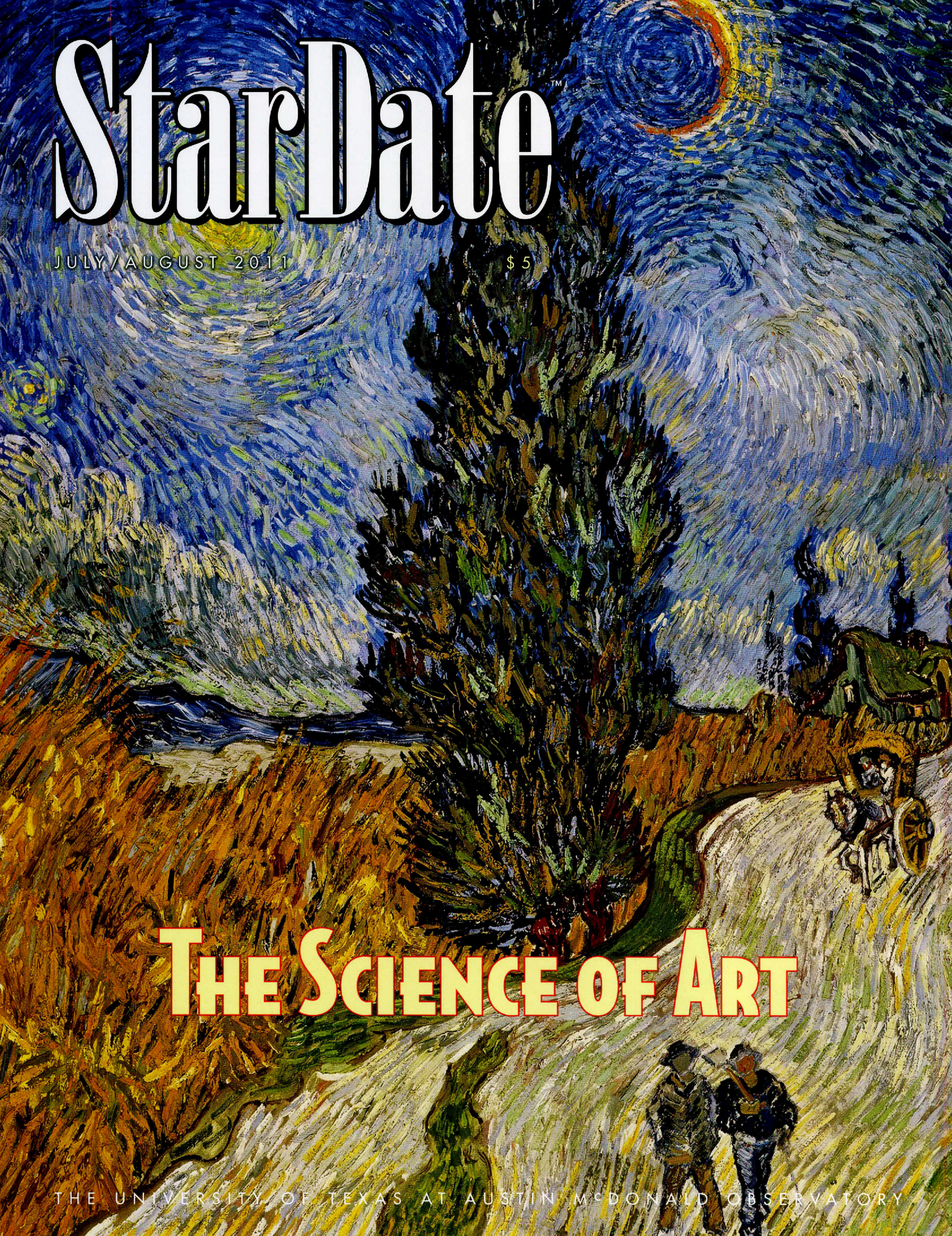

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JULY/AUGUST 2011 • Vol. 39, No. 4

FEATURES

DEPARTMENTS


KROLLER-MULLER MUSEUM

On The Cover
Donald Olson and his team deduced that in Van Gogh's Road with Cypress and Star, *the Moon is joined by brilliant Venus and tiny Mercury as seen from Saint-Rémy, France, on April 20, 1890. For more of Olson's investigations,* *see page 4.*

This Page
The Rock House Fire burned nearly 500 square miles of West Texas in April, coming within a mile of McDonald Observatory. On April 17, firefighters set a controlled burn on Black Mountain (above the Hobby-Eberly Telescope) to head it off. The controlled burn is the bright line at left; the fire, the bright line at right.

Coming Up
In the September/October issue of StarDate, *we'll bring you skywatching information and charts for fall, along with new astronomy features, Merlin's answers to your cosmic questions, and the latest astronomy news.*

FRANK CIANCIOLO/McDONALD OBSERVATORY

MERLIN

Dear Merlin,

If the speed of light is about 300,000 kilometers (186,000 miles) per second, what's the speed of gravity? How would you measure it?

Tom Rees
Tehuacana, Texas

The speed of gravity is most likely equal to the speed of light, although there is a little wiggle room in that number.

The wiggle room comes from the fact that there is no way to directly measure the speed at which gravity "wiggles" across the universe. Instead, the best measurement to date comes from the gravitational dance between two ultradense neutron stars.

In the classical theory of gravity created by Isaac Newton, gravity is a force that acts instantaneously. In this view, if the Sun suddenly disappeared, Earth would "feel" the difference instantly, as though someone had cut a string that tied our planet to its star.

But Albert Einstein's theory of gravity, known as general relativity, posits that gravity is a curvature in space-time caused by matter or energy. As any object moves, it produces "wiggles" in space-time known as gravitational waves. Since the speed of light in a vacuum is the universal speed limit, there is no way for these waves to travel faster than light. So if the Sun suddenly disappeared, Earth wouldn't feel the difference for a bit more than eight minutes, which is the time it takes light (and gravitational waves) to cover the distance between them.

And that brings us back to the neutron stars.

The strongest validation of the speed of gravity comes from observations of a close pair of neutron stars. If Einstein's theory of gravity is correct, then the two stars should emit gravitational waves as they spiral closer together, causing the distance between them to shrink and their speed around each other to increase. And observations of a pair of neutron stars known as PSR 1913+16 show that their orbit is evolving just as Einstein's equations predict, to within an accuracy of about one percent. (The finding, incidentally, earned a Nobel Prize for its discoverers.)

Hence, gravity propagates across the universe as waves that are limited to the speed of light, once again confirming Einstein's theories of relativity.

Dear Merlin,

The crescent Moon last night (April 6) was bowl shaped. Is there a specific name for the Moon when in this phase/position?

William Wilson
Shady Side, Maryland

Merlin's preferred name is "beautiful." Otherwise, there's no specific name. A thin crescent Moon is sometimes described as "the old Moon in the young Moon's arms," but that's a bit unwieldy for a name, and it doesn't require a specific orientation for the crescent. The bowl shape simply means that the Moon's path stands straight up from the horizon, so the fattest part of the crescent is pointing straight down toward the Sun.

Dear Merlin,

Are crop circles real? Are there any astronomical theories about what causes them?

Monica Adams
Ruckersville, Virginia

Yes, they are real. And yes, there is a leading theory to explain them: They are created by smart, inventive people with way too much spare time on their hands.

Dear Merlin,

I enjoyed the March/April article about the gentleman who spent many years trying to locate a planet closer to the Sun than Mercury is. It made me recall something I read many years ago. It said there was a time when Venus as the Morning Star and Venus as the Evening Star were thought to be two planets. The Morning Star Venus was referred to as "Vulcan." Am I correct or crazy?

Claire P. Greene
Milwaukee

Crazy? No way! Unfortunately, you're not quite correct, either.

Many cultures did indeed see the morning and evening manifestations of Venus as separate objects, and gave them separate names. In ancient Greece, for example, morning Venus was known as Phosphorous ("bringer of light"), while evening Venus was known as Hesperus ("evening star").

In Roman mythology, Venus, the goddess of love, was married to Vulcan, the god of fire, so it would make sense to think of the morning and evening stars as manifestations of the couple. The Romans never did so, however, and Merlin is aware of no culture that used the name "Vulcan" or any variation thereof to describe the planet.

Merlin is unable to send personal replies. Answers to many astronomy questions are available through our web site:

stardate.org/resources/

Send questions to:
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stardate.org/magazine

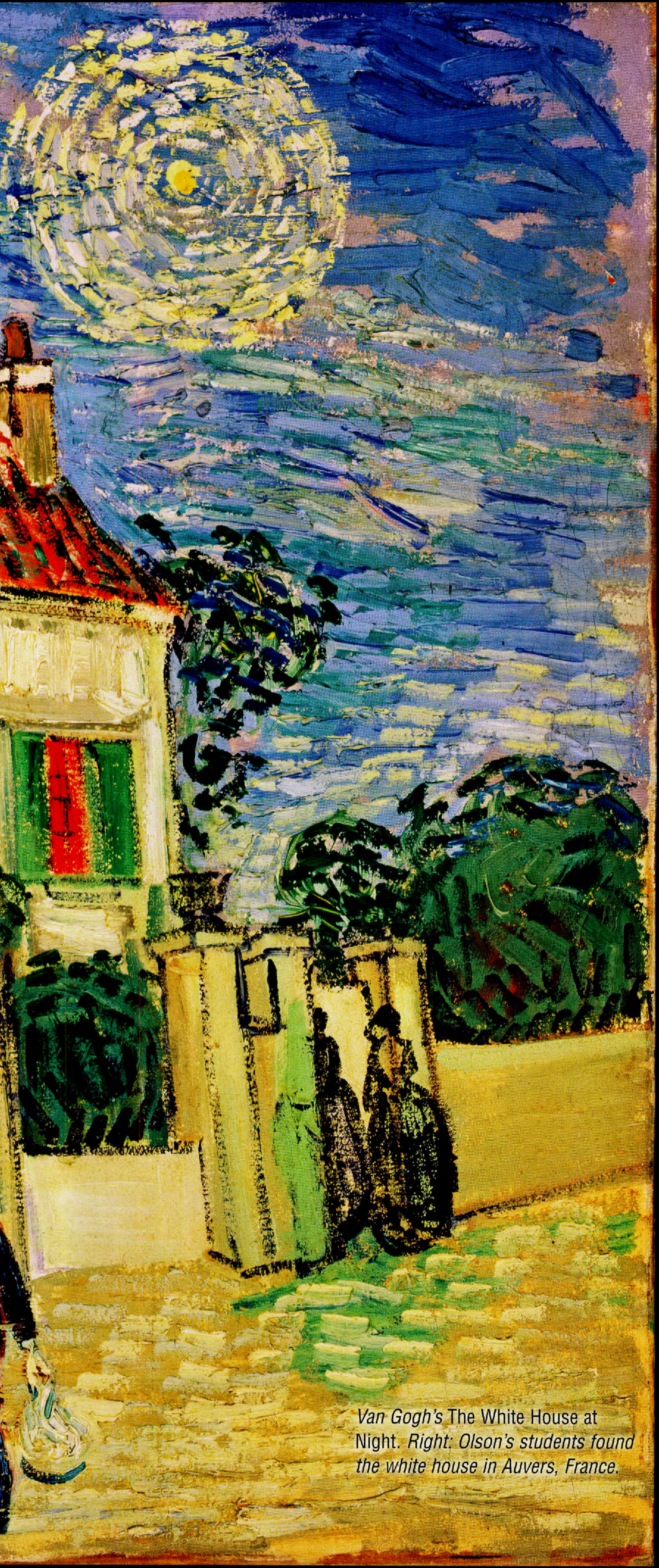
Celestial Sleuth

On the trail of astronomy in art, literature, and history with Donald Olson

By Rebecca Johnson

Science and the humanities often are portrayed as opposing forces these days. But one scientist and his students are using scientific methods to illuminate mysteries in the humanities — work they say helps them appreciate the humanities even more.

