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AUGUST 2023

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# AUGUST 2023

VOL. 51, NO. 8

## ON THE COVER

In celebration of 50 years of *Astronomy* magazine, we created a collage of past covers. Find the full spread on page 12. *ASTRONOMY:* ROEN KELLY AND KELLY KATLAPS

## FEATURES





## COLUMNS



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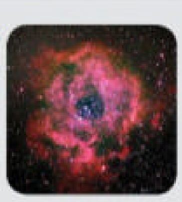
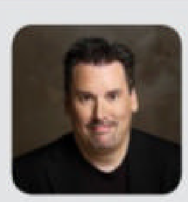
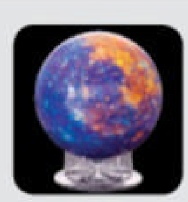


**Picture of the Day**
Gorgeous photos from our readers.

**News**
The latest updates from the science and the hobby.



**Dave's Universe**
The inside scoop from the editor.



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Perfect gifts for your favorite science geeks.

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# *Astronomy* celebrates 50 years

David J. Eicher in 1982, the year he joined *Astronomy* magazine. DAVID J. EICHER

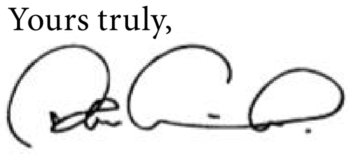
Fifty years ago, Steve Walther, a young astronomy and journalism student, had a dream. At first a college project, *Astronomy* magazine was eventually launched in full force. The first issue was published in August 1973 and featured a speckle interferogram of the star Betelgeuse on the cover. By 1980, the magazine had become the most widely read title on the subject. Now, with this 601st issue, we celebrate the 50th anniversary of Steve Walther's dream.

I missed the first decade, joining the team in September 1982. Every day since has been an adventure, a great journey through the exploration of the universe. In its early days, the magazine was steeped in a special era. The afterglow of the Apollo missions was still fresh, and the robotic discovery of the solar system lay just ahead. We are now in a special era once again, poised to return to lunar journeys and awash in a sea of discovery and adventure like we've never had before. The "big questions" — the origin, evolution, and fate of the cosmos — are coming into ever-sharper focus.

We open this issue with two special contributions. First, on page 14, David Walther describes the origin of *Astronomy* magazine. David, an attorney, helped to get his brother's title up and running. And then Ann Druyan, a friend, executive producer of *Cosmos*, and Carl Sagan's widow, describes the world of astronomy and space exploration in the '70s (page 16). In those times, Carl was not only the revolutionary popularizer of astronomy on TV, but he was also an active early contributor to *Astronomy*.

I hope you'll like this issue's other special features, some looking back and some ahead. *Astronomy* magazine continues as the largest brand of astronomy enthusiasts in the world. We look forward with great excitement to the 50 years to come.

Yours truly,



David J. Eicher
Editor

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The Horsehead Nebula in the constellation Orion is a popular target for amateur astronomers, but can pose a challenge to view, depending on the type of equipment used. PATRICK KUYPER

*We welcome your comments at Astronomy Letters, P.O. Box 1612, Waukesha, WI 53187; or email to* **letters@astronomy.com**. *Please include your name, city, state, and country. Letters may be edited for space and clarity.*

### With intensity

I have enjoyed Bob Berman's articles for many years and continue to do so. Just a comment regarding his April 2023 column "Danger and glory": He mentioned how difficult it is to view the Horsehead Nebula with an amateur scope. And it is. However, with larger scopes using a hydrogen beta filter, it is doable. Even with small scopes, it is easy to see it if one uses an image intensifier. I have a friend with a 12-inch scope who found it very easily using an image intensifier, while I found it was easy with my larger 18- and 28-inch scopes. But of course, an intensifier is expensive.
**—Robert Douglas,** San Francisco, CA

### Clear definitions

Bob Berman's column on a star in Orion's belt (April 2023) contained everything a reader like me would like to see from stories in *Astronomy* magazine. The article gave the name of the star (Alnitak) and how to pronounce it. It told the distance to the star in light-years and described the basic astrophysics of the star, and how it compares to other stars. It told about the past and future for this object in Earth-like terms (referencing the first appearance of grasses in prehistory) and outcome of its stellar evolution. **—Richard Clark,** Centerville, OH

### Glowing crater

I read Stephen O'Meara's March 2023 column ("Atwood's flash," about Hypatia crater) with great interest because in 2013, I photographed that same area of the Moon, trying to see if I could capture Tranquility Base. Hypatia is just southwest of Tranquility Base, and I wanted to compare my photo with the image of that area printed in the article to see how accurate I was in the placement of the landing site. I was happy to see that I was right. The column also mentioned that "under the right geometry, a ray of sunlight can slice across Hypatia's otherwise shadowed crater floor." And when I looked at my image of Hypatia I saw, for the first time, the Hypatia ray! **—Jay C. Dahl,** Rolling Meadows, IL

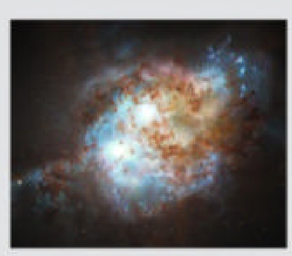
SNAPSHOT

# HOPE BUZZES DEIMOS

## A new look at Mars' smaller moon highlights its mysterious origin.

Mars looms large, but the highlight of this shot is the Red Planet's smallest moon: Deimos, just 7.7 miles (12.4 kilometers) wide. The close-up was taken by the United Arab Emirates' Hope spacecraft, which has been orbiting the Red Planet since 2021. On March 10, Hope made its first of several planned flybys of Deimos, sending back unprecedented photographs of the moon's farside. "This was approximately 100 kilometers [62 miles] up, and I don't believe we will get that close again," Hessa Al Matroushi, the science lead for the Emirates Mars Mission, tells *Astronomy*. The flyby allowed the probe's two spectrometers to record crucial data about the moon's composition. They suggest Deimos is made of material similar to Mars itself and not the carbon-rich rock that would be expected if Deimos was a captured asteroid, as scientists once suspected. That supports theories that both Deimos and Phobos — Mars' other moon — formed in orbit when a large object, perhaps a dwarf planet, struck Mars in the distant past. –TOM METCALFE

## » HOT BYTES



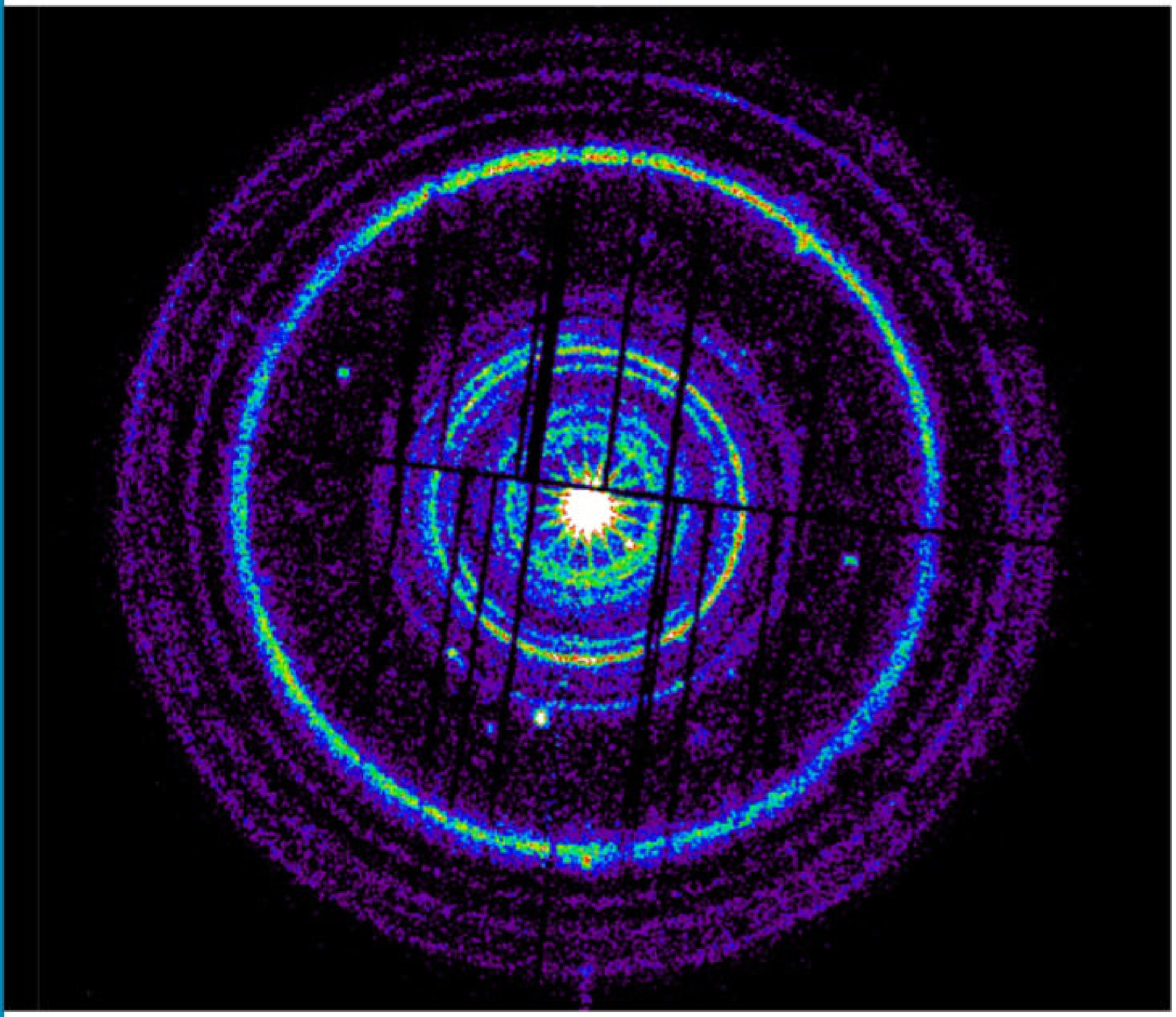
**DOUBLE QUASAR**
The Hubble Space Telescope found that J0749+2255 is a rare binary quasar. It hosts two active supermassive black holes at the centers of merging galaxies, shown in this illustration.

**SALT TRAIL**
Data from the NASA/ESA Solar and Heliospheric Observatory show that the asteroid Phaethon's cometlike tail is not dust, as previously thought, but glowing sodium atoms.

**LOST LANDER**
The HAKUTO-R Mission 1 robotic lander, developed by Tokyo-based startup ispace, crashed on the Moon's surface April 25 in a bid to make the first private soft lunar landing. A 2019 attempt by an Israeli firm also failed.

EMIRATES MARS MISSION. BOTTOM FROM LEFT: NASA, ESA, JOSEPH OLMSTED (STSCI); NASA/JPL-CALTECH/IPAC; ISPACE

# THE BRIGHTEST GAMMA-RAY BURST MAY HAVE SPAWNED A SUPERNOVA



**BLAST RADIUS.** The powerful gamma-ray burst GRB 221009A generated rings of dust, 19 of which are captured here by the European Space Agency's XMM-Newton X-ray observatory. The observatory recorded 20 dust rings in all — triple the number previously seen around a GRB. The largest ring in this image is the size of the Full Moon on the sky. ESA/XMM-NEWTON/M. RIGOSELLI (INAF)

On Oct. 9, 2022, NASA's Swift and Fermi observatories detected the brightest gamma-ray burst (GRB) ever seen: GRB 221009A. Astronomers around the world quickly turned as many telescopes as possible to its location, ultimately spending more than two months collecting follow-up data.

Since then, some have concluded that evidence of a supernova could be buried in the glow of the GRB's aftermath. If confirmed, the find would support the prevailing view that GRBs are part of the explosive process that sees massive stars collapse into black holes.

A study analyzing the light curve and possible supernova signature of GRB 221009A was published March 28 in a special issue of *The Astrophysical Journal Letters* devoted to the event.

Gamma-ray bursts are the most intense outpourings of energy known in the universe. But their exact nature is still a matter of ongoing research. Astronomers think that GRBs are sometimes caused by particularly massive stars that go supernova and collapse directly to a black hole. But other GRBs may result from two colliding neutron stars — or perhaps different processes altogether.

GRB 221009A is categorized as a long GRB — one that lasts longer than a few seconds. "Most, but not all, of these long GRBs have been associated with a supernova, which has emerged 10 or 20 days later," University of Cardiff astrophysicist Stephen Smartt, co-leader of the new study, tells *Astronomy*.

There have been a few exceptions, Smartt says, where no supernova was seen after a long GRB, but those were peculiar cases. So it's of great interest to see whether this brightest GRB yet meets expectations or turns out to be an exception. But because GRB 221009A's initial radiation outburst was so strong, detecting a supernova signature buried within it is an extremely difficult task.

Smartt and his doctoral student Michael Fulton led a team that used the PanSTARRS telescope in Hawaii and data from other telescopes around the world to monitor the light from the dimming object until it passed out of sight behind the Sun in December. The team says that even as the GRB dimmed overall, they saw evidence that the light curve contained a slight bump in brightness where it didn't fade as quickly as expected. That bump, they say, matches well with predictions for the telltale brightening signature of a supernova, as the material it ejects slams into and heats surrounding gas.

One other team has also reported signs of a buried supernova, and some researchers are convinced, says Robert Kirshner, director of the Thirty Meter Telescope International Observatory project in Hawaii and a supernovae expert, who was not involved in either study. But he adds that others have looked at data, including from the James Webb Space Telescope, and don't see any signs of a supernova.

Smartt adds, "If we don't find a supernova, that's potentially more exciting," since that would require a complete rethink of the models.

— DAVID L. CHANDLER

# SpaceX Starship explodes minutes after launch

**A ROAR OF CHEERS** and rocket boosters arose as SpaceX's integrated Starship and Super Heavy booster, the most powerful launch system ever created, lifted off the launch pad in Boca Chica, Texas, at 8:33 A.M. CDT on April 20. It was the first test flight of the combined 394-foot-tall (120 meters) rocket stack.

Starship's flight plan called for it to complete nearly one full orbit of Earth, reentering the atmosphere and landing in the Pacific Ocean about 62 miles (100 kilometers) northwest of Kauai.

But not all was well as the rocket lifted off: Multiple engines did not fire, causing the rocket to slide off the pad as it began its ascent. Just 85 seconds later, the flight's fate was sealed when SpaceX lost control of the booster's central 13 engines. Three minutes into the flight, the booster failed to separate from Starship. Perhaps surprisingly, the stack remained intact as it began to tumble, flipping end over end. The rocket peaked at 24.2 miles (39 km) high before losing altitude. SpaceX commanded the rocket to self-destruct, though it did so only after a lag of about 40 seconds — another issue for engineers to troubleshoot.

Despite its brevity, the flight is still considered by SpaceX to be a success. "To get this far is amazing," SpaceX's broadcast host and engineer Kate Tice said during the webcast. "Everything after clearing the tower was icing on the cake." In a statement, the company said it "learned a tremendous amount about the vehicle and ground systems today that will help us improve on future flights of Starship."

Starship is intended to be a fully reusable spacecraft that can carry both cargo and astronauts to the Moon and beyond. A version of the vehicle is expected to play a pivotal role in the Artemis 3 and 4 missions, scheduled for 2025 and 2028, respectively, by serving as the lunar landing vehicle carrying crew and equipment to the Moon's surface.

SpaceX founder and CEO Elon Musk said on his Twitter account that the company hopes to attempt another Starship test flight within a few months. — SAMANTHA HILL

**LAUNCH SEQUENCE.** SpaceX's Starship made it off the launch pad, but several of its 33 Raptor engines did not fire. The rocket stack began tumbling through the air and managers eventually commanded it to self-destruct (inset). SPACEX

## QUICK TAKES

### SUPER NO GOOD

X-ray observations indicate that when stars go supernova, the blast wave of debris slams into and heats surrounding gas, which could send lethal amounts of X-ray radiation to Earth-like planets over 100 light-years away.

### MEMORY WIPE

Meteorites are often identified by testing whether they attract a magnet — but doing so erases the rock's billions-of-years-old magnetic record, including potential information about planetary formation and evolution, a study finds.

### JUICED UP

The European Space Agency's Jupiter Icy Moons Explorer lifted off from French Guiana April 14, beginning an eight-year journey to the jovian system.

### METAL POOR, LIFE RICH?

The ability of an Earth-like planet to sustain a protective layer of ozone hinges in part on its star's composition, models show. Suns with fewer heavy elements emit more UV-C radiation — which helps generate ozone — while metal-rich stars emit more ozone-destroying UV-B radiation.

### DUNE SEA

Images and measurements from China's Zhurong rover on Mars show evidence that small pockets of frozen water may have melted and run across the planet's dunes as recently as 400,000 years ago.

### STAR CHILDREN

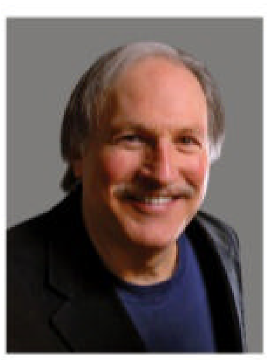
The likelihood of space tourists having sex and possibly conceiving children in space — with unknown consequences for fetal development — pose bioethical and reputational risks to the space tourism industry, warns an international group including scientists and clinicians.

— MARK ZASTROW

# Celestial half-century medals

Can anything beat the last 50 years of astro-discoveries?

How could the editors of *Astronomy* have known to launch the magazine at such a good time for the field? WAVE BREAK MEDIA LTD/DREAMSTIME.COM



**BY BOB BERMAN**
*Bob's recent book,* Earth-Shattering *(Little, Brown and Company, 2019), explores the greatest cataclysms that have shaken the universe.*

Most of us know what works and what doesn't. When my pal Seth Shostak explained to me how SETI hunts for possible aliens, the methodology sounded impressive even if success at locating ETs seemed as doubtful as scanning individual Super Bowl attendees' faces at the turnstile and discovering that some are lizard people.

Launching *Astronomy* magazine in 1973 seemed to display a similarly implausible optimism. Was the subject popular with a broad enough audience? Would the magazine encounter competition? Furthermore, major publishing changes were afoot in the early 1970s. Long-established publishing houses were folding, and the initial transformation to digital was underway — a harbinger of today, when most people stare at screens. I'd just returned from four years overseas, post-college, and thought the new magazine looked amazing. But would it persevere?

**Launching *Astronomy* magazine in 1973 seemed to display implausible optimism.**

*Astronomy* was born just before the first-ever U.S. landers, the Vikings, rewrote the Red Planet's storybook. Then the Pioneers launched and went on to become the first crafts to permanently escape the solar system. They were followed by the Voyagers, with their exquisite close-ups of Jupiter, Saturn, Uranus, Neptune, and dozens of their satellites.

In the ensuing years, huge new telescopes were built. Exoplanets were discovered. As it turns out, the launch of *Astronomy* was accompanied by an exciting era of cosmic discoveries — perhaps the most exciting ever — where every issue was a portal into astounding new knowledge. But how could anyone have known that 1973 would be the optimum time to unveil a new publication that blended astounding discoveries with innovative, cutting-edge images? There was only one possible explanation: The editors were sent here from the future.

Science demands evidence! Very well. Let's prove that these past 50 years really have been packed with an unprecedented number of mind-twisting discoveries, enough to overcome those unique late 20th-century publishing jinxes. How do the past five decades compare with earlier half-century historical periods?

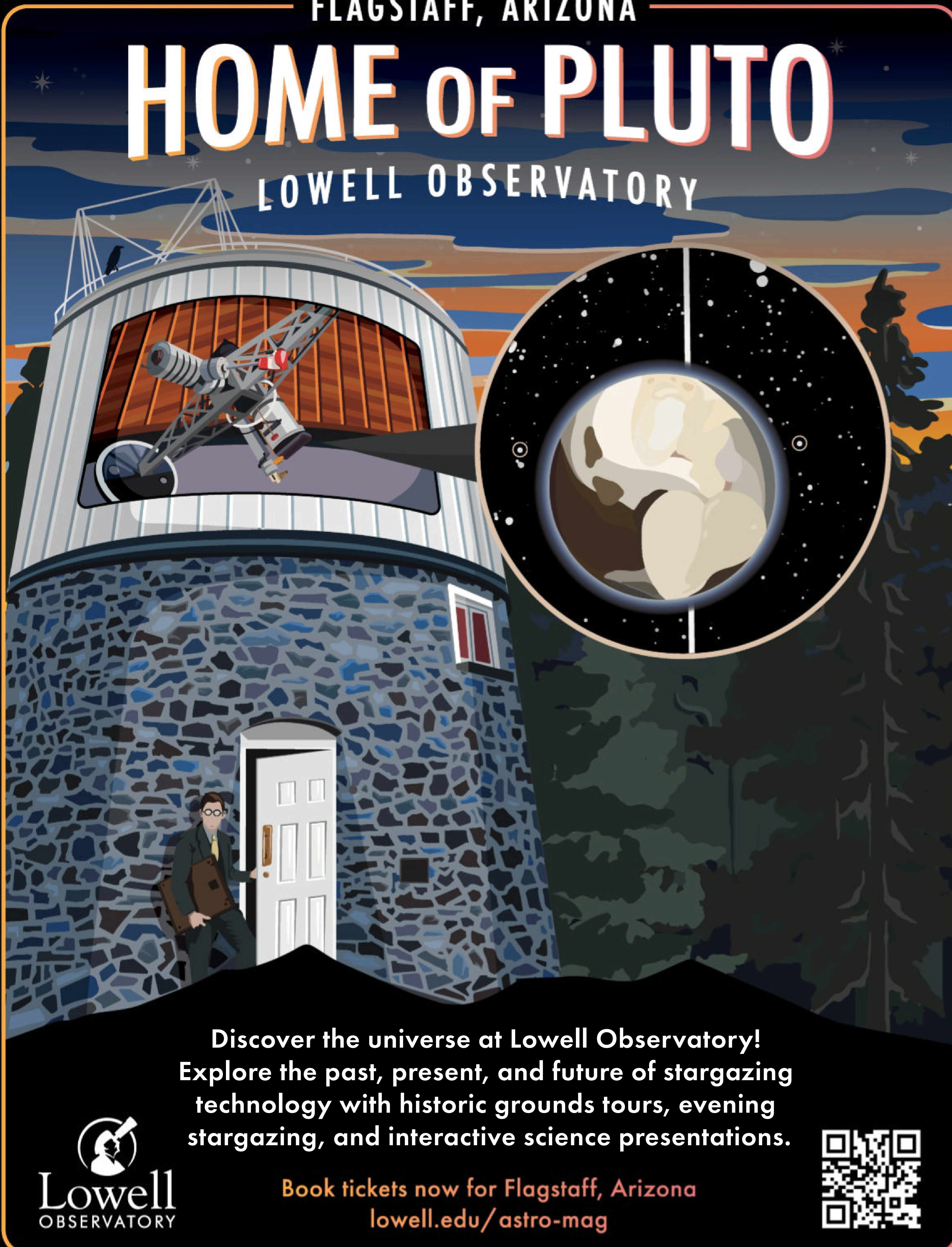
Here are a few examples. In 1543, Nicolaus Copernicus published his heliocentric theory, saying Earth orbits the Sun, and then 29 years later, Tycho Brahe discovered the brightest supernova in centuries. Or what about Dutch eyeglass-maker Hans Lippershey's inventing the telescope in 1608, while Johannes Kepler completed his third and final law of planetary motion just 11 years later? Or Isaac Newton's inventing the reflecting telescope in 1668 but arguably getting topped by Ole Roemer's accurately measuring the speed of light eight years later?

There is also this game-changing pair of mind-rattlers that turned our cosmos upside down. In 280 B.C., on the Greek island of Samos, Aristarchus provided the first-ever estimate of the Earth-Sun distance. He also insisted that Earth orbits the Sun, not the other way around. (He wrote this 1,800 years ahead of Copernicus!) And just 40 years after that, the guy in charge of the Library of Alexandria, Eratosthenes, not only announced that our planet is round — a fact still disputed by internet conspiracy dummies — but calculated and published its circumference to within 5 percent of its true value. He used math alone, without ever once setting foot outside Egypt.

Those events might outclass John Dobson's inexpensive "Lazy Susan" mount in the hot news department, but can they overcome the sheer swarms of astro-headlines that have kept us sleepless since this magazine first took flight? And could anyone but time travelers have predicted that astoundingly fecund half-century of revelations?

I'll let you decide. Regardless, to my biased eyes, the magazine is beautiful enough for its ancestry not even to matter.

BROWSE THE "STRANGE UNIVERSE" ARCHIVE AT **www.Astronomy.com/Berman**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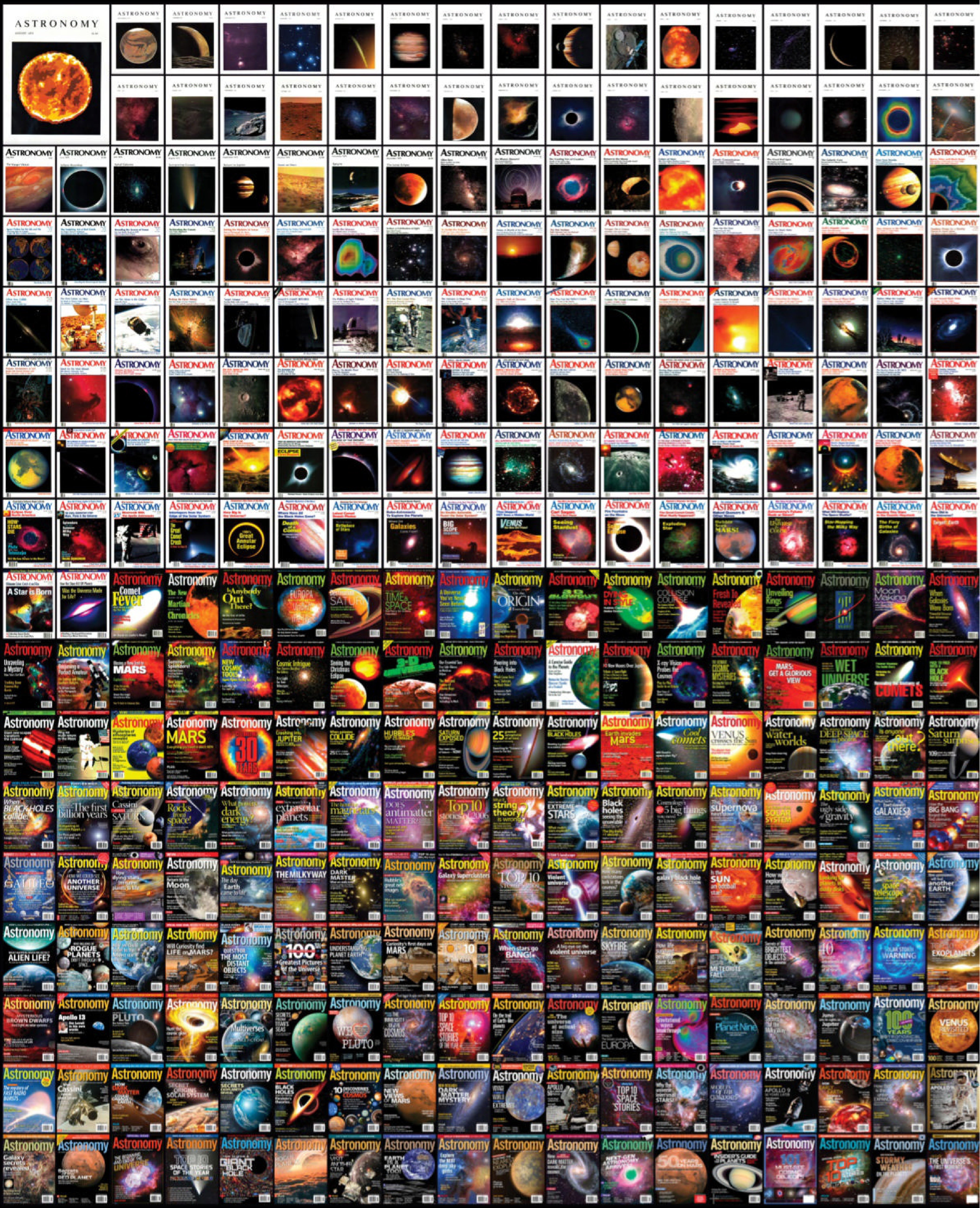


## *Astronomy* magazine 1973-2023

# MILWAUKEE SENTINEL

MONDAY MORNING, SEPTEMBER 30, 1974

## Monthly Aims At Heavens

By RAY KENNEY
*Business News Editor*

Stephen A. Walther says it was a "cerebral itch."

Others may consider it a sort of heavenly inspiration.

Whatever it was, it gave birth more than a year ago to Astronomy Magazine, a breathtakingly illustrated and authoritative monthly published in something less than celestial quarters here.

Walther, the 30 year old publisher and editorial director obviously is more concerned with the appearance of the publication than he is about the appearances of the offices of AstroMedia Corp., behind a nameless door at 757 N. Broadway.

"The World's Most Beautiful Astronomy Magazine," the masthead boasts, and the young staff of skilled editors, artists and graphics specialists team with other Milwaukee firms to make it that way.

The first issue came off the presses in August of 1973 and was mailed to about 14,000 charter subscribers, according to Walther.

The November issue now is in the final stages of development, and it will be mailed to 31,000 subscribers (at an annual rate of $12). By January, the AstroMedia organization believes, the circulation of the magazine will be above 40,000, as a result of a direct mail solicitation presently going on.

Amateur astronomers and schools are the major subscribers. The magazine, as Walther has fashioned it, is designed to appeal to the amateur astronomer — "you only have to be interested in the stars and space travel" — and does not require a scientific degree to wade through the monthly features and digest of space and astronomical news developments, according to the publisher.

Walther considers himself nothing more than that — an amateur astronomer.

His interest in the heavens dates back 20 years ago, when, as a child of 10, he developed an interest in unidentified flying objects, saucers, and the question: "Is there life elsewhere in the Universe?"

He still isn't sure.

"There is a greater probability that there is life elsewhere in the Universe than there isn't," he shrugs. "But we will have the answer soon," he adds.

Walther was in college (Class of 1971) when he combined his interest in writing with his interest in astronomy. He began searching out all the markets for astronomical journals, he recalls, and could find very few.

He was amazed, he recalls. With all the interest in space, as a result of US space exploration efforts, few magazines were devoted to the topics. Early in 1972, he recalls, he conducted a feasibility study to determine whether anyone was truly interested in a new magazine about the heavens and space.

There was only one other — Sky & Telescope — and that was an extremely technical publication, according to Walther, who is the younger brother of Atty. David, a mayoral candidate a couple of years ago.

Astronomy was born, and E. F. Schmidt Co., Menomonee Falls, agreed to do the printing.

American Color Systems, New Berlin, Wis., handles the difficult color separations produced by astronomical photographers — the magazine devotes a section each month to the increasingly popular hobby of astro-photography — and Grafilm, Inc., also headquartered here, handles the typesetting.

The result is a mindbending exercise in celestial contemplation.

There are 100,000 amateur astronomers who may subscribe to the magazine in the future, but there are thousands of additional space buffs, according to Walther. He estimates that the circulation of the magazine — which, he says, is not dependent on advertising and can make it on subscription prices alone — could level out at 100,000 but rise to 200,000 plus.

"There's a whole universe out there," according to Walther. And it is difficult to determine whether he is talking about subscribers or subject matter.

ASTRONOMY MAGAZINE'S STEVE WALTHER —*Sentinel Photo*

On Sept. 30, 1974, the *Milwaukee Sentinel* published a story on Stephen Walther and his nascent magazine.

FRAMED ARTICLE: SCOTT KRALL. WOOD BACKGROUND: NATALLIA KHLAPUSHYNA/DREAMSTIME.COM

# The origins of ASTRONOMY MAGAZINE

Steve Walther's college project sparked a revolutionary idea. BY DAVID WALTHER

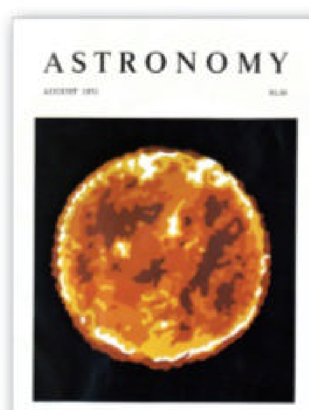
**ON MAY 27, 1973,** a young journalist named Stephen Walther filed incorporation papers to begin publishing *Astronomy* magazine. The first issue was August 1973; by 1981, it was the largest-circulation title on the subject. It retains this distinction by a factor of two. Tragically, Stephen died a few years after the founding of the title. Here David Walther, older brother of Stephen, recounts *Astronomy*'s earliest days.

Stephen Andrew Walther, founder of *Astronomy* magazine, was born in Stevens Point, Wisconsin, July 22, 1944.

From childhood, Stephen was passionate about amateur astronomy. His mother supported this astronomy interest, and to her despair, his struggle with mathematics was a roadblock to a career in what he loved most. He entered the University of Wisconsin-Stevens Point, and in time he found his outlet in the journalism department, where he created a blueprint for the publication of a magazine for amateur astronomers. After graduation, he came to Milwaukee, where he worked for a while in public relations. But he never lost his interest in the magazine, so after a few years he left his job and devoted all of his time to the creation of what would become *Astronomy*.

Stephen was an admirer of what was the most prominent astronomy magazine at the time, *Sky & Telescope*, but he felt that it was too technical to serve the needs of amateurs. He deeply believed that the amateur community provided an essential adjunct to professional astronomy, and that his magazine could best serve its needs.

Taking advice from his accounting firm, he created a subtle and complex model using testing and mail campaigns to get his magazine off the ground. An initial test mailing of 250,000 names returned a response for an initial issue with 14,000 subscribers. Additional short-term financing enabled a mailing to 1.5 million names, which built the subscription list to 31,000. That was enough for the magazine to survive, pay off debts, and build onward.



August 1973: first issue.

The magazine's initial home was in a loftlike office over a seamstress shop on Mason Street in Milwaukee. The initial staff consisted of Stephen along with Penny Oldenburger and a few others. Penny was listed as managing editor. I saw her as Stephen's chief assistant, and she ran all operations.

Later additions to the staff included Craig Brown (art director), Terence Dickinson (eastern regional editor), Richard Berry (technical editor), Henry Phillips (associate editor), Mary Jane Lamers (staff writer), and David Schwartz (production manager). Richard would continue on for many years as editor, while sadly Henry died quite young.

With additional staff, the team moved into a larger downtown space, at Broadway and Mason Street. It was a comfortable group of people with a good sense of humor. I remember the humorous way they treated the discovery that Uranus has rings.

At a very early date, David Eicher came to Stephen's attention. He was impressed by what the teenager had created in his newsletter, *Deep Sky Monthly*, a publication for small-telescope observers. Stephen tried to coax David into joining the magazine. That did not happen during his lifetime.

Stephen collapsed in August 1976, at a celebration for staff and friends at Villa Terrace in Milwaukee. At first, his condition was diagnosed as work-related exhaustion. But later, X-rays revealed a terminal glioblastoma, an aggressive form of brain cancer.

Bob Maas was hired to run the company while Stephen was ill, which he did until Stephen's death on Sept. 14, 1977. Bob continued running the company under my ownership thereafter. What he contributed to the growth, management, and salvation of the magazine was invaluable and cannot be overstated.

David Eicher eventually joined *Astronomy* in 1982, fulfilling Stephen's hope, and Bob Maas facilitated the sale of the magazine to Kalmbach Publishing Co. in 1985.

**David Walther** *is a retired attorney.*

# The cosmos

The ’70s gave us a magical and unique time in astronomy. BY ANN DRUYAN

Carl Sagan and Ann Druyan stroll together during the heyday of the production of *Cosmos*. COURTESY OF ANN DRUYAN

Carl Sagan blazed a unique path forward in popularizing astronomy in the 1970s and 1980s, one that would be followed by countless other astronomers. NASA

**THE MYTHIC ACHIEVEMENTS** of the Apollo program gave our civilization a jolt of self-confidence and ambition. It fueled a zeitgeist that promised even greater things. We were on our way to Mars with the Viking landers and to the outer planets and the stars with the Voyager probes. Was there anything we could not accomplish if we simply applied our will and our brains to it?

Yes, there were intimations of trouble ahead, signs that we were living at odds with our environment. The month before the first Moon landing, the polluted, oil-slicked Cuyahoga River that runs through Cleveland burst into flames. But there was a feeling of optimism that we could solve the ecological disasters we created just as we had the seemingly insoluble challenges of human space travel to the Moon and back.

The atmosphere at NASA’s Jet Propulsion Lab for the Viking landings was downright heady. I remember standing in the cafeteria as the first image from the surface of Mars came in. There were monitors everywhere. The din of mealtime stopped abruptly, as if someone had pressed mute. Everything came to a halt as the image arrived in a series of vertical stripes. When

# comes to life

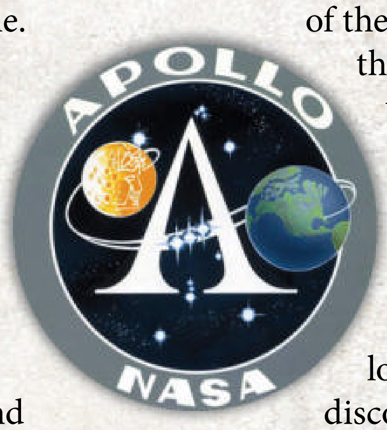
the picture was complete, we stood there in awe with our plastic trays. Outside, journalists from every news-gathering organization on Earth were waiting for the scientists to come downstairs and interpret the data.

As Carl Sagan would later write in our *Cosmos* television series, this was the fulfillment of a lifelong dream of his. As a child, he had stood in an empty lot in Brooklyn, closed his eyes as tightly as he could, and tried to "wish his way to Mars," as the fictional hero John Carter had. And now, on that day in 1976, on the seventh anniversary of the first Moon landing, scientists and engineers had found that "better way" to get there. He was part of that. And the world looked to him, more than any other individual, to explain what it all meant.

That was a year before our lives together began, but we were already friends. I remember those thrilling evenings in Pasadena where four or five of us would sit with Carl, each of us poring over a different image of the martian surface, hoping to be the one to discover the anomaly that no one else had caught yet. The brand-new galleys of *The Dragons of Eden* on the coffee table would have to wait. There was a new world to explore.

Back then, NASA had a very different attitude toward public outreach than it does today. Those of us around Carl could sense palpable antagonism toward his efforts to attract as many of us to science as he possibly could. He could never understand why anyone with access to the wonders that science reveals would not want to share it with everyone.

