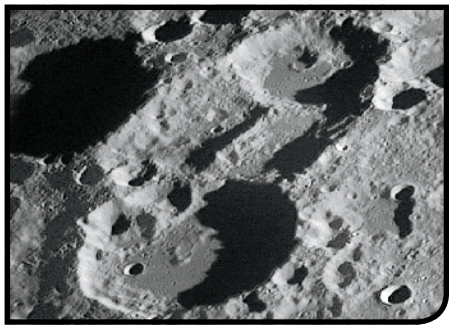
Observing tips

For some observers, the First Quarter Moon appears too bright through a telescope. You can deal with this in several ways. You could use a neutral density filter, which is a (carefully made) dark piece of glass that screws into the bottom of an eyepiece. A similar device, a variable polarizing filter, lets you change the amount of light passing through it. Another way you can reduce the Moon's apparent brilliance is to turn on a white light behind you. The additional light suppresses the eyes' tendency to adapt to the dark, allowing you to use normal



7 Albategnius Crater is so large that lunar scientists often refer to it as a walled plain or a ring mountain. Look closely at the most prominent overlapping craters: Klein, which sits to the lower left in this image, and Albategnius B, just inside the northern rim at the top. Note that Albategnius' outer wall has a rough hexagonal shape.

8 Stöfler is a large impact crater located in the Moon's southern highlands. Look for Faraday Crater, which overlays its western edge. The rim of Stöfler is worn, but its outline remains intact except at Faraday. In a reverse of Manilius Crater, Stöfler's floor has a low reflectivity, making the crater easy to identify.



9 Heraclitus is a complex crater in the Moon's rugged southern highlands. Licetus Crater forms the northern end of the formation. Just to the east is Cuvier Crater, and due south is Lilius Crater. The entire formation is heavily worn, with features smoothed down by a long history of impacts.

scotopic (daytime) vision, which is of much higher quality than dark-adapted photopic vision. Finally, you can use an aperture mask — a piece of cardboard that covers the front of your scope with a small hole cut in it — to turn your telescope into one of much smaller aperture.

All the features shown in the photos accompanying this story lie along the terminator around First Quarter. If you get a string of clear nights, view these features two or more evenings in a row. You'll be surprised at how different they appear after 24 hours. Compare what you see with the images.

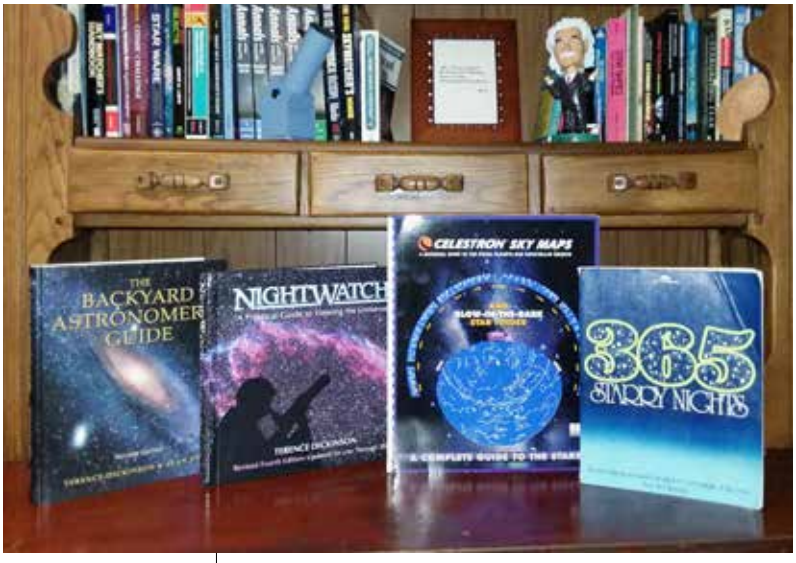
As practical advice, sit while you observe. Try different eyepieces of increasing magnification until the image starts to deteriorate because of the atmosphere. Note any additional details that high powers make visible.

Remember, when you observe the Moon, there's nothing you need to do quickly. Take your time and relax. This is easy observing, so have fun.

Michael E. Bakich *is a contributing editor of* Astronomy *who points his 4-inch scope at the First Quarter Moon each month.*

Picking a beginner's guide

Your key to unlocking the night sky awaits.



A sampling of the author's personal collection of beginner guidebooks is seen on display at his home. Though there are numerous guides aimed at beginners, the four examples shown above are a great introduction for any budding backyard astronomer. GLENN CHAPLE

BY GLENN CHAPLE

Glenn has been an avid observer since a friend showed him Saturn through a small backyard scope in 1963.

When it comes to putting together a list of favorites, whether it be restaurants, movies, or TV shows, I always run into trouble if I try to limit myself to a specific number. In putting together a "Top 10" list, for example, I invariably find a No. 11 that's just as good as No. 9 or No. 10.