For 25 years, Donald Olson and his students at Texas State University in San Marcos have investigated astronomical connections in art, literature, and historical events. They have written nearly 40 popular articles detailing their probes into paintings by Van Gogh and Munch, the works of Chaucer and Shakespeare, and historical events from ancient Greece through World War II.



Van Gogh's The White House at Night. *Right: Olson's students found the white house in Auvers, France.*

THE HERMITAGE

RUSSELL DOESCHER

A physicist by training, Olson earned his PhD in the early 1970s studying relativity at The University of California, Berkeley. His choice of specialty led him into astronomy, he says, because "most of the important applications of General Relativity are in astronomy and cosmology." After leaving Berkeley, Olson spent several years at Cornell. In 1979, he came to The University of Texas at Austin for two years to study the structure and distribution of galaxies with famous galactic astronomer Gerard de Vaucouleurs.

While at Texas, Olson was asked to teach an astronomy class one semester when several faculty members were on sabbatical. This chance teaching experience led him into a professorship at Texas State, less than an hour south of Austin, where he has taught astronomy and physics since the early 1980s.

Today, Olson says he spends only about 10 percent of his time on what he calls "straight physics." His investigations into the intersections between science and the humanities fill most of his time. A journalist long ago bestowed him with the moniker "the celestial sleuth." Olson likes it, he says, because it highlights that he is "using evidence to solve mysteries — and the mysteries come from the humanities."

Olson's first foray into these investigations began at an English department party he attended with his wife, Marilynn Olson, a professor in that department. Another English professor asked Olson if he could help decipher some astronomical references in *The Canterbury Tales*, Geoffrey Chaucer's late-14th century volume of stories told by fictional pilgrims journeying to England's Canterbury Cathedral.

At first, Olson and his partner were simply trying to decipher Chaucer's words in *The Franklin's Tale*. "It's *real* language [of astronomy], not just some phony-baloney throwing a few terms around. He's really describing how you would do a sophisticated astronomical calculation using medieval methods," Olson says.

But as the project went on, Olson says he discovered something even more significant. "The key climactic moment in *The Franklin's Tale* is a high tide that covers the rocks in Brittany. Well, you know what makes high tides: the Moon. And not just the Moon, it's … the configurations of the Sun and the Moon."

Olson says he realized that a highly unusual configuration of the Sun and Moon had taken place during the author's lifetime that might have inspired Chaucer. In this cosmic configuration the Moon was at perigee (closest to Earth for the month) while Earth was at perihelion (closest to the Sun for the year). These and a few other factors contributed to an especially high tide on December 19, 1340. And indeed, the Franklin explains that the events of his tale occurred in "the cold and frosty season of December."

Eventually Olson and his collaborator published articles on this and several other astronomical allusions from *The Canterbury Tales*. Word spread about those projects, leading another Texas State faculty member, this time from the history department, to approach Olson with a mystery. Thus began the first of many probes into how the skies influenced famous historical events.

A former Marine, the professor said that no one had ever understood what happened with the tide during an amphibious landing of Marines on the Japanese island of Tarawa in 1943. "The landing craft had to clear a reef to get up to the beach and land at Tarawa," Olson says. "And they were hoping for a high tide and the tide failed to rise that day. It just went up a little bit. The landing craft grounded on the reef, stopped 600 yards from the island, and the Marines had to get out and walk, in water up to their waists and up to their chests, carrying their rifles over their heads."

In the ensuing three-day battle, almost 1,000 Marines were killed and more than 2,000 wounded. The reason for the unexpected behavior of the tide, which was responsible for many of these casualties, had been a mystery for decades.

To attack the Tarawa problem, Olson took inspiration from an astronomer at Harvard. "Owen Gingerich wrote articles reconstructing the sky as it would have been on the nights Galileo went out. You know, reading the documentation, getting the dates right, doing the calculations," Olson says. Gingerich also did this for the skies of Copernicus and Kepler. These recreations of past skies to study the history of astronomy, Olson says, inspired him to apply the same idea to problems in the humanities. This was in the mid-1980s, before desktop planetarium software and the Internet made the skies of the past (and future) instantly accessible to all.

Olson's group wrote its own programs to re-create the tides and the positions of the Sun and Moon for the date of the Tarawa landing, November 20, 1943. The researchers found that "the Moon was at apogee, which means the Moon is far from Earth, and that weakens its tide-raising force," Olson says, "and it was a quadrature," meaning that it was a first- or third-quarter Moon. During quadrature, Olson says, "the tide range always goes down." This unusual configuration, called an apogee quadrature, happens

JUDITH FILENBAUM HERNSTADT

Students surveying in Norway as Olson (right) looks on during an investigation of Edvard Munch's painting 'Girls on the Pier.'

RUSSELL DOESCHER

Olson investigated Walt Whitman's poem 'Year of Meteors' and found that it describes a meteor procession seen over the northeastern U.S. on July 20, 1860. Fredric Edwin Church painted the event in 'The Meteor of 1860' (above).

only twice each year, and it occurred the night before the Marines landed at Tarawa.

Once they solved the Tarawa mystery, Olson says, he and his team pondered what else they could do with their computer programs. They decided to look into the astronomical references in some of the paintings of Vincent Van Gogh. This started them on the trail of some of their most well-known projects, probing the astronomical aspects of famous works of art.

"Every painting, we do four things," Olson says. "They're Ws: where, when, which way, what. Where was the artist, as precisely as we can do it. … When were they there? What year, what month, what day? … Which way are they looking? North, south, east, west, or somewhere in between? That obviously affects which part of the sky they're looking at. And finally, what are they looking at? The Sun, the Moon, stars, planets?"

Not all paintings lend themselves to this type of investigation, Olson says. "What really helps is if a painting has a distinctive foreground. In other words, to be an astronomy painting, there's got to be a sky — sunset sky, twilight sky, or a night sky. Maybe there's stars, maybe there's the Moon, maybe there's planets, maybe just the setting Sun. What I need is a distinctive foreground. [It] could be a river, could be a distinctive building. If all the foreground has is an open field and a tree in it, I've got a problem. Because there's a lot of open fields and there's a lot of trees."

Olson and his team have studied three Van Goghs. Their most recent subject was *The White House at Night*, which features a bright object in the sky (see pages 4 and 5). Presumed lost for half a century, it actually had been looted from a German collection during World War II and hidden in the bowels of Russia's state museum, The Hermitage. The painting resurfaced in 1995 when the museum mounted an exhibition of more than 70 paintings from German collections, called "Hidden Treasures Revealed."

The work of Olson and his students on *The White House at Night* gives a good overview of their research methods. After many months of research at home in Texas, they travelled to the French town of Auvers, near Paris, where Van Gogh lived before his death on July 29, 1890. During his 70 days there, he produced about 70 paintings, including *The White House at Night.*

The team's first order of business was to find the white house. "Once you've found the white house, then you can back off and see where Van Gogh must have been standing to get perspective," Olson says. But locating it was no mean feat — scholars and townspeople had disagreed on the house's identity for a long time.

Seven books identified possible locations; six favored one house and the seventh another. Rather than assume the house was one of these two, Olson had his 10 students break into four groups, each heading off in a different direction with a print of the painting. "My students looked at every house in Auvers, many hundreds of houses," Olson remembers. "They went down every street and looked at every house to find it. Oh, it was just thrilling."

Though the house had undergone several changes from the time of its depiction by Van Gogh, the students were able to identify it by its uneven windows (one of which had since been enclosed; the team was able to enter the house and verify the window had been there in the past).

Once Olson's team identified the house, it was able to use cues from the painting itself. "The sunlight hitting the house, cutting from right to left" revealed that Van Gogh was showing "the last rays of the setting Sun," Olson says, meaning that the scene is at evening twilight. Armed with that knowledge and the dates that Van Gogh lived in Auvers, the team used its computer programs to find dates when a bright object would be in the position depicted above the house during evening twilight. Several possibilities emerged.