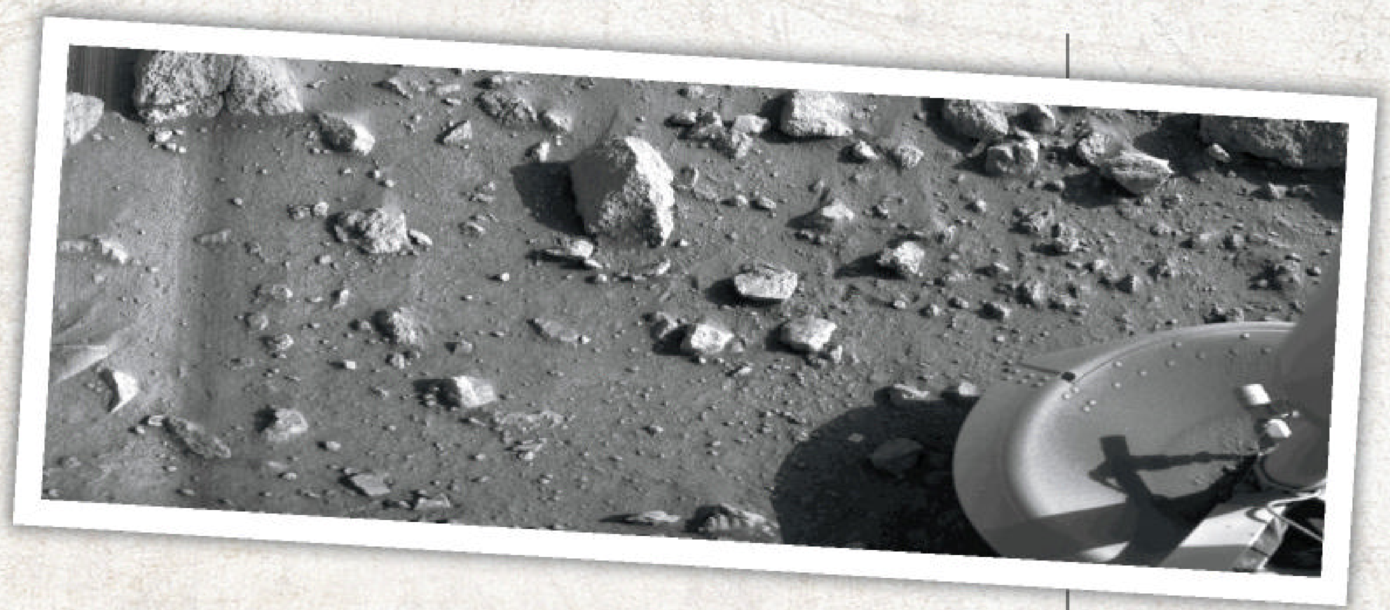
Carl was also worried about the future. How could we hope to maintain the degree of democracy we had achieved if most of us were excluded from the methods and insights of science? He knew that a society dependent on science and high technology required a citizenry that understood something of the way they worked.




That's why he was such a devoted supporter of *Astronomy* magazine and the other media that served those eager to know more. He wanted us to stay on the path of exploration, and he understood that major programs of research and exploration required an informed constituency.

As the first person to correctly understand the atmosphere of Venus, which he described in his Ph.D. thesis, he was more keenly aware than most of the dangers of the greenhouse effect and the climate change it would inevitably bring. He brought the same prodigious energy to warning about these dangers as he did to his joyful love of scientific discovery.

I would never speak for Carl. Still, I am often asked what he would do now if he were alive. There is no way of knowing, but I suspect he would remind us of the ancient human tradition of problem solving, of surmounting even the most daunting obstacles in our path. I think he would wage an all-out campaign to instill hope about the spectacular diversity of worlds and thrilling possibilities that the future can hold if we empower ourselves with knowledge and act now to protect the habitability of *the only home we've ever known.*



Carl Sagan was intimately involved in the Viking missions to Mars, which rewrote our understanding of the nearest planet in the solar system. NASA/JPL

"Carl wanted us to stay on the path of exploration, and he understood that major programs of research and exploration required an informed constituency."

**Ann Druyan** *is the Emmy- and Peabody-award-winning writer, director, and producer of* Cosmos, *and Carl Sagan's widow.*

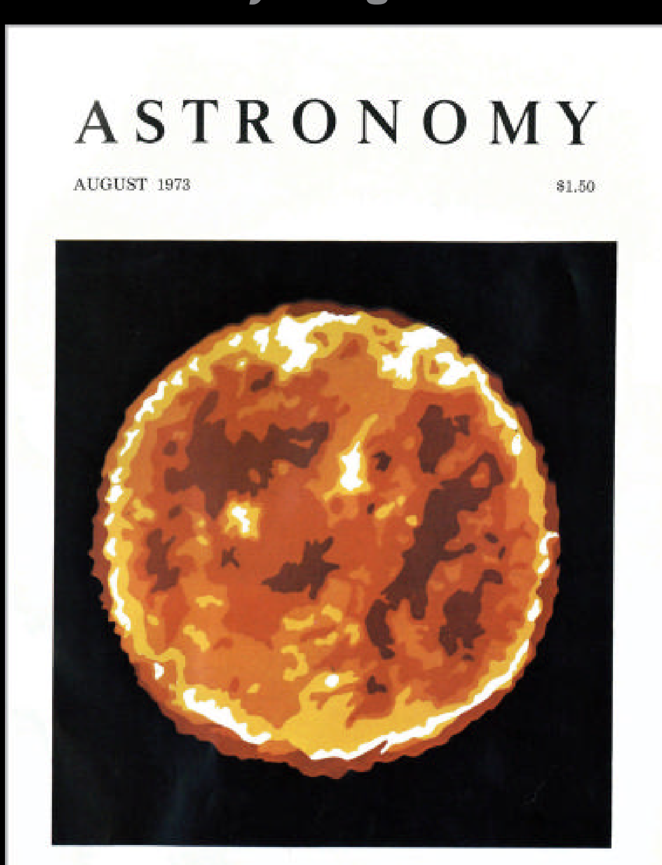
PAPER BACKGROUND: VISIVASNC/DREAMSTIME.COM. APOLLO EMBLEM: NASA

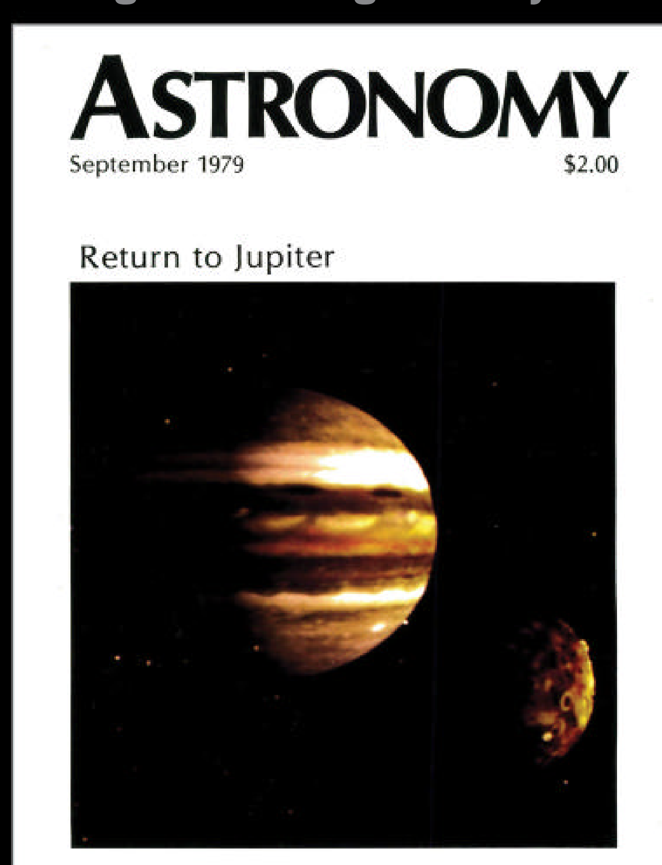
# The history of *Astronomy* magazine

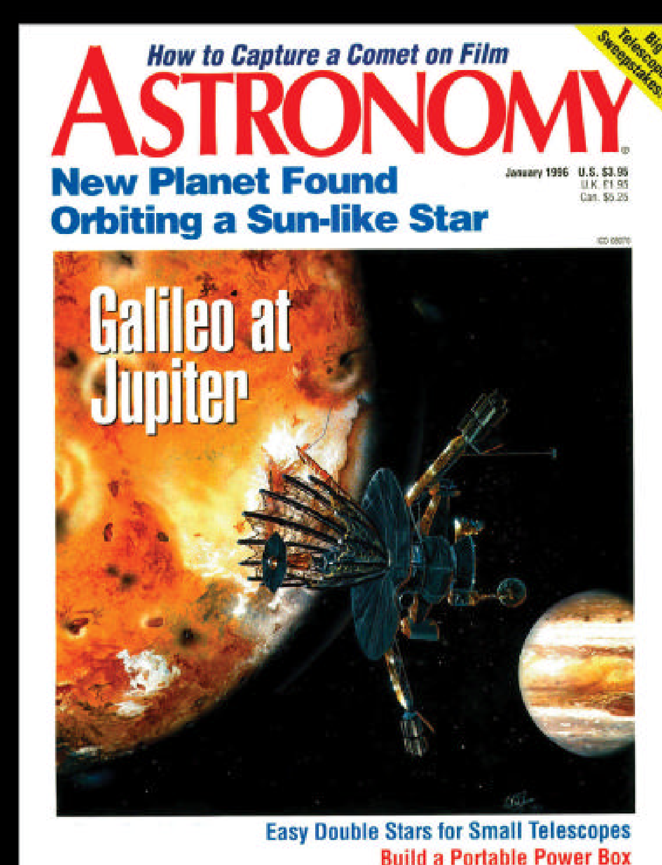
# 1973-2023

Over half a century, the world's leading cosmic brand has had an adventurous ride. BY DAVID J. EICHER

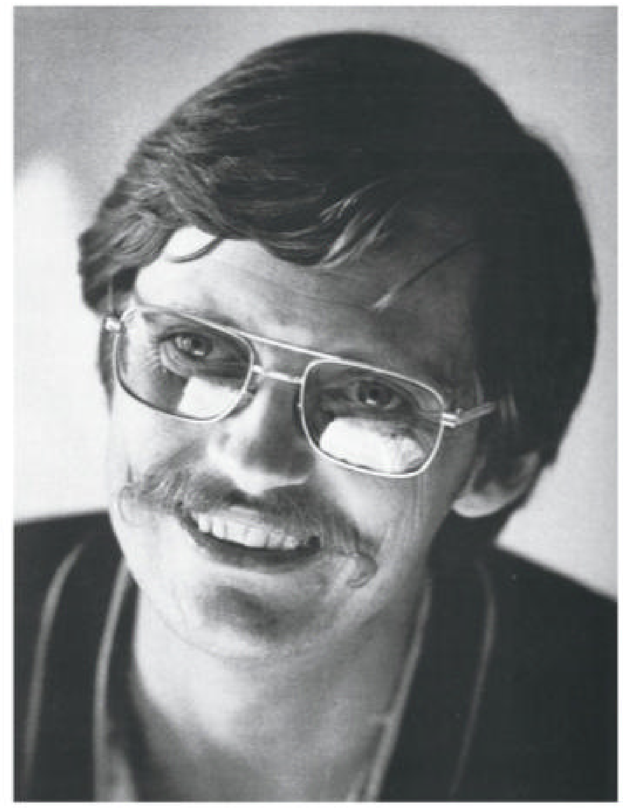
*Astronomy* magazine's look changed through the years:



**IN MID-SEPTEMBER 1982,** I arrived at our little stone building at AstroMedia Corp. in Milwaukee for my first day of work. I had no idea what adventures awaited. I was hired as the junior assistant editor of *Astronomy* magazine, and I couldn't have been more excited. Straight from Miami University in southwestern Ohio, I brought the observer's magazine I had started in high school, *Deep Sky*, with me. I was 21, wide-eyed, and ready to explore everything the astronomy world had to offer — and to report on it too.



A Wisconsin native, Steve Walther founded *Astronomy* magazine in 1973 as an outgrowth of a college journalism project at the University of Wisconsin-Stevens Point. Seven years later, it had become the largest-circulation magazine on the topic in the world and has remained so since. KALMBACH MEDIA CO.

This year we celebrate *Astronomy*'s 50th anniversary. I've been on the staff for only 40 of those years, but I've seen the majority of the history of this title.

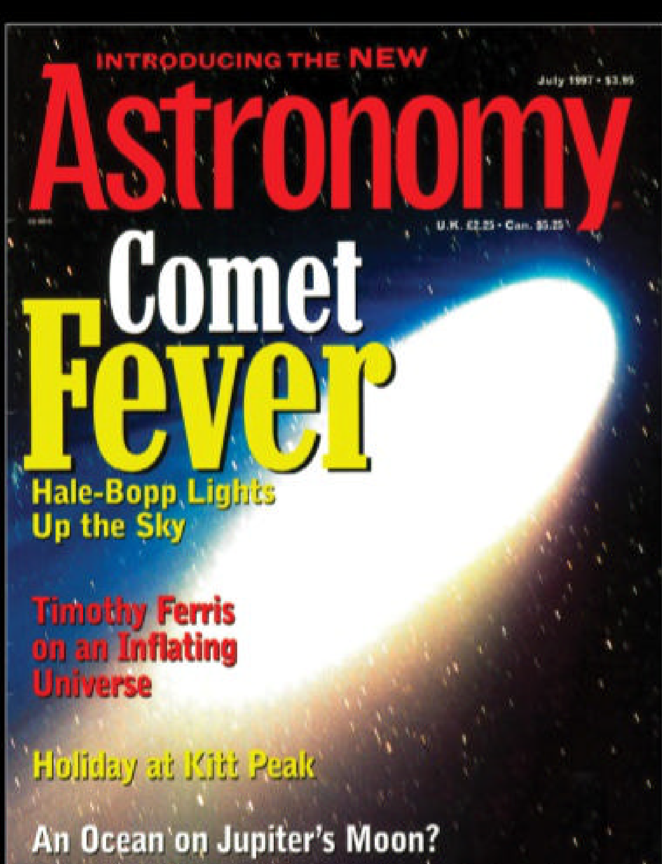
## First issues

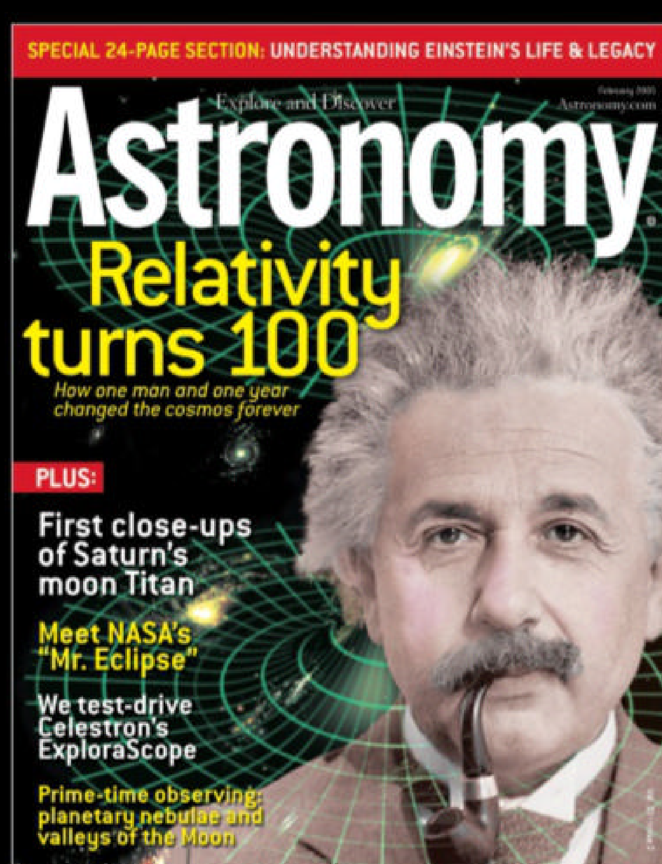
The magazine was founded on May 27, 1973, by Stephen Walther, a 29-year-old astronomy enthusiast who began the venture several years earlier as an experiment in college. His brother, David Walther, was a Milwaukee attorney who supported the publication's launch. Steve put together a dynamic staff of young, enthusiastic writers and editors, and the first issue appeared in August 1973, with a speckle interferogram of the star Betelgeuse on the cover.

Steve commenced publishing *Astronomy* because he felt the long-established *Sky & Telescope* was too technical for most beginners in the astronomy hobby. In time, both magazines would cover the spectrum well and coexist for decades.

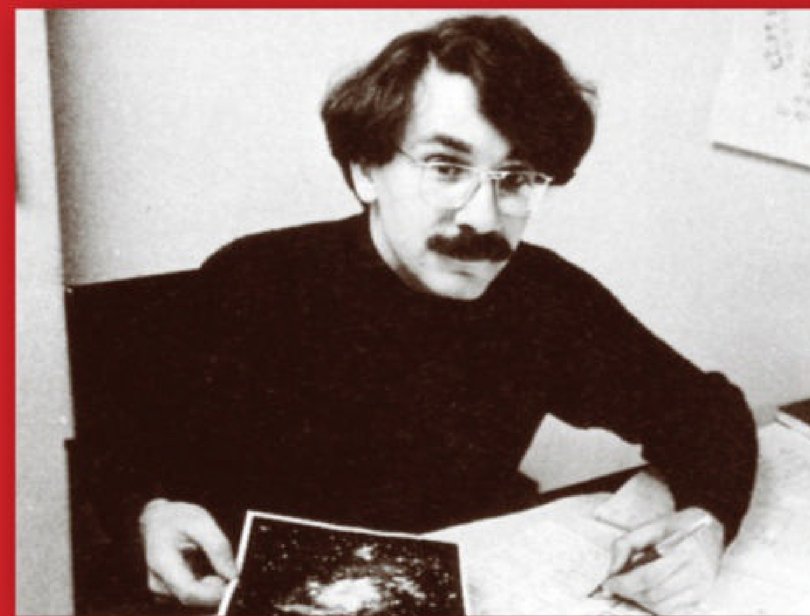
*Astronomy* got off to a somewhat uneven start. It did include some impressive early contributors. Carl Sagan, Jay Pasachoff, George Abell, Bill Hartmann, and Gerrit Verschuur were among the title's earliest authors. Many of the stories were superb, though a few — exemplified by 1974's "The Zeta Reticuli Incident," which reported on silly claims of a UFO abduction — marked a temporary stumble. Years later, we staff would refer to that as "The Zeta Ridiculi Incident."

The first issue checked in at 48 pages. But the title grew in size and rapidly in







Richard Berry became the magazine's editor following Steve Walther's death and began an important 15-year tenure overseeing *Astronomy*'s growth into the world's leading title on the subject. KALMBACH MEDIA CO.

Robert Burnham was another major influence in the magazine's history. A friend of Richard Berry's who joined the staff as an associate editor in 1978, he would serve as the engine driving much of the magazine's content. He became editor-in-chief following Berry's tenure. KALMBACH MEDIA CO.

circulation. In the summer of 1976, with momentum rocking, *Astronomy* published an oversized "History of American Astronomy" issue and Steve decided to throw a big party for contributors and friends at a lakeside conference center in Milwaukee. Beside a pool, drink in hand, he collapsed. The next day he was diagnosed with an aggressive brain tumor, and he died about a year later.

## Picking up steam

The earliest team was small. The magazine established an office in Milwaukee, first on Broadway and then nearby on Mason Street. Terry Dickinson briefly joined the staff as editor to support Steve, as well as Managing Editor Penny Oldenburger, Assistant Editor Ray Villard, Art Director Craig Brown, and a few others. After Steve's diagnosis, Richard Berry joined the staff as technical editor, and would become the magazine's chief driving force for a decade and a half. He became editor and worked as such until 1992.

Under Richard's leadership, the editorial focus of the magazine sharpened. This was also a bit of a golden age for astronomy, with the afterglow of the Apollo era still alight. In 1975 and '76, Comet West (C/1975 V1) dazzled observers, the Viking landers explored Mars, and the launch and anticipated discoveries of the Voyager missions had everyone abuzz. Henry Phillips joined the staff as an associate editor; tragically, soon thereafter, he also died young. Robert Burnham and Dewey Schwartzenburg came on as associate editors.

Astro events were cooking and by 1981, when big stories rolled in from the Voyager results, *Astronomy* exceeded the old standby, *S&T*, in circulation. It has been the largest-circulation publication on the topic ever since. The group also began publishing *Odyssey*, a children's magazine about the universe. Expanding, it moved into a Lannon-stone building on St. Paul Avenue in Milwaukee, a structure that also served as David Walther's law office, adjacent to the Summerfest grounds. Previously, it had been a bar that occasionally featured mud wrestling.

## Great times

When I arrived in 1982, the hobby of astronomy was booming. Star parties and astronomy conventions were at record levels, and so too were astronomy club memberships. Pushed forward by the "Dobsonian revolution" — the technology that allowed building simple telescopes with large mirrors — amateurs were discovering countless new targets to seek out in the sky. The anticipation for the long-awaited return of Halley's Comet was building. And my little publication, *Deep Sky*, was now a quarterly. It had started as a monthly, first created on my dad's chemistry office mimeograph machine, and now I huddled in a closet (figuratively!) one day a week working on it, cranking away on *Astronomy* the rest of the time.

Its companion quarterly was *Telescope Making*, founded by Richard Berry to cover the equipment side of the hobby.

By the early 1980s, the magazine had evolved into a balanced and quite serious format. The science of astronomy got front-of-the-book treatment and hobby topics drifted toward the back, the two worlds separated by a central update on sky events for the month and a sprawling Star Dome evening sky map. The staff grew and evolved. We now had my fellow assistant editor Frank Reddy, Kate Bond was managing editor, and Robert Burnham had been promoted to senior editor. Our art director was Tom Hunt.

## Coming under Kalmbach

Big change arrived in 1985, just as we were ramping up the excitement over Halley's Comet. Our AstroMedia Corp. group, numbering about 40 people, functioned essentially as a big family — an extended astronomy club, if you will. Then Kalmbach Publishing Co., a company across town with multiple titles in other areas, bought us. At first, it seemed like we had been swallowed up by IBM. Kalmbach had perhaps 150 employees at that time, and functioned much more by the book than AstroMedia. We soon moved across town to spend several years in Kalmbach's headquarters on Milwaukee's 7th Street. The acquisition was of course very beneficial to *Astronomy* in numerous ways. Famous for its linchpin titles *Model Railroader* and *Trains*, Kalmbach gave us marketing strength our astronomical title had previously lacked.

NASA/JPL

**Launched in 1977, the two Voyager probes gave us the first up-close tour of the solar system. In 1979, 1980, and 1981, explorations of Jupiter and Saturn and their moons revolutionized our knowledge.**

Another of our brand's longest serving and most valuable editors, Richard Talcott, joined the group. The apparition of Halley's Comet gave the astronomy hobby a big boost. (Bright comets always do.) We had large issues with great coverage of the comet's appearance, the science learned from it, and of course all the observational and astroimaging results. Great sadness prevailed, of course, with the explosion of space shuttle *Challenger*, but interest in astronomy, even as we moved from the Apollo era into the routine coverage of space shuttles, was white-hot.

And then we moved again: In 1990, Kalmbach shifted from Milwaukee out into the surrounding countryside, to a glass-and-steel building complex that was far more spacious and modern. We were in Waukesha, on the edge of an upscale suburb called Brookfield. And that is where the company, now known as Kalmbach Media Co., has been ever since.

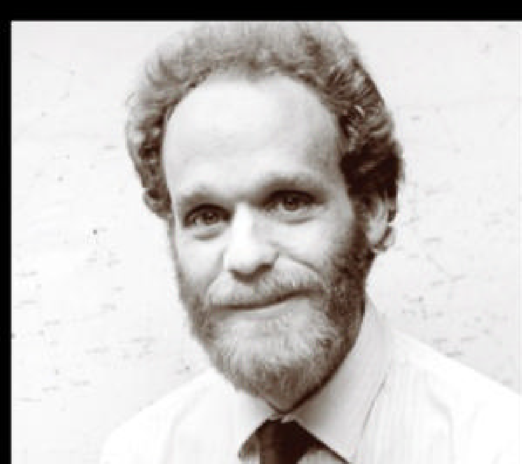
## The '90s

The 1990s were filled with cool stories to cover. Spacecraft missions had us visit an asteroid and explore Mars and Jupiter in unprecedented detail — including sending the first rover, Sojourner, to visit another planet.

Comets were also a recurring theme during the '90s. In 1993, astronomers Gene and Carolyn Shoemaker and David Levy discovered a comet that was destined to slam into Jupiter's cloud tops. In 1994, that incredible event was visible in small telescopes and drew many new people to the hobby of backyard astronomy. Moreover, after a bit of a drought, two very bright comets graced our skies in 1995, 1996, and 1997. Comet Hale-Bopp was a physically huge comet and a bright naked-eye sight, visible for a long time, and Comet Hyakutake was also bright and wowed observers and imagers with an incredibly long tail.

The 1990s also marked an era of major change at *Astronomy*. In 1992, Richard Berry left the magazine and Robert Burnham succeeded him as chief editor. *Telescope Making* was Richard's baby, and so the company decided to end its publication, and also my quarterly *Deep Sky* with it. The company wanted me to focus exclusively on the larger





Richard Talcott joined the staff in 1986 as an assistant editor. He has played a significant role in the magazine's history ever since, rising to senior editor and becoming centrally involved with many important aspects of the title. KALMBACH MEDIA CO.

Assistant Editor David J. Eicher is interviewed on television in 1984 at *Astronomy*'s offices in Milwaukee. The editors of the magazine remain popular radio and television sources for scientific discoveries and upcoming celestial events to this day. ROBERT BURNHAM

In 2013, *Astronomy*'s staff posed for a portrait during the last era before the current one. This enthusiastic group included, back row (left to right): Editorial Associate Valerie Penton, Illustrator Elisabeth Roen Kelly, Managing Editor Ronald Kovach, Senior Graphic Designer Chuck Braasch, Publisher Kevin Keefe, Associate Editor Sarah Scoles, Assistant Editor Karri Stock, and Associate Editor Liz Kruesi; front row (left to right): Senior Editor Michael E. Bakich, Editor David J. Eicher, Art Director LuAnn Williams Belter, and Senior Editor Richard Talcott. KALMBACH MEDIA CO.

*Astronomy* magazine. We also sold *Odyssey*, which had always been a bit of a challenge as a title aimed at kids on the periodical newsstand. We went from a four-title house to one focusing merely on the large title Steve Walther had begun.

It was a fun time on the magazine staff, but also one of considerable transition. Alan Dyer, Jeff Kanipe, Dave Bruning, and John Shibley were editors for a time; Rhoda Sherwood was a managing editor with a big personality. Steve Cole also served as managing editor before moving on. Bob Naeye and Tracy Staedter joined us as members of the team. When Robert Burnham decided to depart in 1996, a New York generalist, Bonnie Gordon, took over as editor. In a few weeks I went from associate editor to senior editor to managing editor.

Bonnie's tenure lasted a few years, and in 2002 I was made the chief editor, and have been in that role now for more than 20 years.

## Expanding science

The new millennium delivered an amazing and active era for the magazine.

One of several associate editors for the title in the 2000s, Liz Kruesi poses at her desk, busily working on a story about solar system exploration. She is famous among the staff for originating the story title "Corona Light" for a piece about a total solar eclipse. DAVID J. EICHER

As we know, astronomy was accelerating into an time of exploration and discovery that had us scrambling to keep up. The Hubble Space Telescope's countless findings, the exponential growth of discoveries of extrasolar planets, and a wide variety of findings on "big questions" gave us lots to adjust to. The age, size, and fate of the universe came into sharper view, as did the nature of black holes. We also experienced a resurgence of exploration of the solar system, with missions to Jupiter, Saturn and its moon Titan, the first landing on an asteroid, the first cometary material returned to Earth, and a campaign of more martian rovers. Once again the U.S. space program experienced tragedy, though, with the loss of the shuttle *Columbia*.

The magazine expanded its activities to create and develop its website, Astronomy.com, and covered a huge variety of science and hobby stories. Our staff during this period added such folks as managing editors Pat Lantier and Dick McNally, and another longtime and valuable editor, Michael E. Bakich. Robert Burnham also returned as a senior editor for a time, as did Frank Reddy. Our art director position evolved, including Carole Ross, Tom Ford, and LuAnn Williams Belter, who served for many years. And for many years, an extraordinarily talented illustrator, Elisabeth Roen Kelly, has produced diagrams that have enlivened the magazine's pages.

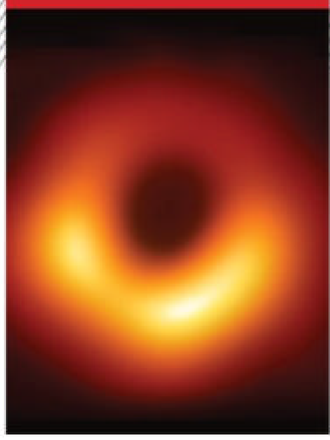
## Moving into the modern era

The 2010s saw the nature of discovery and exploration only accelerate. We had the first spacecraft that orbited Mercury, the winding down of the Space Shuttle Program, the discovery of gravitational waves, and the great Curiosity rover landing on Mars. A superb highlight came with the final step in the long-ago planned exploration of the major solar system when the New Horizons spacecraft flew past Pluto and its system of moons. The Voyagers, launched way back in the '70s, made their way past the heliosphere, far out into deep space.

How could there be more? There was. We experienced the first spacecraft to orbit a comet, also sending a small lander onto the comet's surface. And we witnessed the first image of the shadow of a black hole.

This incredible era in astronomy and astrophysics saw further changes in the *Astronomy* magazine staff. Our group of associate editors included Liz Kruesi, Bill Andrews, Sarah Scoles, Eric Betz, and Korey Haynes. Alison Klesman joined us as an associate editor and subsequently became a senior editor. Jake Parks came on as an associate editor and later became our digital editor. Our copy editor, Karri Stock, soon expanded her role into production editor. For years, our publisher was Kevin Keefe, a veteran who had been the editor of *Trains* magazine but who also had a passion for astronomy.

As we approached the pandemic era, things got a bit strange, as they did for everyone. The science of astronomy kept rocking, and the hobby experienced a renewal as people holed up at home looked to explore the cosmos from their backyards. We worked remotely for about two years, and I learned that I could have run *Astronomy* from anywhere — say, even the Moon.



EHT COLLABORATION

In 2019, astronomers using the Event Horizon Telescope produced this first image of the shadow of the black hole at the center of the galaxy M87. Black hole dreams were coming true.

The current *Astronomy* staff includes, front row (left to right): Sarah Gerkhardt, Jake Parks, Alison Klesman, David J. Eicher, Mark Zastrow, Nicole McGuire, and Melissa Valuch; back row (left to right): Jodi Jeranek, Michelle LaPinske, Samantha Hill, Elisabeth Roen Kelly, and Kelly Katlaps. KALMBACH MEDIA CO.: SCOTT KRALL

Our current group came together on the cusp of the pandemic. Two of our most experienced and longest serving editors, Rich and Michael, retired. Longtime art director LuAnn also retired and was succeeded by Kelly Katlaps. I was the sole long-term employee left. Steve George, who serves as editor of our sister publication, *Discover*, and is also editorial vice president for the entire company, became a close colleague. A dynamo, Elisa Neckar is our senior production editor, and she keeps the work moving for both *Astronomy* and *Discover*. Not only did Alison become a senior editor, but we added Senior Editor Mark Zastrow and Editorial Assistant Samantha Hill. Most recently, Associate Editor Daniela Mata has joined us. We have a terrific, young, knowledgeable group that loves bringing you the best from the world of astronomy.

And the world of astronomy continues at high velocity, showing no signs of slowing down. In 2021, we experienced the first powered flight on another planet when the small helicopter Ingenuity flew around Mars. The first spacecraft to enter the Sun's atmosphere, the Parker Solar Probe, returned incredible data. And although Hubble is still working, with NASA's launch of the James Webb Space Telescope, we have now entered a new era of amazing discoveries that should last for 30 years.

The life of *Astronomy* magazine has been an amazing journey. With 50 years now in the books, one can only wonder about the incredible knowledge and experiences we'll see in astronomy in the next 50 years. The magazine has been the largest-circulation title in the field for more than 40 of its 50 years. I know that it will continue on, reporting the most exciting discoveries and amazing things to see in the sky, in a unique and unprecedented way. And I hope you'll be with us in this shared sense of discovery for many years to come.

**David J. Eicher** *is editor of* Astronomy, *the author of 26 books on science and history, and a member of the board of the Starmus Festival and of Lowell Observatory. He has enjoyed his decades at* Astronomy *more than he can express.*

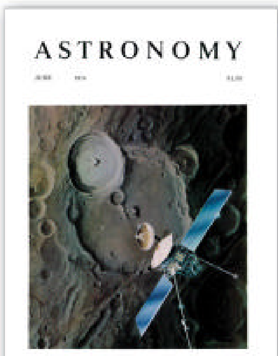
# *Astronomy* covers 50 YEARS OF SCIENCE

# From exploring upcoming missions to reporting fantastic finds, the magazine has watched the field grow.

**BY ALISON KLESMAN**

**CARL SAGAN WROTE** in the June 1974 issue of *Astronomy*: "Clearly the best time to be alive is when you start out wondering and end up knowing. There is only one generation in the whole history of mankind in that position. Us."

In its 50-year tenure, this magazine has seen breathtaking change — far too much progress to mention it all. But, for this special anniversary issue, let's highlight a few key journeys we've made, as seen through the lens of science stories that have appeared in *Astronomy* magazine.




June 1974 issue

## THE ROAD TO THE OUTER SOLAR SYSTEM

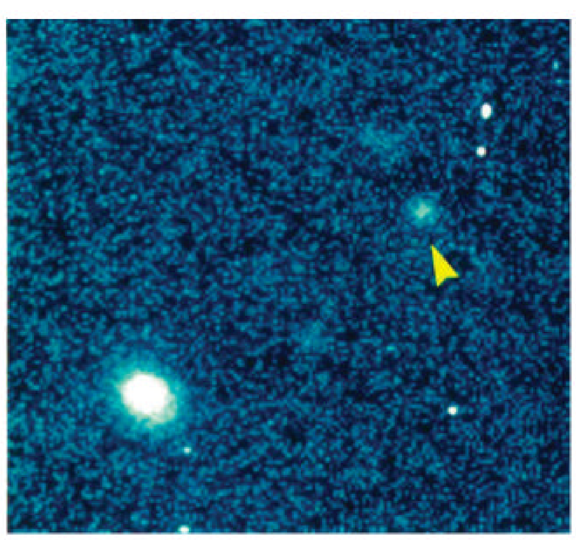
When *Astronomy* began publishing in 1973, the solar system as we knew it was a very different place. It had nine planets and we had not yet seen the worlds beyond the main belt up close. Pluto was the most distant object known, though a Kuiper Belt of icy objects was thought to lie beyond it.

As early as 1978, articles appeared asking whether Pluto was really a planet. This oft-repeated theme picked up speed as the Kuiper Belt sprang into reality following the August 1992 discovery of 1992 QB$_1$. In a December story that year, a quote from S. Alan Stern likened its discovery to that of Ceres, the first known asteroid. Stern's stories have continued to update readers on outer solar system topics throughout the years.

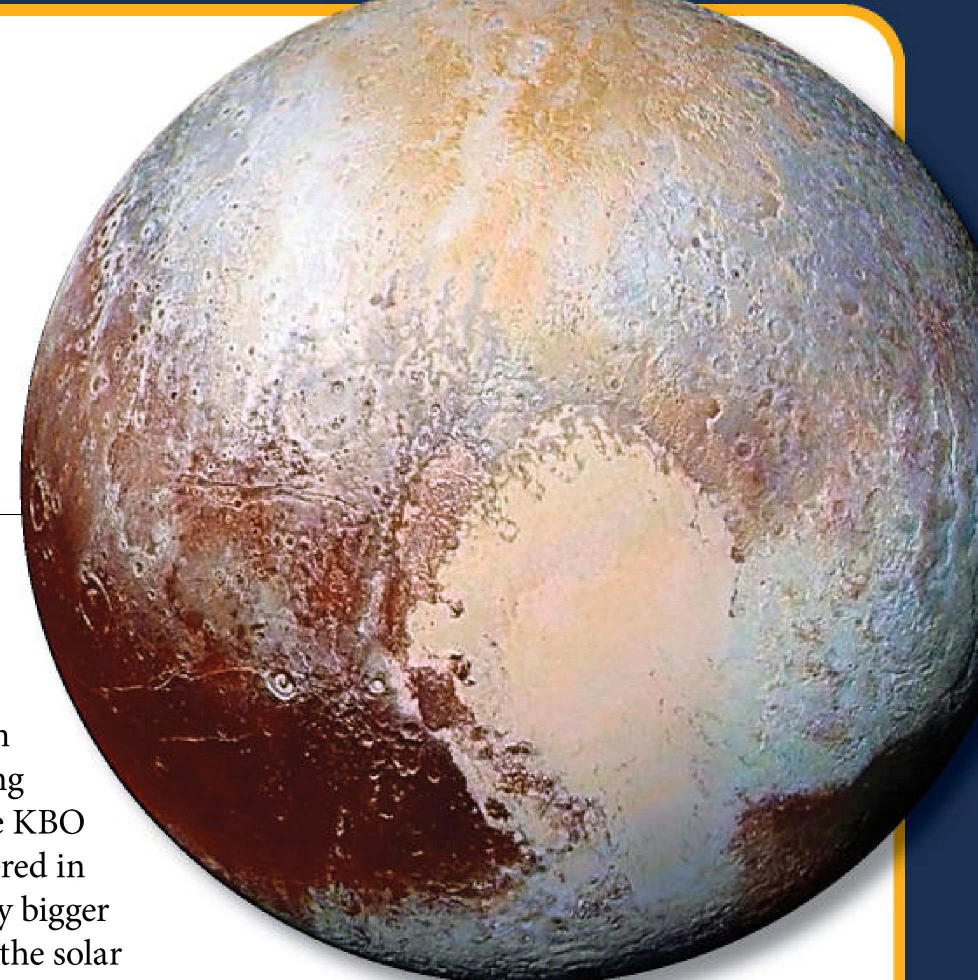
A July 1999 feature by Senior Editor Rex Graham asked once again "Is Pluto a Planet?" Astronomers argued that with hundreds of Kuiper Belt objects (KBOs) now known, Pluto should be considered one of them. Then, in November 2005, astronomer Mike Brown said, "Start rewriting the textbooks." The KBO 2003 UB$_{313}$, discovered in July 2003, was likely bigger than Pluto. Should the solar system now have 10 planets?