This is the problem I faced as I set out to write this month's column, which highlights guidebooks for the backyard astronomer. By limiting myself to those I could adequately describe in a one-page article, I'd be sure to leave out some goodies. So, with a little trepidation, I'll begin with a rundown on guides directed toward the novice skygazer (or the veteran who's looking to brush up).

Foremost in this genre is *365 Starry Nights: An Introduction to Astronomy for Every Night of the Year* by Chet Raymo (Prentice Hall, 1982). If your knowledge of astronomy is nil, this book is an essential starting point. As the name indicates, *365 Starry Nights* is a night-by-night astronomy primer that helps the reader identify what's on display in the current night sky, while also adding information on basic cosmology and astronomical history. Entries for March include: an in-depth look at the constellations Cancer, Hydra, and Lynx; an intro to stellar classification; and historical notes on the Messier catalog and Olbers' paradox.

Celestron Sky Maps combines two essential tools for the backyard astronomer: a planisphere and a star atlas.

Your next step is to explore Terence Dickinson's *NightWatch: A Practical Guide to Viewing the Universe* (Firefly Books, fourth edition, 2006). This handbook covers the organization of the universe, the fundamentals of skygazing, astronomical equipment (binoculars, telescopes, and accessories), and tips on observing everything from meteors and aurorae to distant galaxies — in other words, pretty much anything a fledgling backyard astronomer would need to know.

Those two guides alone would suffice to get any newcomer started, but Dickinson also has another handbook, co-authored with Alan Dyer. Not only does their *The Backyard Astronomer's Guide* (Firefly Books, revised edition, 2002) mesh nicely with *NightWatch*, it adds enough advanced material to help the beginner transition to intermediate status. Part 1 deals with equipment, from binoculars and telescopes to eyepieces and accessories. Part 2 handles the basics of observing — naked eye, as well as with optical aid. And part 3 covers advanced tips on digital astrophotography, go-to telescopes, computer-related aids, and telescope maintenance. *The Backyard Astronomer's Guide* is regularly updated on its website: www.backyardastronomy.com.

I'm going to throw one more beginner-oriented guide into the mix. *Celestron Sky Maps* (Hubbard Scientific, 2007) combines two essential tools for the backyard astronomer: a planisphere and a star atlas. A planisphere works like the Star Dome in the middle of each issue of *Astronomy*, except that it can be adjusted to any date and time of the year. While a planisphere helps you locate a constellation in the sky, a star atlas provides a detailed look at that constellation. The front cover of *Celestron Sky Maps* is a glow-in-the-dark planisphere, while the main body is an eight-chart atlas arranged by season. Facing each chart is a table describing key deep-space objects plotted on the chart. The guide is printed on heavy cardstock with a protective overcoat for outdoor use, and it's also spiral bound to allow the charts to lie flat.

The guides in this article can be purchased at your local bookstore or ordered online. Remember, picking up a used edition is always a good idea — it's more environmentally friendly, and usually costs less.

Alas, as I feared, I've run out of room and I've only discussed beginner's guides. Next month, we'll look at guides geared for the intermediate and advanced skygazer.

Questions, comments, or suggestions? Email me at gchaple@hotmail.com. Next month: guides that list sky objects for binoculars and telescope. Clear skies!

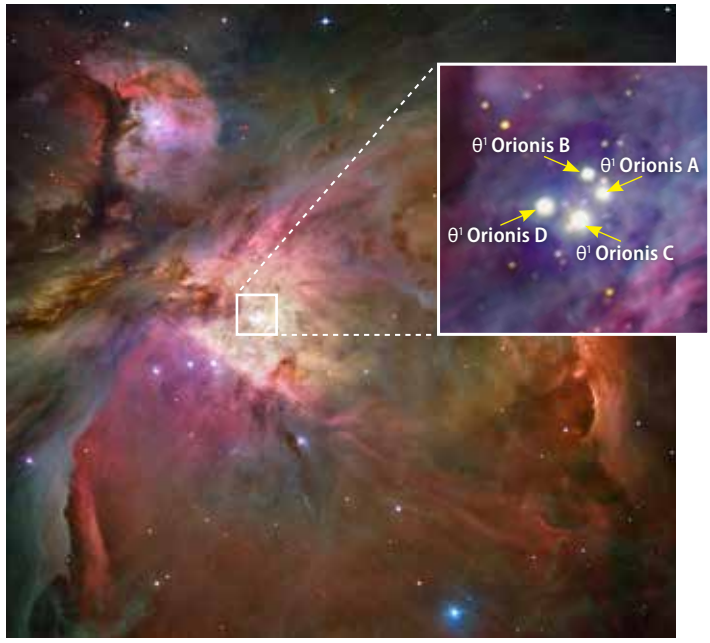
BROWSE THE "OBSERVING BASICS" ARCHIVE AT **www.Astronomy.com/Chaple**

OBSERVING**BASICS**

BY GLENN CHAPLE

Experience the Orion Nebula

It's so visually stunning, you could almost sing its praises.