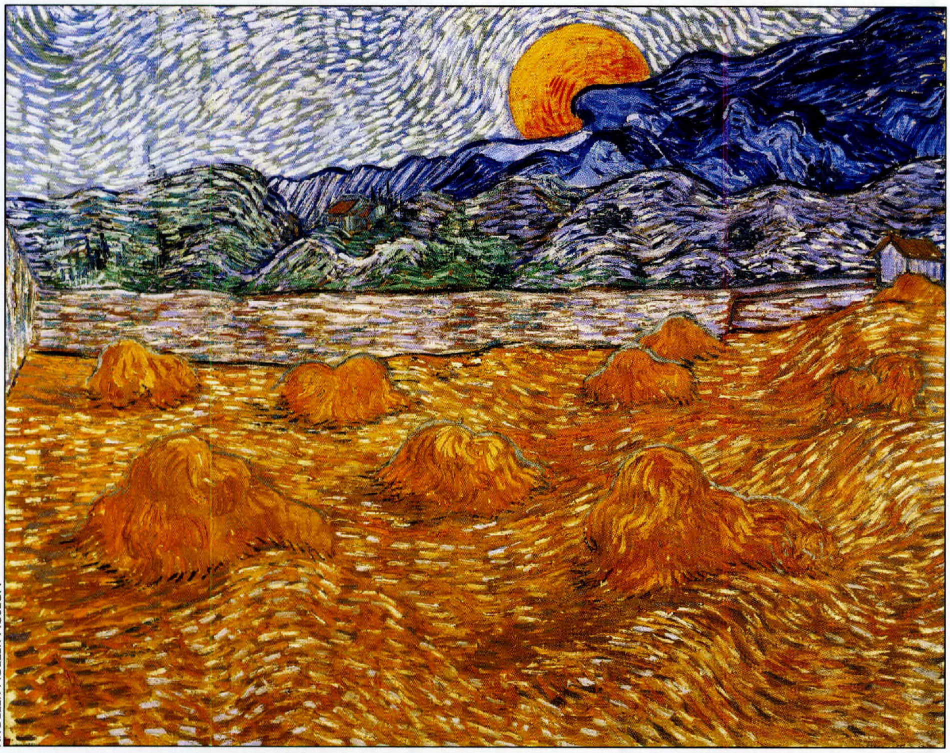
List in hand, the researchers were able to find the exact date by using weather records of the period, which showed that June 16, 1890, was the first clear night after 10 days of rain. The weather worsened again the next day.

The bright object above the house on June 16, 1890, was Venus, the evening star.

The fact that Van Gogh wrote a letter to his brother Theo on June 17 describing the painting lends additional support to that date. The letter also illustrates one of the main points Olson says he tries to teach his students: Go to primary sources. "We don't just read the letters of Van Gogh in a paperback translation," Olson says. "We don't even read it in a French transcription. We get photographs of the original letters."

In so doing, they found out that the published translation of the June 17 letter referencing *The White House at Night* omitted a sentence — the sentence in which Van Gogh describes the bright "star" in the painting's sky. (Van Gogh did not identify the star as Venus.)

Other primary sources include weather records — often century-old, hand-written ledgers. In this, Olson says he was influenced by another Harvard astronomer, Charles Whitney, creator of what Olson calls the "definitive analysis" of Van Gogh's *Starry Night Over the Rhone*. (Whitney's work also influenced Olson to have his students "travel in the footsteps of the artist." In his earliest investigations, his team did not travel to the sites of works they studied. Today, it's an integral part of the process.)



KRÖLLER-MÜLLER MUSEUM

Olson proved the scene in Van Gogh's 'Moonrise Over the Wheat Field' occurred at 9:08 p.m. on July 13, 1889. Some thought the painting included a rising Sun.

Though many have found Olson's investigations fascinating, not everyone enjoys learning the scientific aspects of artworks whose main value they consider to be in evoking thoughts and emotions. "Some people say 'Oh, you're destroying the mystery of the painting by doing a scientific explanation,'" Olson says. "We don't think so. We think we're adding to our enjoyment and understanding, to know what's real and what's not real."

Olson says his kind of investigation simply brings a different perspective to the appreciation of art. "It's historical research that involves calculations," he says. "What can astronomers do? They can tell you where Venus was on a certain night in 1890. Or they can tell you the azimuth or the compass direction of sunrise during the summer of 1893. And once I know the [vantage] spot, I can calculate when the Moon would be partially hidden behind that overhanging cliff" in Van Gogh's *Moonrise Over the Wheat Field* (left). But he emphasizes that he has great respect for art historians. "I couldn't do what I do without the art historians," he says. "They carry the ball. We're using all of the materials assembled by art historians."

The project that garnered the biggest reaction, Olson says, was his probe into *The Scream*, Edvard Munch's iconic 1893 depiction of a man standing on a bridge, his head clasped in his hands and a look of agony on his face while an ominous blood-red sky looms overhead. The team determined that the red sky was

Munch's interpretation of a real event: a twilight sky glowing red due to dust in the air from the massive 1883 eruption of the Indonesian volcano Krakatoa.

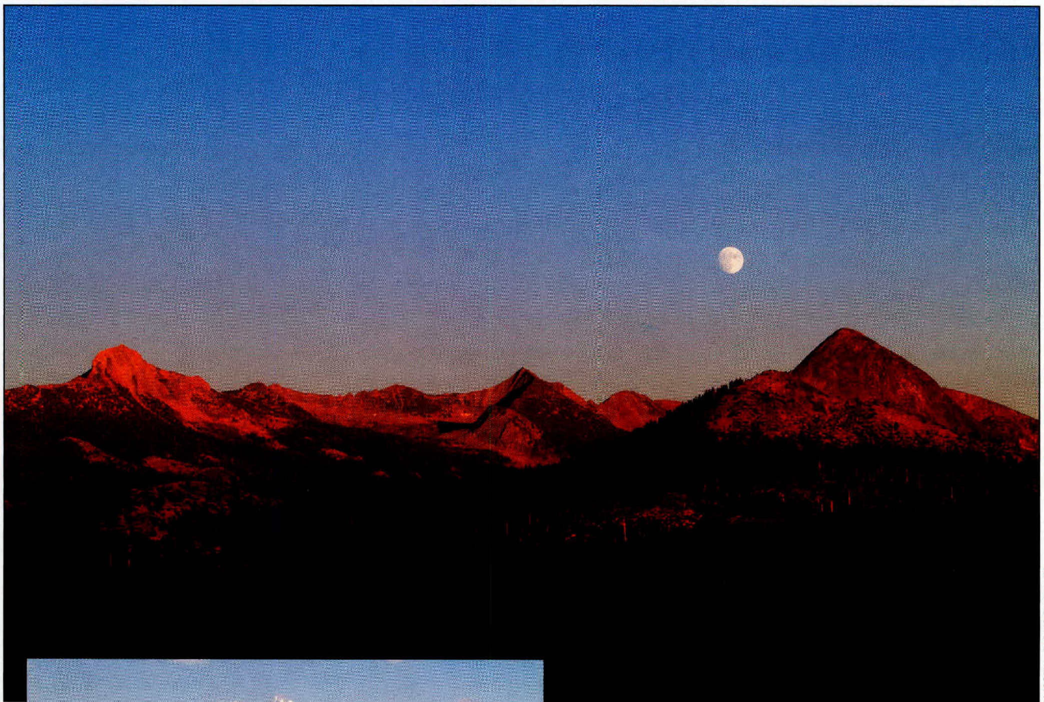
After 25 years, Olson's investigations are still going strong. His primary collaborators are Marilynn Olson and Russell Doescher, a senior lecturer in physics at Texas State who, in addition to scientific know-how, also contributes photography skills to the investigations. And of course, the "cast of students changes like crazy." Olson teaches an honors course, Astronomy in Art, Literature, and History, every couple of years; his student collaborators come from this course.

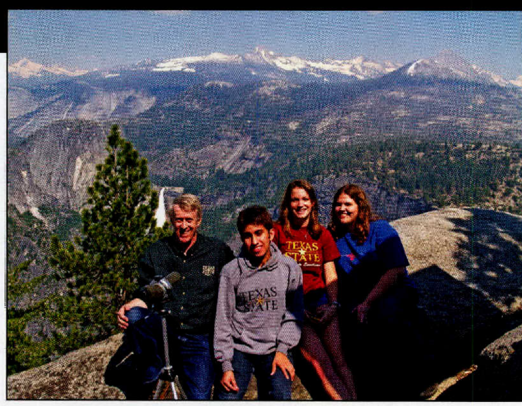
Olson's methods have evolved somewhat over the decades, but while technology has changed significantly, one thing hasn't: Even though commercial desktop planetarium programs are now widely available, his team still writes its own programs to compute the positions of the heavens and tides. "To get accurate results for historical projects, you have to understand calendars and timekeeping," Olson says. They don't just trust someone else's calculations. "How do you know that a [commercial] computer program is getting a calendar right?" he asks. Many of their projects involve not just the modern Gregorian calendar, but, when looking into Chaucer, the earlier Julian calendar, and even older calendars when probing Julius Caesar's entry into Britain or the Battle of Marathon in ancient Greece.

Part of what he's trying to teach the students is to "be careful and check their work," he says. "We don't just calculate things one way." For each sky simulation they do, the team will run at least one of their own programs as well as several commercial ones, and compare results — in one instance, among seven different programs. There's always at least one that doesn't agree, Olson says. They occasionally have notified manufactures of software bugs they've discovered.

Today, Olson is hard at work on a couple of new projects. He prefers not to detail them before he publishes the results, saying simply that one involves a well-known work of literature, the other a famous historical event, as science and the humanities continue to work together in the quest to understand our cultural heritage.

Rebecca Johnson is editor of StarDate *magazine.*





RUSSELL DOESCHER (2)

Olson and his students determined that Ansel Adams shot his famous 'Autumn Moon' on September 15, 1948, from Glacier Point above California's Yosemite Valley, and found the spot where Adams set up his camera. They recreated the photo almost exactly (above) on September 15, 2005. Left: Olson and students at Glacier Point.

Resources

Articles

"Edvard Munch's Starry Nights, Stormy Skies, and Summer Sunrises," by Donald W. Olson, Russell L. Doescher, Joseph C. Herbert, Robert H. Newton, and Ava G. Pope, *Griffith Observer*, August 2009

"When the Sky Ran Red: The Story Behind *The Scream*," by Donald W. Olson, Russell L. Doescher, and Marilynn S. Olson, *Sky & Telescope*, Feburary 2004

"Dating Van Gogh's Moonrise," by Donald W. Olson, Russell L. Doescher, and Marilynn S. Olson, *Sky & Telescope*, July 2003

"Identifying the 'Star' in a Long-Lost van Gogh," by Donald W. Olson, Russell L. Doescher, and the Southwest Texas Honors Astronomy Class, *Sky & Telescope*, April 2001

SKY CALENDAR

by Alan MacRobert

Saturn and Spica descend into twilight this summer. As the Milky Way arches its highest overhead after dark, the Big Dipper and Cassiopeia balance each other on either side of the North Star. And Jupiter climbs up into view in the late-night hours.

JULY 1 - 15

As twilight deepens late on these high-summer evenings, look southwest for Spica and Saturn coming out to greet you. They're at about the same height, a little more than a fist-width at arm's length apart (13 degrees), and similar in brightness. Saturn is the one on the right. Can you make out their subtle color difference? Saturn is pale yellowish white; Spica is pale blue-white. The waxing Moon passes below them on July 7 and 8.