"Pluto gets the boot!" appeared in December 2006, following the International Astronomical Union's decision to reclassify it as a dwarf planet — a category it now shared with Ceres and 2003 UB$_{313}$ (renamed Eris). There are currently five recognized dwarf planets; we've since added Makemake and Haumea.

Nonetheless, Pluto remained a last frontier of sorts. A May 2002 story mentioned the tentatively confirmed New Horizons mission, set to launch in 2006 and reach the distant world in 2015 or 2016. *Astronomy* eagerly followed New Horizons leading up to the July 2015 flyby. That was a huge year for Pluto in our pages, culminating with a triumphant November headline: "The Pluto system explored!" No longer envisioned as a cold, quiet, dead world, Pluto was a complex and active "icy wonderland," Stern wrote. The data delivered surprises at every turn, including a possible slushy ocean beneath the surface.



The first Kuiper Belt object found beyond Pluto, 1992 QB$_1$ (indicated with an arrow) appears as a tiny speck in this discovery image. *Astronomy* ran the photo in December 1992. As more objects were found, astronomers began questioning whether Pluto should be considered a planet. DAVID JEWITT/UNIVERSITY OF HAWAI'I



This stunningly detailed enhanced-color image of Pluto, now widely known, ran above the triumphant headline "The Pluto system explored!" in the November 2015 issue. NASA/JHUAPL/SWRI

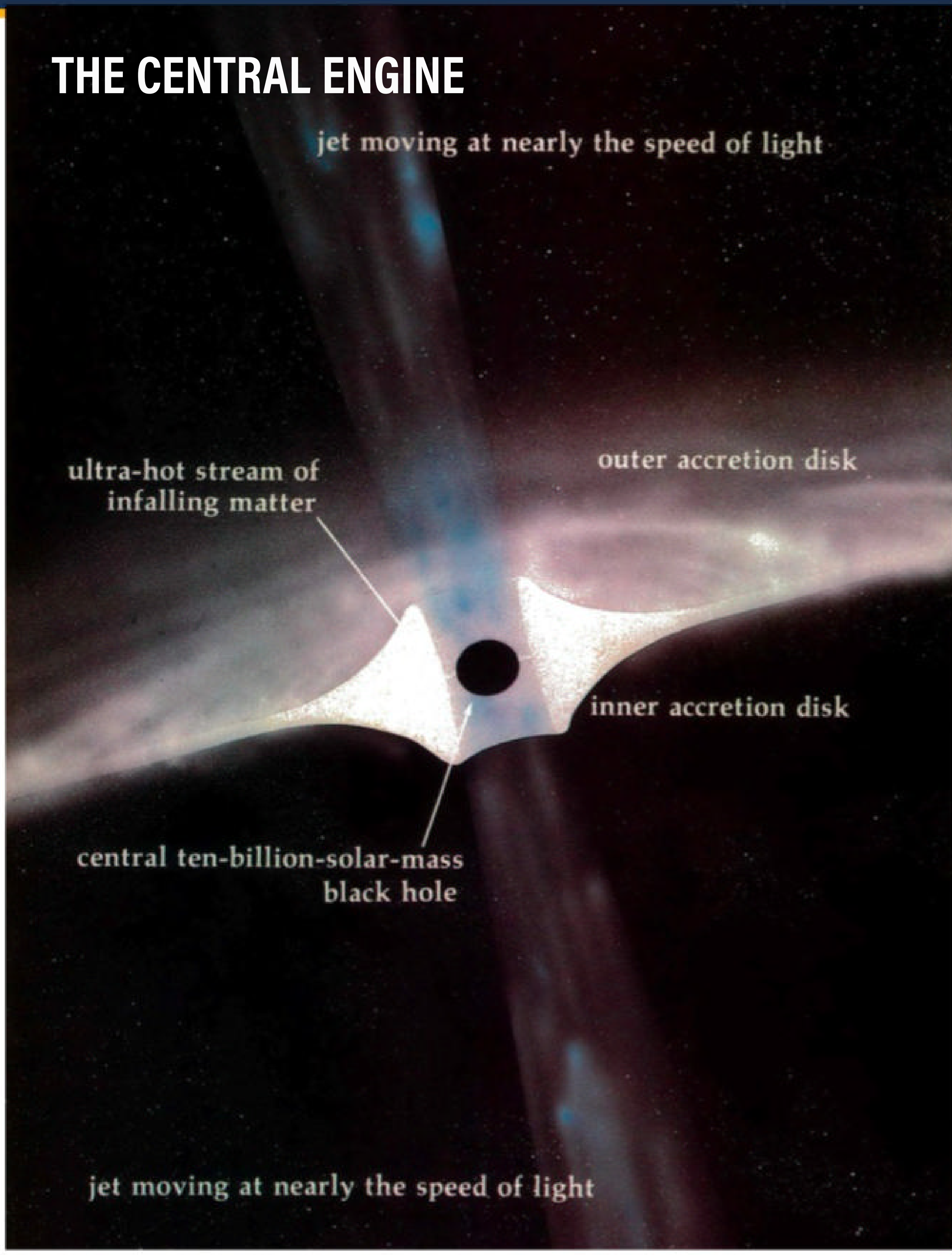
New Horizons has since returned up-close views of Arrokoth (formerly named Ultima Thule), a smaller KBO beyond Pluto and the farthest world ever imaged. *Astronomy* has covered how its strange shape and intriguing past have shed light on a cold, dark region of our solar system that, when this publication began, was entirely theoretical.

## QUASARS AND SUPERMASSIVE BLACK HOLES

In five decades, we've learned much about the galaxies that populate our universe. But solving one particular mystery has had far-reaching implications for our understanding of how those galaxies evolve.

ALES UTOUKA/DREAMSTIME.COM

## THE CENTRAL ENGINE




A 1982 story featured this now-familiar diagram showing what astronomers considered the likeliest "central engine" of a quasar: a supermassive black hole. Infalling material in the disk around the black hole shines incredibly brightly, generating the light we see, while near-light-speed jets shoot out from the poles. *ASTRONOMY*

### PLANET X

*Astronomy*'s inaugural issue included an article titled "In Search of Planet X." Astronomers thought an undiscovered planet 300 times more massive than Earth might travel on a highly inclined orbit twice as far from the Sun as Neptune. The influence of such a planet could explain observed irregularities in the movements of Halley's Comet.

Planet X faded into history, but a similar idea appeared in June 2016, when astronomers led by Mike Brown discovered a strange clustering in the orbits of several KBOs, suggesting they'd been nudged by an unknown planet. The 10-Earth-mass "Planet Nine" must lie some 600 AU from the Sun, with an orbit inclined 30° to the ecliptic. Several teams are now searching for a glimpse of the faraway, dim world. —*A.K.*

In *Astronomy's* fourth year, "Quasars: Oddities of Space" discussed the blazing beacons discovered just 15 years before. Each of these objects was as bright as some 1,000 Milky Way galaxies, yet emitted its light from a region only about twice the diameter of Pluto's orbit — and astronomers had no idea what powered them. The possibilities ranged from exploding primordial black holes to objects launched from galactic cores to numerous supernovae going off in a chain reaction. Or perhaps, as astronomer Donald Lynden-Bell suggested, they might be related to massive black holes, one of which could even lurk in the center of the Milky Way.

Over time, quasars began to take shape. A December 1979 feature reported that researchers were exploring the connection between active quasars in distant, young galaxies and quiescent, modern-day galaxies, wondering whether one might transform into the other. (We now know they do.) The same story noted the Milky Way's center showed "uncanny resemblances to a scaled-down quasar."

Throughout the 1980s and early '90s, better observations clinched the case for quasars as accreting supermassive black holes. Their immense light came from the massive disk formed as material swirled inward. Friction between particles in the disk generated vast amounts of radiation, while jets shot out along the poles, sometimes reaching far beyond the host galaxy. By the mid-90s, every mention of "quasar" within our pages stated firmly that they were powered by supermassive black holes. Astronomers had also determined that the numerous classes of galaxies with bright centers — just not *quasar* bright — also contained feeding supermassive black holes. Their differences could be explained by which way the black hole was oriented relative to Earth and how much obscuring dust was (or wasn't) present.

In 1998, a feature proclaimed that "supermassive black holes probably lurk in the centers of all the big galaxies," including our own. (Estimates then pinned the Milky Way's black hole at 2 million solar masses — a tad light.) But something else was afoot. A February 2001 story explained that astronomers had previously believed these behemoths and their home galaxies were largely unaware of each other. New evidence was throwing that idea out the window by showing supermassive black holes and their galaxies had properties that were tightly linked. Researchers were starting to suspect that supermassive black holes were a vital part of galactic evolution. By July 2013, astronomers had discovered that feedback from supermassive black holes dramatically affects the growth of their host galaxy. It became clear the supermassive black holes and their hosts evolve together, and this relationship has shaped the galaxies in our universe.

But how did such massive black holes get there in the first place? This is an answer we don't yet have. Stories in March 2004 and in March 2021 focused on the quest for the answer; the latter is our most recent on the matter. It notes that we have now seen supermassive black holes just 700 million years after the Big Bang. There is no way to build such early black holes from mergers of smaller black holes. Perhaps these start out with most of their mass already in place. Only more work will tell.

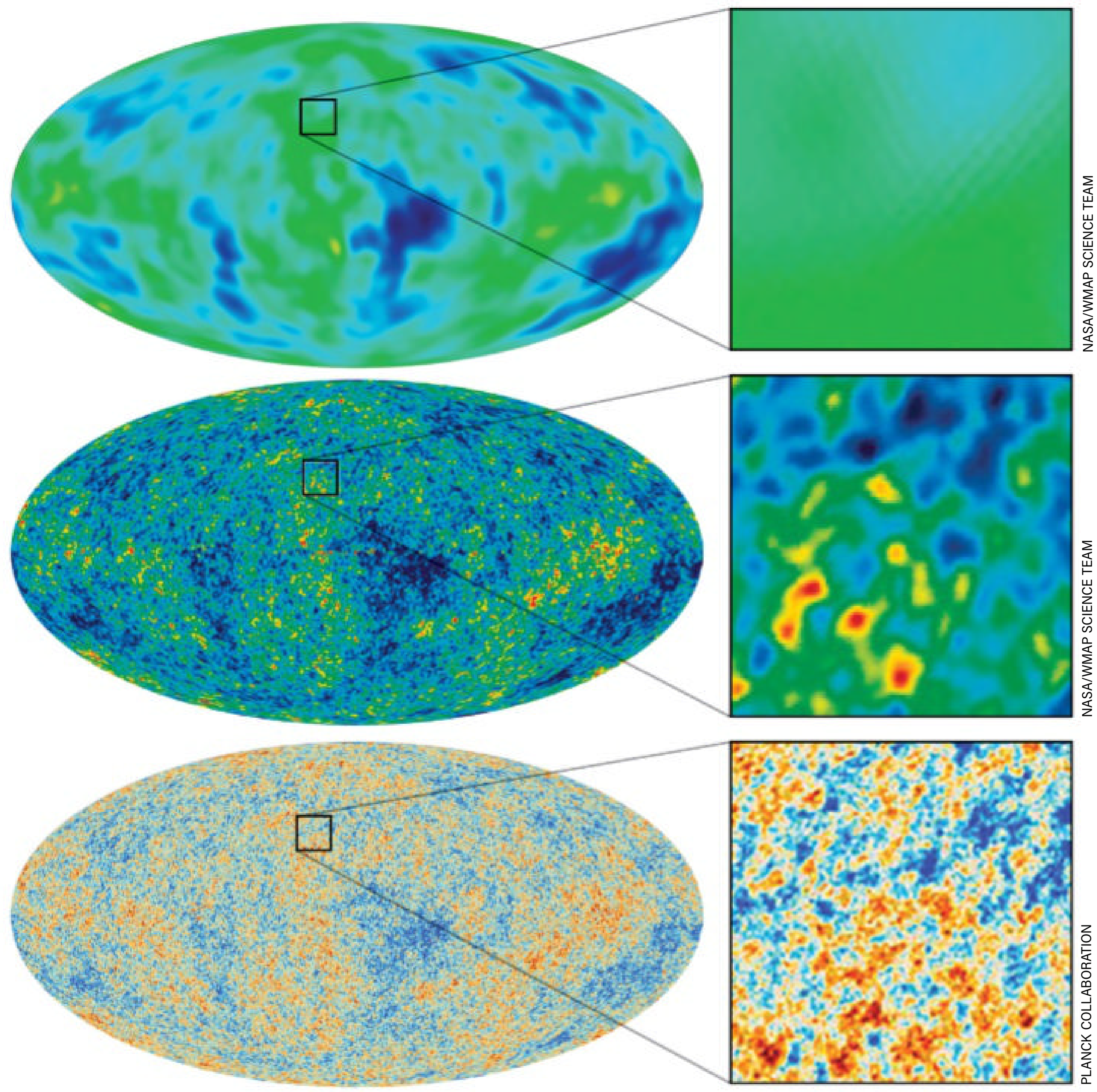
## THE NATURE OF THE UNIVERSE

*Astronomy* has witnessed numerous groundbreaking and paradigm-shifting discoveries in our understanding of the cosmos.

One such shift began in June 1990, when *Astronomy* revealed initial results from the Cosmic Background Explorer (COBE), recently launched to observe the cosmic microwave background (CMB) radiation left by the Big Bang. COBE's picture of a perfectly uniform Big Bang was a stunning achievement, but left astronomers wondering how galaxies, stars, and planets could have formed from such smoothness.

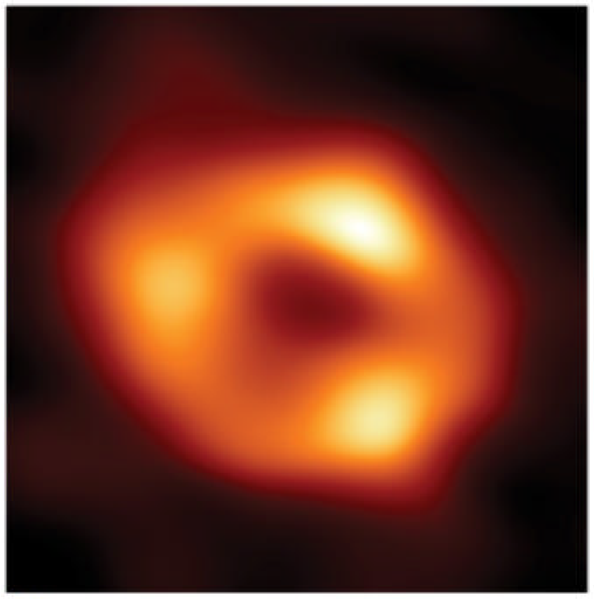
Two years later, another story appeared. Careful analysis of COBE's map showed tiny temperature variations — on the order of 0.001 percent — across the CMB. These variations, cosmologists said, were the seeds of all structure in the universe. Wanting to be absolutely sure, the researchers had delayed the announcement until they had checked and re-checked their findings. COBE's results now supported a universe with inflation and "cold" dark matter made of particles, wiping out several alternative scenarios overnight.

### ZOOMING IN ON THE CMB

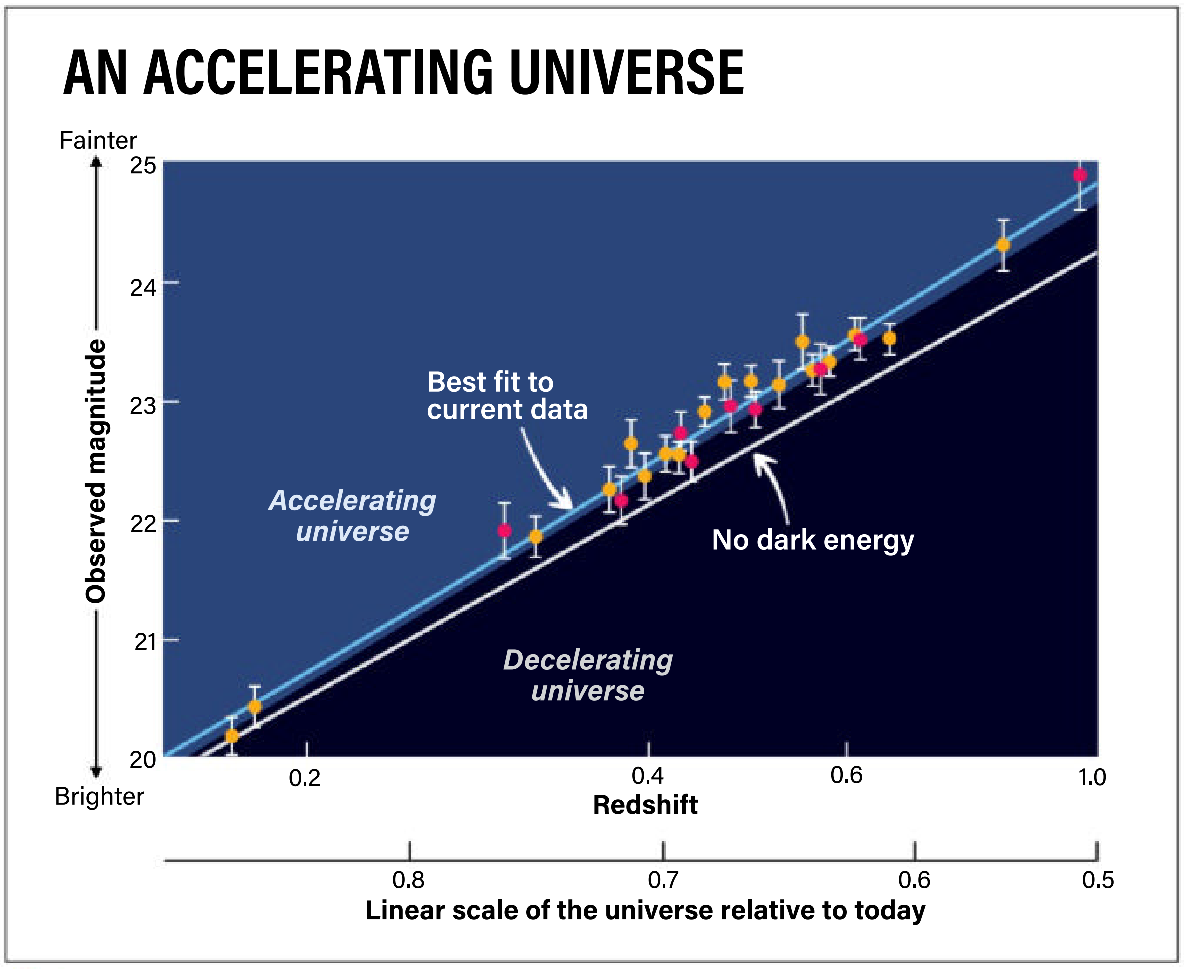



From top to bottom are all-sky maps created by WMAP, COBE, and Planck. With each successive probe, astronomers' view of the CMB improved. This has allowed us to determine that tiny variations in temperature and density led to the cosmos we see today. Finer measurements have also helped pin down values such as the age of the universe and the makeup of its contents. *ASTRONOMY*: ROEN KELLY

Before astronomers could get a closer look at the CMB, November 1998's "Exploding Stars Tell All" revealed that observations of distant type Ia supernovae made by two competing groups both indicated our universe was fated to expand forever. Even more stunning, the expansion rate had recently sped up. "It's a weird idea that unsettles just about everyone, for it may mean that some mysterious pressure pervades all of space — repelling space from itself with increasing magnitude as the volume of the universe grows," the story read. That mysterious pressure has been named dark energy, and along with dark matter has garnered frequent features in this publication.



A September 1997 feature ended with: "perhaps someday you'll even open *Astronomy* to an article titled 'Case Closed for the Milky Way's Giant Black Hole.'" In 2022, the Event Horizon Telescope revealed this image of the Milky Way's central supermassive black hole. The case is now as closed as it can get! EHT COLLABORATION




In 1998, astronomers revealed that observations of distant type Ia supernovae showed the universe is now expanding faster than in the past. Over the years, this discovery has held up, indicating that dark energy is a significant contributing factor in our cosmos. This graph shows the brightness of distant supernovae plotted against their redshift, a proxy for distance. The blue line shows the best fit to the current observations, which match predictions for an accelerating universe. The white line indicates how bright such supernovae would appear in a universe with no dark energy. It predicts that distant explosions should appear brighter than they actually do. *ASTRONOMY*: ROEN KELLY, AFTER CARROLL, BRADLEY W. AND OSTLIE, DALE A., AN INTRODUCTION TO MODERN ASTROPHYSICS, 2ND ED., PEARSON EDUCATION, INC., 2007.

The Wilkinson Microwave Anisotropy Probe (WMAP) launched in 2001 to view the CMB with better resolution. It saw an "absurd universe," said a November 2003 story, in which normal matter made up a miniscule fraction of a percentage of the total contents of the cosmos. Instead, dark matter and dark energy dominated.

In October 2013, *Astronomy* featured the Planck satellite's first cosmology results. Planck gave the most detailed look at the CMB to date, updating our estimates of the universe's contents to 68.3 percent dark energy, 26.8 percent dark matter, and 4.9 percent normal matter. It confirmed WMAP's finding of the universe's age: 13.8 billion years. These values and others derived from the three satellites' observations have honed our understanding of the Big Bang and how the universe has evolved to its present form.

But what about its future? All we know is that dark energy holds the key to how the cosmos will end. As of yet, astronomers cannot measure the cosmological parameter determining the universe's fate with enough accuracy to differentiate between scenarios. The most up-to-date information on our ideas about the beginning and end of the universe appears in our January 2021 special issue.

## EXOPLANETS EVERYWHERE

Our pages have documented the birth of entire branches of astronomy. One of the most compelling to emerge has been the study of extrasolar planets.

Let's start in September 1987. "Possible Planetary Systems Discovered" announced that, by looking for "wobbles" exhibited by stars in the presence of an unseen orbiting mass, astronomers had found two potential gas giant planets: one each around Gamma (γ) Cephei and Epsilon (ε) Eridani. (These remained unconfirmed until 2003 and 2000, respectively.)

Skip ahead to December 1991, when "The First Planet Beyond the Solar System" reported a Uranus-sized world around the pulsar PSR 1829-10. Researchers had found it by noting regular discrepancies in the timing of pulses received on Earth, and were now scrambling to confirm the find

## IT'S A BIG SOLAR SYSTEM

This magazine has witnessed many missions uncover the planets, asteroids, and comets of our solar system in stunning detail.

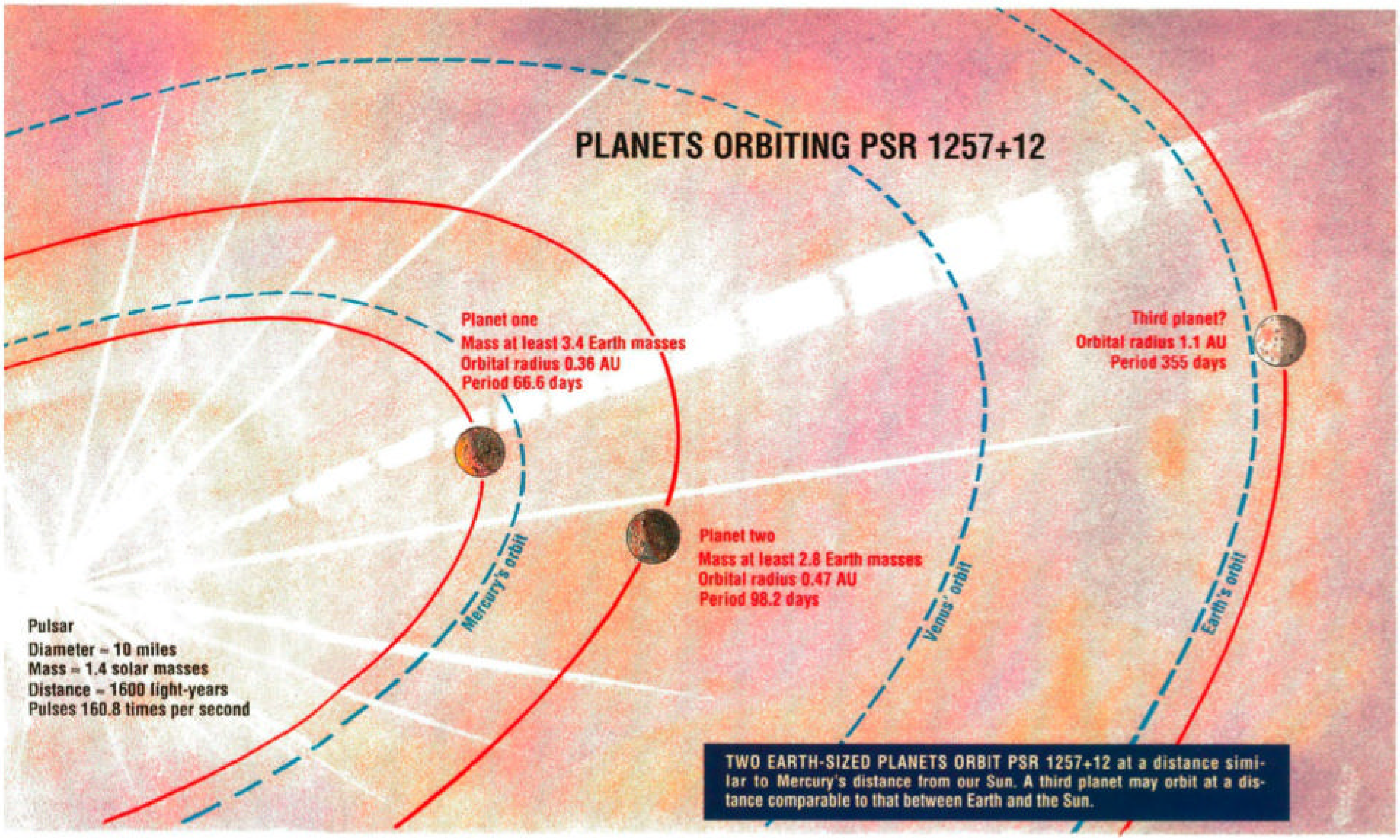
The Voyagers dominated much of *Astronomy*'s first two decades. Photo-rich stories recount our first looks at Saturn, Uranus, and Neptune, as well as our second glimpses of Jupiter (following Pioneer 10, which was featured in February 1974). The October 2017 issue was devoted to Voyager's 40th anniversary.

In the 2000s, Cassini and Huygens returned exquisite images from the saturnian system. (Our March 2018 issue was dedicated to them.) Jupiter has been visited multiple times, including by Galileo, Juno, and soon JUICE and Europa Clipper.

William K. Hartmann penned a 1976 article showing the first photographs from the Red Planet. "The Martians aren't to be seen yet," he wrote of Viking 1's finds. "But all conditions for life seem to be there, or at least were there in the past." An armada of missions since have confirmed that Mars was once warmer and wetter. Pioneer and then Magellan unmasked Venus' geologic complexity from above, while the Soviet Venera missions sent back tantalizing glimpses from the ground. MESSENGER charted Mercury's unique landscape and BepiColombo's mission to the innermost planet is still in its early stages.

It's not just planets that we've visited, either. Humankind has sent spacecraft zipping by comets and even shot one with an 800-pound (360 kilograms) impactor. We've tagged asteroids the same way,

## THE FIRST EXOPLANETS




This illustration appeared in the June 1992 story announcing the discovery of the first planets beyond our solar system. The worlds circled PSR 1257+12 — the remnant of a massive star. The system's third planet was later confirmed. *ASTRONOMY*: ROBERT WEGNER

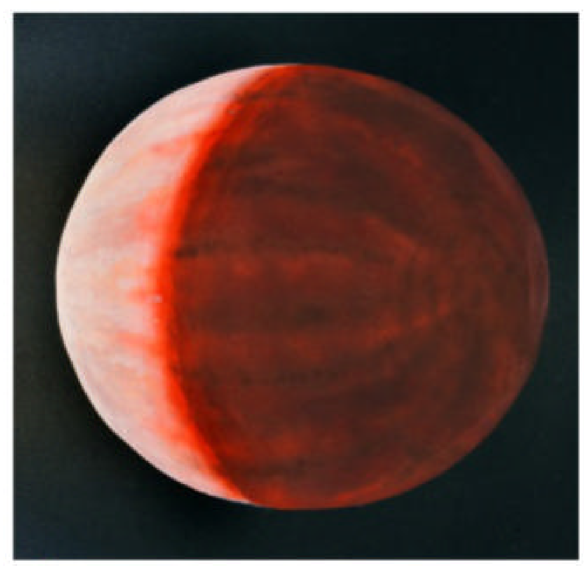
and figure out how a planet had even formed around a dead star.

In June 1992, readers learned PSR 1829-10's planet wasn't real. The pulse delays were due to Earth's orbit around the Sun. However, the story went on, astronomers had found a second pulsar, PSR 1257+12, showing similar behavior even with Earth's motion accounted for. At least two planets circled it. This is recognized as the first extrasolar system ever discovered. A January 1996 story confirmed a third planet and hinted at a fourth (later retracted).

Then, *Astronomy*'s March 1996 issue reported the discovery of 51 Pegasi b orbiting a Sun-like star. This planet was slightly heavier than Jupiter but closer to its star than Mercury to the Sun. Our theories of planet formation said it couldn't have formed there, so how had it gotten there? Perhaps it migrated inward?

By March 2000, all 33 known extrasolar planets were massive gas giants on either close-in or highly elliptical orbits. Researchers wondered whether our solar system might be the exception rather than the rule. (Today, we know that our solar system has characteristics of many others, but in several respects remains unique. We still need more data!)

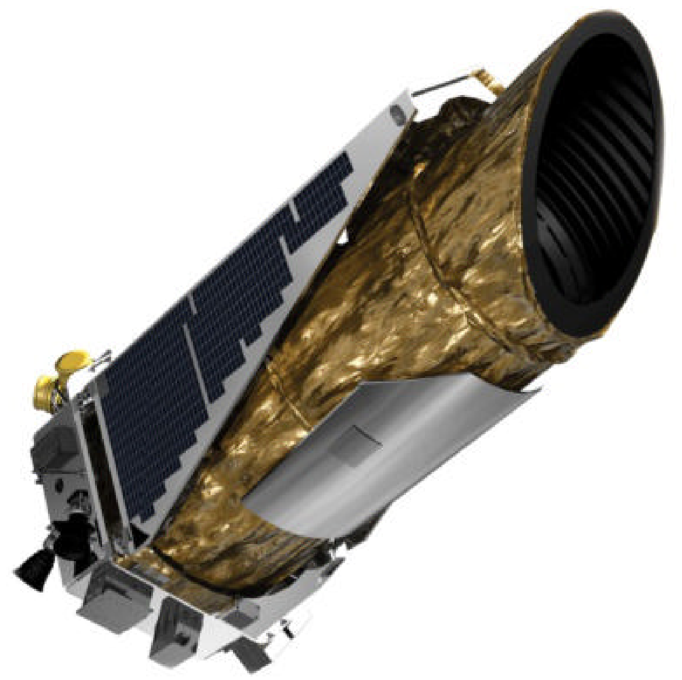
This state of affairs left astronomers itching to try a new detection technique: watching a planet transit its star. This method might find smaller, farther-out worlds that were difficult to spot via radial velocity. Dedicated to detecting transits, NASA's Kepler launched in March 2009 and had racked up five new planets by the time a November 2010 feature on the mission appeared. When it retired in 2018, Kepler had added thousands of known planets. The Transiting Exoplanet



51 Pegasi b, depicted in this artist's rendition, was the first planet discovered around a Sun-like star. It is considered a hot Jupiter — a massive gas giant orbiting close to its sun. WILLIAM HARTMANN

even returning samples to Earth for study. Dawn orbited the biggest worlds in the main belt, while Lucy is now on its way to study Jupiter's Trojans. And we continue to develop and launch spacecraft to study the center of it all: the Sun.

Every mission — and many more — appears within the pages of *Astronomy* as our solar system has become a vastly richer, more dynamic, and even more life-friendly place. —*A.K.*



Survey Satellite (TESS), featured in July 2017 and August 2021 stories, replaced it as NASA's main transit-seeking space mission, albeit with different capabilities and goals than Kepler.

Transits finally allowed astronomers to search for the Holy Grail: a planet like ours. We'd find one "any day now," according to the astronomers quoted in an August 2004 feature. But stories on the continuing search in April 2009, October 2010, and April 2011 showed that estimate had been optimistic. We finally spotted our first in 2014: Earth-sized Kepler-186 f, orbiting in at a distance where liquid water could exist.


The James Webb Space Telescope successfully launches aboard an Ariane 5 rocket on Dec. 25, 2021. NASA/BILL INGALLS

The Kepler spacecraft revolutionized our understanding of exoplanets, discovering thousands of worlds by watching stars for the subtle dimming caused by a planet transiting the disk. NASA

Other Earths remain elusive. To date, just 4 percent of the 5,000-plus known planets are Earth-mass or smaller. Astronomers have uncovered, however, a type of planet absent from our solar system. A January 2005 story revealed three so-called super-Earths. Though massive (15 to 20 Earths), all were small enough to possibly be rocky worlds. Such planets have since become some of the most frequently found, featuring in stories from November 2008 and April 2017.

## THE ERA OF SPACE TELESCOPES

In November 1976, a preview appeared for an orbiting observatory with a 2.4-meter mirror. Called the Space Telescope, it would study the universe from above Earth's pesky atmosphere. Ten years later, *Astronomy*'s March 1986 issue looked ahead at the Hubble Space Telescope's (HST) upcoming August launch.

But the March issue had gone to press before the tragic *Challenger* disaster in January grounded all shuttles for nearly three years, postponing Hubble's launch. So it was the July 1990 issue that celebrated HST's arrival in space. Then came a November report explaining that due to a mirror-grinding error resulting in spherical aberration, the telescope was not performing as expected. A solution would take time; meanwhile, observations continued. In some cases, blurry images could be processed to re-create the sharp eyesight the scope should have had, so Hubble photos quickly began to grace *Astronomy*'s pages.

In late 1993, astronauts finally placed corrective optics in the telescope, in orbit. An April 1994 story contains a triumphant quote from space telescope project scientist Ed Weiler: "Hubble is fixed beyond our wildest expectations." Now the Hubble images were truly breathtaking.

Follow our Hubble-based headlines and you'll see how it transformed so many aspects of astronomy, from our solar system to the most distant galaxies we'd ever seen. *Astronomy* followed HST through every servicing mission

JWST's first released science image was of the galaxy cluster SMACS 0723. This infrared view took only 12.5 hours to achieve; Hubble's deepest fields have taken weeks to gather light from such early galaxies. NASA, ESA, CSA, STSCI and celebrated its anniversaries, including an issue devoted to the space telescope in April 2015.

You'll also find mentions of HST's impending demise — which has, fortunately, not yet occurred. But a May 1998 feature explained how the 8-meter Next Generation Space Telescope might take over from Hubble (which was then expected to retire in 2005). Tentatively launching in 2007, this behemoth would sit far from Earth and explore the universe's earliest galaxies by peering into the cosmos at infrared wavelengths.

Sound familiar? This would become the 6.5-meter James Webb Space Telescope (JWST). Admittedly, a few numbers were a bit off.

By August 2005, JWST had a new projected launch date of 2011. A feature in September 2010 showed the observatory taking shape for its late 2014 or early 2015 launch. An August 2014 behind-the-scenes tour of the scope's ongoing construction (for a launch now predicted for 2018) noted that engineers were testing and retesting every system. JWST could not be serviced once in space and no one wanted a Hubble-type mistake.

After more delays, including a worldwide pandemic, *Astronomy* celebrated the scope's successful debut in the February 2023 issue, naming it the top astronomy story of 2022. This June, JWST's early discoveries netted a full-length feature, including the deepest ever infrared image of the universe.

JWST, like Hubble, promises to revolutionize the field of astronomy. Here's a taste: In June 1988, a story explored how the discovery of ever-more-distant galaxies was shaking up theories about how soon after the Big Bang such objects could exist. Deeper observations were pushing back the time by which galaxies could have formed earlier than imagined. Now, JWST has potentially discovered mature galaxies a mere 500 million to 700 million years after the Big Bang. Our picture of the early cosmos may be about to change yet again.

The pages of *Astronomy* have shown that for every answer uncovered, several new questions spring up that could never have been asked before. There's still so much left to discover, and we will be here to cover it all!

*Astronomy* ran this iconic photo of Hubble drifting gently away from the space shuttle *Discovery* after the telescope's successful deployment in April 1990. NASA

HST suffered from spherical aberration that initially severely limited the observatory's vision. In 1993, astronauts installed the COSTAR package to correct the issue. These images show the galaxy M100 before (left) and after (right) the fix. NASA

*Senior Editor* **Alison Klesman** *hasn't been alive for the magazine's entire run, but she did study Pluto when it was still a planet.*

# How amateur astronomy has evolved

Our hobby has gone through some major changes since August 1973. BY MICHAEL E. BAKICH

With this issue, *Astronomy* celebrates its 50th anniversary. I bought the first issue of the magazine from a newsstand in Columbus, Ohio. While the stories eventually drew my interest, I was more fascinated with the ads. With the turn of each page, my question was, "Is there anything new that can help me observe?"

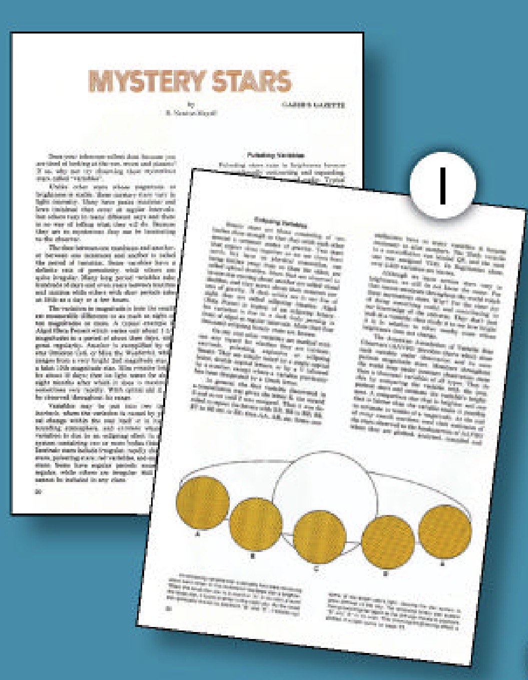
Things haven't changed much. Now — as I begin construction on a new observatory — my interests tend more toward innovative mounts and eyepieces rather than scopes and cameras. But doing something new makes me think of all the innovations that have led to this point. With that mindset, I offer a look at some of the benchmarks of our hobby that have taken place during the past 50 years. If I missed anything significant, please let me know by sending an email to mbakich@astronomy.com.