Embedded within Orion the Hunter is the Orion Nebula (pictured), which, in turn, contains a tight cluster of stars known as Trapezium (inset). NASA, ESA, M. ROBBERTO (STScI/ESA), AND THE HUBBLE SPACE TELESCOPE ORION TREASURY PROJECT TEAM; INSET: THEOFANIS N. MATSOPOULOS

What's the top-ranked nebula in the entire night sky? The No. 1, must-see target for the backyard astronomer? By sheer grandeur, the hands-down winner would be the Carina Nebula. However, I can only guess at its visual splendor because it lies at a declination of –60° and I've never had the fortune to travel far enough south to spot it.

For that reason, I would cast my vote for the Orion Nebula. It's smaller and fainter than the Carina Nebula, but it's just 5° south of the celestial equator, making it accessible to virtually anyone on the planet. It's a nebula for everyone!

Before I sing a paeon to the beauty and wonder of Orion's Great Nebula, let me lay out a few nuts-and-bolts facts. The Orion Nebula is classified as an emission nebula — a cosmic cloud of dust and gas that shines by emitting its own light. Recent studies place its distance at about 1,300 light-years. Its apparent size of 1½° by 1° translates to a true diameter of some 25 light-years. The nebula's discovery is credited to the French astronomer Nicholas Peiresc, who spotted it in 1610. Charles Messier observed and cataloged it the night of March 4, 1769, designating it M42.

On second thought, maybe I'll pass on "An Ode to the Orion Nebula," as music and words fail to adequately capture its visual grandeur. You don't just observe the Orion Nebula — you experience it! I suggest doing that in three stages: first with your unaided eyes, then with binoculars, and finally through a telescope.

A naked-eye view of the Orion Nebula from a dark site allows us to admire its namesake constellation — arguably the grandest of all. Orion the Hunter consists of an 18°-by-11° lopsided rectangle formed by four bright stars framing a distinctive diagonal row of three more recognizable luminaries. Each of these seven stars ranks among the 70 brightest in the night sky. Two of them — 1st-magnitude Betelgeuse and Rigel — are in the top 10. The mythological Orion was an imposing figure, and his namesake constellation is no less impressive.

A naked-eye view of the Orion Nebula allows us to admire its namesake constellation — Orion the Hunter.

Hanging vertically from the three-star row (Orion's Belt) is a fainter three-star chain (Orion's Sword). Look at the middle member. It seems hazy. Is it the nebula, or is it an illusion?

Binoculars allow us to key in on the Sword and its surroundings, proving that the haze at its center is not an illusion after all. This hazy, puffy ball is a definite attention-getter, but it has competition from its surroundings. A degree to its north is the open cluster NGC 1981. At the bottom of the Sword and next to the bright star Iota (ι) Orionis is the wide double star Struve (Σ) 747, whose magnitude 4.7 and 5.5 components are 36" apart. It's interesting to note that Galileo himself observed and mapped the Sword but failed to see the Orion Nebula. The magnifying power of his telescope was comparable to that of modern-day binoculars, but its ¼° field of view would have been too small to encompass the nebula.

A telescope places the Orion Nebula at center stage — no competition from constellations or immediate surroundings! Even a common 2.4-inch refractor magnifying at just 30x to 50x captures impressive detail. Nebulous wreaths branch outward like the open wings of a ghostly eagle. Larger scopes reveal a mottled, almost chaotic, texture and an overall greenish color. Just north of the Orion Nebula is a 7th-magnitude star surrounded by haze. This detached portion of the Orion Nebula was discovered in 1731 by the French astronomer Jean-Jacques d'Ortous de Mairan and later became the 43rd entry in Messier's catalog.

The visual impact of the Orion Nebula is so overwhelming that we initially overlook an amazing little quartet of stars embedded in the nebulosity and best seen with a magnification of 75x to 100x. This is the Trapezium, a tight cluster of stars birthed by the Orion Nebula. Small scopes reveal the four stars — magnitudes 5.1, 6.4, 6.6, and 7.5 — that make up the group. The brightest of these four suns is Theta¹ (θ¹) Orionis C. Larger instruments will add a pair of 11th-magnitude stars to the mix. Although some may question the choice of M42 as the sky's finest nebula, there is no doubt that the Trapezium is the heaven's most beautiful multiple star.

Questions, comments, or suggestions? Email me at gchaple@hotmail.com. Next month: I correct an error I made in *The Edmund Scientific Mag 6 Star Atlas*. Clear skies!

Glenn Chaple has been an avid observer since a friend showed him Saturn through a small backyard scope in 1963.