Look for a fainter star next to Saturn, to its right. That's Porrima, or Gamma Virginis. Saturn will pull away from it, leftward, for the rest of the summer.

Look due south as darkness creeps in for orange-red Antares, the brightest star of Scorpius. Other stars of Scorpius sparkle to Antares' right and in a long, low loop to its lower left. The Moon passes just above Antares on the evening of July 11.

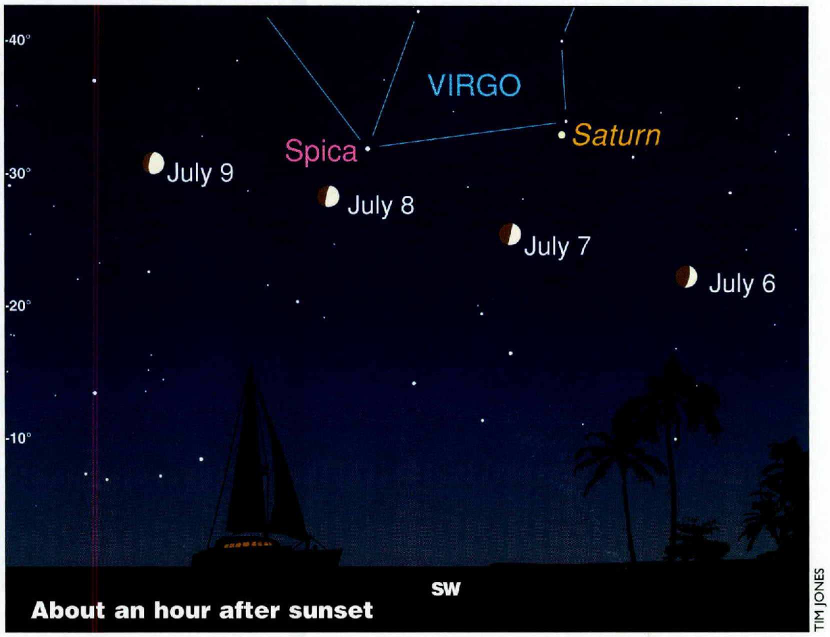
Look back to Spica and Saturn. Bright Arcturus stands high above them. Far to Arcturus' right, in the northwest, the Big Dipper hangs down by its handle. As night grows late, the Dipper descends and dips to the right as if scooping up water — which it will dump onto the world from high in the northeast next spring.

Vega shines high in the east at nightfall, about as high as Arcturus is in the southwest. These two are the brightest stars of summer and, in fact, are the fourth and fifth brightest on the entire celestial sphere (not counting the Sun).

Vega highlights the small and otherwise faint constellation Lyra, the harp. Arcturus is the brightest star of big, kite-shaped Boötes, the herdsman. The kite pattern, rather thin, leans toward the Big Dipper, with Arcturus marking its bottom where the tail is tied on.

If you're out as late as 1 or 2 a.m. (depending on your location), watch for bright Jupiter rising above the eastern horizon. By the first light of dawn Jupiter is shining higher and even brighter.

Also at dawn's first light, look for much fainter Mars far to Jupiter's lower left. Aldebaran, similar to Mars in both brightness and color, is nearby. At the start of July Aldebaran is below Mars; by mid-month, you'll find it to Mars' right.



JULY 16 - 31

July is the month when loopy, bright-sparkling Scorpius poses at its highest in the south right after dark. On either side of fire-colored Antares, the scorpion's heart, look for the "Outriggers of Antares," two stars just to its right and lower left.

Look farther right for the nearly vertical row of three stars marking the scorpion's head. The rest of his body extends down and to the left of Antares.

In the scorpion's tail (if you can see that low in the south) is a pair of stars known as the Cat's Eyes. They're canted at an angle and unequally bright; is the cat winking? It doesn't take much imagination to see them as the glowing eyes of an animal in the night.

As evening grows late, Vega passes overhead. Vega's little constellation Lyra is well worth learning. Lyra's main pattern has two parts: a tiny equilateral triangle and a long parallelogram. Vega forms one corner of the triangle; the parallelogram hangs from another corner. The third corner is Epsilon Lyrae, a quadruple star. Binoculars easily separate Epsilon into two equal components, and a telescope at 100 power or more resolves each of these in turn into a much closer double star.

Lyra also has two other nice double stars for binoculars. The star connecting the triangle and parallelogram is Zeta Lyrae, which good binoculars can barely resolve if you brace them to hold very still. Delta Lyrae, the next farthest star in the pattern from Vega, is much easier. Its widely separated components are orange-red and blue.

Stay up late and you can see Jupiter now rising in the east in the middle of the night. The waning Moon shines to the upper right of Jupiter on the morning of July 23, and to its left on the morning of the 24th. Although they look close together, Jupiter is currently 1,860 times farther away.

AUGUST 1 - 15

Spica and Saturn have been sinking lower in the west-southwest in twilight, but they're still in sight. The waxing crescent Moon hangs below Saturn on August 3 and closer below Spica on the 4th.

Vega now shines near the zenith soon after dark. Whenever Vega is highest overhead, the teapot pattern of Sagittarius is at its highest in the south. The teapot, a little larger than your fist at arm's length, tilts to the right as if pouring. It tips farther over as the evening and the summer grow late — forever pouring tea onto Scorpius' tail.

Look to the upper left of the teapot's handle for a rather faint asterism called the teaspoon. Look below the teapot (if you live at a southerly latitude and have a clear view due south) for Corona Australis, the southern crown, a little arc of four stars sometimes called the saucer.

In a fairly dark, Moonless sky you'll see some of the brightest star clouds of the Milky Way hanging above the teapot's spout, like puffs of steam.

AUGUST 16 - 31

No bright planets shine high in the evening now, and you still have to wait until nearly midnight for Jupiter to rise in the east-northeast. The waning Moon shines just above Jupiter on the night of August 19; the pair forms a spooky late-night apparition.

With the Moon out of the evening sky now, this is Milky Way time. As summer ages and autumn looms, the glorious summer Milky Way arches high across the eastern side of the sky right after dark. It runs from Sagittarius and the tail of Scorpius low in the south, up behind bright Altair and Deneb high in the southeast and east, and all the way down to Cassiopeia in the north-northeast.

Below the Milky Way in the east, constellations of fall already are appearing. Pegasus is the foremost of these, with the Great Square of Pegasus due east and balancing on one corner. The Great Square is somewhat larger than your fist at arm's length.

Andromeda, another signature constellation of fall, extends from the Great Square's left corner. Look to the right of Pegasus for big, dim, hard-to-make-out Aquarius and Capricornus.

Meteor Watch

The Shower
Perseids
Named for the constellation Perseus, the hero, which climbs into view in the wee hours of the morning.

Peak
Night of August 13

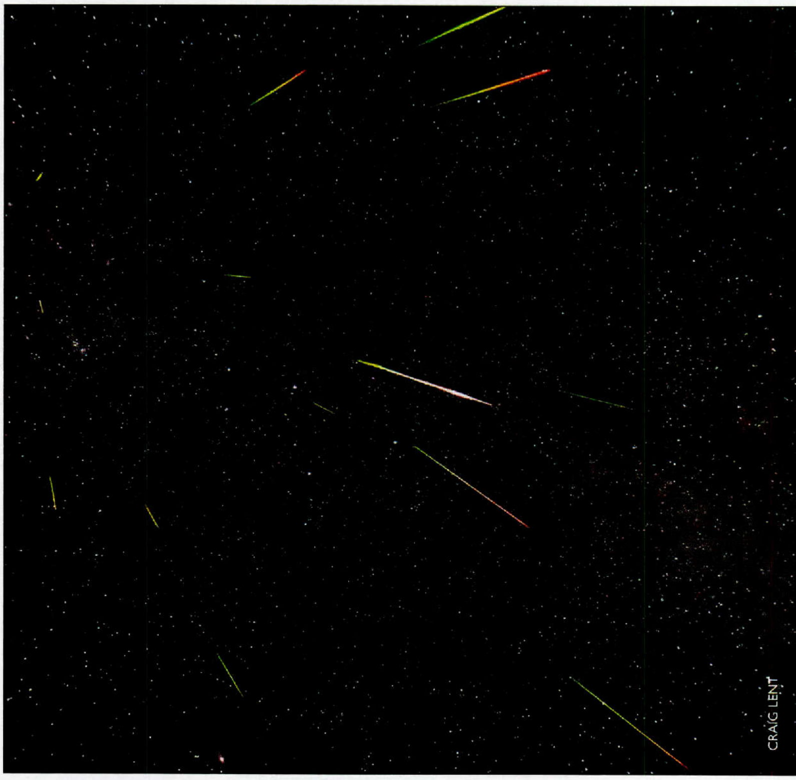
Notes
Alas, the pesky Moon is full on August 11, so on the night of the shower's peak it rises in mid-evening and blazes through the sky the rest of the night. Its brazen glow will overpower all but the brightest meteors. Still, from a dark-sky location, a few streaks should still shine through, punctuating the moonlit sky.

WEB BONUS
Find more about the Perseids online, August 8
stardate.org/mediacenter

This is also the time of year when the Big Dipper, sparkling in the northwest, and Cassiopeia, its opposite number sparkling in the northeast, balance each other at the same height after dark. Cassiopeia, queen of Ethiopia, has five main stars that form a broad W pattern. The right-hand side of the W (the brighter side) is currently tipping upward.

Look midway between the Big Dipper and Cassiopeia (and just a little higher) for Polaris, the North Star. The two patterns wheel around Polaris all night — and all year — while Polaris stays essentially fixed, a nail on the wall of the sky.

To the upper left of Polaris, by a little less than two fist-widths at arm's length, look for a star that is just as bright. This is Kochab, tinted pale orange. Just above Kochab is fainter Gamma Ursae Minoris. The pair march around Polaris, earning them the title of the Guardians of the Pole.


CRAIG LENT

This composite of 1,200 exposures shows Perseid meteors raining against the Milky Way as seen from Marshall County, Indiana.

For night owls or early risers, little Mars has gradually been brightening and creeping higher in the pre-dawn sky. Look for it in the east-northeast from about 3 or 4 a.m. until it becomes lost in the dawn. Mars is in the constellation Gemini, with Castor and Pollux off to its left (lined up almost vertically) and Orion a good deal farther to its right.

Orion in summer? Yep. Orion rising low before dawn tells you that another winter is coming, though still months away. Before dawn in late August, you get a preview of the early evening sky at year's end.