## The 1970s

On April 7, 1973, while the first issue of *Astronomy* was being laid out, the Astronomical Association of Northern California conducted the first Astronomy Day. This celebration of the sky was the brainchild of the club's president, Doug Berger. A number of scopes were set up in busy locations so that passersby could enjoy a free look at the 27-percent-illuminated Moon, as well as Saturn, only 5° to our satellite's lower right in the western sky. The event was popular and now hundreds of clubs around the world participate.

Both Celestron and Meade had been established in the early part of the decade, and their products were rising in popularity. During the year *Astronomy*

1970s


MYSTERY STARS

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debuted, Celestron offered a 14-inch Schmidt-Cassegrain telescope. And while you could purchase the optical tube assembly separately, the company included a tripod, a 26mm Plössl eyepiece, and a wedge, which turned the mount into an equatorial one that could compensate for Earth's rotation. Amateur astronomers could unpack the boxes and observe on the same night!

In 1975, California companies Orion Telescopes & Binoculars and DayStar Filters began operation. Orion started as a retailer rather than a manufacturer, and offered a wide range of products. DayStar was the first company to produce Hydrogen-alpha filters for amateur astronomers to observe the Sun in that wavelength. Both companies are still going strong today.

Mobile astronomy saw a major innovation in 1976, when New Jersey-based Edmund Scientific introduced the Astroscan, a fire-engine red 4.1-inch f/4.2 reflector. The scope, whose length was less than 18 inches (45.7 cm), had a rounded base that sat atop a fitted stand you could place on a table.


4

What most observers did, however, was sit in a chair and cradle it. Many thousands were sold until it was discontinued in 2013.

In 1978, Kodak released its Technical Pan Film, an extremely fine-grain panchromatic (responsive to all wavelengths) black-and-white film. It wasn't just the grain that amateurs liked, though. Tech Pan had low reciprocity failure, meaning its speed remained constant during long exposures. It also was sensitive to the Hydrogen-alpha wavelength (6562.8 Angstroms), which made it a good choice for photographers imaging nebulae. The company officially discontinued the film in 2014 (but had stopped making it at least a decade earlier).

As the decade closed, one of the most popular star parties began operation. In August 1979, the first Texas Star Party was held at Davis Mountains State Park. Three years later, it moved to the Prude Ranch in Fort Davis, where it's been held ever since.

## The 1980s

The first year of this decade was a big one. In *Astronomy*'s March issue, amateur Don Machholz made the first written mention of a "Messier marathon." Springtime observing hasn't been the same since.

Large-scope observing became common for amateur astronomers when Coulter Optical introduced the Odyssey I, a 13.1-inch Dobsonian-mounted reflector. It sold for $395. Tele Vue Optics started a trend

1 The first issue of *Astronomy* included numerous ads, feature stories, and columns that focused on observing, like this one by R. Newton Mayall. *ASTRONOMY*

2 Astronomy Day activities now happen around the world. This picture was taken in 2015 at the Digha Science Centre & National Science Camp, New Digha, West Bengal. BISWARUP GANGULY/WIKIMEDIA COMMONS

3 Celestron Schmidt-Cassegrain telescopes brought high-quality views of celestial objects to observers. GEOF/WIKIMEDIA COMMONS

4 Hydrogen-alpha filters allowed amateurs to view a lot more on the Sun than just spots. MICHAEL P. CALIGIURI

5 Edmund Scientific's AstroScan was a highly portable Newtonian reflector that could be set up on a table or handheld. ANDREWBUCK/WIKIMEDIA COMMONS

6 Each annual Texas Star Party attracts amateur astronomers from all over the world. ERICA RIX

5


6

in wide-field eyepieces when it introduced the 13mm Nagler, which sported an 82°-wide apparent field of view. And a 13-part PBS television series called *Cosmos: A Personal Voyage* debuted Sept. 28.

The following year, the era of the apochromatic refractor began when Astro-Physics produced the first oil-spaced triplet objective lenses. The company labeled them "color free." On Sept. 16, 1982, now-Editor David J. Eicher began working at *Astronomy*. He's been with the magazine — working pretty much every job — 41 out of its 50 years.


7 Late March is the time amateur astronomers gear up for the Messier marathon, a night when all M objects are in view. This image shows M95 (right), M96 (bottom), and M105 (brightest on left). DANIEL B. PHILLIPS

8 Many comets shone brighter than Halley's Comet in 1986, but none generated as much excitement. NASA/W. LILLER

9 This Celestron StarSense Explorer reflector sits on a Dobsonian mount. CELESTRON

10 Vic Maris started Stellarvue Telescopes in 1997. STELLARVUE

11 Comet Hale-Bopp was the most observed comet in history — by far. PHILIPP SALZGEBER/WIKIMEDIA COMMONS

12 Since the turn of the millennium, astronomical tourism has been on the rise. This group visited Easter Island for the total eclipse on July 11, 2010. MICHAEL E. BAKICH

Two major amateur get-togethers began mid-decade: The Okie-Tex Star Party in 1984 and the Winter Star Party in 1985. Also in 1985, the first mention of a CCD camera for sale appeared in *Astronomy*. It was five short lines of text in the "Astronomical Equipment Directory."

It was also in the 1980s that amateurs embraced the concept of astronomical tourism. The main reason was that lots of us were smitten with the idea of seeing Halley's Comet, which, at its peak in March and April 1986, was a much better sight from the Southern Hemisphere. Supernova 1987a, which appeared in February of that year, also was a draw to southerly locales.

## The 1990s

Imagers who were early adopters of CCD cameras rejoiced as the 1990s began and Adobe Systems released Photoshop. The following year, amateurs who wanted to try their hand at making a telescope could buy a copy of John Dobson's book, *How and Why to Make a User-Friendly Sidewalk Telescope*. The so-called Dobsonian revolution had begun (and continues today).

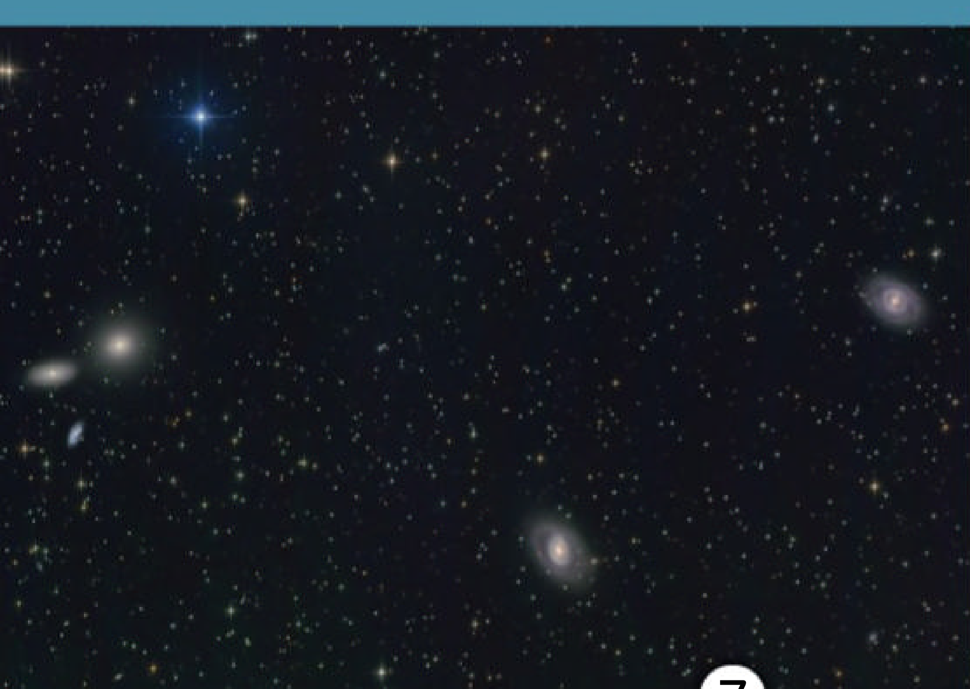
For those who chose to buy a scope rather than build one, finding and tracking objects got a lot simpler when, in 1992, Meade Instruments began selling the first successful amateur go-to telescope: the LX200.

A pair of popular telescope companies got their start in the 1990s as well. Rick Singmaster founded Starmaster Portable Telescopes in Arcadia, Kansas, and Vic Maris started Stellarvue Telescopes in Auburn, California.

Amateur astronomers — especially those who were active in astronomy clubs — also remember the '90s for three amazing comets that caught the public's attention in major ways. The first was the impact of Comet Shoemaker-Levy 9 (which had been discovered in March 1993) with Jupiter. Twenty-one fragments of the comet hit the giant planet in July 1994. I recall doing as many as 10 lectures a night about the impact at the Astronomical Society of Kansas City's public observatory in Lewisburg, Kansas. Good times.

Second was the close approach of Comet Hyakutake in March 1996. At a distance of only 9.3 million miles (15 million kilometers), it sported a colorful

1980s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1990s


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(green! blue! purple!) tail that stretched more than halfway across the sky. With its head near Polaris and its tail stretching through Leo, if you saw it from a dark site, you'd never forget it.

And then came Comet Hale-Bopp. Visible to naked eyes for a year and a half, it reached perihelion (its closest point to the Sun) April 1, 1997. It holds the record for the most-observed comet in history — by far. But more than being great sights, these three comets — especially Hale-Bopp — were responsible for substantial increases in telescope sales, astronomy club membership, and magazine subscriptions.

## The new century

The past two decades have contributed significant improvements to telescopes, mounts, cameras, and accessories. But by far the greatest leaps have been in the area of image processing.

As of this writing, Photoshop is up to version 24 (and it can't even open files created by its 1990 incarnation). Other image-processing programs include DeepSkyStacker, GIMP, PixInsight, Registax, SiriL, and Star Tools.

The astronomical (yes, I said it) rise in cellphone usage has triggered a major influx of astronomy-related apps. One set — dubbed planetarium software — offers detailed, full-sky celestial maps that will identify anything you point the phone at.

Telescope companies also are starting to embrace cellphone tech. In 2022, Celestron introduced its StarSense Explorer line. These telescopes incorporate simple (also inexpensive) alt-azimuth mounts and the GPS feature in your phone. Using the company's free app, which guides you via arrows, you move the telescope by hand until the bull's-eye is on your chosen celestial target.

With regard to events, the 21st century has seen a huge rise in what I like to call "eclipse tourism." A growing number of amateur astronomers are combining trips to view total solar eclipses with fanciful destinations. Since 2001, for example, my wife and I have been part of eclipse tours to South Africa, French Polynesia (including Pitcairn Island), Italy, Greece, Bolivia, Easter Island, Australia, Chile, and more.

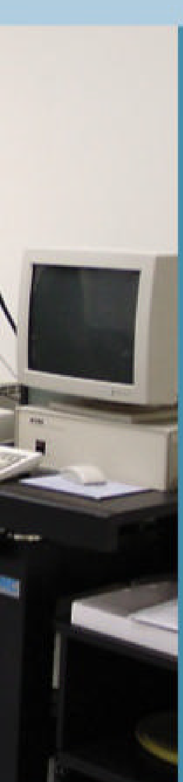
Eclipses closer to home, of course, can be just as amazing — and a lot less expensive to get to. The upcoming solar eclipse on April 8, 2024, will provide another grand spectacle for millions of amateur skywatchers across the U.S. Make sure you see it so that it becomes part of your personal astronomical history.

## The future

During my entire time with *Astronomy*, I've made a single correct prediction about the future of our hobby: I said that telescopes would eventually have "one-button" setup. Turn it on, give it some time, and observe. That said, my record is better than most people I know.

My point is that it's hard to predict where inventive minds and advances in technology will take amateur astronomy. But it will be a grand journey, and we'll all benefit from the results. Here's to another spectacular 50 years.

**Michael E. Bakich** *is the oldest person ever to work for* Astronomy. *His life spans the history of our beloved hobby.*



Visible to the naked eye
Visible with binoculars
Visible with a telescope

THE SOLAR SYSTEM'S CHANGING LANDSCAPE AS IT APPEARS IN EARTH'S SKY.

BY MARTIN RATCLIFFE AND ALISTER LING


Saturn (at right) and Jupiter (left) dominate the morning sky this month. The ringed planet offers especially good viewing as it reaches opposition. ALAN DYER

# Saturn's time to shine

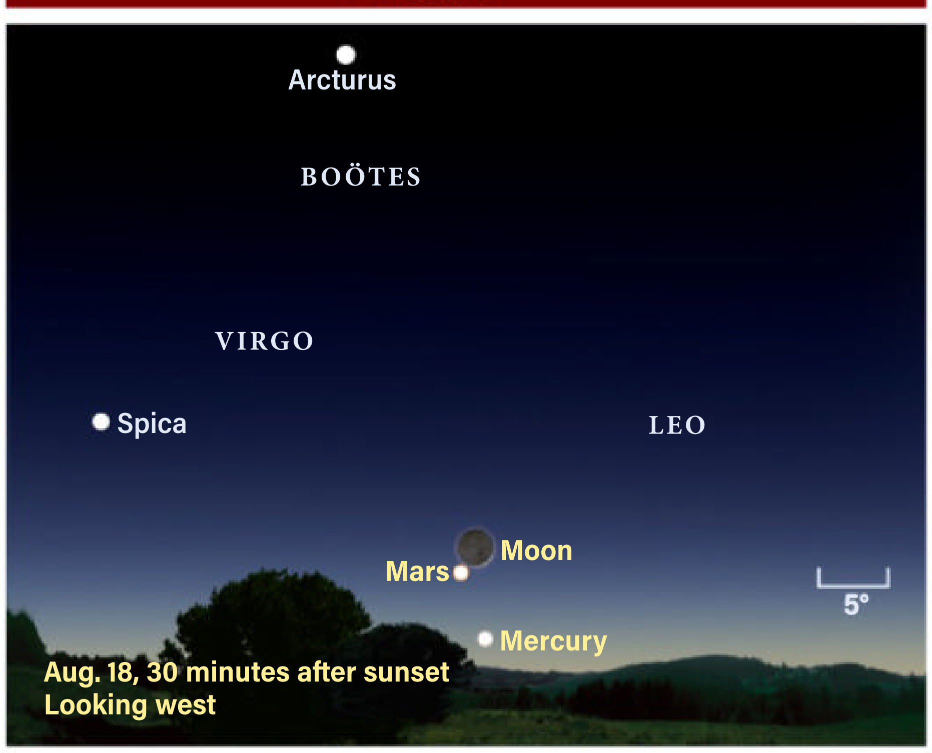
The gas giants reign as spectacular objects overnight; their moons also attract attention. Our evening sky has a rapidly diminishing view of Mercury, with Mars difficult to spot. Morning carries Uranus and Neptune, easily viewed in binoculars. And in the second half of August, Venus returns as a brilliant object in the predawn sky.

**Mars** is challenging at magnitude 1.8 in the twilight sky, but you might get a glimpse on Aug. 18, when it stands 1¼° south of a waxing crescent Moon in the west after sunset. The pair sets just over an hour after the Sun and Mars becomes increasingly harder to spot as its altitude declines. Find the Moon first, then search for Mars.

On Aug. 1, **Mercury** stands 6° high in the western sky 30 minutes after sunset, shining at magnitude 0.1. The planet dims to magnitude 0.4 by Aug. 10 and is now 5° high half an hour after sunset. It's nearly 5° lower than Mars, but the Red Planet is much fainter and less visible.

One day earlier, on the 9th, Mercury reaches greatest eastern elongation, when it stands 27° east of the Sun. However, the low angle of the ecliptic renders the planet difficult to see; it is more favorable for Southern Hemisphere observers. On the 18th, while you're searching for Mars near the Moon, Mercury sits some 6° below our satellite. It's very close to the horizon, too low to be easily seen.

### A little lunar assistance




You might spot Mars using the help of the slim crescent Moon Aug. 18. Mercury, though brighter than the Red Planet, sits extremely low to the horizon. ALL ILLUSTRATIONS: *ASTRONOMY*: ROEN KELLY

**Saturn** reaches opposition Aug. 27 and the ringed planet is visible from dusk to dawn. On Aug. 1, Saturn rises by 9:30 P.M. local daylight time and is well placed 25° above the southeastern horizon by midnight. It's located in Aquarius the Water-bearer. The planet reaches its opposition magnitude of 0.4 by Aug. 16.

The night of Aug. 2/3, Saturn stands within 4° of a bright, nearly Full Moon. The Moon returns to Aquarius Aug. 30, when the two stand 6° apart a few hours after rising. Also near Saturn is the bright 1st-magnitude star Fomalhaut, located 20° southeast of the planet in Piscis Austrinus.

Telescopic views reveal the sunlit northern side of the rings, which are tilted earthward by 8° in early August. Their angle increases to 9° by the 31st. In just a few years, the rings will appear edge-on with only a small annual fluctuation. The disk of Saturn spans 19" at opposition — pretty impressive when viewing it from a distance of 820 million miles. Saturn's rings span 43", more than double the disk's width.

Experienced observers will look for the Seeliger effect, a brightening of the rings at opposition when the shadows of ring fragments are hidden from view as the illuminating Sun stands directly behind us. Observe the rings over a few nights around the 27th to see whether you notice the effect. You might also record Saturn photographically to create a permanent record.

Three separate rings are

## OBSERVING HIGHLIGHT

**SATURN** reaches opposition Aug. 27, rendering it visible virtually all night this month.

visible in small telescopes. The outer A ring is dusky. Under excellent conditions, its Encke Gap might be seen. A broader dark gap, the Cassini Division, is easily visible at the inner edge of the A ring. Interior to that is the brightest ring, the B ring. Darker and more ethereal than the A ring is the innermost C ring, also called the Crepe Ring for its diaphanous nature.

Orbiting Saturn in the same plane as the ring system is a collection of moons, many visible in small telescopes. Most obvious is Titan, which shines at magnitude 8.5. This moon's atmosphere gives it a slightly yellowish hue. It stands north of the planet Aug. 7 and 23, and south Aug. 15 and 31.

Fainter moons orbit closer to the rings. At opposition, they're at their brightest for the year. Rhea is brightest around magnitude 9.7, then Tethys around 10.3 and Dione at 10.5. Magnitude 11.9 Enceladus, which orbits every 33 hours, is challenging to see due to Saturn's brilliance. This icy moon sports active geysers near its southern pole.

Thanks to their orbital tilt, the moons now undergo transits and occultations with Saturn. Such events are more difficult to observe than their jovian counterparts due to the larger contrast between Saturn and its moons. For a challenge, see if you can spot Dione as it's occulted by Saturn on the

*— Continued on page 42*

## RISING MOON | Young and old together

**TYCHO AND CLAVIUS** are two longtime favorites of selenophiles. The duo stands out in the Moon's southern half in a magnificent play of light and shadow when the Sun rises over them on the 24th. Under a low Sun angle, Tycho's normally brilliant ray system is largely hidden from view. (It's best seen a few nights from now.) But there are enough hints pointing back to it. A different giveaway to its identity are the signs of its youth: a prominent deep bowl, sharp rim, and well-defined central peak. The vast majority of objects in the crater-crowded southern highlands are anything but young.

Clavius is the huge feature closer to the limb. Its debris-filled floor and softer rim are the telltale consequence of age-old battering by smaller impacts at the end of the solar system's period of heavy bombardment. Take a closer look inside the shallow bowl to see a neat curving chain of impact features. Over the course of an hour, track the shadows' retreat and spy the appearance of even smaller craters.

In the following nights, Tycho's rays become increasingly obvious. Also note the darker ring around its raised rim. The heat from the blast that formed it caused the surrounding surface to partially melt and lose its lighter shade. While Clavius never gets lost because it is so big and distinct, average-sized craters nearby that were obvious on the 24th are now practically unidentifiable amongst dozens of divots.

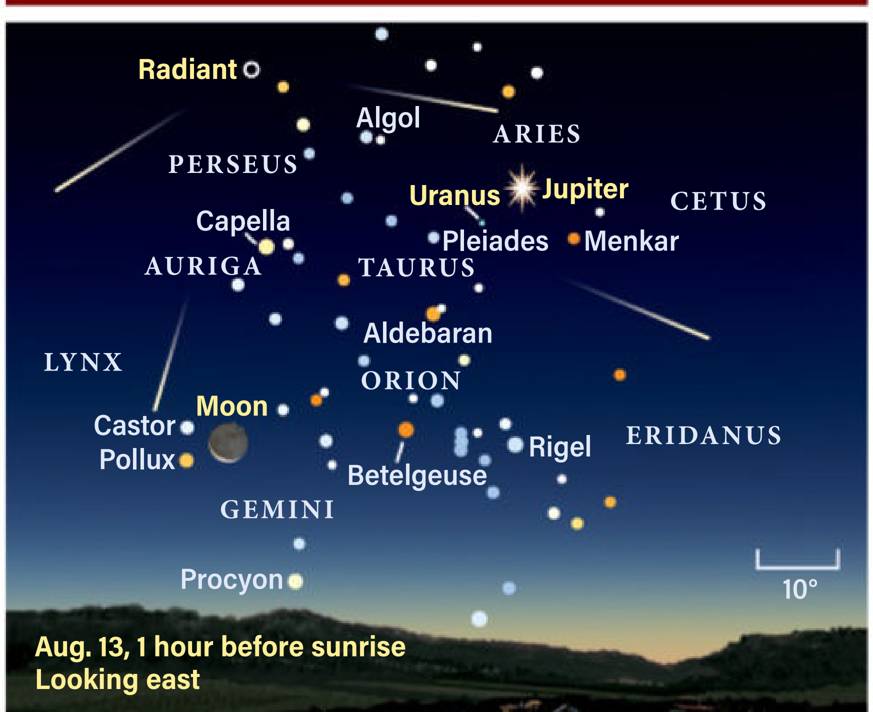
The region can be viewed under reverse lighting at 5 A.M. on the 7th and 8th, when the Moon is high in the south.

**Clavius and Tycho**


Without its rays illuminated, you'll need to use other indicators to identify Tycho.
*CONSOLIDATED LUNAR ATLAS*/UA/LPL. INSET: NASA/GSFC/ASU

## METEOR WATCH | Perseid prospects

**Perseid meteor shower**




Perseid meteors appear to radiate from the constellation Perseus — purely a perspective effect.

**PERSEID METEORS**
**Active dates:** July 17–Aug. 24
**Peak:** Aug. 13
**Moon at peak:** Waning crescent
**Maximum rate at peak:** 100 meteors/hour

**THE PERSEID METEOR SHOWER,** one of the year's best, peaks Aug. 13 with expected rates exceeding one per minute in the hour before dawn, even as a slender 8-percent-lit crescent Moon hangs in Gemini. This year is one of the more favorable times for North American observers, with the predicted peak starting around 3 A.M. EDT.

The best place to look for Perseids is typically at 45° altitude some 40° to 70° away from the radiant. A favorite constellation to watch during the Perseids is Cygnus, as many shower members run its length.

The shower is active from July 17 through Aug. 24. Around these dates the rates are very low, rising to a peak in the second week of August. The expected zenithal hourly rate on Aug. 13 is 100 meteors per hour. In the hour before dawn, Perseus is about 60° high, so expect a rate closer to 50 or 60 per hour at peak for North American observers (as the altitude of the radiant strongly affects the observable rate).

# STAR DOME

## HOW TO USE THIS MAP

This map portrays the sky as seen near 35° north latitude. Located inside the border are the cardinal directions and their intermediate points. To find stars, hold the map overhead and orient it so one of the labels matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

The all-sky map shows how the sky looks at:

11 P.M. August 1
10 P.M. August 15
9 P.M. August 31

Planets are shown at midmonth


## MAP SYMBOLS

- Open cluster
- Globular cluster
- Diffuse nebula
- Planetary nebula
- Galaxy

## STAR MAGNITUDES

- Sirius
- 0.0
- 1.0
- 2.0
- 3.0
- 4.0
- 5.0

## STAR COLORS

A star's color depends on its surface temperature.

- The hottest stars shine blue
- Slightly cooler stars appear white
- Intermediate stars (like the Sun) glow yellow
- Lower-temperature stars appear orange
- The coolest stars glow red
- Fainter stars can't excite our eyes' color receptors, so they appear white unless you use optical aid to gather more light

BEGINNERS: WATCH A VIDEO ABOUT HOW TO READ A STAR CHART AT **www.Astronomy.com/starchart.**


## AUGUST 2023

| SUN. | MON. | TUES. | WED. | THURS. | FRI. | SAT. |
|---|---|---|---|---|---|---|
| | | 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 | | |

ILLUSTRATIONS BY *ASTRONOMY*: ROEN KELLY

**Note: Moon phases in the calendar vary in size due to the distance from Earth and are shown at 0h Universal Time.**

## CALENDAR OF EVENTS

**1** Full Moon occurs at 2:32 P.M. EDT

**2** The Moon is at perigee (222,022 miles from Earth), 1:52 A.M. EDT

**3** The Moon passes 2° south of Saturn, 6 A.M. EDT

**4** The Moon passes 1.5° south of Neptune, 6 P.M. EDT

**8** The Moon passes 3° north of Jupiter, 6 A.M. EDT

Last Quarter Moon occurs at 6:28 A.M. EDT

The Moon passes 3° north of Uranus, 9 P.M. EDT

**9** Mercury is at greatest eastern elongation (27°), 10 P.M. EDT

**13** Perseid meteor shower peaks

Venus is in inferior conjunction, 7 A.M. EDT

**16** New Moon occurs at 5:38 A.M. EDT

The Moon is at apogee (252,671 miles from Earth), 7:54 A.M. EDT

**18** The Moon passes 1.1° north of asteroid Pallas, 7 A.M. EDT

The Moon passes 7° north of Mercury, 7 A.M. EDT

The Moon passes 2° north of Mars, 7 P.M. EDT

**23** Mercury is stationary, 1 A.M. EDT

**24** First Quarter Moon occurs at 5:57 A.M. EDT

The Moon passes 1.1° north of Antares, 10 P.M. EDT

**27** Asteroid Flora is at opposition, 4 A.M. EDT

Saturn is at opposition, 4 A.M. EDT

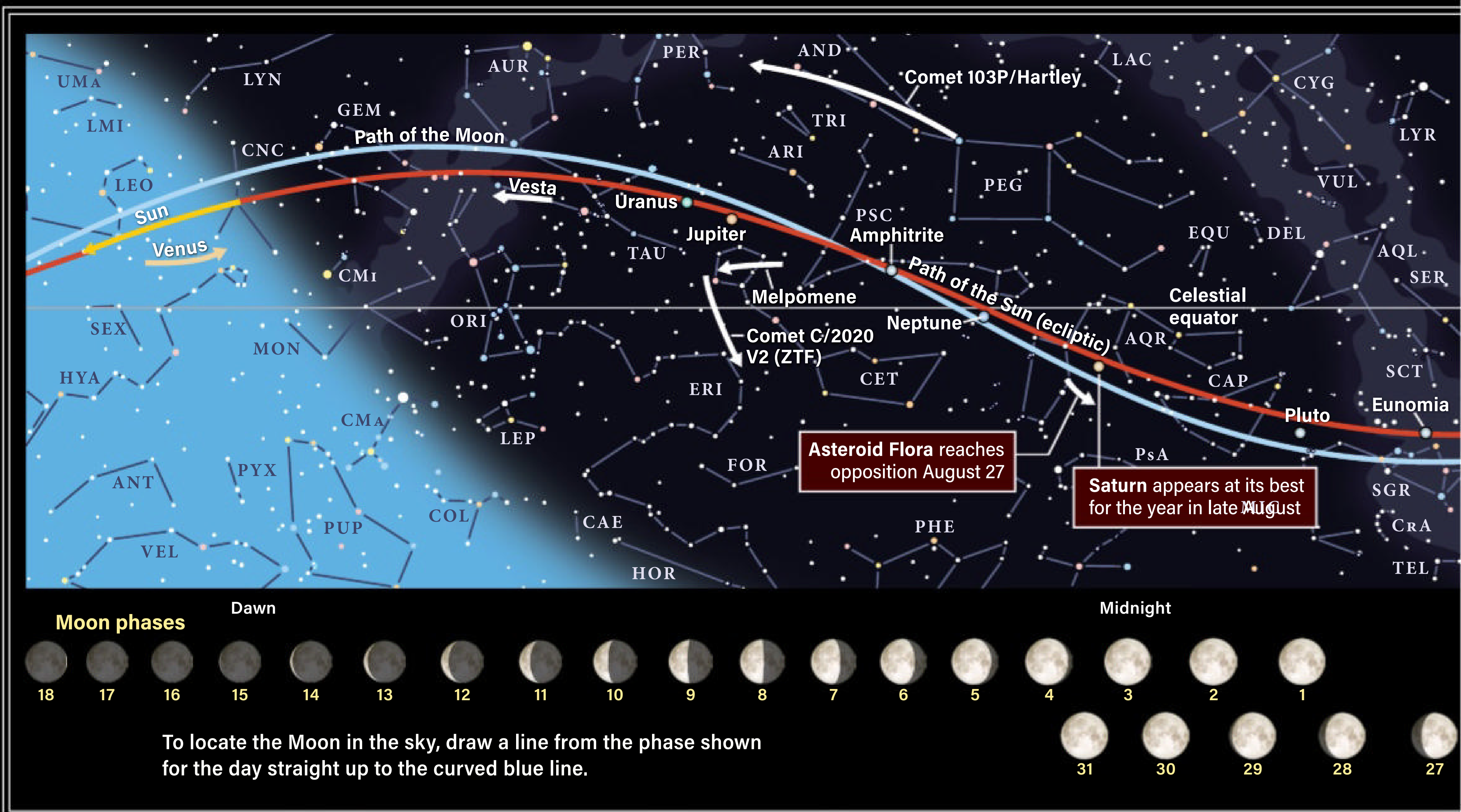
**28** Uranus is stationary, 11 P.M. EDT

**30** The Moon is at perigee (221,942 miles from Earth), 11:54 A.M. EDT

The Moon passes 2° south of Saturn, 2 P.M. EDT

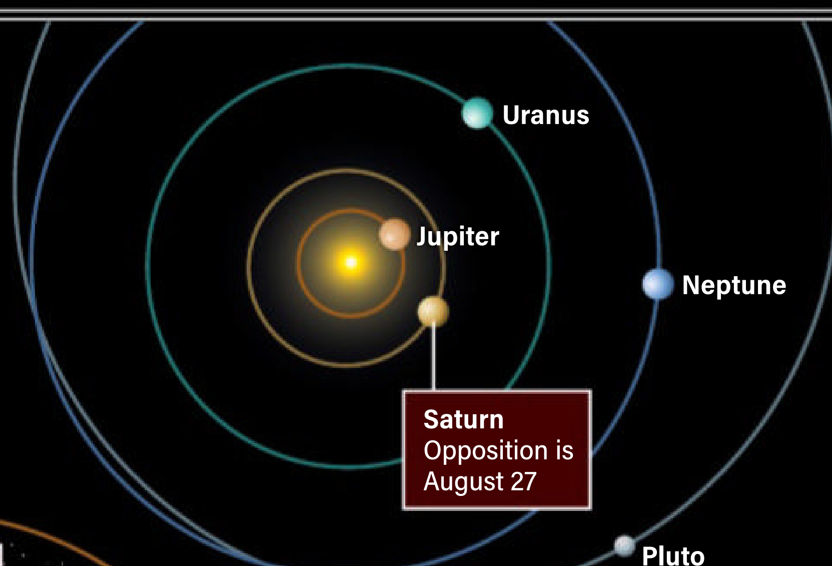
Full Moon occurs at 9:36 P.M. EDT

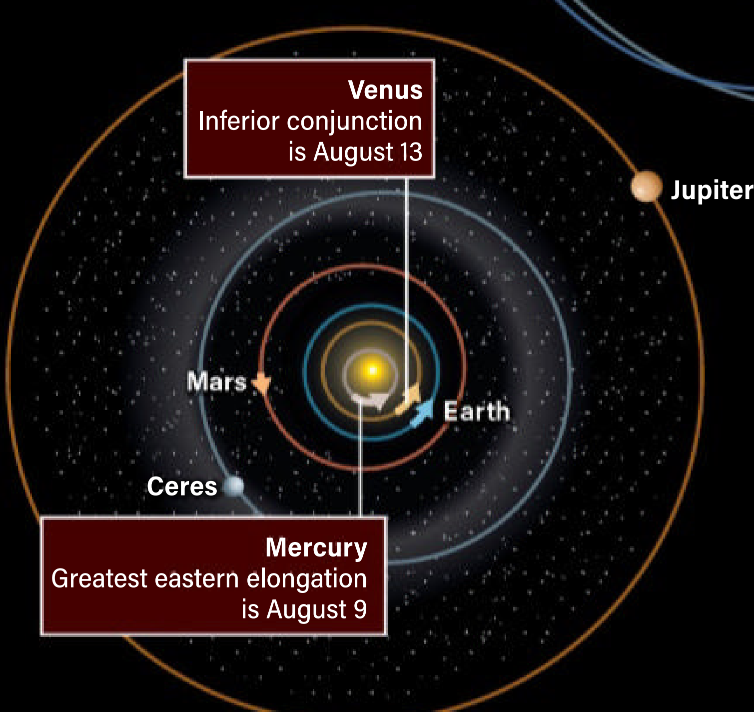
# PATHS OF THE PLANETS

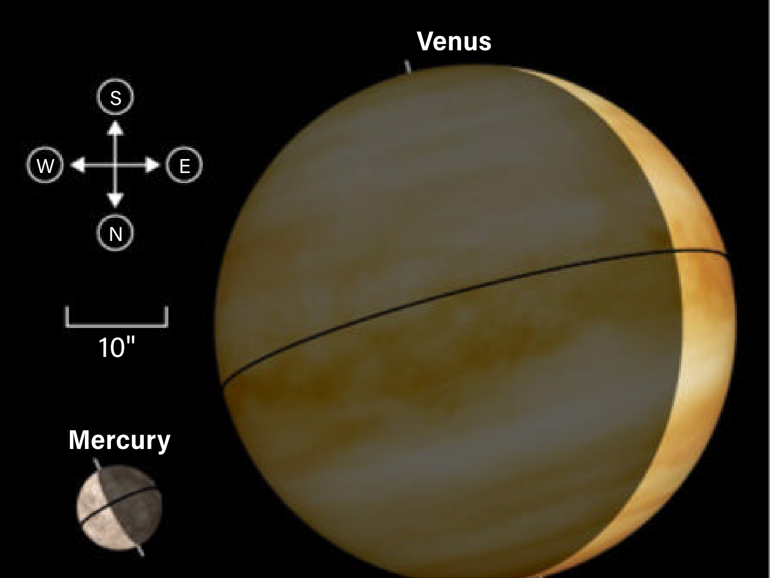



## THE PLANETS IN THEIR ORBITS

Arrows show the inner planets' monthly motions and dots depict the outer planets' positions at midmonth from high above their orbits.



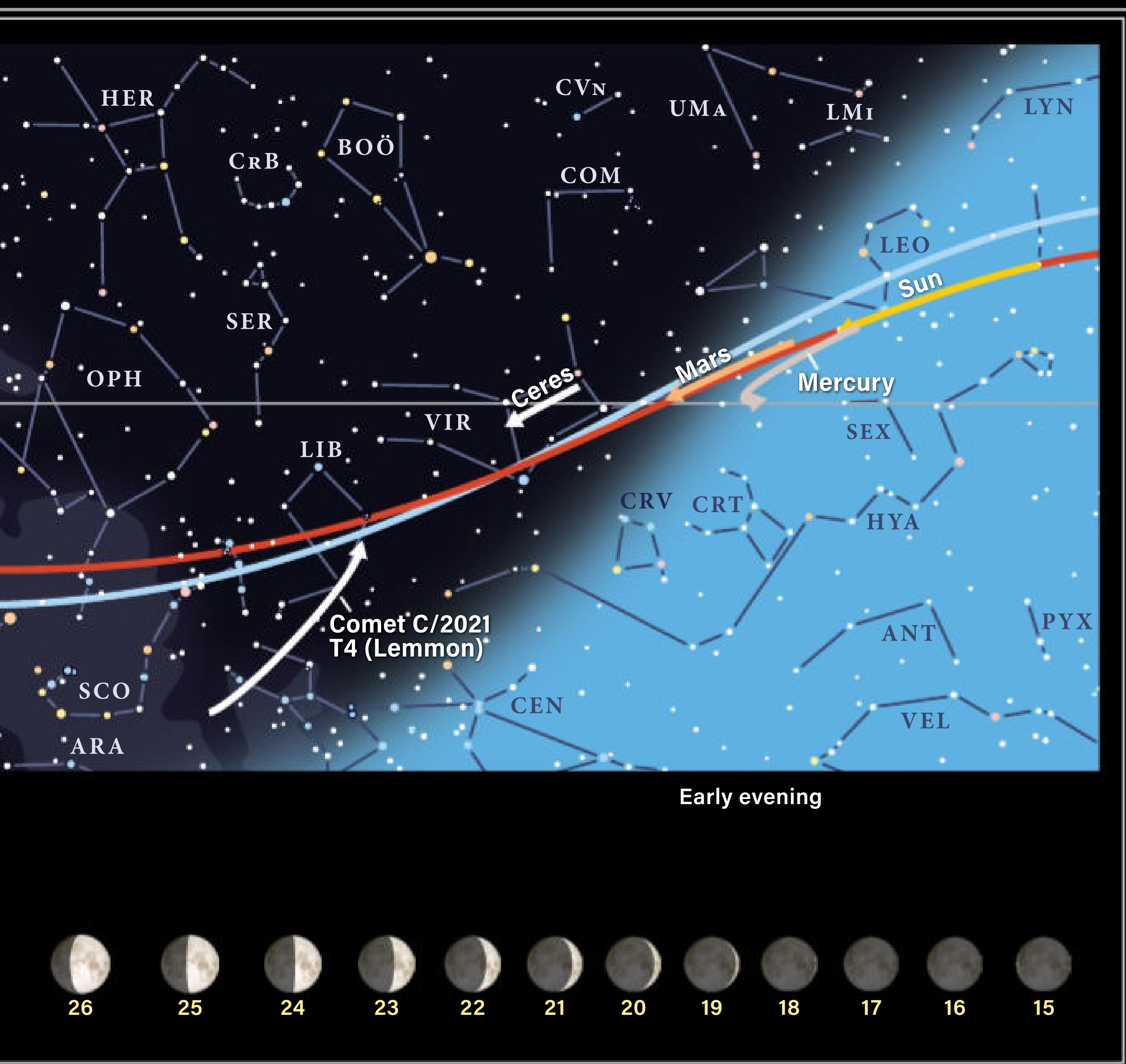




| PLANETS | MERCURY | VENUS |
|---|---|---|
| Date | Aug. 15 | Aug. 31 |
| Magnitude | 0.5 | –4.6 |
| Angular size | 8.2" | 50.6" |
| Illumination | 41% | 10% |
| Distance (AU) from Earth | 0.820 | 0.330 |
| Distance (AU) from Sun | 0.464 | 0.727 |
| Right ascension (2000.0) | 11h12.9m | 8h50.2m |
| Declination (2000.0) | 2°15' | 9°55' |

This map unfolds the entire night sky from sunset (at right) until sunrise (at left). Arrows and colored dots show motions and locations of solar system objects during the month.

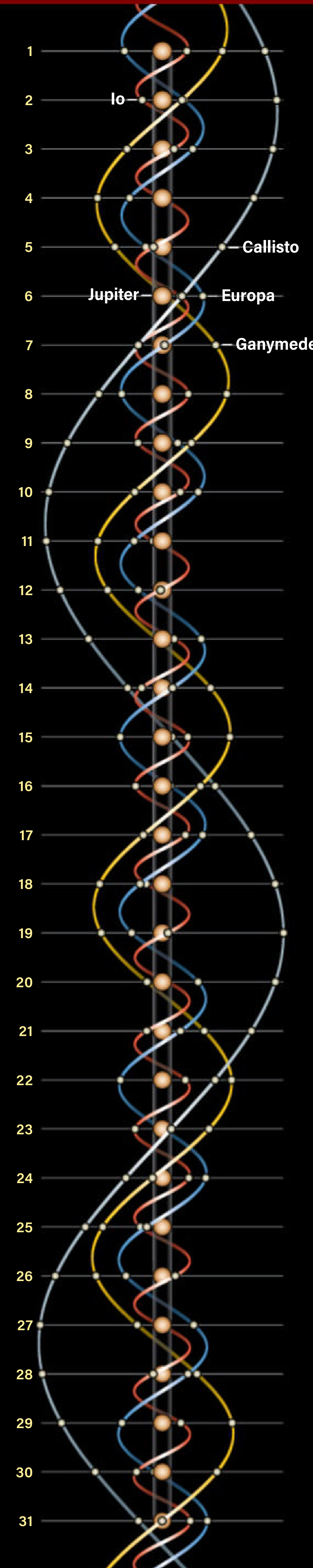
# AUGUST 2023





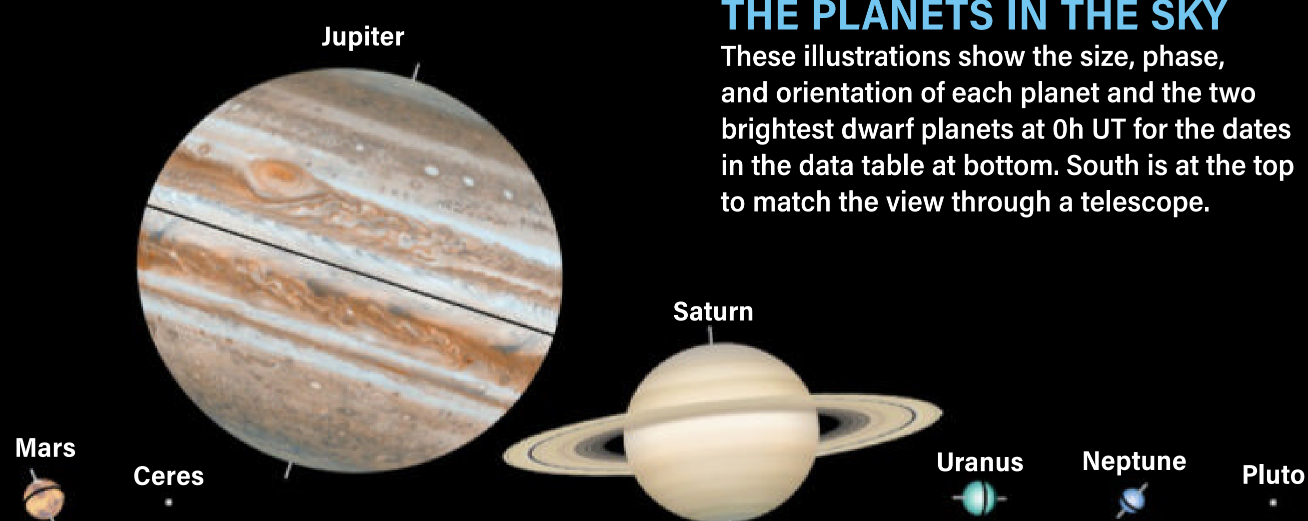
## JUPITER'S MOONS

Dots display positions of Galilean satellites at 4 A.M. EDT on the date shown. South is at the top to match the view through a telescope.



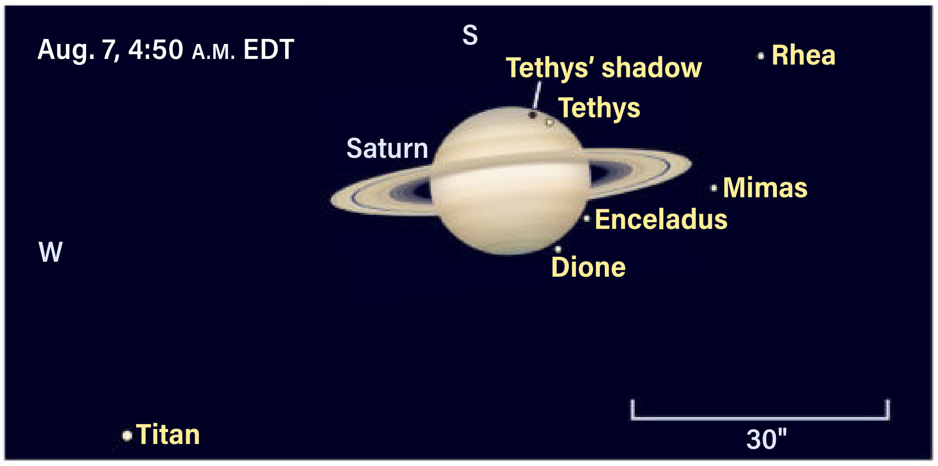

## THE PLANETS IN THE SKY

These illustrations show the size, phase, and orientation of each planet and the two brightest dwarf planets at 0h UT for the dates in the data table at bottom. South is at the top to match the view through a telescope.




| | MARS | CERES | JUPITER | SATURN | URANUS | NEPTUNE | PLUTO |
|---|---|---|---|---|---|---|---|
| | Aug. 15 | Aug. 15 | Aug. 15 | Aug. 15 | Aug. 15 | Aug. 15 | Aug. 15 |
| | 1.8 | 8.9 | –2.5 | 0.4 | 5.8 | 7.7 | 15.1 |
| | 3.8" | 0.4" | 41.6" | 18.9" | 3.6" | 2.3" | 0.1" |
| | 98% | 97% | 99% | 100% | 100% | 100% | 100% |
| | 2.434 | 3.083 | 4.736 | 8.786 | 19.628 | 29.074 | 33.898 |
| | 1.638 | 2.651 | 4.963 | 9.776 | 19.635 | 29.907 | 34.829 |
| | 11h30.7m | 13h13.3m | 2h49.9m | 22h27.8m | 3h21.4m | 23h50.4m | 20h03.8m |
| | 4°02' | –0°50' | 15°00' | –11°32' | 18°08' | –2°25' | –23°10' |

### Moons on the move




Aug. 7 is a busy morning for Saturn's moons. Shortly after Dione and Enceladus appear from behind the disk, Tethys and its shadow begin a transit. Note that Mimas, at magnitude 13, may not appear in some scopes.

morning of Aug. 7, when it skims the northern limb of the planet between approximately 3:15 A.M. and 4:45 A.M. EDT.

Exceedingly difficult is the reappearance of 12th-magnitude Enceladus from behind Saturn the same morning at 4:41 A.M. EDT, reappearing off the planet's northeastern limb. Meanwhile, a third event is occurring south of the rings. Tethys and its shadow begin a transit, starting with the shadow just before 4:40 A.M. EDT. The moon follows six minutes later. Many similar events will occur quite regularly now, given these moons' short orbital periods.

Iapetus lies far from Saturn, orbiting every 79 days. It reaches eastern elongation Aug. 1, standing 9' east of the planet. It's magnitude 11.9, with its darker hemisphere facing Earth. Iapetus brightens through the month; track it as it reaches inferior conjunction Aug. 20 at midnight EDT, just 25" northwest of Saturn and shining near 11th magnitude. The following night, it's already skipped nearly a full arcminute away, brightening as it goes. Iapetus reaches western elongation next month at magnitude 10.2.

**Neptune** rises just after 10 P.M. local daylight time on Aug. 1 and before 8:30 P.M. on Aug. 31. This brings it into the evening sky not far from the Circlet of Pisces. At magnitude 7.7, the planet is easy to confuse with the background stars, but its location just northwest of a line of three stars — 6th-magnitude 20 and 24 Piscium, and 5th-magnitude 27 Psc — aids with identification. You can find this trio of stars 5.6° southeast of Lambda (λ) Psc, the southeasternmost star in the Circlet. Can you spot Neptune's tiny, bluish 2"-wide disk through a telescope? It will depend on seeing conditions.

As August opens, Neptune forms an equilateral triangle with 20 and 24 Psc. From night to night, the planet tracks southwest toward 20 Psc, ending the month 19' from the star. Get familiar with this star — during next month's opposition, Neptune gets much closer!

**Jupiter** rises shortly after midnight on Aug. 1 and is best placed for observing in the hours before dawn, when it stands more than 40° above the eastern horizon. It is in Aries the Ram and shines vividly at magnitude –2.4 in early August. On the morning of Aug. 8, Jupiter is less than 2.5° from a Last Quarter Moon. Note the Pleiades (M45) in Taurus, some 16° to Jupiter's northeast.

## WHEN TO VIEW THE PLANETS

**EVENING SKY**
Mars (west)
Mercury (west)
Saturn (east)
Neptune (east)

**MIDNIGHT**
Jupiter (east)
Saturn (southeast)
Uranus (east)
Neptune (southeast)

**MORNING SKY**
Venus (east)
Jupiter (southeast)
Saturn (southwest)
Uranus (southeast)
Neptune (southwest)

Swing binoculars toward the gas giant and hold very steady — you'll likely spot a few bright moons. Step up to a telescope to truly reveal the jovian system of four Galilean moons and a planet replete with light and dark cloud bands. Note the

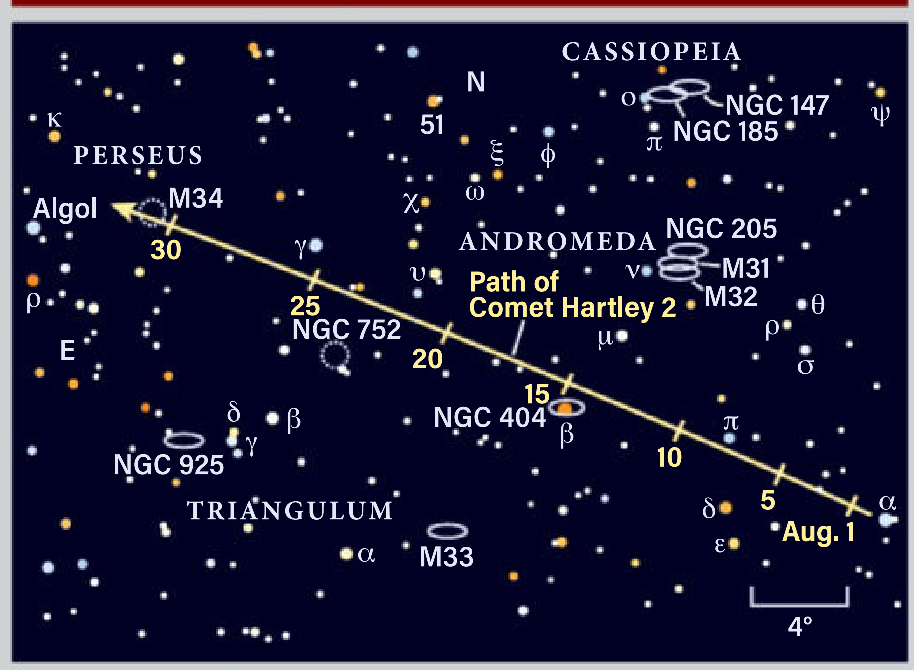
## COMET SEARCH | Location, location, timing

**FINALLY!** An extended period of decent comets begins, and we even have choices. Don't dally if you want to catch C/2021 T4 (Lemmon). Tracking northward into Libra, this 8th-magnitude fuzzball from the Oort Cloud is fading after its closest approach to the Sun July 31. Compare it with globular clusters such as the concentrated NGC 6144 near Antares, then diffuse NGC 5897. Because Lemmon is already setting in the southwest as it gets dark, be ready at the start of your observing session.

Better suited for late arrivals at the dark site is short-period (6.5 years) 103P/Hartley 2. Glowing a modest magnitude 10, Hartley slides from head to toe in Andromeda as it rises higher with each hour of the night. By midmonth, the comet is a second Ghost of Mirach, passing by Beta (β) Andromedae not far from the galaxy NGC 404. This object can catch imagers unawares, posing as an internal lens reflection of the bright star. The green glow of diatomic carbon around the comet's coma should make for a nice contrast with the gray smudge of the galaxy.

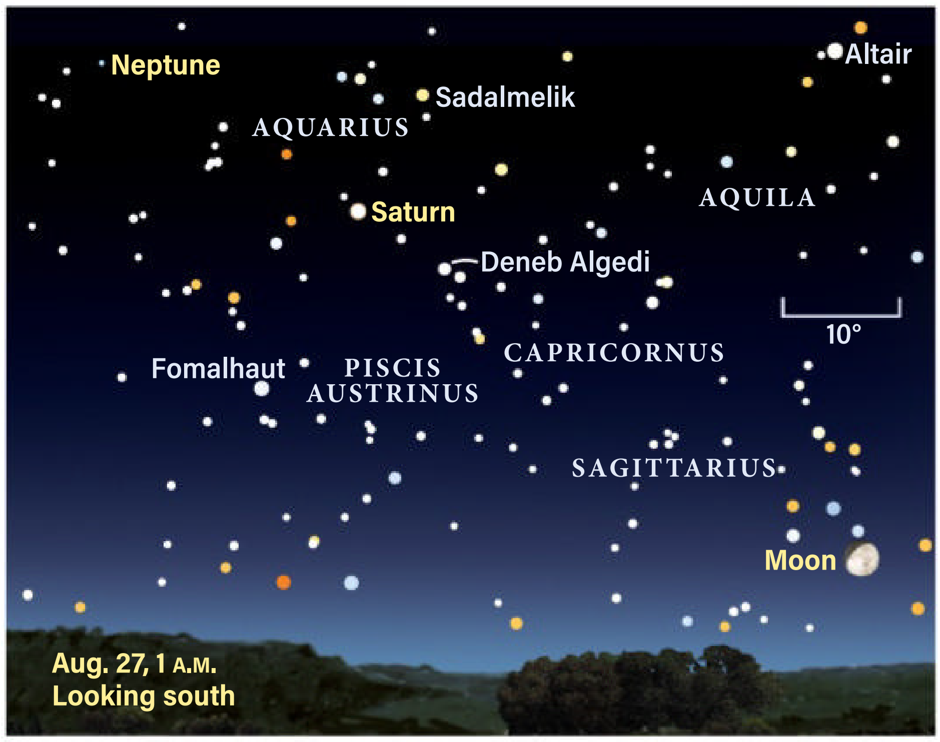
Despite the nearly Full Moon, catch Hartley 2 on the 31st when it is less than a degree from M34, a nice star cluster in Perseus.

### Comet 103P/Hartley 2




Comet Hartley 2 flies past several deep-sky objects in April. The comet mirrors the famous Ghost of Mirach midmonth.

## Southerly apparition




Saturn sits high in the south in the hours around local midnight at opposition. You'll need binoculars to locate Neptune, nearby in Pisces.

evident pair of belts straddling the equator. More subtle belts reside at northerly and southerly latitudes. Jupiter's fast rotation — just under 10 hours — carries cloud features, including the Great Red Spot, across the disk. Their movement is noticeable to an attentive observer within 10 to 15 minutes.

The Galilean moons orbit roughly every two to 17 days. Their changing relative positions are fascinating to watch, as are transits and occultations.

The morning of Aug. 3, Io's shadow falls on the jovian cloud tops at 4:45 A.M. EDT, followed by the moon itself at 5:07 A.M. CDT (right around sunrise on the East Coast). Europa follows suit midmonth. Its shadow begins a transit at 3:23 A.M. EDT on Aug. 14, followed by the moon at 5:12 A.M. CDT. Notice the longer gap between the transits of shadow and moon for Europa compared with Io — the latter has a smaller orbit.

Ganymede plays hide-and-seek for 77 minutes near Jupiter's north pole Aug. 13. The shallow angle of the limb slowly hides the moon around 5:33 A.M. EDT — you'll notice Ganymede dimming a few minutes before this. The large moon may appear to blend with the limb of Jupiter quite a bit earlier, depending on your seeing conditions. Ganymede reappears by 5:51 A.M. CDT, but be on the lookout earlier, again because it may reappear sooner.

Ganymede transits the south polar regions for an hour the morning of Aug. 31, from 3:26 A.M. to 4:27 A.M. EDT.

Note that the 5th-magnitude star Sigma (σ) Arietis lies close to Jupiter the last two weeks of the month, coming within an arcminute or two of the planet Aug. 21 and 22. Don't confuse the star with the moons — they're of similar brilliance.

**Uranus** stands between 7.5° and 9° northeast of Jupiter during August. It also lies in Aries and is a binocular object at magnitude 5.8. Uranus is best viewed in the hour before dawn, when it is 60° high in the southeast and roughly level with the Pleiades. Few other stars are nearby — the brightest are 4th-magnitude Delta (δ) and 5th-magnitude Zeta (ζ) Arietis, which stand 1.5° apart to Uranus' northwest. East of them is 63 Ari, a bit brighter than Uranus, which lies 2.6° south of this star. Uranus wanders slowly east and slows to a stop late on Aug. 28, then begins its retrograde motion. A telescope will show a 4"-wide disk with a greenish hue.

**Venus** passes inferior conjunction Aug. 13 and quickly springs into the morning sky as a bright object nearly 4° high 30 minutes before sunrise on Aug. 21. By the end of August, Venus is 26.5° west of the Sun and almost 10° high among the dim stars of Cancer about an hour before sunrise. A telescope will show a beautiful 11-percent-lit crescent spanning 50".

**Martin Ratcliffe** *is a planetarium professional with Evans & Sutherland and enjoys observing from Salt Lake City.* **Alister Ling**, *who lives in Edmonton, Alberta, is a longtime watcher of the skies.*



## LOCATING ASTEROIDS |
### A familiar place

**IF YOU DON'T KNOW** where M22 is, find out and return year after year. Located about 2.5° northeast of the tip of Sagittarius' Teapot (in the south for most readers), this massive globular cluster is an easy find in binoculars from a rural sky. M22 is our anchor point for an all-month stakeout of main-belt asteroid 15 Eunomia.

Thanks to the many dark dust lanes crossing the front of our Milky Way's core, magnitude 9 Eunomia won't be lost among throngs of more distant stars. On the other hand, its apparent motion is on the slow side, so we'll want to make a sketch of a star field and come back a night or two later to see which dot has moved. The 1st to the 2nd and especially the 6th through the 8th are the best opportunities. During the last third of August, Eunomia is almost the brightest dot in its region.

Discovered in 1851 by Annibale de Gasparis, the potato-shaped boulder spans a respectable 220 miles end to end and 130 miles across the middle, putting it among the top 10 largest bodies in the main belt. It appears to be the parent of an associated asteroid family formed by a collision long ago. Named for the mythological Greek personification of law and order, Eunomia was among the evidence used to demote asteroids to their own group from their original status as planets.

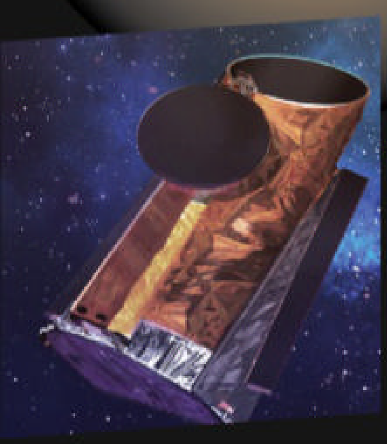
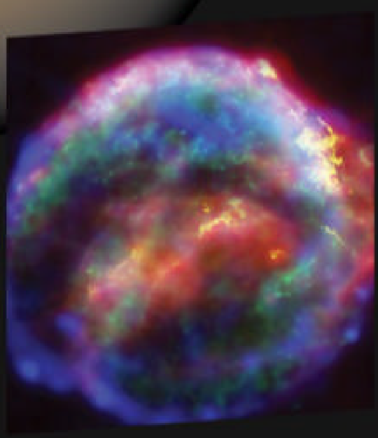
### Globulars galore

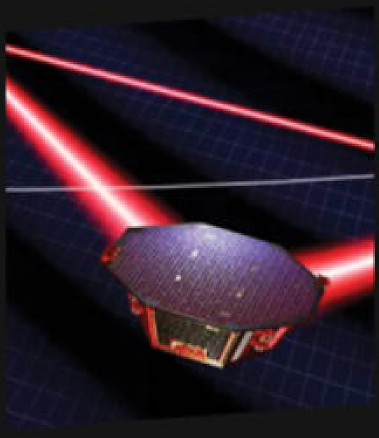

Eunomia traces a slow, curving path past several globular clusters — including M22 — near the galactic center this month.

# THE NEXT OF ASTRONOMY

What will astronomy look like in 2073? A panel of astronomers and planetary scientists give their predictions. EDITED BY MARK ZASTROW

# 50 YEARS



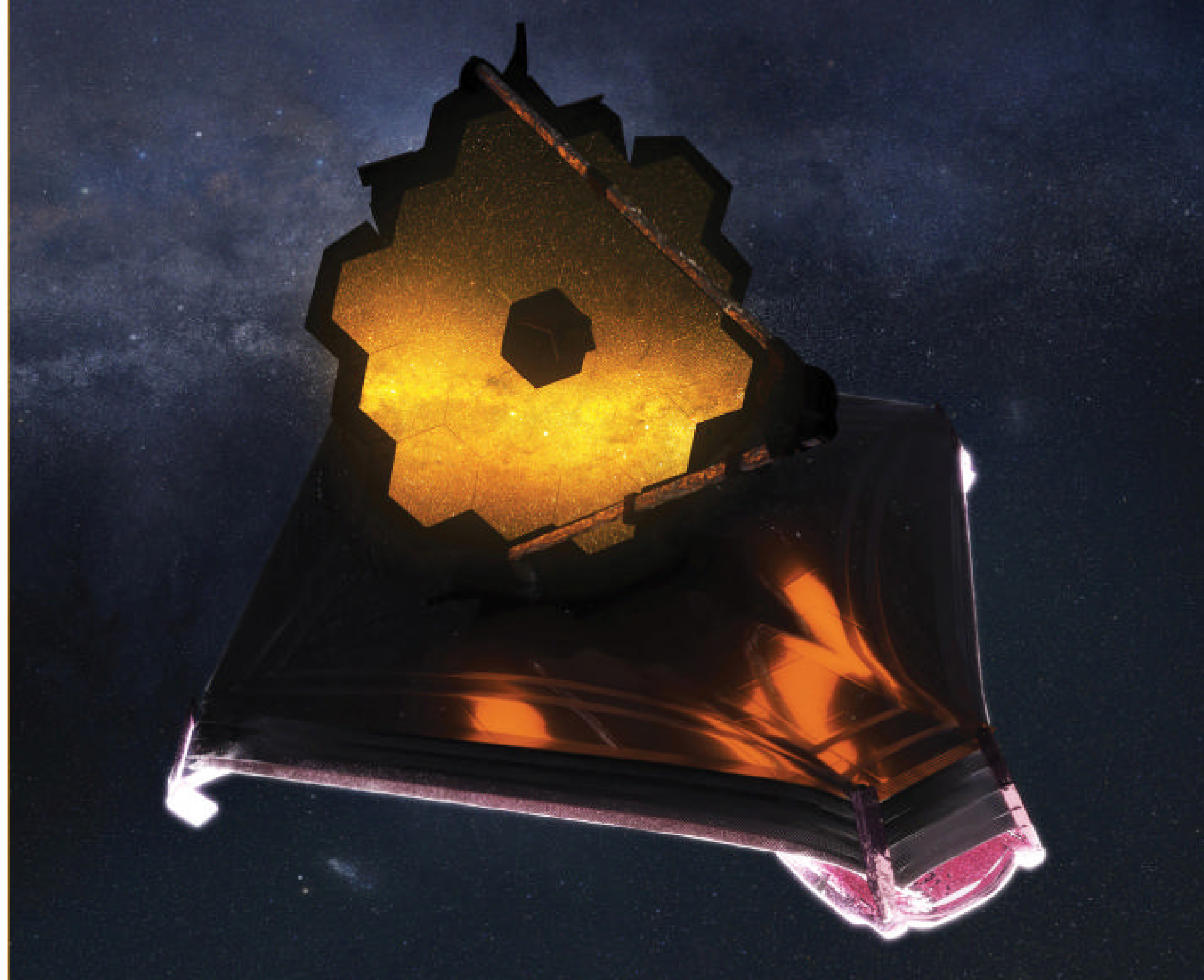
ABOVE: The future of astronomy is bright, with plans in the works for new facilities not just on Earth, but also on the Moon and in deep space. VLADIMIR VUSTYANSKY

LEFT TO RIGHT: Telescopes, nearby supernovae, advanced propulsion methods, and gravitational-wave observatories are on astronomers' wishlists for the next half-century.

Trying to predict anything about science or technology a half-century in advance may seem like folly.

But there's a reason we're willing to go out on a limb. For one, astronomy is a field in which looking 50 years ahead doesn't seem so far-fetched. The project that would become the James Webb Space Telescope (JWST), which is currently revolutionizing the field, was first proposed in writing in a 1996 report, a quarter-century before its launch. Its successors are already in the works. Thus, we are only extrapolating a couple of generations of flagship observatories into the future.

To get a bead on where the field will be 50 years from now, we asked a panel of astronomers, many of whom are contributors to this magazine. Enjoy this preview of the next 50 years — and be sure to check back to find out how we did.

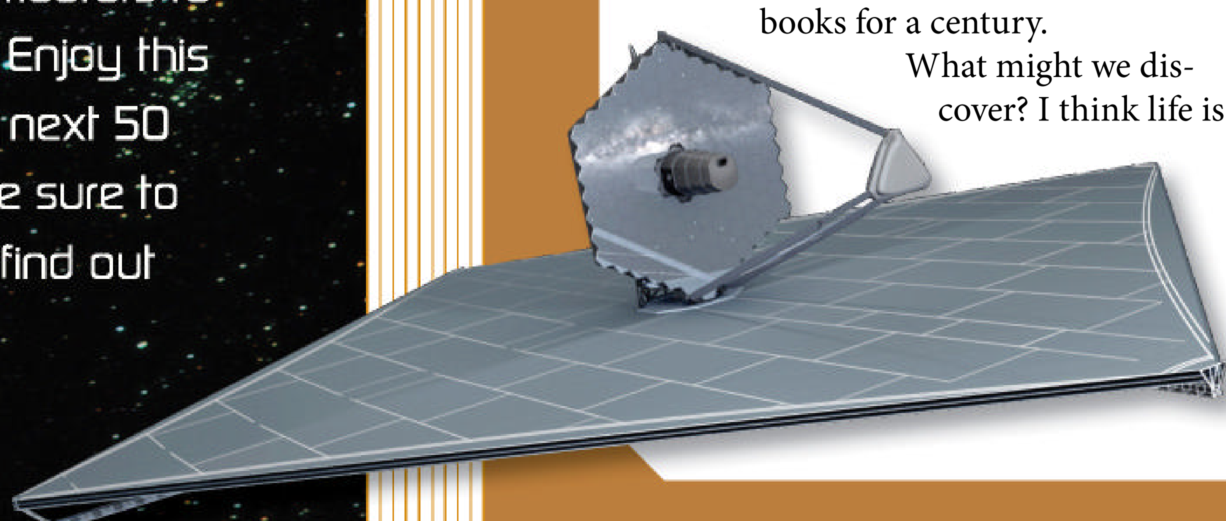


## JOHN MATHER
## Blueprints for the future

**IT'S EASIER TO THINK OF** what we can build than what we might discover, because with building we can see the steps. And we have instruction books: the reports from committees, like the decadal surveys published by the U.S. National Academies of Sciences.

We've already got our hands full with wishes for observatories. We've wished for the Habitable Worlds Observatory, a Hubble Space Telescope on steroids that will see Earth-like exoplanets around Sun-like stars. We've wished for a far-infrared observatory, the Origins Space Telescope, to detect molecules in cold, dusty objects and see stars and planets forming. We've wished for the Lynx X-ray observatory, to understand extreme temperatures around black holes and explosions of all sorts. At the rate of one per 20 years, we won't have all of these telescopes until 2083, and then it will take more decades to use them and make sense of the data. Our decadal surveys are really wish books for a century.

What might we discover? I think life is



The Habitable Worlds Observatory (HWO) would be designed to study all kinds of astrophysical objects, but with a particular emphasis on habitable exoplanets. The design concept is in progress, but it could blend elements of two previous proposals: the Large UV/Optical/IR Surveyor (at left) and the Habitable Exoplanet Observatory (HabEx, at right). However, HWO will likely not incorporate HabEx's starshade, a separate craft meant to block out stars so the telescope could better see the faint light of exoplanets. Perhaps a subsequent mission will pioneer that technique by 2073. FROM LEFT: JOBY HARRIS, JPL; NASA'S GODDARD SPACE FLIGHT CENTER CONCEPTUAL IMAGE LAB

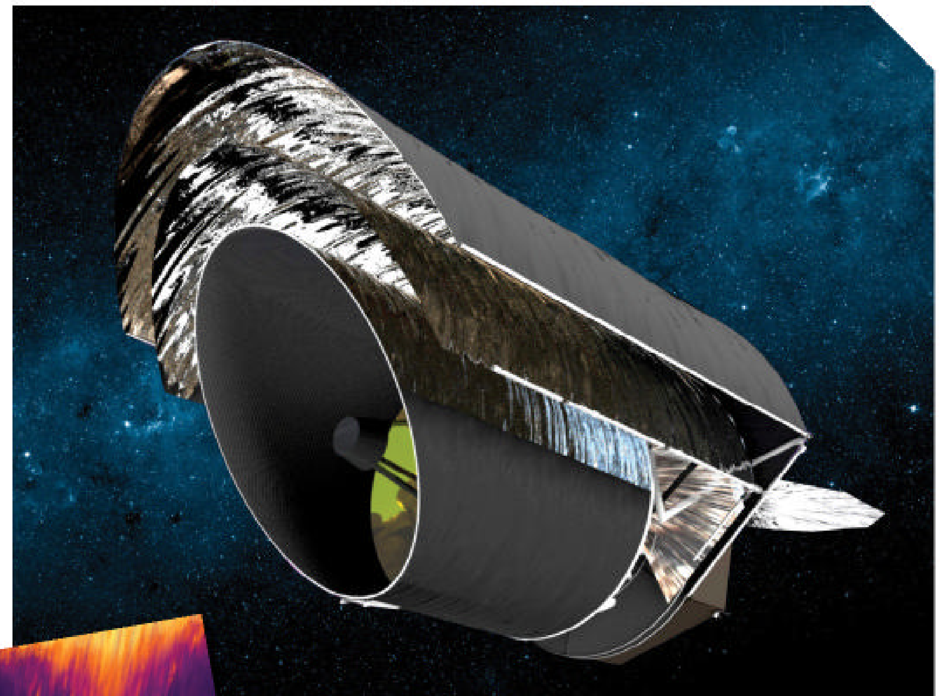
The James Webb Space Telescope (JWST) took over 25 years from proposal to first light — making 2073 just two JWST-gestation periods away. NASA/ ADRIANA MANRIQUE GUTIERREZ

a thermodynamic imperative, that it will begin quickly wherever conditions are suitable. But we don't know what governs the timescale for the growth of complexity into civilizations, and we don't know which conditions are suitable. We do know that planetary systems like ours — four rocky planets, an asteroid gap, and four cold gas giants — are rare. Quite possibly our own situation with a very large moon to stabilize our planet's tilt is a necessary condition for our own existence. Finding another place like home may be the most difficult problem in astronomy, requiring much larger telescopes in space than we can yet design. There's no law of nature against them; we can build them when the time comes. But not this year.

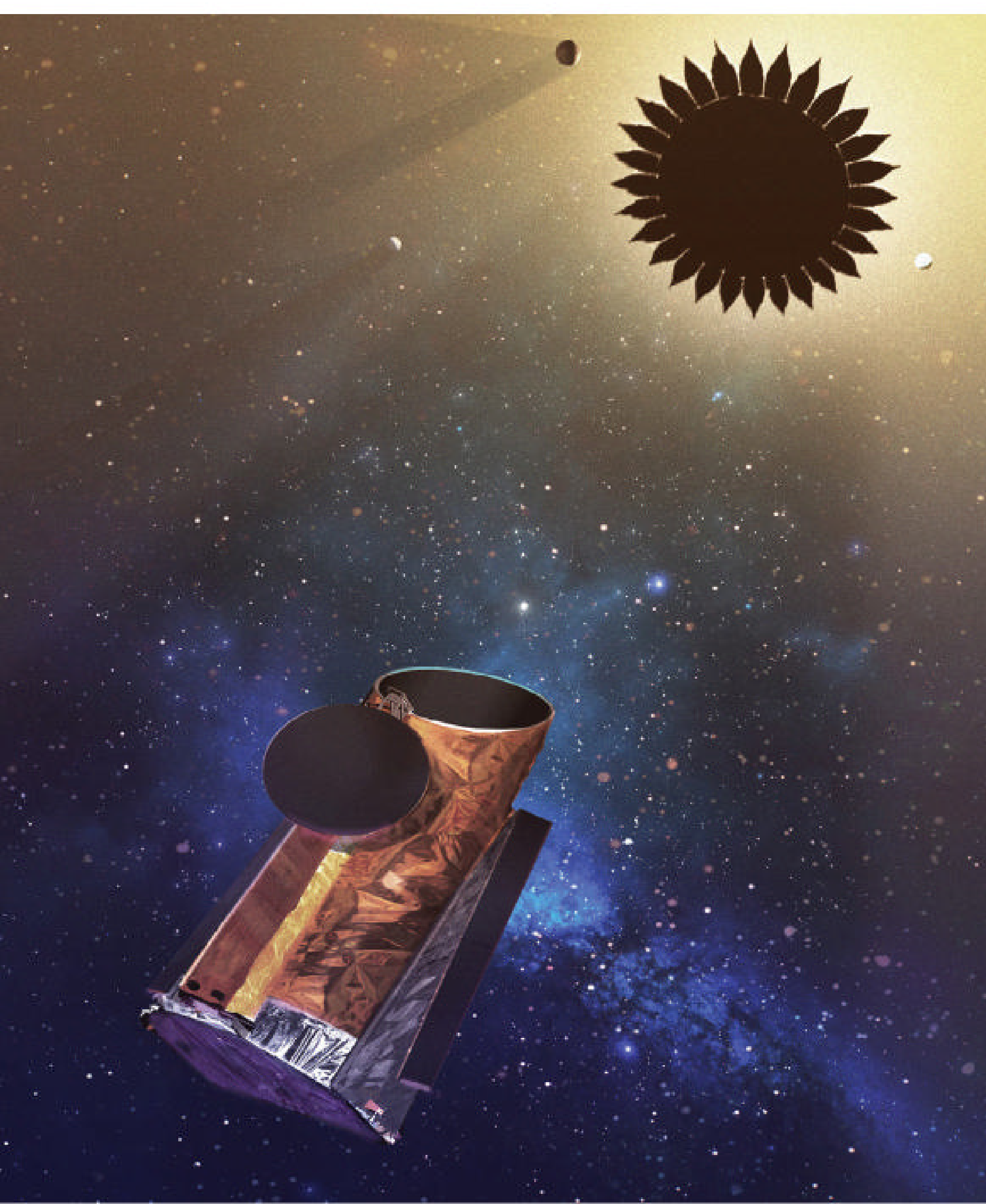
I am guessing that we will find something strange about the early universe. The first objects that grew after the Big Bang might surprise us, and we already know from JWST that the first galaxies we can see are bigger, brighter, hotter, and quicker than we expected. We still can't tell how the supermassive black holes in the centers of galaxies were formed, or how they grew so large so fast.

Will we understand dark matter and dark energy? They seem unobservable in laboratory experiments, and all we know so far from astronomy is their gravitational effect on ordinary matter. Neither were predicted by theory based on the other three forces of nature.

A breakthrough could occur at any time, and when it occurs, we may say, "Why didn't I think of that? It's so obvious!" But more likely, the solutions will come from some shocking extension of curved space-time geometry into higher dimensions and quantum mechanics that would astonish even Einstein. We are already confronted with the mysteries of quantum entanglement — that measuring a particle in one place can instantly affect a particle across the universe. Perhaps the interpretation of measurement and wave functions — the equations that describe the infinitude of quantum possibilities — will finally be firmly established.




After the Habitable Worlds Observatory, the Astro2020 decadal survey's wishlist includes a far-infrared telescope based on the Origins Space Telescope concept (top) and an X-ray observatory based on the Lynx proposal (left). The Habitable Worlds Observatory, the far-IR scope based on the Origins Space Telescope, and the X-ray telescope based on Lynx will form a trio of observatories that span the electromagnetic spectrum. They have been dubbed the New Great Observatories — the heirs to the triumvirate of the Hubble, Spitzer, and Chandra space telescopes. FROM TOP: ORIGINS SPACE TELESCOPE STDT/CALTECH; LYNX X-RAY OBSERVATORY/ANTONIO HOLGUIN



In addition to new telescopes, we have new computing tools. We can already make movies of the history of the universe based on hypothetical initial conditions and the laws of physics, just as we can predict the weather with hydrodynamic codes. These simulations are limited: As objects evolve and become smaller and hotter, the computation to describe them becomes too difficult to include in the original simulations. But AI may allow us to overcome this by reducing the computation necessary to get good results.

Jumping ahead, I see no law of nature preventing artificial general intelligence, a form of AI that truly understands the words it uses to talk with us. Given the billions of dollars being spent every year, and the immense motivations leading to those budgets, I think it's only a matter of time. We don't have to understand how it works to use it. We don't understand the human mind, either. Be ready to be amazed.