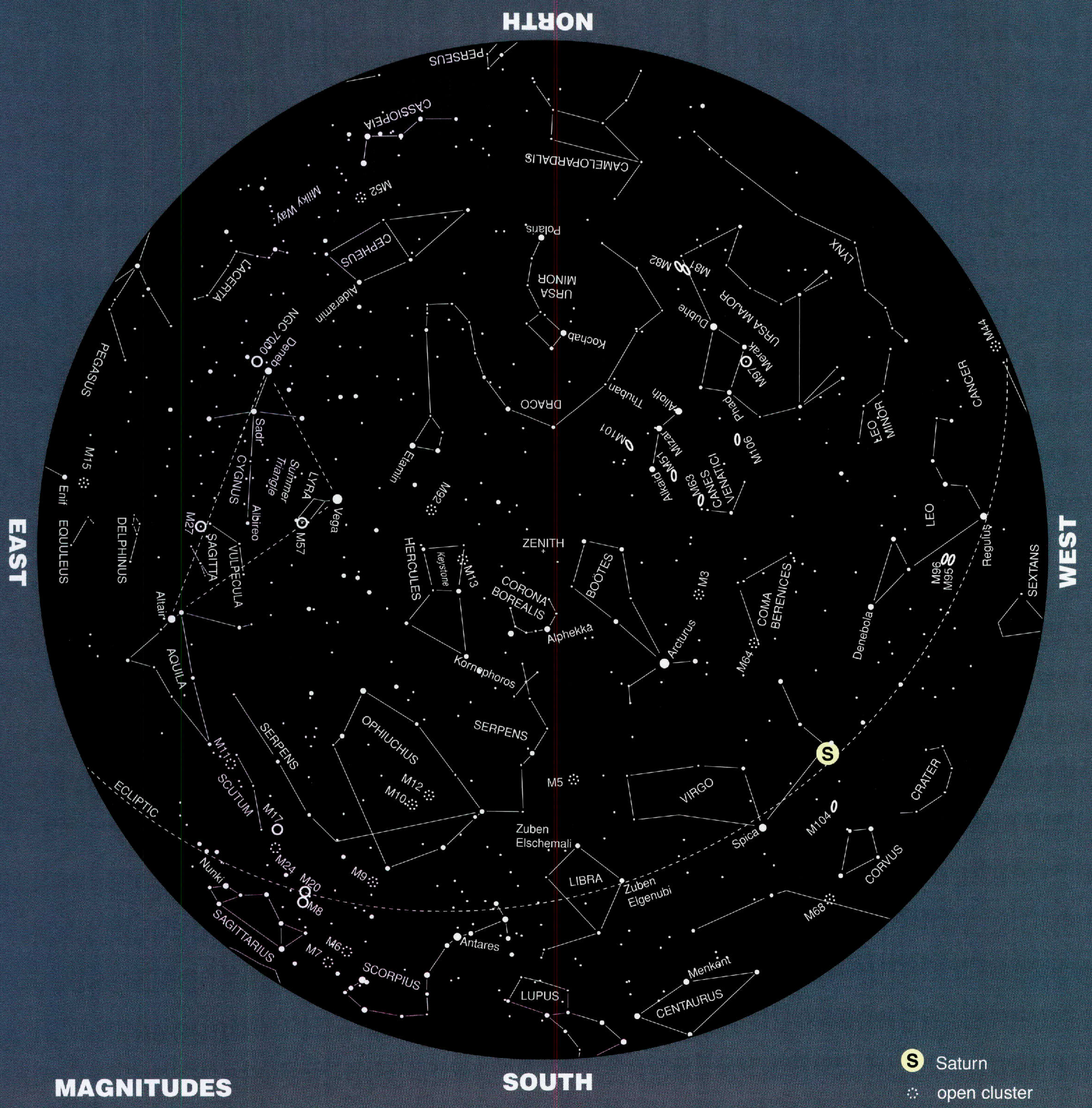
But not entirely. The planets are always on the move against the starry background, Mars especially so. By the end of 2011, Mars will have vacated Gemini, crossed Cancer, and moved most of the way across Leo to reach Leo's hind foot. It will also be brighter by then — magnitude 0.2 compared to magnitude 1.4 now, on its way to magnitude –1.2 when it passes closest to Earth early next March.

Alan MacRobert is a senior editor of Sky & Telescope *magazine (skyandtelescope.com).*

JULY

How to use these charts:
1. Determine the direction you are facing.
2. Turn the chart until that direction is at the bottom.

June 20	11 p.m.
July 5	10 p.m.
July 20	9 p.m.



MAGNITUDES
- 0 and brighter
- 1
- 2
- 3
- 4 and fainter

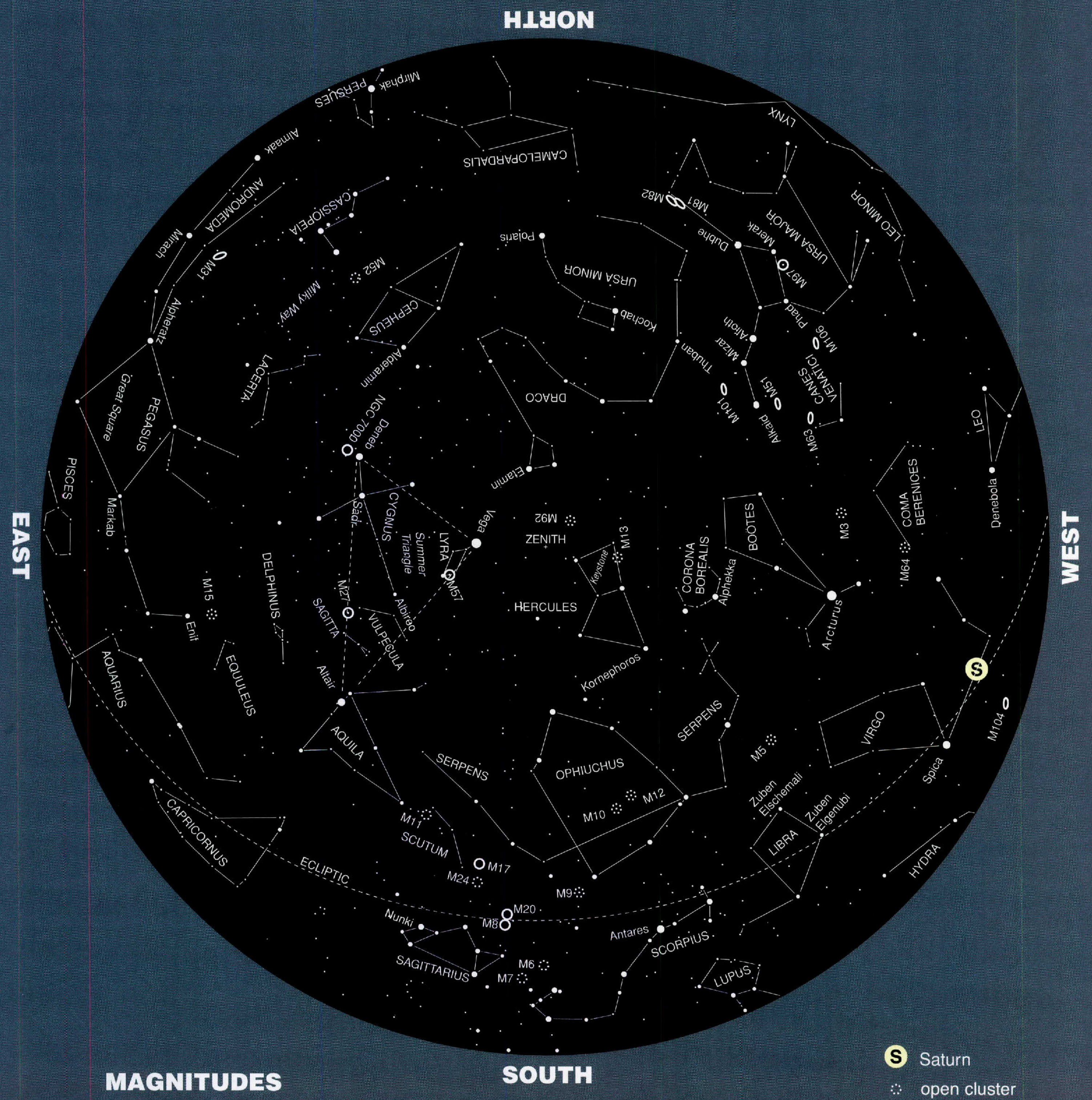
S Saturn
open cluster
globular cluster
nebula
planetary nebula
galaxy

Charts produced with Voyager II software.

AUGUST

How to use these charts:
1. Determine the direction you are facing.
2. Turn the chart until that direction is at the bottom.

July 20	**11 p.m.**
August 5	**10 p.m.**
August 20	**9 p.m.**



MAGNITUDES

- 0 and brighter
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- Saturn
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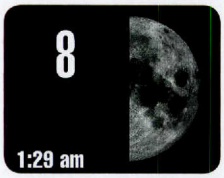
- nebula
- planetary nebula
- galaxy

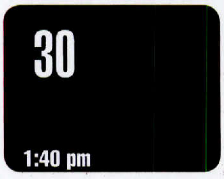
Charts produced with Voyager II software.

SKY HIGHLIGHTS

by Damond Benningfield

JULY





2/3 The Moon passes Mercury in the western evening twilight. The planet, which looks like a fairly bright star, is to the upper right of the Moon on the 2nd, and farther to the right on the 3rd.

4 Earth is at aphelion, its farthest point from the Sun for the year, about 1.5 million miles (2.4 million km) farther than the average distance of 93 million miles (150 million km).

4 Regulus, the brightest star of Leo, stands to the upper right of the Moon at nightfall.

7/8 Saturn is to the upper right of the Moon, and the star Spica to the upper left, on the evening of the 7th. Spica is close to the right of the Moon on the 8th.

11 Antares is the bright orange star below the Moon this evening.

12 Mars and the star Aldebaran greet the dawn. They are side by side at first light, with fainter Mars to the left. They are separated by less than the width of a fist held at arm's length.

19 The planet Mercury stands farthest from the Sun for its current evening appearance. It is low in the west at nightfall, with the star Regulus to its upper left.

23/24 Brilliant Jupiter is to the lower left of the Moon at first light on the 23rd, and to its right on the 24th.

26-28 The Moon sweeps past Aldebaran and Mars in the pre-dawn sky. It is closest to Aldebaran on the 26th, Mars on the 27th.