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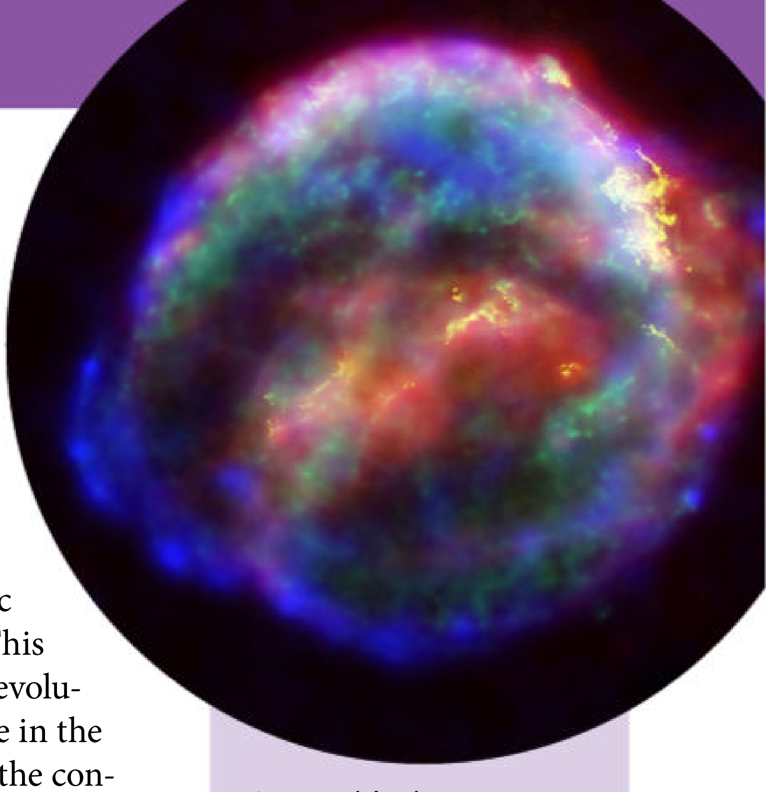
**John Mather** *is senior project scientist for the James Webb Space Telescope. He shared the 2006 Nobel Prize in Physics for discovering the nature of the cosmic microwave background.*

# YVETTE CENDES
## A 50-year grand adventure

**ONE THING THAT PARTICULARLY** excites me when thinking so far ahead is that it's reasonable to imagine we'll have a sizable radio telescope on the farside of the Moon. This is important to shield the telescope from all the human-generated radio frequency interference (RFI) on Earth. It will also open up the lowest frequencies from space that are blocked by Earth's ionosphere. There's probably some exciting new science down there we don't know about! However, I anticipate this observatory will be automated and I will never see it with my own eyes — with remote observing now routine, it seems hard to imagine a farside lunar radio telescope wouldn't be, too.

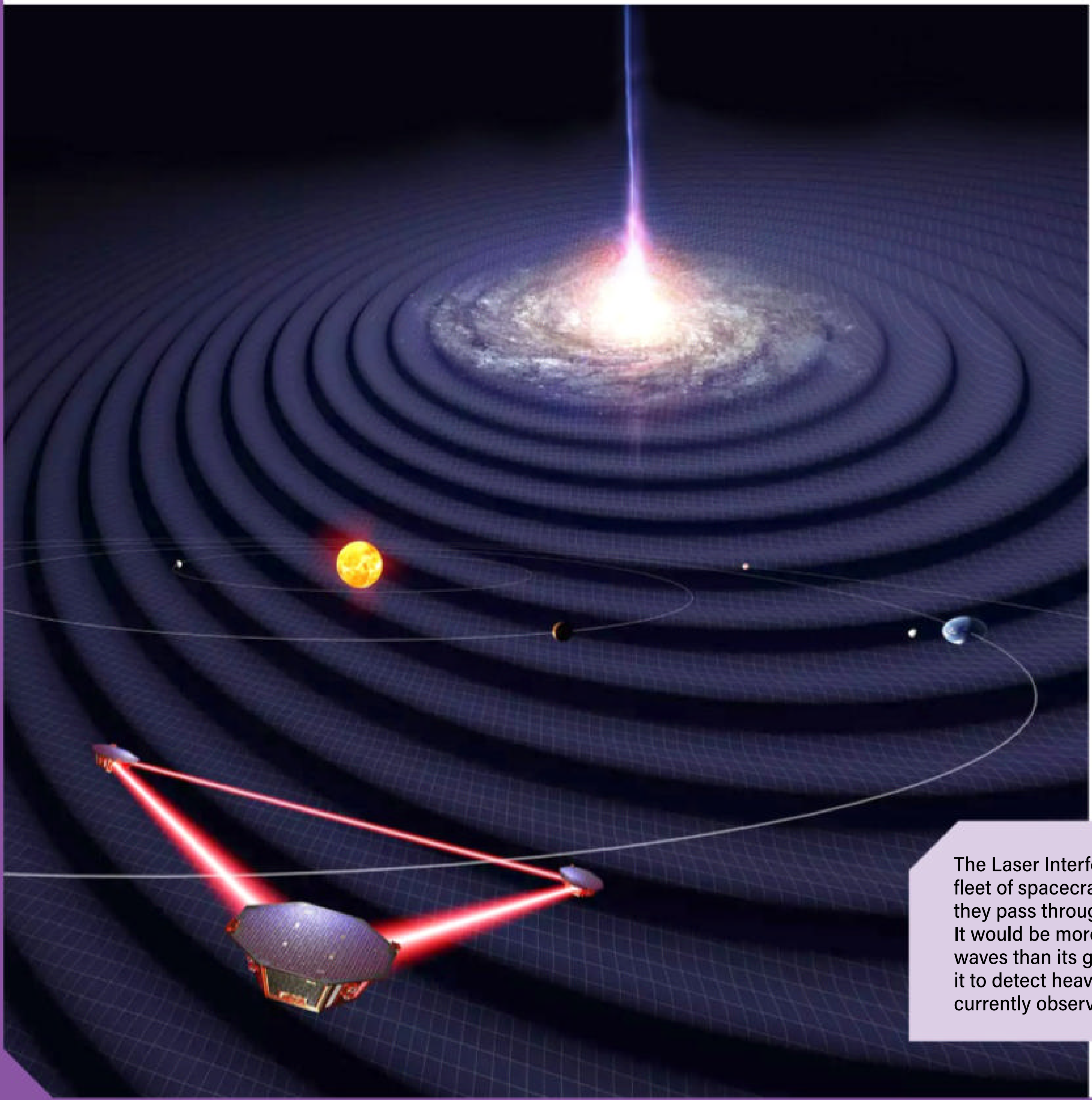
I think we will still have ample amounts of radio astronomy occurring on Earth (as long as we get a handle on regulations for satellite megaconstellations and don't run out of resources due to catastrophic climate change). This is because of the revolution that will come in the next decade from the construction and commissioning of the Square Kilometer Array (SKA) in Australia and South Africa and the Next Generation Very Large Array (ngVLA) in North America.



SN 1604 (also known as Kepler's supernova) was the last supernova in our galaxy visible to the naked eye. It occurred over 400 years ago, before telescopes had been invented. We're due for another one, but will its light arrive before 2073? NASA

That places 2073 roughly as far into the future from the construction of the SKA and ngVLA as we are now from the construction in the 1970s of the original Very Large Array, which is still my primary science instrument today. While there is great optimism about the cost of space launches going down over coming decades, for complicated arrays that literally span continents, it will still be cheaper to maintain and upgrade these workhorses on Earth than put a new one into space.

I am also particularly excited about how routine gravitational-wave (GW) astronomy and follow-up will be in 50 years. Right now, a sizable fraction of the planet's astronomers and



The Laser Interferometer Space Antenna (LISA) is a proposed fleet of spacecraft that would detect gravitational waves as they pass through and distort the space-time in between them. It would be more sensitive to lower-frequency gravitational waves than its ground-based counterparts. This would allow it to detect heavier objects with much wider orbits than those currently observed. UNIVERSITY OF FLORIDA/SIMON BARKE (CC BY 4.0)

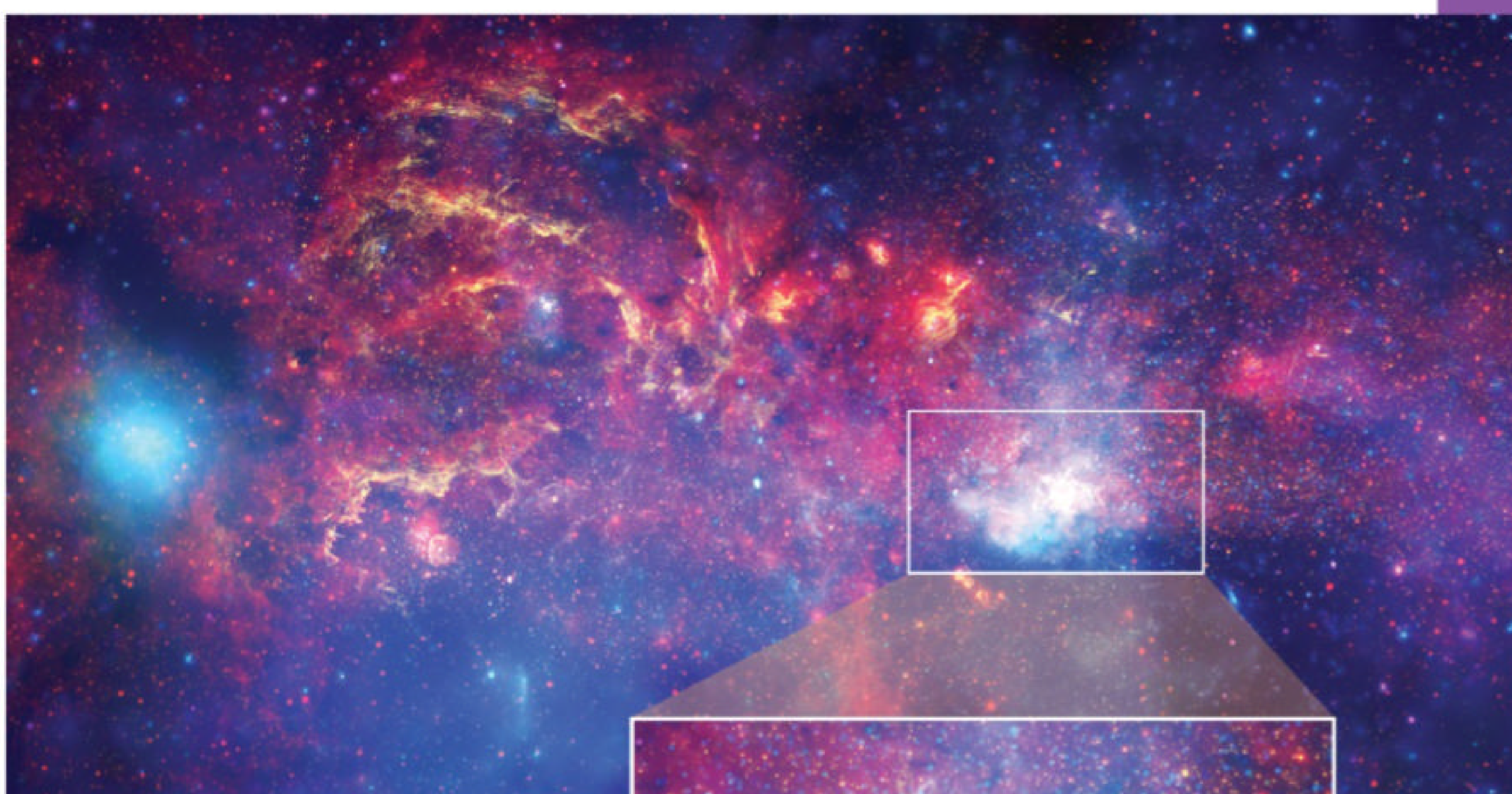
telescopes scramble after a promising signal, but by 2073, we'll probably have hundreds of such alerts every week from many GW-emitting objects we have no chance of detecting now. Thanks to the next-generation Cosmic Explorer observatory, NASA's space-borne Laser Interferometer Space Antenna (LISA), and their successors, it will be a completely different kind of astronomy, and a complete game changer!

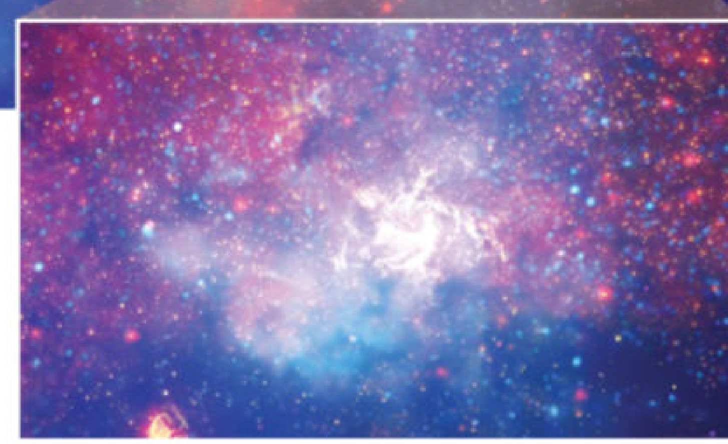
On the science side, I am fairly confident we will have proof of life elsewhere in the universe — maybe not via signs of extraterrestrial intelligence, but instead via the confirmation of biosignatures on exoplanets. Life is a chemical process, after all, so it seems the height of hubris to assume it only happened on Earth. In the next 50 years, our technology should be able to detect it.

Also, I very much wish that by 2073 we will mark the first supernova observed in our own galaxy in nearly 400 years, potentially bright enough to see with our own eyes. A galaxy the size of the Milky Way should have a supernova every 50 to 100 years, and we are overdue. There's no way of knowing when we will see the next one, but it will either be a highlight of my career — or its biggest disappointment, if we wait another 50 years without one.

Finally, one favorite thing to think about is that if we know anything about history, it's that in 50 years there will be exciting and new mysteries we can't even begin to contemplate today. (Heck, we're talking eight years after the next pass of Halley's Comet, which, frankly, is the furthest ahead I tend to think in my astronomical lifetime.) When *Astronomy* was founded, no one had a clue what dark energy or fast radio bursts (FRBs) were, or that exoplanets are as common as stars. Today, these are at the forefront of active research. While none of us know what the future holds in science, the only thing we can bet on is that it will take us in exciting directions we don't know exist yet — a grand adventure in itself. I can't wait to see how it will unfold!

The Square Kilometer Array was in planning stages for 30 years before breaking ground in 2022. Its first stage will comprise 197 mid-frequency dishes in South Africa's Karoo region (left) and over 131,000 low-frequency antennas in the Australian outback (right). The inner sections of this composite are real images of current infrastructure; the outer sections incorporate artist's illustrations of the completed array. SKA ORGANISATION

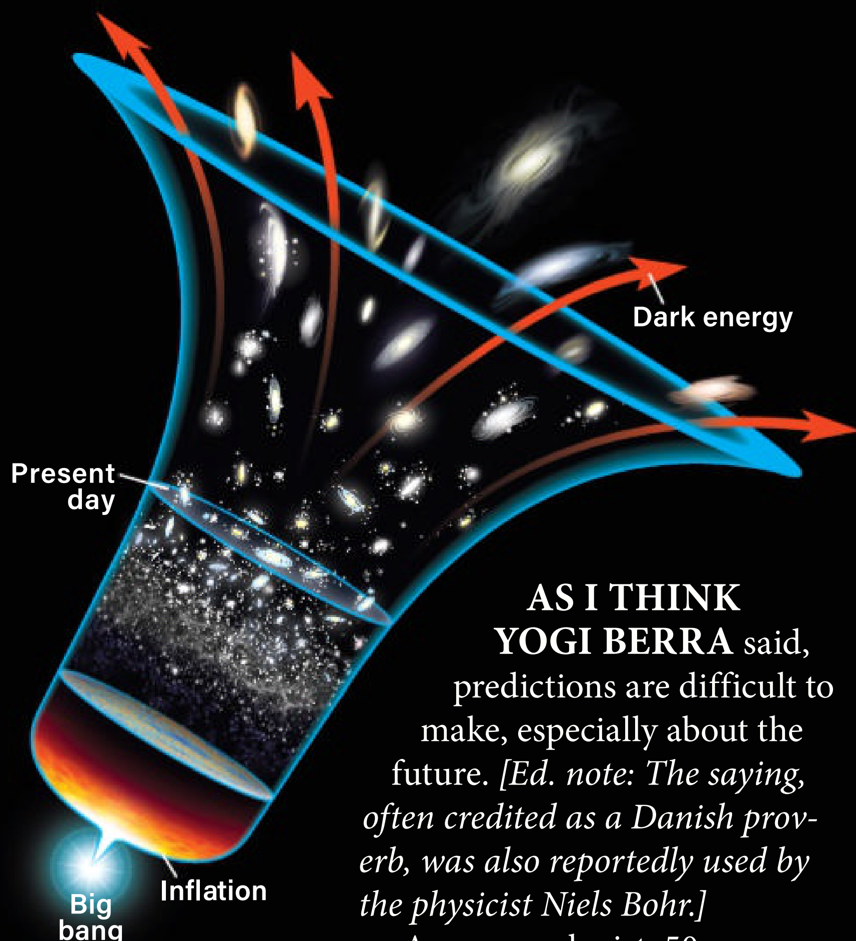




The power of multiwavelength observations is evident in this image of the center of the Milky Way taken by the original Great Observatories. X-rays observed by Chandra are depicted in blue and violet, and emanate from hot gas; the blob at left is gas heated by a binary system that contains either a neutron star or a black hole. Near-infrared observations from Hubble are shown in yellow; infrared data from Spitzer are displayed in red. Arcs of gas and dust glow bright in infrared, including a vortex (inset), that surrounds the supermassive black hole at the galaxy's heart, Sagittarius A*. NASA, ESA, SSC, CXC, AND STSCI

**Yvette Cendes** *is a radio astronomer at the Center for Astrophysics | Harvard & Smithsonian. She studies variable and transient sources, with a particular interest in supernovae and tidal disruption events.*

## ADAM RIESS
## Unpacking inflation




Cosmic inflation holds that the early universe underwent an exponential growth spurt that smoothed out nearly all its imperfections. It's the leading theory to explain why the universe is so smooth — but not the only one. Also unexplained is the universe's current period of accelerating expansion due to the mysterious force called dark energy. ASTRONOMY: ROEN KELLY

**AS I THINK YOGI BERRA** said, predictions are difficult to make, especially about the future. *[Ed. note: The saying, often credited as a Danish proverb, was also reportedly used by the physicist Niels Bohr.]*

As a cosmologist, 50 years from now, I am looking forward to Big Answers to the Big Questions about the universe. What is dark energy? What is dark matter? Why is the universe so flat? Did inflation happen? And more recent questions, like why the universe is expanding faster and appears smoother than our best model predicts.

Inflation is a powerful theory, and it is the leading hypothesis to explain certain features of the universe, like flatness, that are hard to explain otherwise. However, inflation has not yet been experimentally verified to a high degree of certainty. And because the theory is rather general with regard to observables, we have not been able to rule out alternative scenarios. These include the ekpyrotic universe, in which the Big Bang we observe is just one Big Bounce in a cycle of Big Bounces. Future data available in 2073 are likely to be far more definitive.

Fifty years is a fair fraction of the time or longer than we have had these questions, so I expect we will have at least one or two answers by 2073. (Please tell me the answers loudly because I will be 103 years old then.)

However, I would also predict we will have a few new questions by then to ponder.

**Adam Riess** *is a cosmologist at Johns Hopkins University. He shared the 2011 Nobel Prize in Physics for the discovery that the expansion of the universe is accelerating.*

## S. ALAN STERN
## The whole solar system within reach

**IN THE NEXT 50 YEARS,** I think that planetary science will advance in so many fundamental ways that it may be almost unimaginably more advanced than it is today. In fact, my prediction is that the advances from here to the 2070s will dwarf those from the 1970s to the 2020s, which is saying a lot.

By the '70s, I expect we'll have human exploration taking place on multiple worlds in the solar system, with Antarctic-like, semipermanent bases scattered around the globes of at least Luna and Mars. I also expect we may by then have much larger and more powerful launch vehicles, even fusion-based or high-power electric propulsion, making trip times an order of magnitude shorter than today. Just think: Mars in a few weeks, Pluto and the Kuiper Belt in a year!

I expect that by the 2070s, we'll also see

## CHANDA PRESCOD-WEINSTEIN
## Resolving tensions

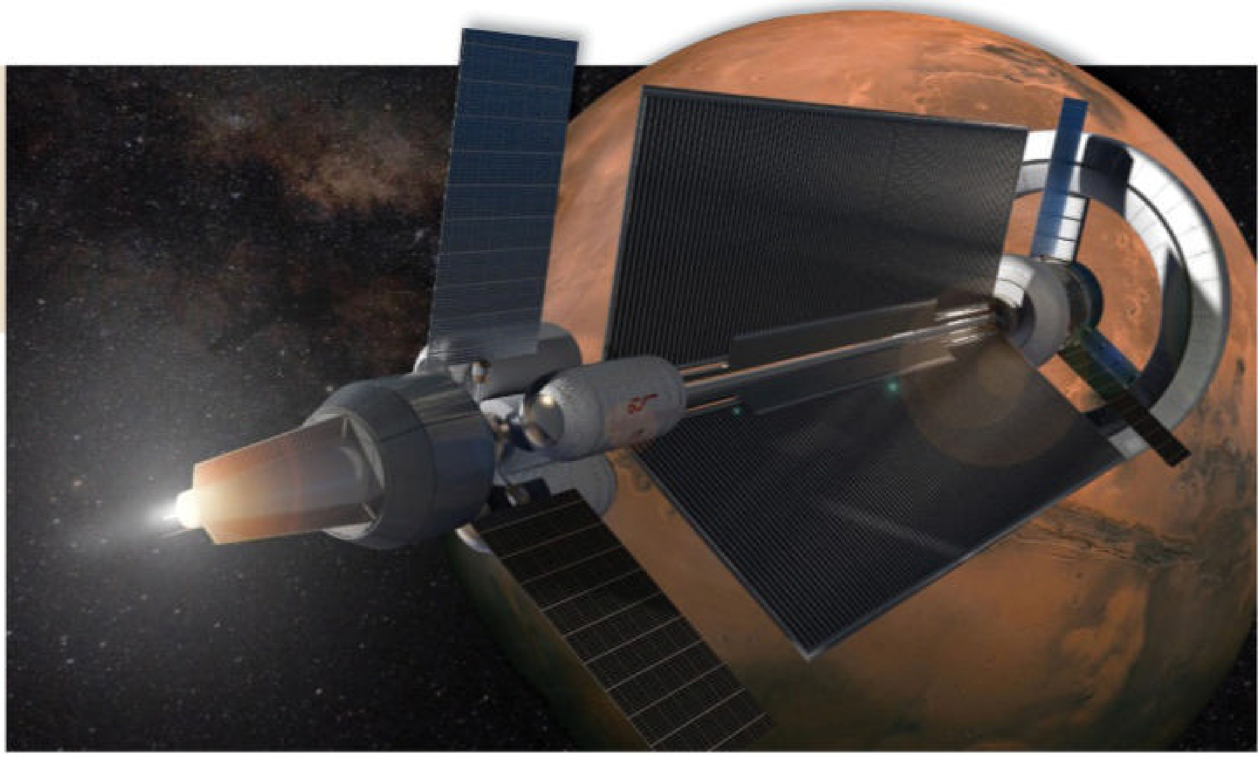
**AS OF 2023,** astronomers have been arguing about how fast space-time is expanding for nearly a century. So I'm going to be real and say that I expect us to be arguing about this for another 50 years.

Today, astronomers are divided on the pace of the universe's expansion, known as the Hubble constant. One camp finds that in the modern universe, two galaxies separated by 1 million parsecs (1 Mpc, or 3.26 million light-years) appear to recede from each other by roughly 73 kilometers per second. The other group, based on measurements of the early universe and our cosmological models, finds this rate to be around 68 km/s/Mpc. Yet a third type of measurement has landed at 69 km/s/Mpc.

The Hubble tension, as this debate is now known, is big drama with a high reward for the scientists involved. Whoever can make a truly compelling case for their number — one that stands the test of time — will be remembered for measuring the length of the largest ruler in the cosmos. And by 2073, perhaps we will also have a better sense of the physics that underpins cosmic acceleration — the increasing speed of space-time's expansion.

But there are also interesting questions of *how* the next

100-meter-class telescopes on Earth, with many large time-domain telescopes (studying objects as they evolve over time and finding new ones), enormous radio and submillimeter arrays, and even airborne stratospheric observatories that will make a lot of today's Antarctic astronomy obsolete. With those capabilities, we'll catalog every last object of any consequence out to the inner Oort Cloud and be able to image everything out to the Kuiper Belt at geologically interesting resolutions that only spacecraft can provide today. And of course, the return of samples to Earth (or perhaps to off-Earth labs to protect our planet from possible harmful contamination) from a wide variety of locales will be routine.



Rockets powered by nuclear fusion, like this artist's concept, could cut the travel time to Mars from nine months to a couple of weeks. HELICITY SPACE

But most of all, I expect that the art of doing planetary science will be fundamentally changed by artificial intelligence. By then, it will be so powerful that the work of science — data analysis and interpretation, coding and theory, and even writing papers — may be nothing like what planetary scientists do today.

And since biology is now advancing rapidly as well, there's even a chance I might live to test all these predictions as an alert and productive 115-year-old! At least, I hope so.

**S. Alan Stern** *is a planetary scientist and member of the U.S. National Science Board. He has led 14 NASA flight missions and science instruments, including New Horizons to Pluto and the Kuiper Belt.*

The Alcântara Launch Center was constructed in the 1980s after authorities displaced hundreds of families of quilombolas — descendants of enslaved Africans who escaped plantations and formed their own communities. Thousands more quilombolas may be evicted in a planned expansion of the facility driven in part by a deal between Brazil and the U.S. that allows for commercial launches using U.S. technology. TV BRASIL

generations of astronomers will resolve questions like the Hubble tension. To survive the ongoing climate catastrophe, communities around the world will have to dramatically revise how we go about everyday life. From the mundane questions of daily water and transit use to the more extraordinary question of how we will understand the origins of the universe, no aspects of human activity are unaffected by the need to respond to climate change. That includes astronomy.

I hope that by 2073, those of us who develop and work with space telescopes will have found an alternative route to constructing them that does not involve working with large defense contractors whose weapons not only cost money that would be better spent on a sound social safety net, but also poison the environment. We will also need to think carefully about the impact that space launches have on local ecosystems, as well as peoples displaced by them, such as the Afro-Brazilian quilombola communities removed from their land for the construction of the Alcântara Launch Center.

By 2073, astronomers should also have developed a clear ethical framework for constructing ground-based facilities and seeking permission for using the land where we want to build. The struggle over the construction of the Thirty Meter Telescope on Maunakea shows that traditional approaches to building facilities on Indigenous lands do not engender good relations between astronomers and the communities that we work in. We can do better.

And we don't have much time. Fifty years is not that far out into the future, and the time for us to start planning is now.

**Chanda Prescod-Weinstein** *is an assistant professor of physics and core faculty member in women's and gender studies at the University of New Hampshire. She is the award-winning author of* The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred *(Bold Type Books, 2021).*

# 50 YEARS OF

Taking pictures of celestial objects has come a long way since this magazine started.

BY MICHAEL E. BAKICH


**IN THE PREMIER ISSUE** of *Astronomy*, dated August 1973, a page labeled "Wanted: Contributors to *Astronomy*" put this call out to imagers: "Photographs, preferably in color whenever possible, but black and white are acceptable. For color, transparencies are preferred over prints, made with as large a film print as possible. We would like to receive 4x5 transparencies, but accept 35mm. Black and white prints should be on glossy paper, 5x7 inches or larger. Photos are used with accompanying articles, singly in special 'Star Gallery' photo spreads and to illustrate articles by other authors."

Let's be honest. Nobody in the '70s was taking great shots of celestial objects. Even the professional observatories were producing images that today would be considered substandard.

I used to purchase slides of deep-sky objects from Palomar Observatory in California to augment the simple talks I was giving at the time. They were created from glass plates attached to the 200-inch Hale Reflector. Many of them required multihour exposures over several nights. And all resulted in black-and-white images.

## Capture it on film

The state of amateur astroimaging in early 1975 was still bad enough that, in a story titled "Piggyback Astrophotography" by Leo C. Henzl Jr., only two images accompanied the text — and both were of equipment! Indeed, backyard photographers were trying lots of new techniques to get the most out of their equipment and photographic emulsions.

As late as the November 1993 issue, Lumicon was still selling gas hypersensitization kits to improve film astrophotography. Such a technique stabilized photographic emulsions against a problem called "reciprocity failure," where the sensitivity of the film would fall off dramatically as the exposure time increased.

The next issue saw the first true ad for a CCD camera, produced by Sirius Instruments of Villa Park, Illinois. The first story about CCD imaging appeared in March 1994. Titled "Virtual Sky," by then-Editor Robert Burnham, the


Advances in cameras and processing techniques allowed astroimagers opportunities for close-up shots, and a favorite target was the Horsehead Nebula (B33). The image to the right was taken in 1999; the one to the left in 2008. FROM RIGHT: GEORGE GREANEY; ADAM BLOCK/MOUNT LEMMON SKYCENTER/UNIVERSITY OF ARIZONA

# astroimaging

author wondered in the story's subtitle, "If it comes at you out of a computer screen instead of an eyepiece, is it still astronomy?"

The next story about the benefits of CCD cameras was "Catching Comets with a CCD," by Glenn Gombert and John Chumack. It appeared in the February 1995 issue. And — oh, my! — the images that accompanied the story were so miserable compared with what's being produced today that they're laughable. (See the images in the middle of page 56, and tell me you don't agree.)

For the October 1996 issue, astrophotographer Tony Hallas wrote "Kodak's Hot New Astrophoto Film." In it he described his testing of Kodak Pro Gold 400 (also known as PPF) film. Accompanying his story were some impressive deep-sky shots — well, impressive for the time.

Then, for March 1997, Chris Schur wrote "Choosing the Right Film for Hale-Bopp," which debuted a few images of the previous bright comet, C/1996 B2 (Hyakutake). It seemed the top imagers weren't quite ready to make the jump to digital imaging.

## The digital age

*Astronomy* announced two

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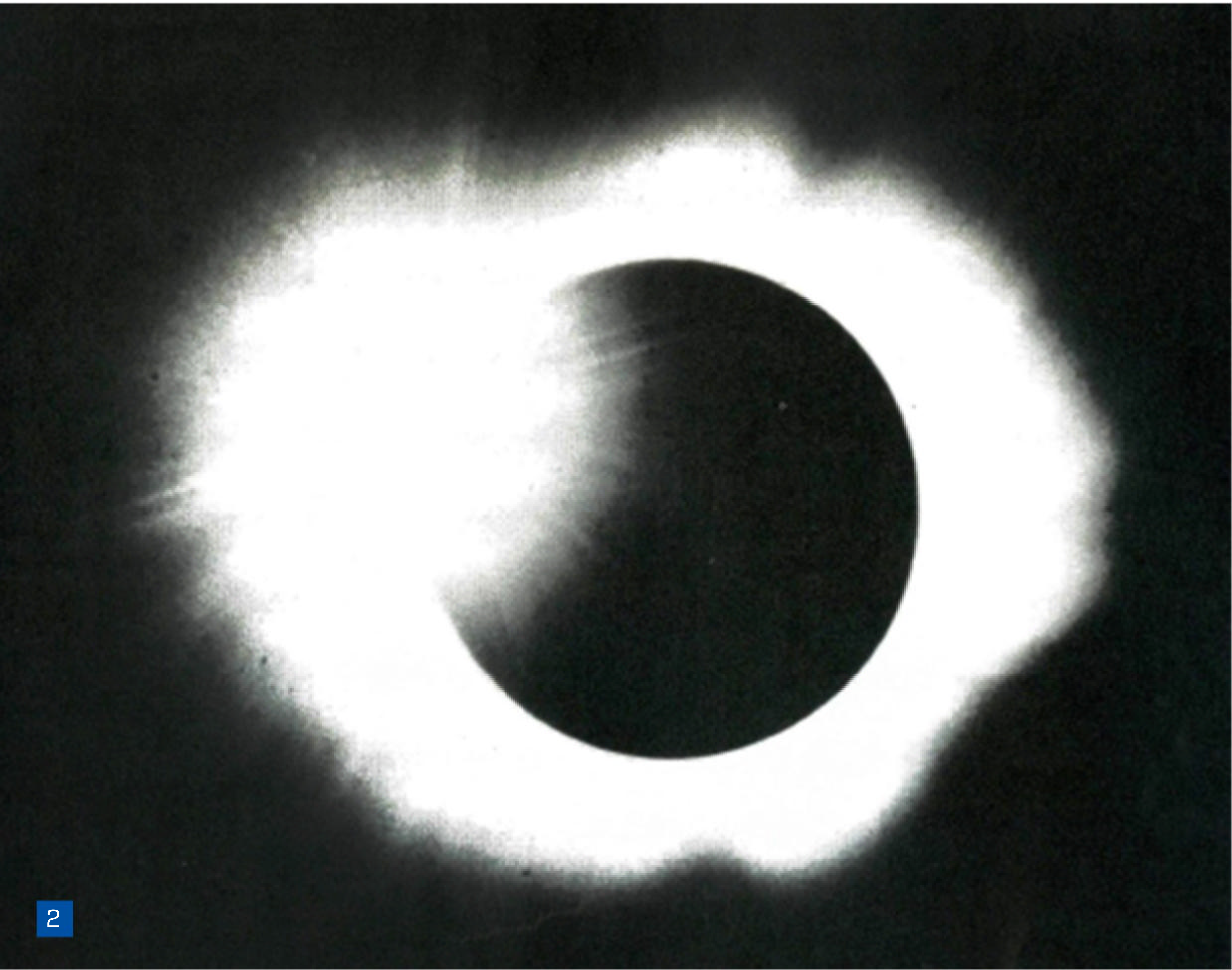


2

“If it comes at you out of a computer screen instead of an eyepiece, is it still astronomy?”