Moon phase times are for the Central Time Zone.

Su	M	T	W	Th	F	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

WEB BONUS
Find more about the Moon-Mars-Aldebaran encounter online, July 20
stardate.org/mediacenter

AUGUST

3/4 The Moon once again sweeps past Saturn and Spica. Golden Saturn is well above the Moon on the evening of the 3rd, with Spica farther to the upper left. On the 4th, Spica is close above the Moon, with Saturn well to their right.

7 Antares, the heart of Scorpius, is close to the lower left of the Moon at nightfall.

16 Venus is in superior conjunction, passing behind the Sun as seen from Earth. It will return to view as the "evening star" in the fall.

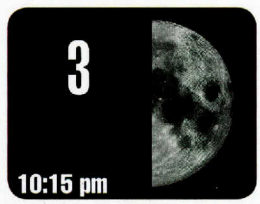
20/21 Jupiter and the Moon team up in the early morning hours. Jupiter is close below the Moon on the 20th, and rises well to its upper right on the 21st.

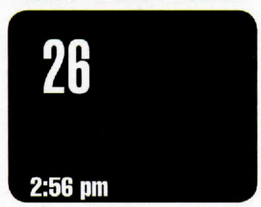
22 Neptune, the solar system's fourth-largest planet, is at opposition. It rises around sunset and remains in the sky all night. It is brightest for the year, too, although you still need binoculars to pick it out, in the constellation Aquarius.

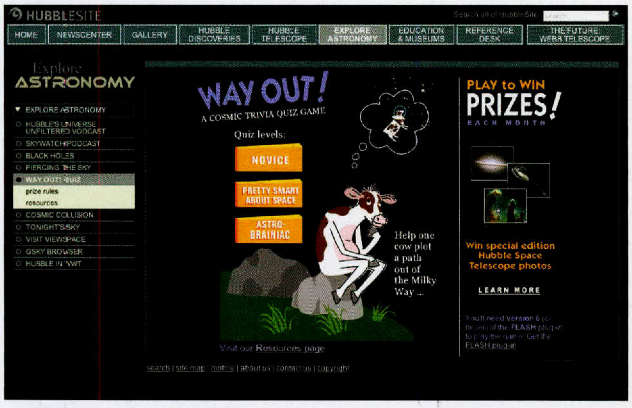
25 Orange Mars stands close to the left of the Moon at first light, with the "twin" stars of Gemini to their left. The brighter of the twins is Pollux, with Castor above it, roughly even with Mars.

31 The Moon, Saturn, and Spica form a pretty triangle low in the west as twilight begins to fade. Saturn is to the upper right of the Moon, with Spica about the same distance to the upper left.

Su	M	T	W	Th	F	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			







Try Hubble's Cosmic Quiz for a Prize

Hubble Space Telescope's website is offering special-edition Hubble photos for folks who do well on their online quiz. Called "Way Out: A Cosmic Trivia Quiz," it has three levels: Novice, Pretty Smart About Space, and Astro-Brainiac. If you get eight out of 12 questions right, and provide a working e-mail address, you will be entered in a monthly drawing. The quiz requires Adobe Flash Player 6 to run in your web browser; the site includes a link to download this free software.

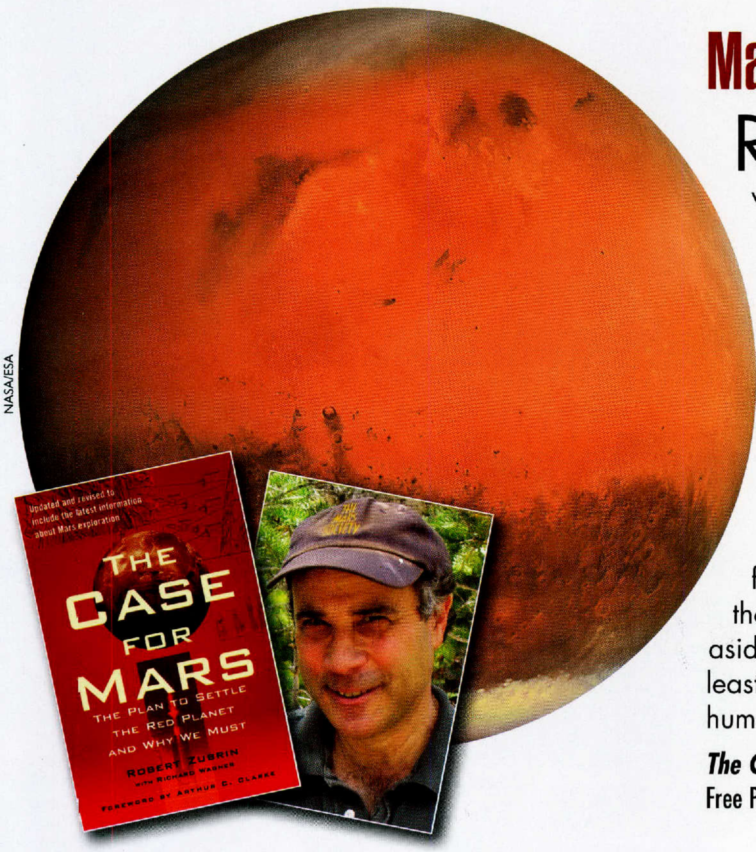
hubblesite.org/explore_astronomy/way_out/

The Art of Relativity

Albert Einstein conceived his theories of relativity through thought problems in which he envisioned how the universe works. For the relativity-challenged, a few pictures help make that vision clearer. That's the concept behind *The Manga Guide to Relativity*, which intersperses Japanese-style manga comics with text and simple graphics that explain such weighty subjects as time dilation, the speed of light, and the equivalence of matter and energy. And for those who aren't math averse, it throws in plenty of equations. It's a clever blend that makes relativity easier to think about — even if you're no Einstein.

***The Manga Guide to Relativity*,**
by Hideo Nitta, Masafumi Yamamoto, and Keita Takatsu
No Starch Press
$19.95 (includes PDF version) $15.95 for PDF only

Making the Case for a Trip to Mars



NASA/ESA

Robert Zubrin, the evangelist of Mars-mission advocates, returns to the pulpit this summer with an updated version of *The Case for Mars,* his 1996 blueprint for sending astronauts to our neighbor world. Incorporating the scientific findings of the latest Mars orbiters and rovers, improved technology, and 15 years of political squabbles, Zubrin once again plots a strategy for reaching Mars, exploring it, colonizing it, and eventually remaking it into a second home for life. *The Case for Mars* explains how to get to Mars, how to live off Martian resources, how to get around, and even how to tell time (with a 24-hour clock in which each second equals 1.0275 Earth seconds) — and all for about the same money as the United States spent on the Apollo missions to the Moon. Although it may brush aside objections a little cavalierly, *The Case for Mars* at least provides a thoughtful starting point in the discussion of human exploration of the Red Planet.

The Case for Mars, by Robert Zubrin
Free Press $16.99

An iridium flare blazes over a star party at McDonald Observatory. Orion hangs to the flare's upper right.

FRANK CIANCIOLO/McDONALD OBSERVATORY

SOLVE YOUR OWN SKYWATCHING MYSTERIES

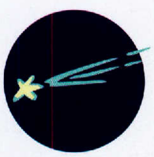
A guide to identifying lights in the night sky when you don't have star maps or guidebooks on hand

By Bradford Behr

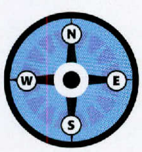
In ancient times, people were often frightened when unexpected sights appeared in the sky. Comets were considered signs of impending doom, bright meteor showers were taken as a sign of the coming apocalypse, and solar eclipses inspired terror among those not expecting them. Such fears have abated in the modern era, but unexpected lights in the night sky still puzzle us. Have you ever stepped out into your yard late at night or early in the morning, peered into the sky, and thought "Wow! What's that bright thing?" In this article, I will describe some of the most common sightings and provide you with a toolkit for identifying them.

The first step in accurately identifying celestial phenomena is taking notice of the right details. If you spy something odd in the sky, run through this quick checklist of key information.

What does it look like?
Is it a single point of light, a cluster of lights, or a fuzzy blob of light? Is it steady, twinkling, or blinking? Are any colors visible? A detailed description of the object's appearance can help narrow down the possibilities.



How does it move?
Does it seem to just sit there, is it moving at a noticeable speed, or does it zip across the sky quickly? The motion of the sighting can tell you a lot about whether it's relatively nearby (inside Earth's atmosphere) or far away (in outer space).



Where in the sky is it?
At the very least, take note of whether it's near the horizon or far overhead, and estimate the cardinal direction. If you want to be more precise, you can estimate how many angular degrees the object is above the horizon. Stretch out your arm and make a fist (with the pinky finger down), and your fist will cover about 10 degrees of angle. If that mysterious light is two-and-a-half fists above the horizon, that's about 25 degrees. Armed with that information, you may be able to find your object on a star map later on.

What time is it?
Because astronomical objects appear to move across the sky as Earth rotates, it's important to note the time and date of your sighting. The time doesn't have to be exact to the second — to within 15 minutes is usually good enough. For satellite fly-overs, it's useful (but not strictly necessary) to know the time to the minute.

Where are you?
The sky looks different depending on where you're standing, especially if your mystery object might be a satellite. Take note of the nearest city or town or road intersection.

Now, with all of this information in hand, let's consider some possible identifications for your sighting.

Single point of light, not moving

If the object is a single point of light that appears stationary in the sky, then you've probably seen a star or a planet. Stars tend to twinkle more noticeably than planets, although both stars and planets will twinkle a lot when they are near the horizon, because the light rays travel through a greater thickness of turbulent air. Sometimes the twinkling effect is so strong that the object will appear to change color rapidly, cycling from red to blue and back again. This phenomenon occurs because bubbles of warm and cool air in the atmosphere act like prisms, bending red light rays through a slightly different angle than blue light rays.

To figure out which star or planet you're seeing, you will need to note the sky position and time, and then consult a star map like the ones in each issue of *StarDate* magazine. If you have access to the Internet, the Neave Planetarium (www.neave.com/planetarium) is also a good option. Just set the correct location and time in the Neave window, then click on the star map to adjust your viewing direction. Look on the screen for bright dots that are in the same general sky position as your sighting, and move your cursor over each dot to see what it is.

A pair of binoculars also can help distinguish a star from a planet. Even when magnified, a star will still appear pointlike — a sharp pinprick of light — assuming that the binoculars are properly focused. All of the brightest planets, on the other hand, show a clear disk — a circle shape. Under good conditions, with quality binoculars, you can sometimes see the crescent phases of Venus, the rings of Saturn, and the four big satellites of Jupiter, which will appear as little "stars" lined up in a row near the planet.

Single point of light, moving slowly

If that point of light is tracking gradually across the sky, then it's probably an Earth-orbiting satellite, although it might also be a high-altitude airplane. Hundreds of satellites circle Earth in low orbits, so it's not uncommon to spot one passing overhead. The largest satellite, the International Space Station (ISS), is sometimes brighter than the brightest stars, while smaller satellites look like faint stars.

Because most satellites are in well-measured, predictable orbits, you can figure out exactly when and where a given satellite is visible, either in the past or in the future. The best tool for these predictions is the Heavens Above website (heavens-above.com). Once you specify your geographical location and time zone, you can request daily predictions for satellite flyovers. Near the top of the predictions page, click on "Prev. PM" or "Prev. AM" to go back in time to find out, for instance, if that spark of light that you saw overhead last night was ISS, Hubble Space Telescope, or some other satellite.

Single point of light, flaring up and fading away

Sometimes you will see a light which gets brighter and then fades away over the course of several seconds. If you see this sort of transient event near the horizon in the vicinity of an airport, then you've likely spotted the forward-facing landing lights of a jetliner as it turned toward you.

However, if the light appeared high in the sky, then you may have seen an Iridium flare. There are about 70 Iridium communications satellites in orbit, each with three mirror-like antennae which reflect narrow beams of sunlight toward the ground. If you are standing in the path of one of these beams, you will see the faint satellite suddenly grow much brighter and then dimmer again.

These flares can be predicted well in advance by the Heavens Above website, and many people make a hobby of checking for upcoming flares and heading outside to see them. If you try this, make sure to enter your location precisely, as an error of even a few miles can make a huge difference in the flare visibility.

Single point of light, moving fast

If that point source goes *zip* across the sky in a second or two, then it was a meteor, also called a "shooting star." Meteors are small pieces of rock, often no larger than a grain of sand, that enter Earth's atmosphere from interplanetary space and heat up rapidly, making an incandescent streak momentarily visible from below.

Meteors can be seen at any time of year, but larger-than-average numbers are seen during meteor showers, when Earth plows through the debris trail left behind by a comet or asteroid.

Multiple points of light, not moving

The night sky has several medium-bright star clusters which can be seen from dark sites. The best-known is the Pleiades, also known as the Seven Sisters or M45, but several other star groups are visible under good conditions. If you think you have spotted one of these clusters, consult the star charts in *StarDate* or acquire desktop planetarium software for your computer. Many commercial programs are available, but you can also download and install a high-quality free program like Stellarium (www.stellarium.org).

Multiple lights, moving slowly or at medium speed

If you see a fixed pattern of two or more lights moving together across the sky, it's probably just an airplane.

Not too exciting, but that's just the way it is sometimes.

Multiple points of light, moving fast

If you spend a lot of time looking at the night sky, you might someday spot a fireball — a very bright meteor, created by a piece of space rock approximately the size of a marble. Fireballs sometimes split apart from the heat and shock of entering Earth's atmosphere, creating several brilliant points of light that arc across the sky together. Fireball sightings are quite rare, so if you see one, consider yourself lucky!

Diffuse light, not moving

A fuzzy patch of light in the sky could be one of several things. It might be as mundane as a small cloud that is illuminated by the Moon or by lights on the ground. If you see a glowing blob about 20 degrees (two fists) away from the Moon, then it's probably a moondog, an optical effect caused by ice crystals in high-altitude cirrus clouds, which bend the moonlight such that it appears to be coming from a different location than the Moon itself.

More interestingly, a fuzzy spot in the sky could be a comet. Unlike meteors, comets appear to move quite slowly across the sky, remaining visible for weeks at a time. Check an astronomy website, like stardate.org, to see if a new comet is currently visible in the sky.

Far away from city lights, it is also possible to see nebulae — interstellar gas clouds or distant clusters of stars. From the northern hemisphere, the Andromeda galaxy is visible; if you're visiting the southern hemisphere you can see the two Magellanic clouds (dwarf galaxies orbiting our Milky Way) and Omega Centauri (the brightest globular star cluster). As with the star clusters mentioned previously, you'll need to use detailed star charts or planetarium software to find out which nebula you're looking at.

Diffuse light, moving

The aurora borealis or northern lights appear as shimmering curtains of faint light with red and green hues. The aurorae are caused by high-speed particles from the Sun getting trapped in Earth's magnetic field and spiraling toward the north magnetic pole, where they slam into air molecules, causing the molecules to glow like a neon light. Aurorae are usually seen only from high northern latitudes, such as the northern United States and Canada, although during times of intense solar storms they may venture as far south as Texas and Florida.

The next time you see something odd or unfamiliar in the heavens, you are equipped to make careful observations and interpret your results. This brief guide cannot cover all possible visual phenomena, of course — you might see something that doesn't fit into the categories listed above. But by taking careful note of the appearance, location, and time of your sighting, you can then consult the proper resources or your local astronomy club and perhaps solve your own celestial mystery.

Astronomer Bradford Behr works near Washington, D.C., designing and building advanced optical systems for stellar spectroscopy and planet hunting.


SENIOR AIRMAN JOSHUA STRANG/USAF

The aurora borealis shines over Alaska.

Resources

Book

Color and Light in Nature by David K. Lynch and William Charles Livingston, 2001

Online

StarDate
stardate.org

Stellarium
www.stellarium.org

Neave Planetarium
www.neave.com/planetarium

Heavens Above
heavens-above.com

Sighting Spacecraft
spaceflight.nasa.gov/realdata/sightings

by Rebecca Johnson and Damond Benningfield

Chilly Detector Heats Up Cosmic Ray Studies

The world's largest astronomical detector began full operations in May, peering "down" through Earth itself to ferret out the sources of the most powerful cosmic rays. Known as IceCube, it is buried more than a mile deep in the ice at the south pole.

Magnetic fields in the galaxy deflect cosmic rays, making it impossible to trace their point of origin. But the same events that produce cosmic rays also are expected to produce torrents of neutrinos, which are almost massless particles that stream through space unimpeded by magnetic fields, stars, or even solid planets. Trillions of them flow through our bodies each second, but only one in a trillion trillion trillion ever interacts with any other matter.

Rarely, though, a neutrino will strike an atom in the ice, creating another particle, which in turn emits a flash of blue light that IceCube's detectors will see. Computers will record the flashes and measure their direction. Scientists can then plot the neutrinos' trajectories, leading them to likely sources.

"The ice is already there, so the detector is already there — all we do is deploy equipment in it to read it out," says Francis Halzen, lead scientist for the National Science Foundation-sponsored project.

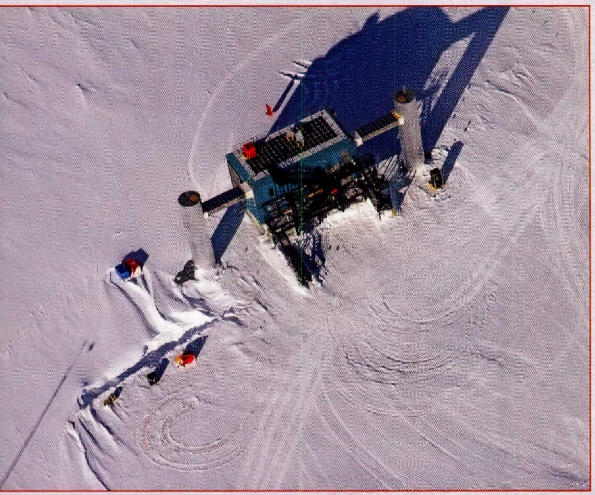
Placing the detectors in the Antarctic ice allows them to use Earth as a filter to screen out the signals from other types of particles, because only neutrinos can pass through the entire planet.

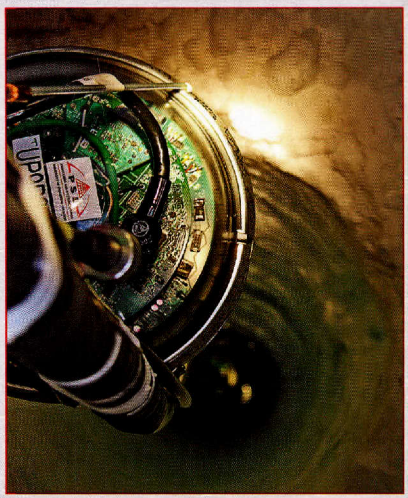
The last of IceCube's 86 strings of detectors was sunk into the ice in December 2010. Testing and verification were completed this spring, with full-time science operations beginning in May. Scientists and engineers will continue to tweak both hardware and software while collecting data, however.

Scientists suspect that the most powerful cosmic rays have two sources. Those produced inside our galaxy come from supernova remnants, which are clouds of debris from exploding stars, while those outside the galaxy are created in gamma-ray bursts, which are the most violent explosions in the universe.

IceCube should be able to verify those sources within about five years, Halzen says. "If IceCube doesn't see these sources within five years then there's something wrong and we'll rule them out. Especially for supernova remnants, this would be a very interesting result because nobody has a clue what else would do it." **DB**

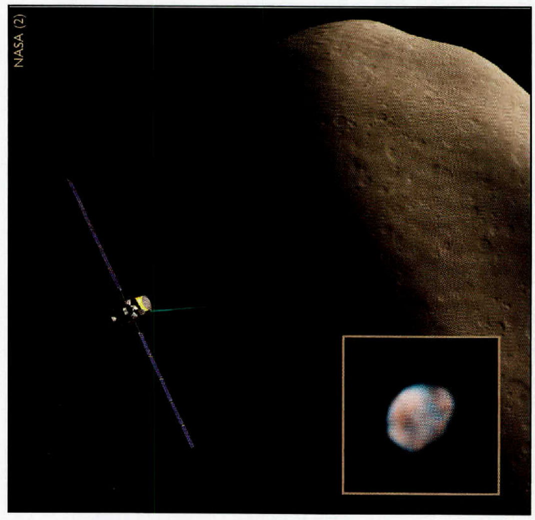
Below, from left: The IceCube laboratory; the final detector is ready for deployment, then submerged in the ice. Background: IceCube is in the 'quiet zone' of the south pole station, which includes radio astronomy experiments (left and center) and the IceCube lab (right).