EYEPIECE: BOGDAN STEBLYANKO/DREAMSTIME.COM

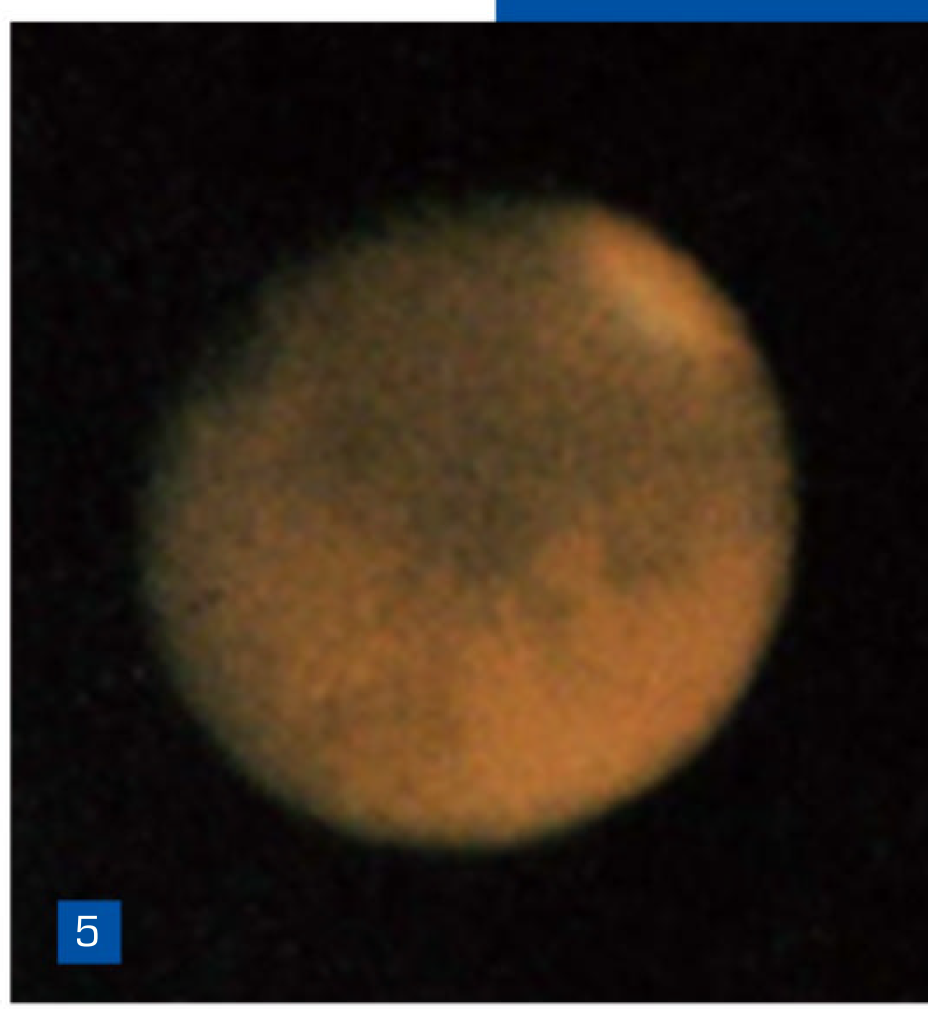
1 The first amateur photograph to appear in issue No. 1 of *Astronomy* (August 1973) was this image of a solar eclipse. JAY M. PASACHOFF

2 Another eclipse image that appeared in the magazine's premier issue, this one of the diamond ring from the 1970 solar eclipse, shows how far astroimagers have come in half a century. HARVARD-SMITHSONIAN-NATIONAL GEOGRAPHIC PHOTOGRAPH

3 Perseus was the first constellation to appear in *Astronomy*. The arrow in the photograph shows the position of the variable star Algol (Beta [β] Persei). R. NEWTON MAYALL

4 This amateur shot of the Moon was the first of our natural satellite to be featured in the magazine. It appeared in September 1973, in the story "Film: A Grainy Dilemma for Sky Shooters," which summed up the state of imaging at the time. JOHN SANFORD

5 The first amateur photograph of a planet appeared in *Astronomy*'s second issue, September 1973. It supposedly approximated what an observer would see through an 8-inch telescope. STEVEN REED



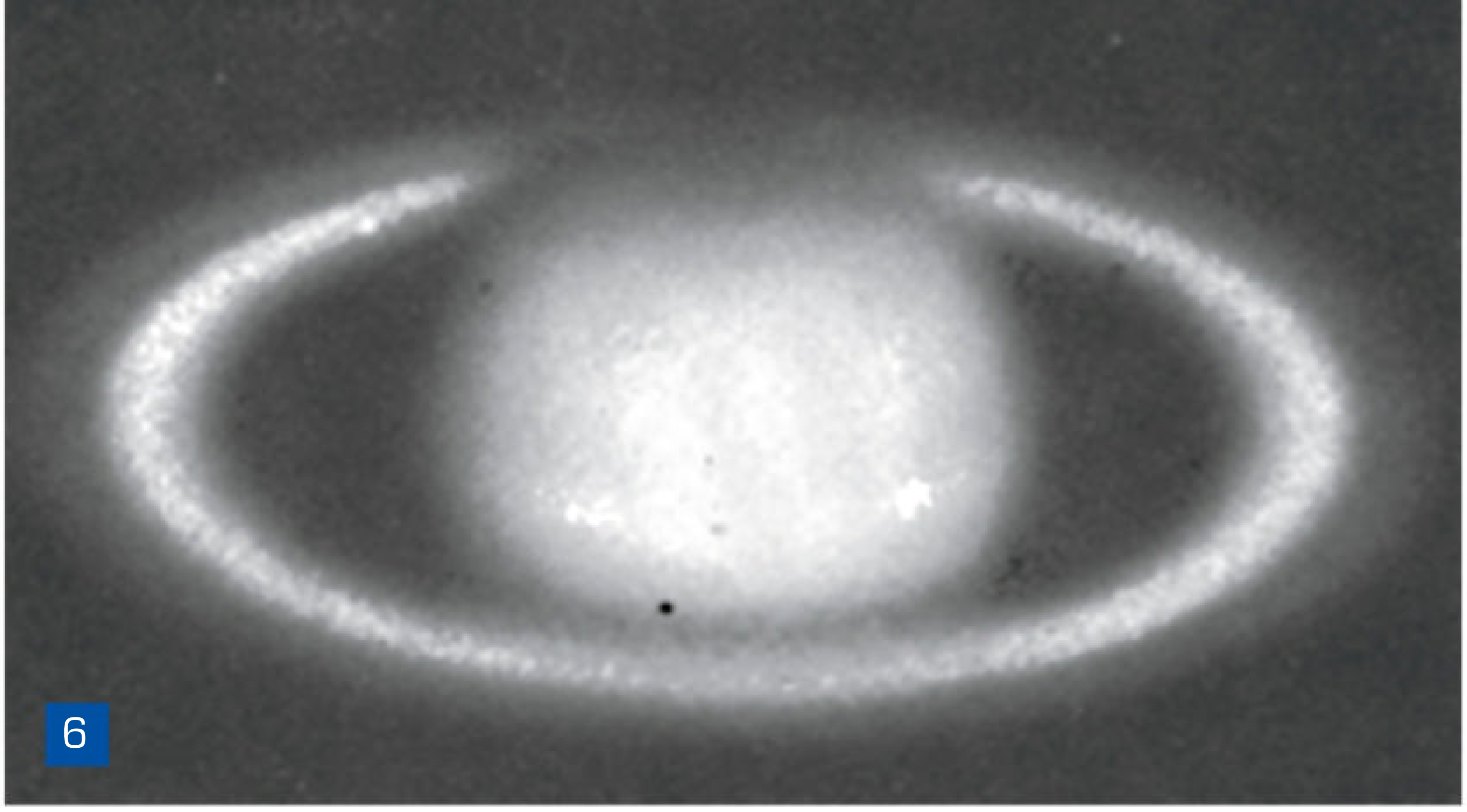
6 This image of Saturn, taken through an 8-inch telescope, was labeled "outstanding" in the story "High Resolution Astrophotography: Improving Your Odds," which appeared in the April 1975 issue. JAMES ROUSE

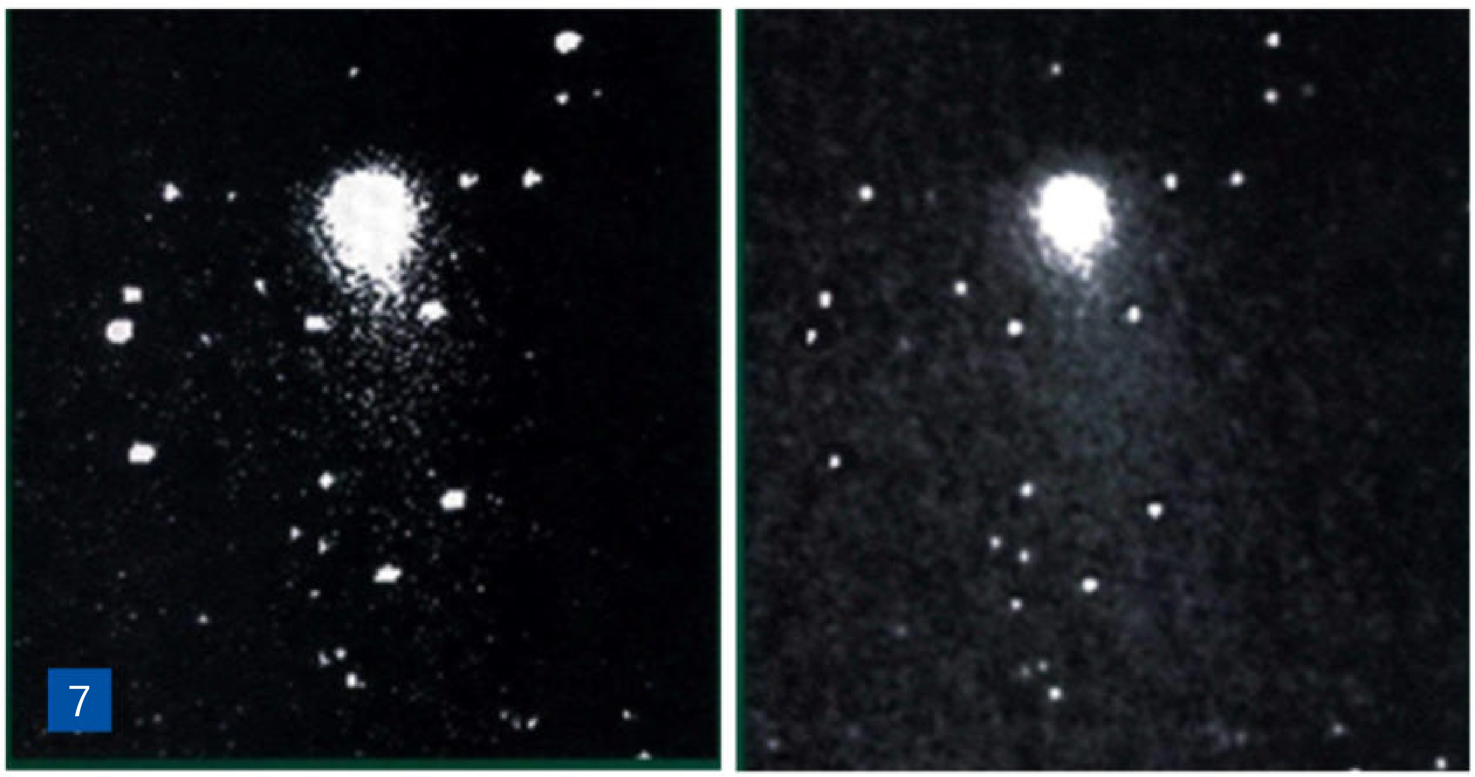
7 Here's the original caption for this image: "BEFORE AND AFTER: Hidden Image, a program for image processing, effectively removes atmospheric blurring from a raw image of Comet P/Schwassman-Wachmann 2 (left) and transforms it into a sharper picture (right)." Wow. GLENN GOMBERT/JOHN CHUMACK

8 This photograph of Comet West (C/1975 V1) shows both its gas and dust tails well, an improvement over previous images. It appeared in "Catch a Comet on Film," a story by Rick Dilsizian in the January 1996 issue. The imager took a 2½-minute exposure on Fuji F100 film in a 5½-inch Schmidt camera. JAMES L. MATTESON

9 As late as the February 2000 issue, these planetary shots were considered high quality by amateur celestial imagers. THIERRY LEGAULT

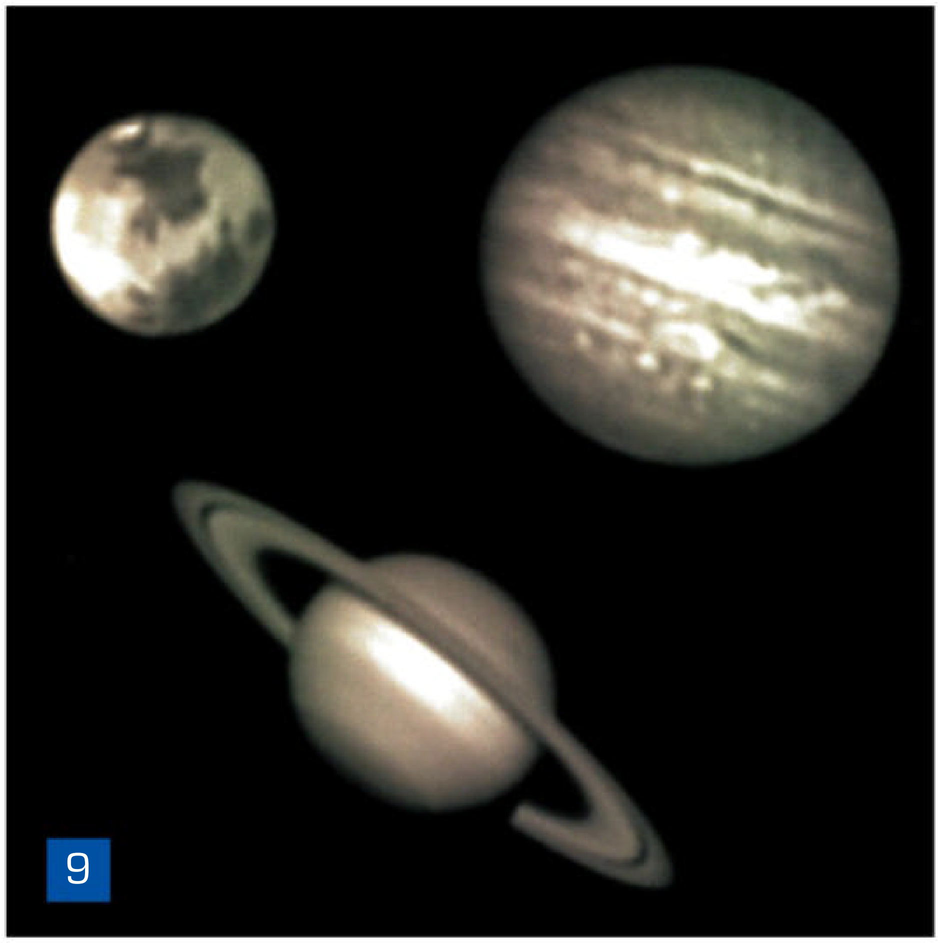
10 The first image I ever selected for Reader Gallery was this magnificent multiple exposure showing the analemma above the Tholos of Delphi, Greece. It appeared in the August 2003 issue and demonstrated to me the care with which imagers were creating and composing their work. ANTHONY AYIOMAMITIS






ROLANDAS GRIGAITIS/DREAMSTIME.COM



Santa Barbara Instrument Group (SBIG) CCD cameras in the April 1998 issue. Each sported a new advancement: an additional chip that made the cameras self-guiding. This was a huge moment for imagers. No longer would they have to sit with their eye glued to the eyepiece of a guide telescope, correcting for inconsistencies in the drive with tiny movements of the scope's motors. In the September 1999 issue, a simple adaptive optics accessory, SBIG's AO-7, promised relief from the curse of atmospheric seeing.

The first roundup and recommendations of CCD cameras appeared in the February 2000 issue. The story, "Capture the Sky on a CCD" by Gregory Terrance, was the first of a three-part series on CCD imaging. And, like most amateur efforts during that time, the pictures that appeared with the stories would be tossed out by today's imagers.

When I became photo editor in 2003, the magazine was still receiving slides and photographs in a rough 3-to-1 ratio. To use them in the publication, I had to send each out to a photographic service company for scanning. Amateurs didn't start sending digital images until

CAMERASGETSAVVY

*A convenient self-guiding feature makes SBIG's ST-7 and ST-8 cameras all the rage.*

*Astronomy* announced two Santa Barbara Instrument Group CCD cameras in the April 1998 issue. Each sported a new advancement: an additional chip that made the cameras self-guiding.

2005, and those were all on CD-ROM disks. Things are so much simpler now.

## A picturesque future

Today's astroimagers benefit from a half-century of improvements in optics, drives and mounts, cameras, and software. We owe our thanks to lots of inventors and manufacturers who were willing to take a chance. Also, let's not forget the hundreds of thousands of examples of trial and error by dedicated amateur astronomers that brought us to where we are now.

Hopefully, history will repeat itself so that when I write "100 years of astroimaging" in the August 2073 issue, we'll all look back and chuckle at the "poor" state of early 21st-century imaging. Until then, keep shooting!

**Michael E. Bakich** *is a contributing editor of* Astronomy *who was fortunate enough to also be the photo editor for more than 16 years.*


11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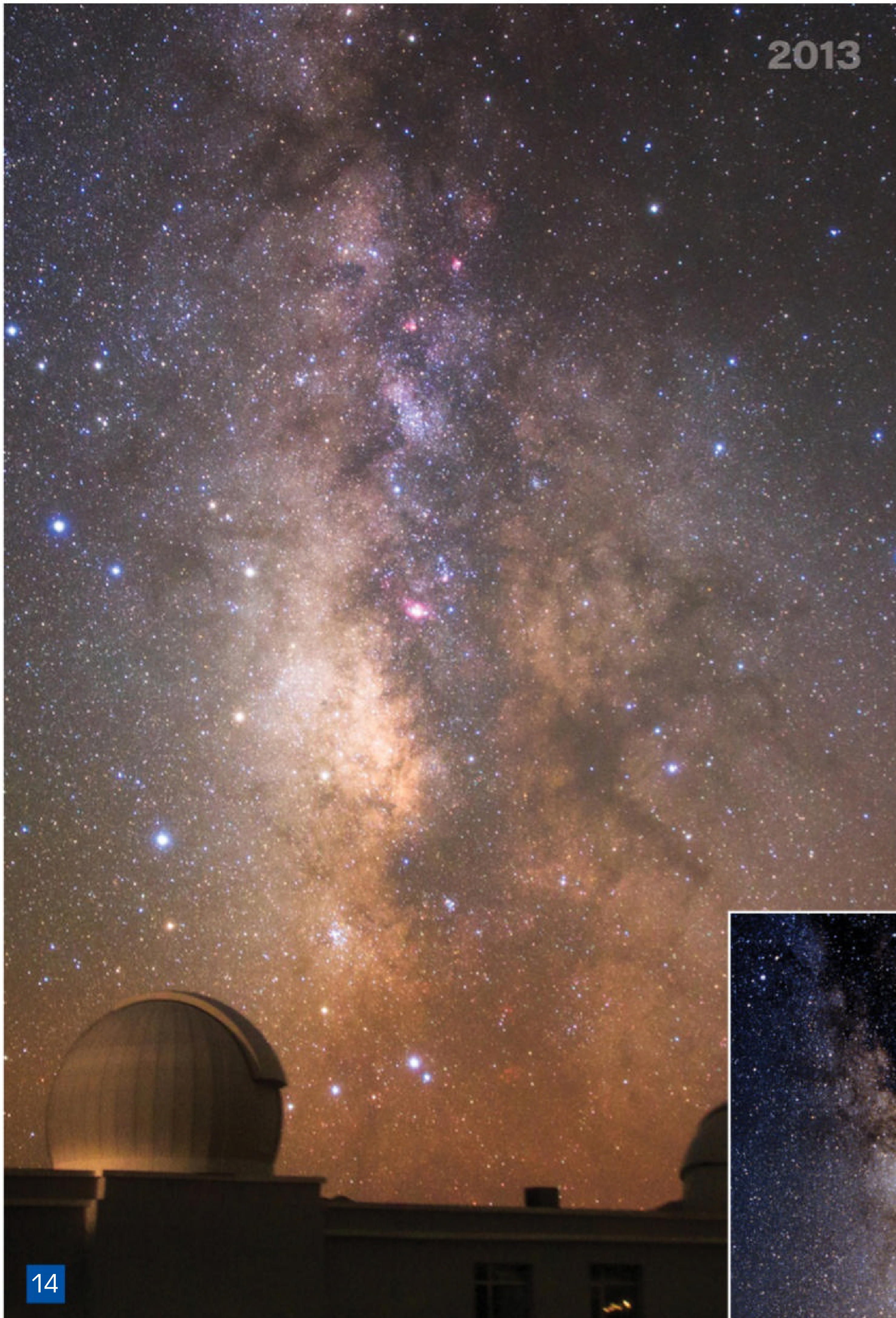
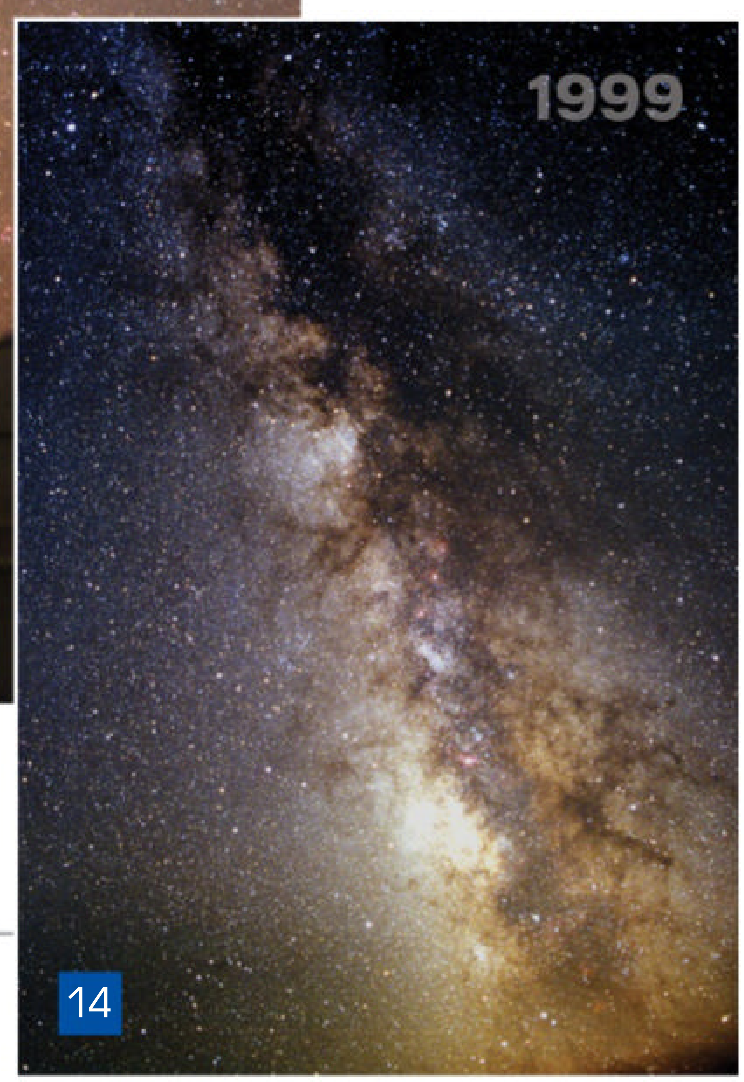



We owe our thanks to lots of inventors and manufacturers who were willing to take a chance.

**11** For the August 2005 issue, astroimager Brian Lula wrote "Image Like a Pro." Among the pictures displayed was this one of spiral galaxy IC 342, which he captured during a gibbous Moon. It required 50 three-minute exposures through a 20-inch telescope. BRIAN LULA

**12** By 2010, eclipse photography had come a long way. This shot of the July 11, 2010, total solar eclipse, taken through a 3.2-inch telescope, was the first to show shadow bands on clouds. MIKE D. REYNOLDS

**13** Only two years separate these images of the Orion Nebula (M42), but new processing techniques used on the one to the right, taken in 2009, put it in another class. FROM LEFT: WARREN A. KELLER; TONY HALLAS

**14** Even wide-field shots of the Milky Way benefited from new cameras, chips, and software. The region of Sagittarius to the left was captured in 2013; the one to the right in 1999. FROM LEFT: JEFF DAI; JOHN CHUMACK

# Send us your best observing story

Win a Celestron scope by telling us your most interesting night-sky tale. BY MICHAEL E. BAKICH

NASA, ESA, AND L. BIANCHI (THE JOHNS HOPKINS UNIVERSITY); PROCESSING: GLADYS KOBER (NASA/CATHOLIC UNIVERSITY OF AMERICA)

**IN THE AUTUMN OF 2002,** I had a not-so-typical observing experience. My wife and I lived in El Paso, Texas, and we had a small observatory just a stone's throw from our house. About 2 A.M. one morning, I walked out to the building to observe some double stars. When I got there, I noticed the door was ajar, and something about it felt odd.

So — and I've never done this before or since — I pulled out a small pocket flashlight and switched it on. There, in the middle of the observatory, was an adult skunk. And it was looking right at me.

I remember thinking, "Well, as long as it's facing me, I'm safe." I turned around and went back in the house to fetch a camera. A few seconds later I returned to the yard, only to see my mammalian visitor scurrying out between the bars of the fence.

Of all the time spent in that observatory, the most profound lesson came from that night: Always close your doors.

## Give it a shot

Whether your most memorable sky session involves an unexpected visitor or an unforgettable sight through the eyepiece, we want to hear from you. *Astronomy* is accepting brief write-ups about your best, most remarkable, favorite, and/or weirdest observing experience in celebration of our 50-year anniversary. The winner will receive a brand-new 8-inch telescope from Celestron.

Your most memorable observation doesn't have to be a 16th-magnitude quasar, Gyulbudaghyan's Nebula, Pluto's moon Charon, or individual red giants in Omega Centauri. It could be a sighting of Jupiter with its four Galilean moons in a notable pattern, or a high-power look at the Moon's Clavius Crater with its curving pattern of ever smaller craterlets. Alternatively, your story could be about something unique that happened during your astronomy journey or an observing session, like my own story. In other words, any type of tale has a chance to win.

---

**Michael E. Bakich** *is a contributing editor of* Astronomy *who won a cash prize from Michigan State University for an observation of the occultation of Epsilon Geminorum by Mars in 1976.*

## THE RULES

**SEND ENTRIES TO ESSAYCONTEST@ASTRONOMY.COM** with the subject line, "Celestron Essay Contest." The length must be between 50 to 350 words, and multiple essays are allowed. Please include your name, address, and phone number. Contestants must reside in the U.S. and be over the age of 18 on the date of submission. Employees and stockholders of Kalmbach Media Co. or Celestron and their families are ineligible to participate. No purchase is necessary to participate. Void where prohibited.

The winning entry will be chosen by *Astronomy* editors based on its flow, clarity, and originality. The winner will be announced on Astronomy.com and may appear in a future issue. The contest begins July 5, 2023, at 12:00:00 A.M. CDT and ends no later than Aug. 31, 2023, at 11:59:59 A.M. CDT.


CELESTRON

### The prize

Our friends at Celestron have demonstrated their generosity by donating the prize for the winning entry: a StarSense Explorer 8" Smartphone App-Enabled Dobsonian Telescope.

This fully operational system includes the optical tube, Dobsonian base, StarSense Explorer dock, eyepiece rack, 2" Crayford focuser with an extension tube and a 2" to 1¼" adapter, a 25mm eyepiece, and more. For more information on the scope, read our review of the 10-inch model in the April 2023 issue.

The price for the scope is $799.95 ARV. The winner will receive a 1099 form and will be responsible for any related taxes. Full contest details are on our website: https://www.astronomy.com/celestron-essay-contest-rules/.

# MORE STORIES

NASA/BILL INGALLS

## Blazing tail

**ON MARCH 23, 1996,** I journeyed to central Oregon to capture an image of Comet Hyakutake. Around 1 A.M., the comet's coma was near Polaris and its tail stretched all the way into Hydra. The stars shining through the long tail produced an incredible 3D effect. I realized this was probably a once-in-a-lifetime view, and I needed to emblazon it in my memory forever.

—RODNEY POMMIER, ASTROIMAGER AND AUTHOR

JIM MAZUR/WIKIMEDIA COMMONS

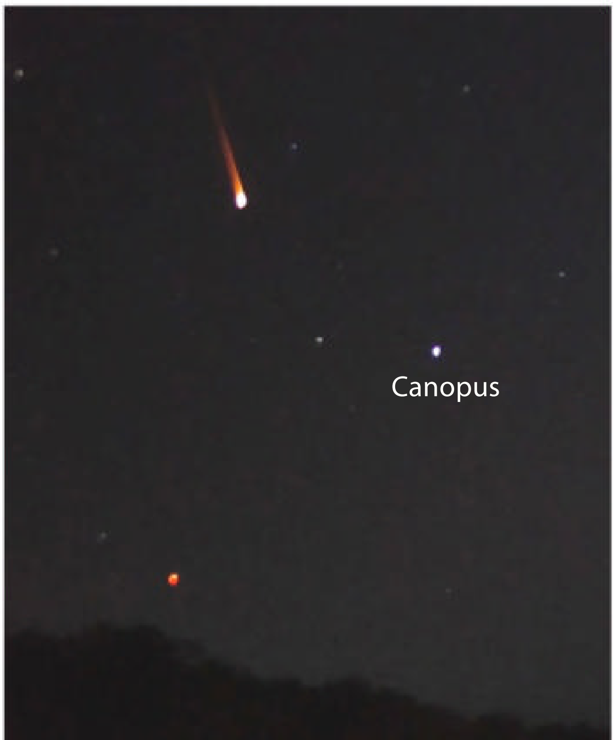
## Comets and dumbbells

**ON A CRISP MICHIGAN NIGHT** many years ago, my buddy and I went out to observe a comet. We were both seasoned observers and didn't take a finder chart, only binoculars and a 4¼-inch scope. After some effort, we found a fuzzy object that had to be the comet. My buddy finally said, "That's not a comet, it's a dumbbell like the two of us!" Indeed, it was the Dumbbell Nebula (M27). Never leave home without a finder chart.

—RAYMOND SHUBINSKI, CONTRIBUTING EDITOR

# Meteor news

I asked readers if anyone had seen a red meteor, and you answered.




The "fiery red meteor" that Frankie Lucena recorded on Jan. 26, 2023, at 01h06m UT, facing south from Cabo Rojo, Puerto Rico, is seen in this still image. For the complete video of the event, scan the QR code below. FRANKIE LUCENA

Before delving into a meteoric X-file, I'd like to share some red meteor news. In my September 2021 Secret Sky column, I described sighting a blood-red meteor. As usual, I asked readers if they had seen a similar phenomenon. I was amazed by the responses. Two years later, I am still receiving reports.

While seeing an all-red meteor is a rare occurrence for any one person, they do appear to be more frequent than I had imagined. What follows is a representative sample of these reports from across the globe.

On the night of Aug. 2, 2021, Julie Seiter of southeastern Indiana was out looking for early Perseid meteors without luck. She decided to have one last look toward Perseus when she saw a "distinctly red meteor just drop" from the sky overhead. The descent was nearly vertical and slow, with a slight wobble about halfway through. The sight made her think, "This is why the poets would say 'a falling star.' "

Clouds on April 21, 2022, almost made Emily Weisse of State College, Pennsylvania, give up on the Lyrid meteor shower. Then, around 11:00 P.M., she saw through a hole in the clouds a slow-moving red meteor. Its long tail was streaking down toward the horizon from a point about 30° high in the northeast, slightly angled to the north. The spectacle was about as bright as Jupiter, and it lasted a couple of seconds. "Long enough," she says, "to spend a little time with it."

In Nottingham, England, Robert Tomlinson was "just about to come inside from imaging Saturn" on the morning of July 9, 2022, when he saw a "huge red meteor" streak rapidly across the sky from west to east in about two seconds. "I have seen many meteors," Tomlinson says, "but I have never seen a red one! I didn't even know they existed. It was magnificent. I will never forget seeing it."

The "bright red" meteor that Heather Karrow of southern Wisconsin saw on Oct. 23, 2022, was both "beautiful and jaw dropping," lasting longer than other meteors she saw that night.

> **"This is why the poets would say 'a falling star.'"**

Nearly a month later, on Nov. 20, 2022, Bryan Bailey of Knoxville, Tennessee, saw a red meteor with a "bright whitish nose and a long, sparkling, deep red tail. It was one of the most miraculous things I have ever witnessed," he says. That same night, Jason Morrow of Paducah, Kentucky, was out walking his dog when he sighted what was likely that same red fireball in the southwest. "It wasn't extremely bright," he says, "but noticeable." He reports that it seemed wider than most meteors he'd seen, and it seemed to "burn or even crumble toward the end."

A month later, on Dec. 26, Gavin Peters in Adelaide, Australia, was looking due south when a "sparkly red/orange" meteor sliced the sky vertically for perhaps 20° of sky, terminating about 10–15° above the horizon.

The red meteor Phil Hartley saw around 10 P.M. over Doncaster, in South Yorkshire, England, on Jan. 22, 2023, made him think jovially of an "alien spaceship being shot down."

## X-Files: Silver Meteor

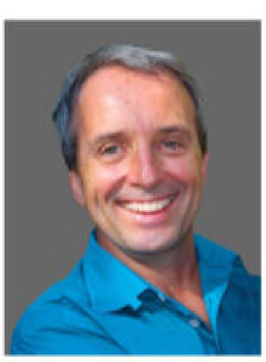
Now, cue the theme music from *The X-Files*. Have you ever seen a silver meteor? In January 2023, I was setting up my 3-inch Tele Vue refractor near the end of astronomical twilight when a swift third-magnitude meteor flashed about midway up the west-northwestern sky over Maun, Botswana. My first impression was a streak of molten aluminum, as the object's sheen was similar to that of tinfoil.

The problem is, while meteors can have an aluminum component, "aluminum would radiate in the near-UV, in between the two strong emission lines of Ca+, in the 390–400 nanometer wavelength range," says Peter Jenniskens, a meteor expert at the SETI Institute in California. "Usually, it is a weak emission. Not sure what combination of wavelengths would create the impression of a 'silver color.' "

I wish I could blame the light of the silvery Moon, but there was no Moon in the sky. But seriously, I am wondering if a color-contrast illusion was at play. Some aerosols from the Jan. 15, 2022, eruption of the Hunga Tonga-Hunga Ha'apai volcano are still present in the southern skies, giving us peach-toned astronomical twilights. As silver is a neutral shade, it can be complemented or enhanced by warm tones, such as orange and pink, which create a peach color when combined.

A preliminary bit of research into visual sightings of meteors turned up no further accounts of silver ones, but if you know of any historical accounts, or have seen a silver meteor yourself, write to me at sjomeara31@gmail.com.

BROWSE THE "SECRET SKY" ARCHIVE AT **www.Astronomy.com/OMeara**



**BY STEPHEN JAMES O'MEARA**
*Stephen is a globe-trotting observer who is always looking for the next great celestial event.*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# Astrophotography without a scope

You don't need fancy equipment to take stunning shots.

The author took this image of star trails above observatory domes from near San Pedro de Atacama, Chile, looking toward the South Celestial Pole. MOLLY WAKELING

**BY MOLLY WAKELING**
*Molly is an avid astrophotographer active in STEM outreach. She is pursuing her Ph.D. in nuclear engineering.*

I got started in astrophotography in July 2015, when I received my first telescope as a gift: an 8-inch Schmidt-Cassegrain on an altitude-azimuth mount. After nearly falling over, seeing Saturn for the first time, I decided I must attach a camera to the telescope somehow so I could share that beauty with the world.

Astrophotography is often associated with expensive telescopes, robotic mounts, and highly technical challenges. But getting started can be easier than you think: All you need is a basic DSLR and a tripod.

**Getting started can be easier than you think.**

## Star trails

Images of star trails are stunning and easy to make. Start with your DSLR and a short-focal-length lens (a stock 18–55mm zoom lens at 18mm is perfect) on a tripod, and pick an area of sky. Capturing the motion of stars as they wheel around the celestial poles is particularly mesmerizing, so facing north (or south, in the Southern Hemisphere) is a good place to start. A nice foreground, such as a barn or a tent or even a distant tree line or mountain, will make for a captivating image.

In Manual mode, set the exposure time to 30 seconds and choose a relatively high ISO, such as 1600 or 3200. Use the widest f/stop, or stop down one or two if you are using a very fast lens, such as f/1.8. If your camera has a built-in multiple-exposure mode, use that to trigger it. If not, an intervalometer is an indispensable tool for all kinds of astronomy purposes. Intervalometers can be programmed to activate the shutter for you (rather than you manually depressing the shutter button), including in Bulb mode, where you can set an arbitrary exposure time. You can get an intervalometer for around $20.

Take long exposures — 15 to 60 seconds to avoid saturation — for at least one hour, although you can go all night. I recommend taking images in JPEG format for ease of processing, or you can convert raw shots to JPEGs later.

Processing star trail images is simple through free software called Startrails (www.startrails.de). Simply load all the photos, press the Startrails button, choose the mode, and watch the magic. You can import the final image into Photoshop or another image processor to tweak colors, contrast, and other details.

## Time-lapse videos

This same technique can be used to take time-lapse videos of objects rising or setting, such as the Milky Way, the constellation Orion, or a crescent Moon. In this case, choose a short enough exposure that the stars don't trail as much. (Fifteen seconds is good for an 18mm lens.) Otherwise, use the same the settings and technique as for star trails.

There are many free and paid programs to turn individual frames into a video. A favorite of mine is TimeLapse DeFlicker ($35 at www.timelapsedeflicker.com), which smooths variation in light between exposures. Add some space-themed music for a fun video of the night!

## Nightscapes

Nightscape (or skyscape) images are wide-field shots of the night sky with a fascinating foreground, such as mountains, buildings, or anything else you might think of. Nightscape photos are best taken in raw format and from dark locations, far from cities.

A fast camera lens, such as a 14mm f/2, can capture the Milky Way rising using a single 20-second exposure. For an even more stunning image, photographers might take a single long exposure of the foreground — say 30 or 60 seconds, while lighting the landscape in some way — and then take several 15-second exposures of the sky to keep the stars from trailing. Stacking software can align and combine the sky exposures into one bright, high-contrast image; the photographer then replaces the sky in the foreground frame with the stacked sky frame.

Eight years after my first astroimaging experience, I now run four automated imaging rigs in my yard, with even bigger plans for the future. And I am thrilled to start sharing my knowledge and love of astronomy here!

BROWSE THE "OBSERVING BASICS" ARCHIVE AT
**www.Astronomy.com/author/molly-wakeling**

# Capricornus close-up

Take a look back at the magazine's first column.


The constellation Capricornus the Sea Goat is one of the oldest in the night sky. ASTRONOMY: ROEN KELLY

UPPER RIGHT: This star chart was featured in *Astronomy*'s first "Constellation Close-up" column. ASTRONOMY

**BY PHIL HARRINGTON**

*Phil received the Walter Scott Houston Award at Stellafane 2018 for his lifelong work promoting and teaching astronomy.*

The premier issue of *Astronomy* featured a column called "Constellation Close-up" written by Thomas C. Bretl. The first installment profiled the zodiacal constellation Capricornus. In honor of the magazine's anniversary, let's rewind to 1973 and revisit Capricornus with our binoculars to enjoy some of the same targets that Mr. Bretl featured 50 years ago.

Although its brightest star is barely above 3rd magnitude, Capricornus is one of the oldest constellations in the sky. Its origins date back at least 3,500 years to summer in ancient Mesopotamia. The name is Latin for "horned goat," but Capricornus is depicted as a sea-goat, with the front half of a goat melded to the tail of a fish. Not something you see every day.

Modern-day Capricornus lies in the "wet" part of the southern sky, near other watery constellations such as Aquarius and Piscis Austrinus, just above the southeastern horizon.

**Modern-day Capricornus lies in the "wet" part of the southern sky, near other watery constellations.**

Just seeing its brightest stars will challenge our unaided eyes from suburban locations, but zeroing in on them is easy thanks to the far brighter Summer Triangle. By extending a line from Vega through Altair southeastward for 22°, you'll come to Alpha (α) and Beta (β) Capricorni. They mark the northwestern corner of the Sea Goat's arrowhead-shaped form and are fine binocular double stars.

**Alpha Capricorni**, also known as Algedi, is easy to resolve into two stars with pocket binoculars. Alpha$^1$, the western star of the pair, is separated from Alpha$^2$ by 6.6'. In fact, they can be resolved by eye alone given dark skies. But since they shine at magnitude 4.3 and 3.6, respectively, most of us will need binoculars to see them. Both are yellow giants that may show a soft buttery tint if you slightly defocus the view. Looks can be deceiving, however. The stars have no physical connection to each other, but just happen to lie along the same line of sight.

If you are using 10x50 or larger binoculars, see if you can resolve Alpha$^1$, which is a true multiple-star system. Its brightest companion shines at 9th magnitude and lies 45" to the southwest. Due to the companion star's faintness, however, you'll stand the best chance by first securing the binoculars on a sturdy support to avoid shaking.

**Beta Capricorni**, also known as Dabih, is just 2.4° southeast of Alpha and so should lie in the same field of view. Even the lowest-power binoculars should easily resolve a pair of stars. Beta$^1$ and Beta$^2$ are separated by 3.5', with the brighter of the pair (at 3rd magnitude) designated Beta$^1$ Capricorni. Beta is actually a quintuple star, although binoculars only show two stars. Beta$^1$ has three components, while Beta$^2$, shining at 6th magnitude, is a two-star system.

In contrast to the crowd of nebulae and clusters to its west, Capricornus holds only one deep-sky target for binoculars: globular cluster **M30**. Charles Messier discovered M30 on Aug. 3, 1764. He wrote, "Nebula discovered below the tail of Capricorn. … One sees that nebula with difficulty in an ordinary refractor; it is round, & I have not seen any star: diameter 2 minutes of arc." It was left to William Herschel to discover the true nature of Messier's "nebula" — that it contains myriad stars.

Finding M30, which has an apparent magnitude of 7.1, can be a chore due to its sparse surroundings. I always begin at Nashira (Gamma [γ] Capricorni) and Deneb Algedi (Delta [δ] Capricorni) at the northeastern point of the Capricornus triangle. Aim about halfway between them and Omega (ω) Capricorni, at the triangle's southern tip, to find 4th-magnitude Zeta (ζ) Capricorni. Center on Zeta and then look toward the eastern edge of the field for 5th-magnitude 41 Capricorni. M30 lies less than ½° to its west.

M30 through binoculars reflects Messier's view much more than Herschel's. Notes made through my 10x50s recall a round, misty patch of light surrounding a brighter core. Larger binoculars increase the apparent brightness of the cluster, which lies about 28,000 light-years from Earth, but do little more. Even my 25x100s fail to resolve any of the several hundred thousand stars that call this tightly packed globular home.