NATIONAL SCIENCE FOUNDATION (4)

Dawn Mission Set to Orbit Moon-Like Asteroid



NASA (2)

An artist's concept shows Dawn firing its ion thrusters to enter orbit around Vesta. Inset: This Hubble Space Telescope view of Vesta is the best image of the asteroid to date.

A different kind of spacecraft is scheduled to enter orbit around a different kind of asteroid on July 16.

"Dawn is an attempt to do exploration in the asteroid belt like exploration has not been done before," says Christopher Russell, the mission's principal investigator and a planetary scientist at UCLA. If it operates as expected, Dawn will become the first spacecraft to orbit two bodies beyond Earth. After surveying its first target, Vesta, it will head for the largest asteroid, Ceres.

Vesta is the third-largest asteroid, with a diameter of about 335 miles (535 km). Unlike most other asteroids, when Vesta formed, it contained enough radioactive material to melt its interior. That allowed lightweight rocks to float to the surface while heavier ones pooled at the center, giving Vesta a metallic core, a mantle of lighter rocks around it, and a crust of the lightest rocks at the top.

Scientists suspect that a group of meteorites are actually chunks of Vesta's crust. The meteorites show that the crust is coated with volcanic rock. Russell says the combination of that composition and Vesta's structure and density make it less like the other asteroids and more like a small version of the Moon.

"We wanted to continue to understand the Moon's formation process" after the Apollo program, Russell says, "so we looked around and said, 'Okay, what would be the best body that would lead us in this direction, give us more understanding?' And that was Vesta."

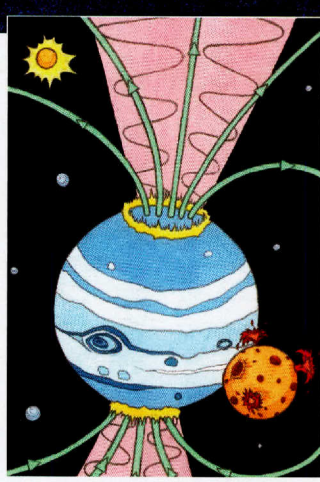
Dawn will add to that understanding by mapping Vesta, plotting the chemical and mineral composition of its surface, and measuring its magnetic and gravitational fields, which can reveal its interior structure.

Then Dawn will use its solar-powered ion thrusters to head for Ceres. Combined, the three thrusters provide up to one ounce of thrust. Unlike conventional rockets, which operate for only a few minutes at a time, the ion thrusters can fire for years without stopping.

Tuning in to Extrasolar Aurorae

New-technology radio telescopes like the Low Frequency Array, or LOFAR, could help astronomers find giant planets that orbit far from their parent stars by detecting the planets' aurorae, according to Jonathan Nichols of the University of Leicester.

BOSTON UNIVERSITY/NASA



EMMA COWLEY

Top: Jupiter's aurora. Bottom: Plasma from a volcanic moon orbiting a giant exoplanet interacts with its magnetosphere, creating aurorae at the poles.

Astronomers have found hundreds of "hot Jupiters" — close-in giant planets that exert large effects on their parent stars. Until now, it has been difficult to find giant planets orbiting at distances similar to Jupiter and Saturn in our solar system. Because these orbits are much longer, the most-used detection methods are biased against them.

"Jupiter and Saturn take 12 and 30 years respectively to orbit the Sun, so you would have to be incredibly lucky or look for a very long time to spot them by a transit or a wobble," Nichols said.

In the transit method, astronomers look for a dip in a star's brightness caused when a planet passes in front of it. Alternatively, astronomers can measure how much a star wobbles due to the gravitational tug of a planet — a type of planet search called "Doppler ranging."

Nichols' idea to use auroras builds on what we know of Jupiter and Saturn. "At both planets, we see radio waves associated with auroras generated by interactions with ionized gas escaping from the volcanic moons, Io and Enceladus," he said. "Our study shows that we could detect emissions from radio auroras from Jupiter-like systems orbiting at distances as far out as Pluto."

Finding giant planets at distances similar to those in our solar system could signal we've found a star with a family of planets like our own — a possible abode for life.

LOFAR will be completed this year, with the central 35 antennas in the Netherlands and outrigger antennas in several nearby countries. **RJ**

Me and My Shadow ...

Computer simulations by Irish astronomers show that a recently discovered asteroid has been following Earth for at least 250,000 years. Many near-Earth asteroids (NEOs) are known, but this one is different. Instead of an egg-shaped orbit that takes it in toward the Sun and back out again, asteroid 2010 SO16's orbit is almost identical to Earth's. A few other NEOs have similar orbits, but these orbits only last for a few thousand years before the NEO will be kicked out of Earth's track around the Sun. 2010 SO16 is larger than these, and stays far enough from Earth to present no danger.

NASA

New Mission Will Peer Into Jupiter's Heart

Although more than a half-dozen spacecraft have studied Jupiter from close range, the planet's structure remains a mystery. The giant planet probably has a small, rocky core surrounded by metallic hydrogen and topped by a thick layer of hydrogen and helium gas. Yet the exact size and mass of the core are uncertain, and so is the process of its formation.

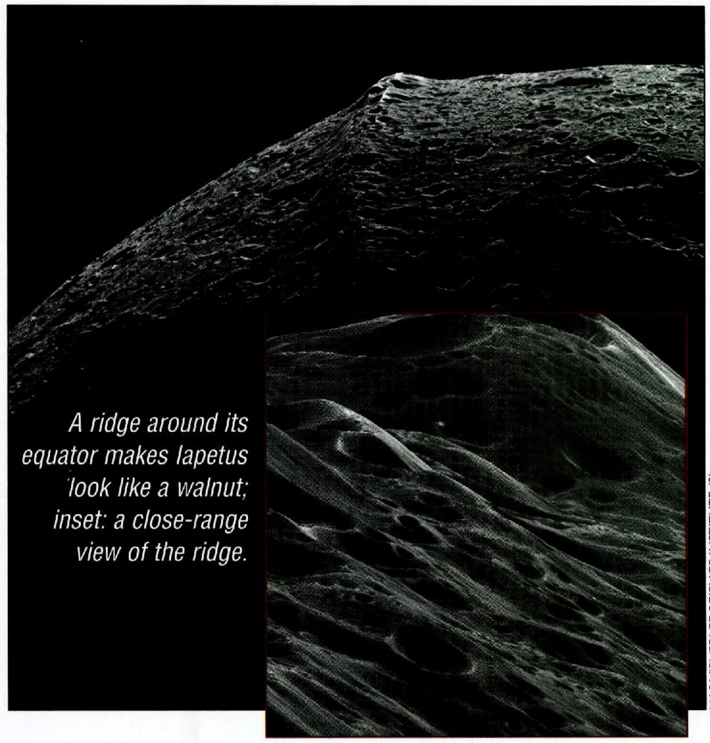
A craft called Juno (artist's concept, above), which is scheduled for launch August 5, is designed to resolve those lingering uncertainties. It will orbit Jupiter from pole to pole to map its gravitational and magnetic fields. Those measurements will reveal Jupiter's interior structure, which in turn can help planetary scientists select the best model to explain its formation.

Juno also will map the structure and motion of Jupiter's atmosphere below its cloudtops, providing the best picture yet of atmospheric circulation patterns. And the craft will study aurorae at Jupiter's poles, providing additional details on its magnetic field.

The MYSTERY *of the* WALNUT MOON

Giant impact, rings, a small moon, and Saturn's gravity may have sculpted the odd surface of Iapetus

In the book version of *2001: A Space Odyssey*, the monolith builders leave earthlings a clear beacon: a two-toned moon of Saturn. When Iapetus is on the front side of Saturn it looks as white as snow. As it begins to pass to the planet's farside, however, it disappears.



A ridge around its equator makes Iapetus look like a walnut; inset: a close-range view of the ridge.

NASA/JPL/SPACE SCIENCE INSTITUTE (2)

The two-toned appearance is the result not of alien engineering, it turns out, but of dark soot blasted off the surfaces of other moons settling on the hemisphere of Iapetus that faces forward as it orbits Saturn.

Iapetus still offers interesting mysteries, though. Its equator is girdled by a ridge that makes the little moon look like a walnut, for example, and an impact basin almost as wide as Iapetus itself gives the moon a lopsided shape.

A team led by Harold Levison of the Southwest Research Institute says it may have solved these mysteries.

The solution, which Levinson emphasizes is preliminary, says that long ago, a Saturnian moon one-tenth as massive as Iapetus slammed into it, blasting material into orbit around Iapetus. Some of the material formed a ring, while some formed a small moon of Iapetus itself.

Levison's simulations show that the ring material settled onto the surface to form the ridge. Interactions between Saturn, Iapetus, and the small moon made Iapetus spin slower. Saturn's gravity then pulled the small moon out of orbit, forcing it to slam into Iapetus, creating the basin.

All of this created a moon like no other — with no help from aliens. **DB**

Possible Neighbors Come in from the Cold

A search of the deep-freeze of the outer solar system has revealed three possible new dwarf planets beyond the orbit of Neptune, the largest major planet.

The objects were discovered by a team led by Scott Sheppard and Andrzej Udalski, which was using a University of Warsaw telescope in Chile to search a large swath of the southern sky. The team's quest was Kuiper Belt Objects, which are iceballs in a wide band beyond Neptune.

The search revealed 14 new objects, three of which appear to be large enough to be classified as dwarf planets — objects that are big enough to pull themselves into a roughly spherical shape, but not big enough to clear out their orbits around the Sun. The most famous dwarf planet is Pluto, but the list already includes four others.

The possible new dwarfs, designated 2010 EK139, 2010 KZ39, and 2010 FX86, likely are at least a quarter of the size of Pluto, and one could be almost as large as Pluto. Their average distances from the Sun range from a bit more than Pluto's distance to almost five times its distance.

An orbiting infrared telescope has examined one of the three to try to refine the estimates of its size. Later, astronomers may be able to watch the objects pass in front of distant stars to further refine the sizes. If their large sizes are confirmed, the objects will receive proper names, allowing them to officially join the growing ranks of dwarf planets.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Vast clouds of gas and dust form swirls, pillars, and curtains in this view of M8, the Lagoon Nebula, from the Gemini South telescope in Chile. The nebula, which is about 5,000 light-years away, is a nursery that has given birth to hundreds of stars. The light from some of the hottest and brightest of those stars illuminates the remaining gas and dust. That energy is also eroding the nebula, shutting down the process of star formation. Many young stars are still swathed in cocoons that are at the tips of many of the pillar-shaped structures in the image.

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