Questions, comments, suggestions? Drop me a line via my website, philharrington.net. Until we meet again next month, remember that two eyes are better than one.

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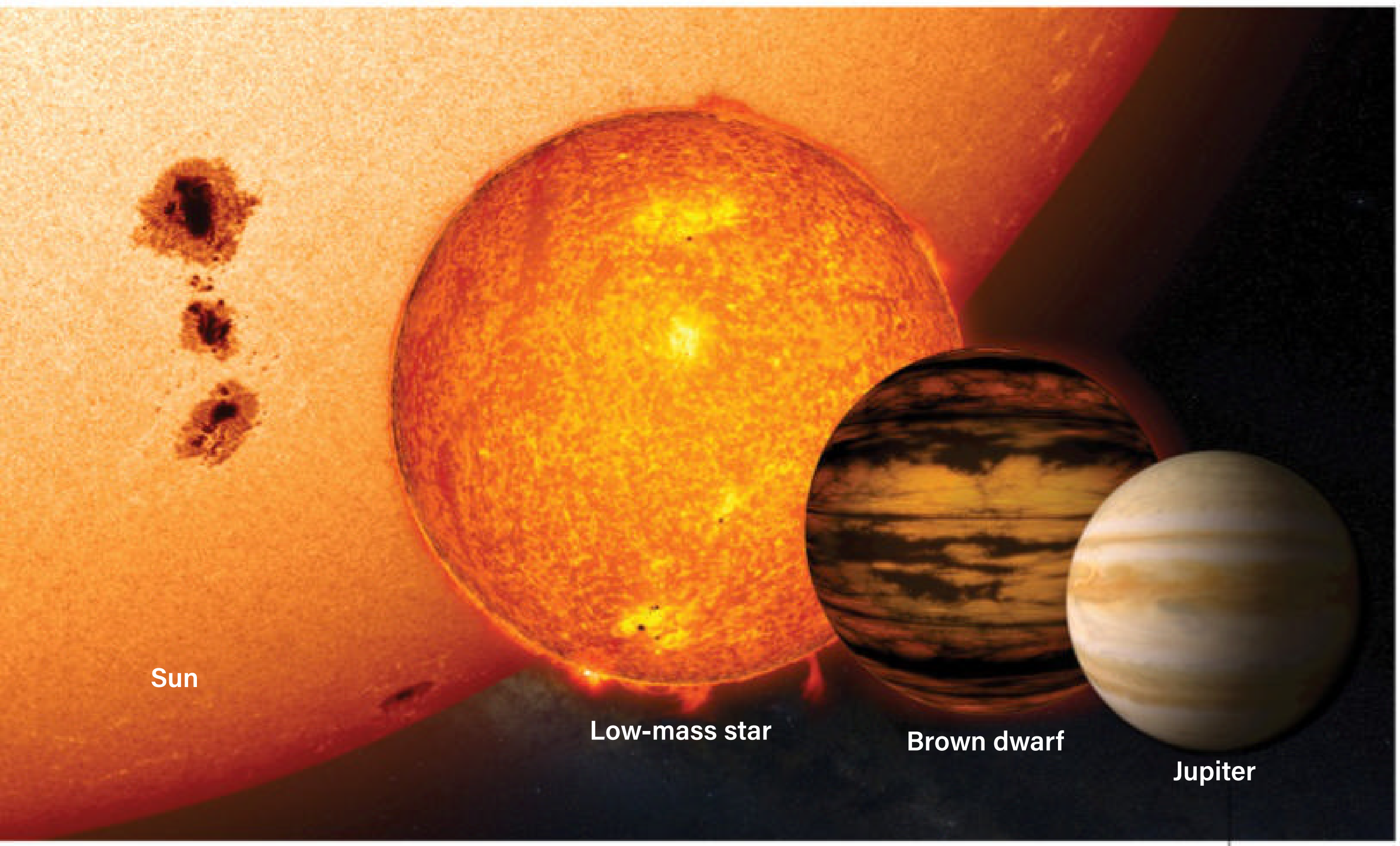



# Greatest hits

**THE JULY 1997 ISSUE OF *ASTRONOMY* included an eight-page article titled "Ask Astro," in which renowned stellar astronomer James B. Kaler answered 20 reader-submitted questions. At the end, a small sidebar announced: "Starting with the August issue, *Astronomy* will be running a monthly question-and-answer column." Since then, this column has answered some 1,000 questions about science and the astronomy hobby.**

**Here are some of the most popular and poignant questions we've answered through the years. The questions have been generalized, as we've received variations of them over and over, while the answers are attributed to the writer according to their professional position and affiliation at the time they provided it.**

ABOVE: Brown dwarfs are considered "failed stars" whose masses span the range between the lowest-mass stars and the highest-mass planets. NASA'S GODDARD SPACE FLIGHT CENTER

RIGHT: Professional observatories such as the Visible and Infrared Survey Telescope for Astronomy in Chile use different techniques than amateurs with smaller scopes do to protect their equipment. G. HÜDEPOHL (ATACAMAPHOTO.COM)/ESO

## Q | WHY IS JUPITER NOT A STAR OR A BROWN DWARF?

**A** | Although 318 times more massive than Earth, Jupiter would need 80 times more mass for its core to be hot enough to sustain thermonuclear fusion — the creation of helium from four atoms of hydrogen with the release of energy. Fusion generates the energy that allows stars to shine.

Brown dwarfs are not massive enough to sustain fusion, either. These "failed stars," however, form entirely from interstellar gas. Planets, on the other hand, assemble from the dust and gas of the remnant disk that forms while the star is accreting matter. The two classes may in fact overlap — as of now, we do not know.

***James B. Kaler***
*University of Illinois at Urbana-Champaign*
*(July 1997 issue)*

Additionally: Today, the International Astronomical Union places the dividing line between brown dwarfs and planets at 13 Jupiter masses. This is the minimum mass required to ignite deuterium fusion. (Deuterium is an isotope of hydrogen.)

***Alison Klesman***
*Senior Editor*

## Q | WHERE IS THE CENTER OF THE UNIVERSE (WHERE THE BIG BANG OCCURRED) AND WHERE IS ITS EDGE?

**A** | As counterintuitive as it may seem, the universe has no center, and it has no boundary.

The idea of a Big Bang acting like a giant fireworks explosion hurtling matter and energy outward is pervasive, but misleading. As bizarre as it sounds, it wasn't "stuff" that exploded outward, it was space itself! In essence, the Big Bang happened *everywhere*. Since the time of Einstein, it has been known that space is not simply a backdrop in which we move, but an actual thing that can be measured. It has shape, it can be bent, and it can expand.

If this sounds nonsensical, think of the surface of a balloon expanding into three-dimensional space. A two-dimensional creature confined to the surface of the balloon could never find the center, because the center is located in 3D space, and not in the 2D space in which the creature lives. We are 3D creatures stuck in a universe with at least four dimensions, so we cannot see the center of our universe. In fact, there's no reason why there has to even be a center anywhere.

The same reasoning holds true for the "edge" of the universe. Where is the edge of a balloon? To define an edge (or a center), you need to assume that there is something into which the universe expands. As I just explained above, that need not be true, and even if it is, we can never detect this "metaverse."

When thinking about cosmology, always remember the words of British biologist J.B.S. Haldane: "The universe is not only queerer than we suppose, it is queerer than we *can* suppose."

***Phil Plait***
*ACC, Inc.*
*(March 1999 issue)*

**Q** | HOW DO PROFESSIONAL OBSERVATORIES DEAL WITH DEW ON MIRRORS AND LENSES?

**A** | As with amateur scopes, dew is a potentially harmful problem at professional observatories because the water that accumulates on optical surfaces can interfere with the telescope's performance, and it may leave a residue that is difficult to remove once the water evaporates. Cleaning these surfaces frequently can be both expensive and impractical.

Most professional instruments use large mirrors and do not have corrector plates like those we find on Schmidt-Cassegrain telescopes. Due to the area of a large mirror's surface (and the mirror's mass), the amount of heat required to avoid the condensation of water would raise the mirror's temperature, distort the incoming light, and ruin the quality of any data gathered.

Amateur astronomers also are often surprised by the amount of dust on the optical surfaces at professional observatories. While this dust does not interfere with the observations, a dust particle can act as a nucleus for water to condense around and make a mess. Thus, most large observatories avoid dew by either closing the observatory well before a dew event is imminent or by air-conditioning the facility so the temperature stays the same as that outside.

A telescope operator acts as a steward for the facility and decides whether to open or close an observatory based on conditions such as high humidity, high winds, lightning, and particulates in the air. Sometimes this decision goes against a visiting astronomer's desires (and thus, interesting conversations can follow). But the equipment is expensive, so erring on the side of caution is the typical policy.

Astronomers also build professional observatories at high and dry locations atop mountains. Humidity levels that exceed 80 percent at these locations usually accompany poor observing conditions (especially clouds) that warrant closing the facility anyway because data gathered would be of poor quality. In mountainous locations, storms can develop quickly during high humidity.

***Adam Block***
*Mount Lemmon SkyCenter, University of Arizona*
*(February 2017 issue)*

Although artist's illustrations are often used to represent the Big Bang, there is no center and no boundary to the universe. *ASTRONOMY*: ROEN KELLY

## SEND US YOUR QUESTIONS

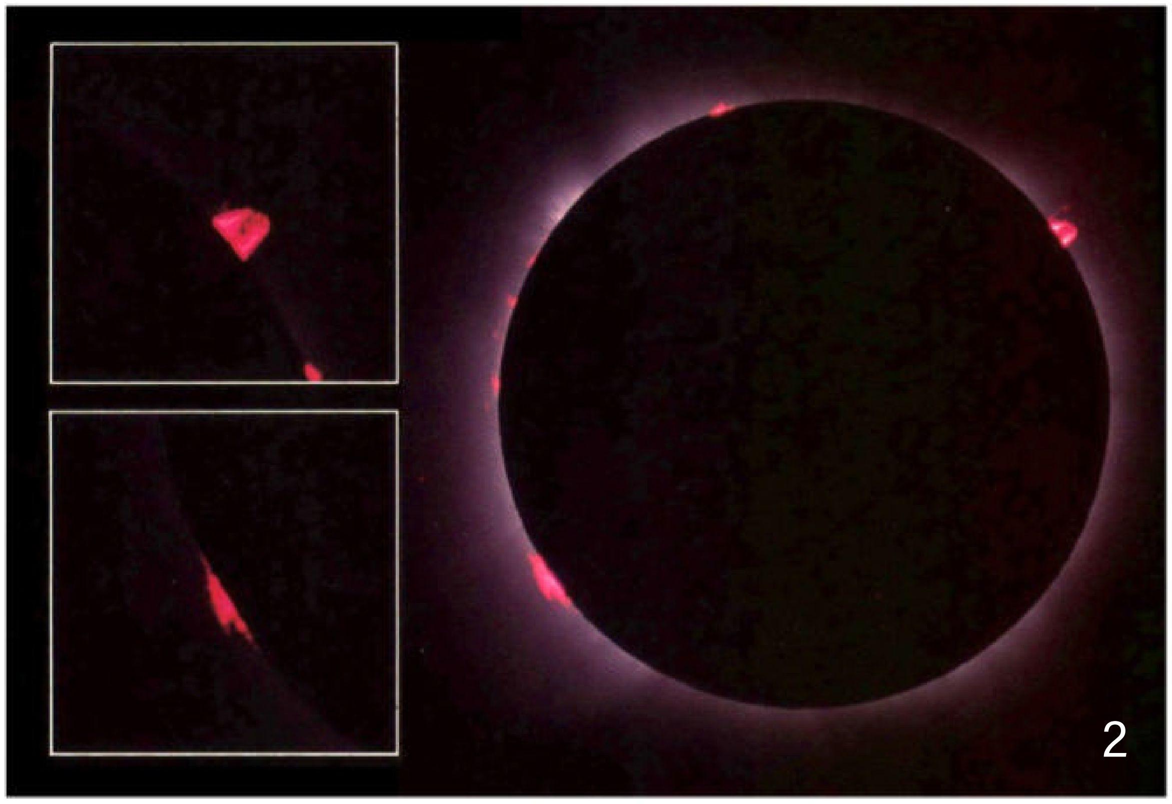
Send your astronomy questions via email to **askastro@astronomy.com**, or write to Ask Astro, P.O. Box 1612, Waukesha, WI 53187. Be sure to tell us your full name and where you live. Unfortunately, we cannot answer all questions submitted.

# Cosmic portraits

**THE APRIL 1988 ISSUE OF *ASTRONOMY* debuted a new department: Reader Reports, dedicated to covering sky events and reader projects, compiled and written by then-Assistant Editor David J. Eicher. "The editors of *Astronomy* look forward to receiving your observations, photographs, and sketches of the sky for possible inclusion," the call for submissions stated — a sentiment that remains just as true today.**

**The July 1989 issue introduced the characteristic gallery format of a full spread of images, and those images grew ever more spectacular over the years. In 1995, the section moved just inside the back cover for greater visibility — where you find it now. For this special edition, we wound back the clock to revisit some of the most notable images from you, our readers.**

1



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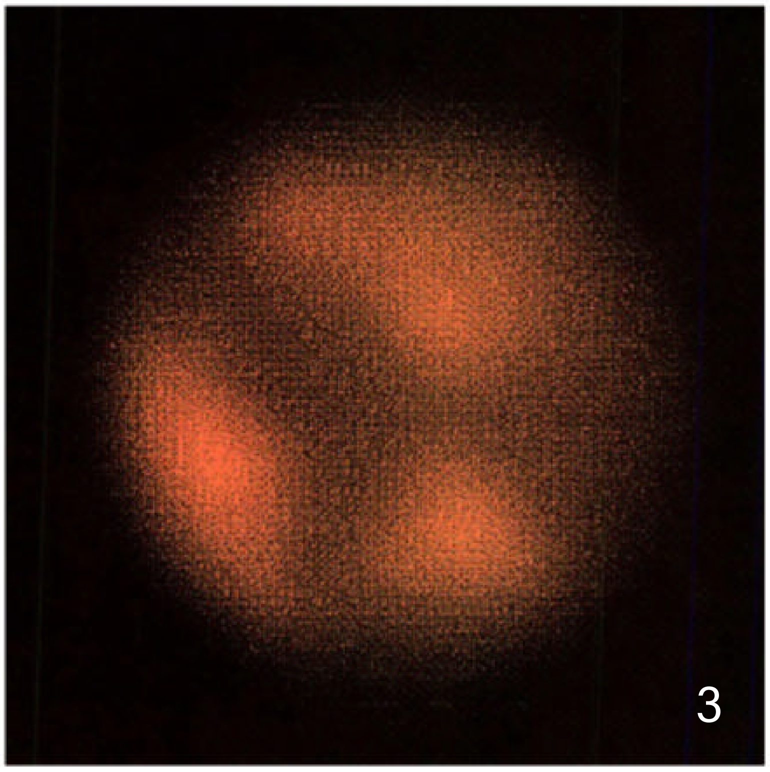

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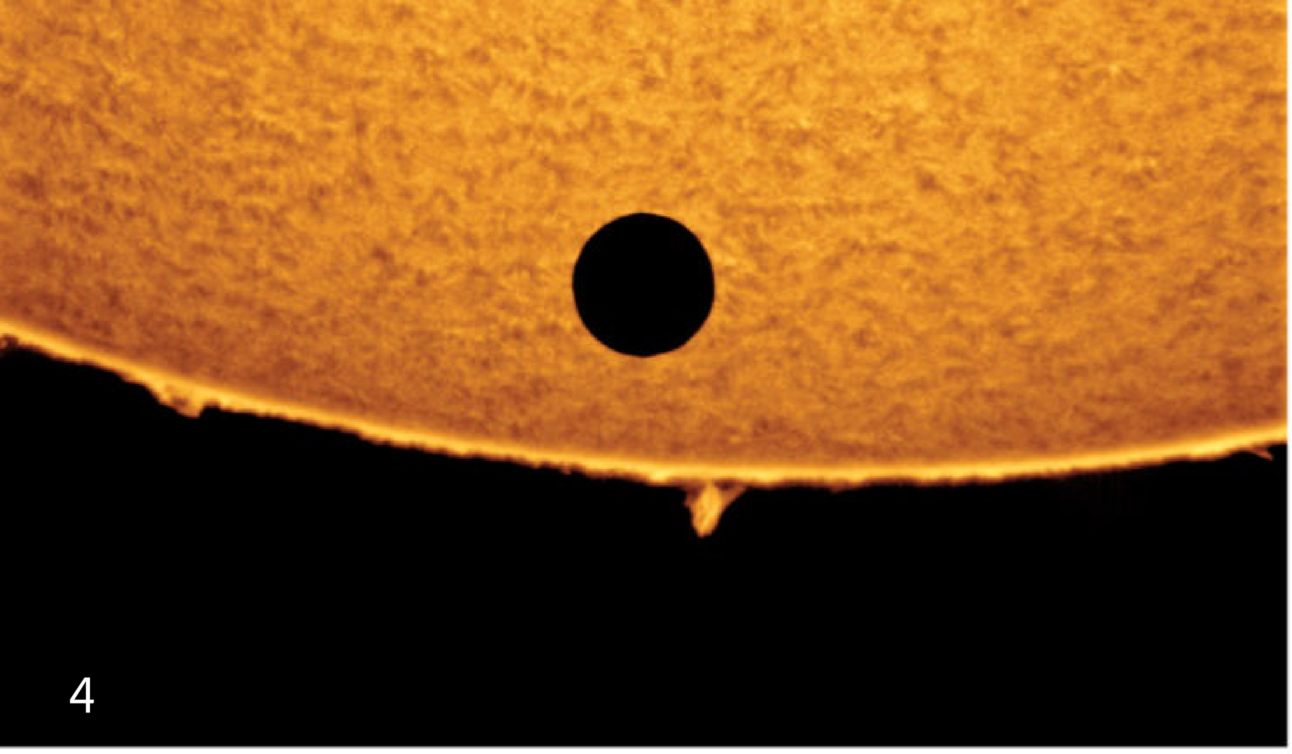
**1. HUMBLE BEGINNINGS**
The first edition of Reader Reports featured Comet Bradfield (C/1987 P1). At the end of 1987, the comet developed a prominent anti-tail, a stream of material that appears to point toward the Sun. "Of the comets I've seen in the past 15 years — over 50 in all — this one is a real gem," wrote Chris Schur, then of Black Canyon City, Arizona. He photographed the comet and its anti-tail on Dec. 20, 1987, with an 8-inch f/1.5 Schmidt camera and hypersensitized Tech Pan film. He used a yellow filter for the 10-minute exposure. ▪ ***Chris Schur***

**2. RISING TO PROMINENCE**
In the next edition of Reader Reports, Glenn Schneider of Baltimore relayed his observations of the total solar eclipse of March 17/18, 1988, from Bangka Island, Indonesia. Glancing through a 4-inch refractor, he said, "I ... was astounded by the sight of the most magnificent prominences I have ever seen during an eclipse." ▪ ***Glenn Schneider***

**3. ANALOG TO DIGITAL**
The first digital image to appear in Reader Reports was of Mars' 1988 opposition. Members of the Santa Barbara Astronomy Club led by Thomas W. Fuller used a CCD camera mounted to a 16.5-inch Cassegrain telescope — stopped down to a 5-inch aperture — at Westmont College. The exposures were "about 1/8-second each and were made by hand using a cardboard shutter," processed in a 256-step grayscale, and printed "on a high-resolution dot-matrix printer." ▪ ***Thomas W. Fuller/ Clyde Kirkpatrick/Ramona White***



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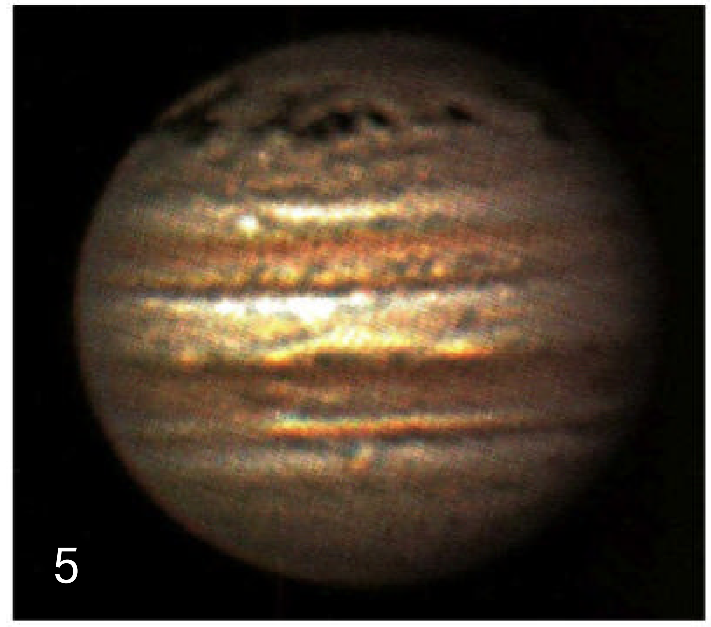

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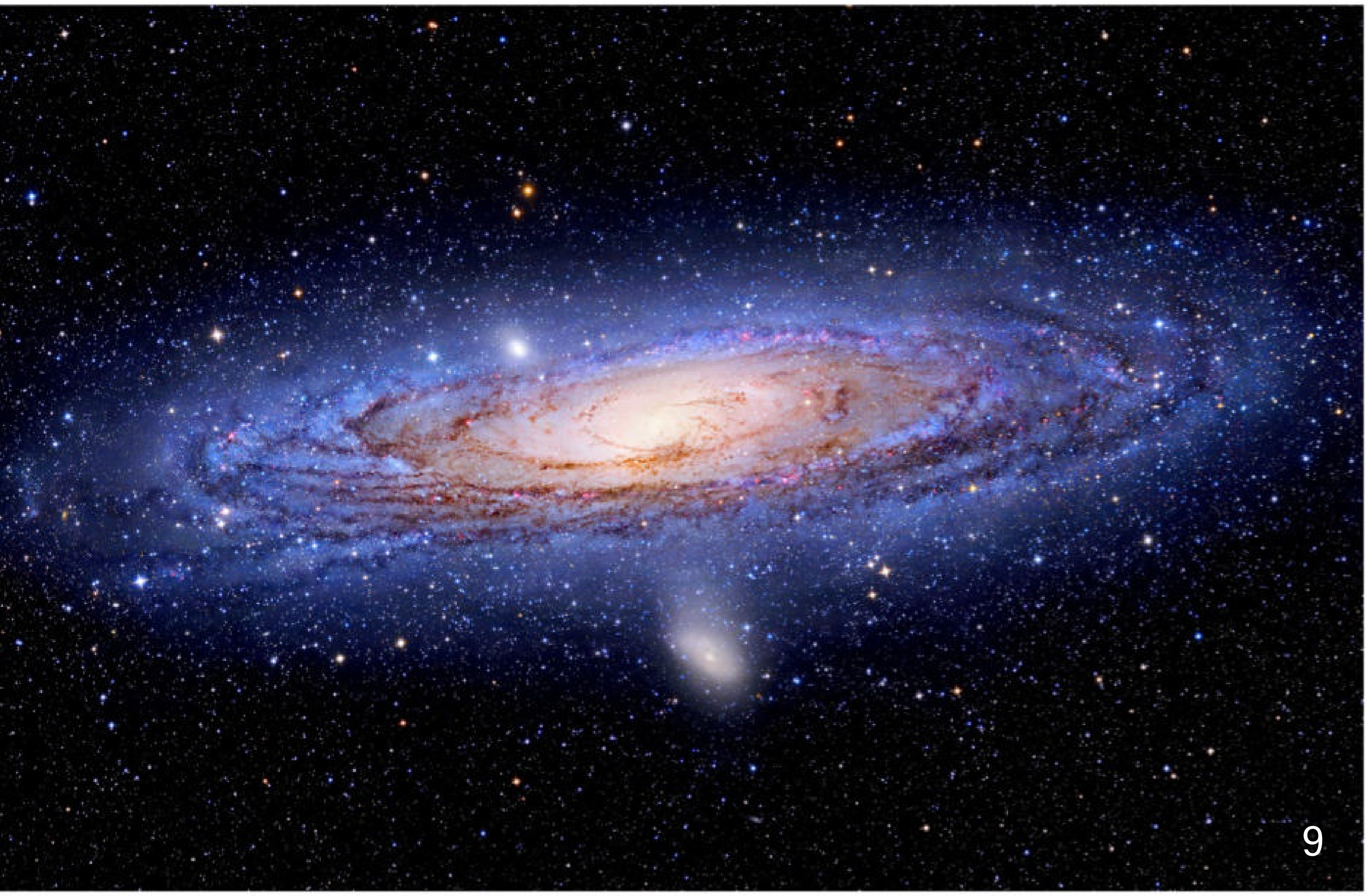
**4. HISTORY IN THE MAKING**
When Venus transited the Sun on June 8, 2004, it was a new experience for everybody — no one had been alive to see the previous one in 1882. This Hα image was taken with a 5-inch refractor, a Pentax LX camera, and Elite Chrome 100 film. It consists of two exposures: 1/8-second for prominences and 1/30-second for disk detail. ***• Marco Cosmacini/Marzia Muradore***

**5. ABSORBING THE BLOWS**
December 1994's special edition of Reader Reports published images of Jupiter being pounded by the fragments of Comet Shoemaker-Levy (D/1993 F2). The impact sites are visible as dark spots in the planet's cloudtops in this image from a 16-inch f/7 reflector and a Lynxx CCD camera, taken July 25, 1994. ***• Donald C. Parker***

**6. PHOTO FINISH**
For the magazine's 25th anniversary, a photo contest was held with two divisions: electronic images and film. The runner-up in the film division was this composite shot of the venerable Orion Nebula (M42), taken with a 12.5-inch refractor at f/5 and two 30-minute exposures on Fuji Super HG 800 film. ***• B. Frank Hinson/J. Steve Foster***

**7. HISTORIC HALE-BOPP**
Comet Hale-Bopp (C/1995 O1) and the Andromeda Galaxy (M31) glow over Wukoki, a 900-year-old pueblo in Wupatki National Monument in Arizona, on March 29, 1997. The shot was taken with a 50mm lens at f/2.8, Fujicolor 800 film, and a six-minute exposure, with the ruins illuminated by photoflash. ***• Joshua Vaughan***

**8. HYAKUTAKE, THE HYPE MAN**
In the history of this magazine, no single event sparked more interest in the night sky than Hale-Bopp's pass in 1997 — but Comet Hyakutake (C/1996 B2) the year before was no slouch, either. Hyakutake's filamentary tail was captured with a 7.5-inch f/2 Schmidt camera and Kodak Gold 400 film in this four-minute exposure taken April 17, 1996. ***• Gerald Rhemann and Franz Kersche***

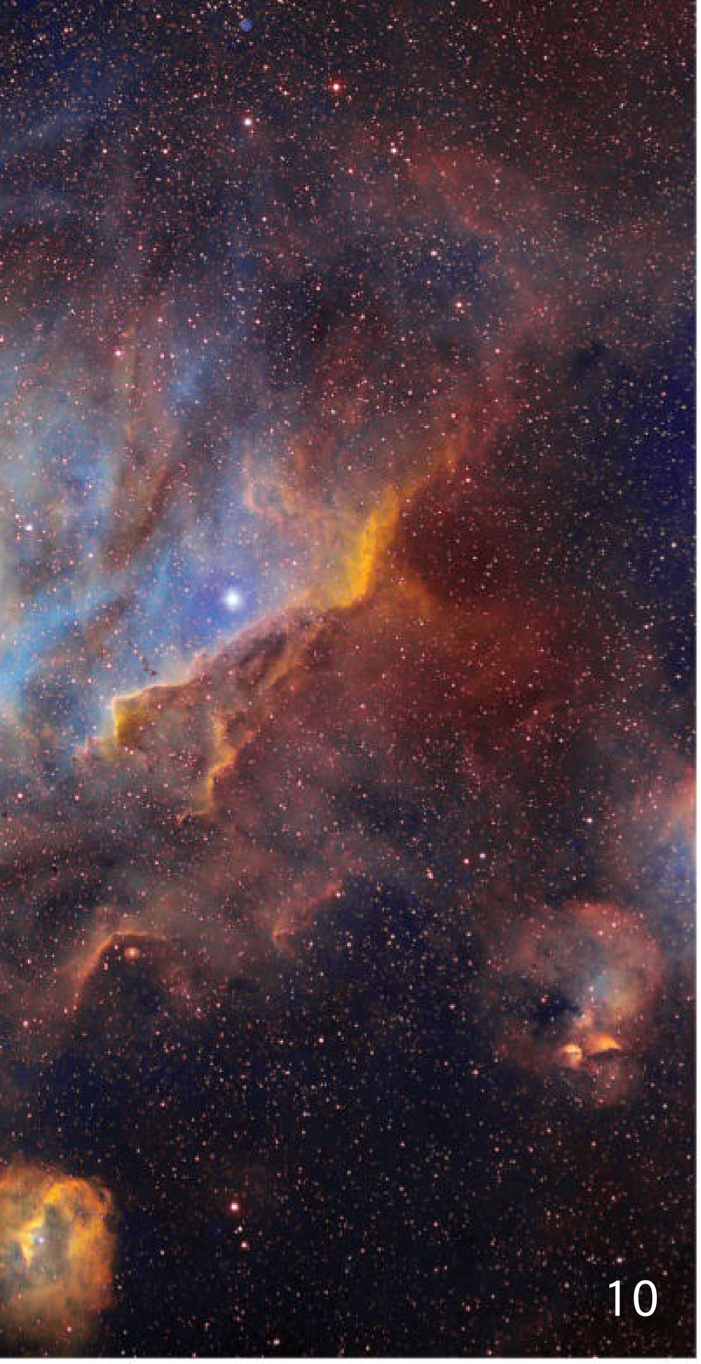


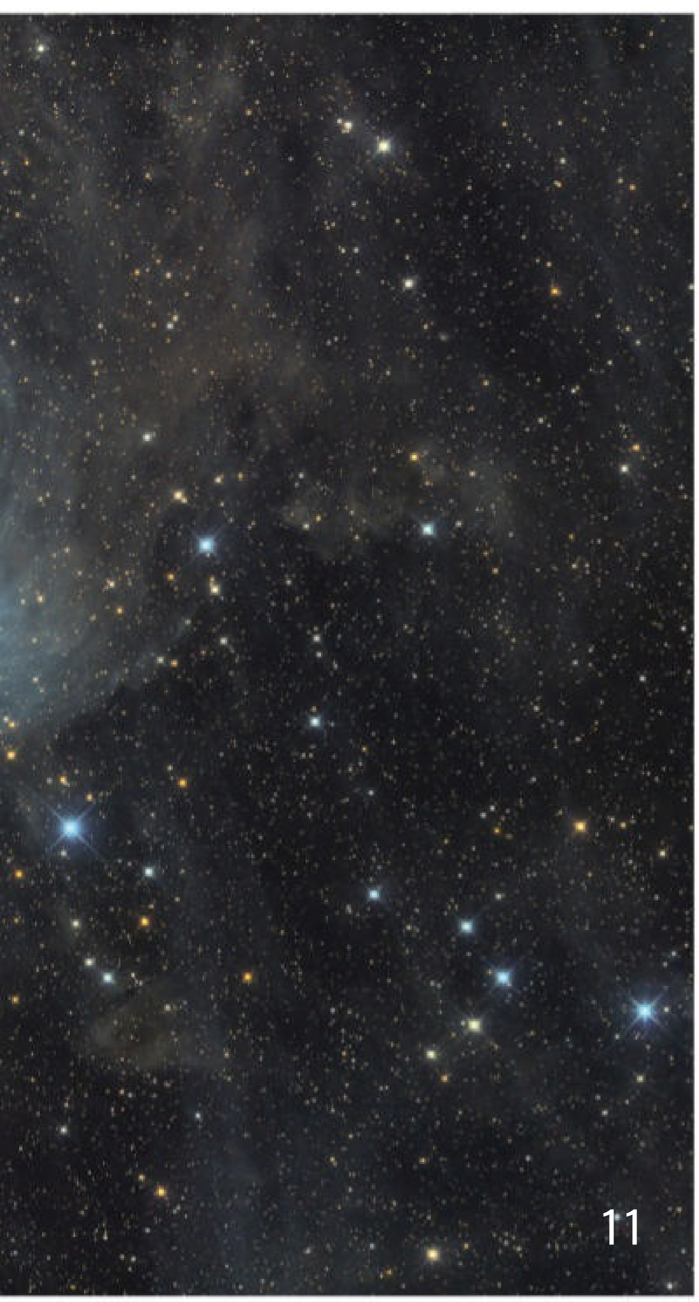

**9. A STAR IS BORN**
Self-taught astroimager Tony Hallas won *Astronomy*'s astroimaging contest in the September 2009 issue with this spectacular LRGB mosaic of our nearest neighboring spiral, the Andromeda Galaxy (M31). The image is composed of 19 panels taken with two different scopes and CCD cameras, totaling roughly 19 hours of exposure. A year later, Hallas began writing a regular column for this magazine, sharing his imaging expertise and techniques. • ***Tony Hallas***

**10. AESTHETIC INNOVATION**
The emission nebula IC 2944 in Centaurus anchors this image — one of the first in this department to feature data with narrowband filters processed in what came to be known as the Hubble palette: SII mapped to red, Hα to green, and OIII to blue. The now-ubiquitous process brought a new colorway to the cosmos, trading the deep scarlets of LRGB images for bright amber and brilliant blues. • ***Ken Crawford***

**11. THE ADVENTURE CONTINUES**
Intricate ribbons of dust are bathed in cool blue light from the Pleiades (M45) in this image taken over 11.2 hours with a DSLR and a 300mm lens at ISO 800. Astroimagers continue to be pioneers in our exploration of the cosmos, using new equipment, developing techniques, and forging collaborations to go deeper and reveal ever fainter detail — even in familiar naked-eye objects. The editors of *Astronomy* look forward to seeing what you find next. • ***William Ostling***

**SEND YOUR IMAGES TO: readergallery@astronomy.com.**
Please include the date and location of the image and complete photo data: telescope, camera, filters, and exposures.






## INDEX *of* ADVERTISERS



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## HAPPY BIRTHDAY, HUBBLE

Everybody loves a party. And scientists couldn't wait to celebrate the Hubble Space Telescope's 33rd birthday with a magnificent portrait of NGC 1333. This stellar nursery lies about 960 light-years from Earth at the edge of the Perseus molecular cloud. A hotbed of star formation near the Hero's southern border, NGC 1333 hosts several hundred newly formed suns embedded within thick clouds of dust and cold molecular hydrogen. Just a few of these youngsters manage to shine through. Near the image's top, dust scatters light from a brilliant blue star. Thicker dust notably dims a second bright star near the photo's center. The ruddy glow near the image's bottom offers a view deeper into the nebula, where blazing hot stars ionize surrounding hydrogen atoms. During its 33 years in low Earth orbit, Hubble has viewed nearly 52,000 celestial objects. NASA/ESA/STSCI


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# October 2023
# A blazing ring of fire

As twilight fades in October, the solar system's most beautiful planet takes center stage. **Saturn** stands out because its ring system looks spectacular through telescopes of all sizes. The rings appear so bright that even Galileo saw them in 1610 with his primitive (by today's standards) refractor. The great scientist did not realize that he was looking at a circular structure around the planet, however. That discovery would fall to Christian Huygens using a far superior instrument in 1655. You can repeat these historic 17th-century observations with a small scope any clear night this month.

Saturn currently shines at magnitude 0.6 among the background stars of Aquarius the Water-bearer. Any telescope reveals the planet's 18"-diameter disk surrounded by a ring system that spans 41" and tilts 10° to our line of sight. The 8th-magnitude moon Titan also shows up easily. A 10-centimeter scope brings in three more satellites — 10th-magnitude Tethys, Dione, and Rhea — closer to the planet.

By midevening, **Jupiter** pokes above the eastern horizon. Gleaming at magnitude –2.9, it dramatically outshines Saturn and every other point of light in the evening sky. Jupiter resides against the backdrop of Aries the Ram, though the planet makes a better guide to this constellation's stars than vice versa.

If you wait a couple of hours for Jupiter to climb higher in the sky, you'll be rewarded with stunning views through any telescope. The planet's disk spans 49" and its colorful cloud tops show plenty of detail. Also keep an eye out for the planet's four large moons: Io, Europa, Ganymede, and Callisto. Galileo also discovered this celestial quartet during his initial observations of the heavens in 1610.

A third planet bears watching in October. Brilliant **Venus** rises about two hours before the Sun and remains visible well into twilight. Shining at magnitude –4.6, it appears five times brighter than Jupiter. The inner world reaches its peak at greatest elongation October 23, when it lies 46° west of the Sun and climbs 15° above the horizon an hour before sunup.

Venus remains a fine sight through a telescope, though its apparent diameter wanes while its phase waxes. On October 1, the planet spans 32" and shows a 36-percent-lit phase. By the 31st, it appears 22" across and the Sun illuminates 54 percent of its Earth-facing hemisphere.

The solar system's other two bright planets lie too close to the Sun to see this month. **Mars** succumbed to the Sun's glare in September and won't return to view until January. **Mercury** passes on the far side of the Sun at superior conjunction October 20.

Although the Sun removes two planets from our view this month, it makes up for this transgression with a nice solar eclipse. On October 14, the Moon passes directly in front of our star and delivers an annular solar eclipse to lucky observers along the eclipse's central path.

The track of annularity runs through parts of the United States, Mexico, and Central America before reaching South America. Residents along the path in Colombia and Brazil will see the Sun reduced to a ring of fire as the Moon nearly covers our star. Residents in most of the rest of South America will witness a partial eclipse. Be sure to use a safe solar filter if you choose to view the eclipsed Sun directly.

A partial lunar eclipse occurs October 28 with the best views coming to those in Africa. The event begins at 19h35m UT and ends at 20h54m UT. Maximum eclipse arrives at 20h14m UT when Earth's dark umbral shadow covers 13 percent of the Moon's diameter.

## The starry sky

Over the past centuries, many constellations have bubbled into existence only to fall into disuse decades later. This month I want to draw your attention to one of the star groups John Hill (1716–1775) invented in the mid-18th century. Hill, the son of a clergyman from Lincolnshire in England, pursued writing — from poetry to plays — as well as several scientific endeavours, including botany and astronomy.

In 1754, Hill published the book *Urania: or a Compleat view of the Heavens; containing the Ancient and Modern Astronomy in Form of a Dictionary.* (Further subtitles enhanced the title page.)

One of the constellations Hill introduced was the Pen Shell, which consisted of stars in parts of today's Aquila the Eagle and Scutum the Shield. A pen shell is a bivalve mollusk, a Mediterranean variety of which, *Pinna nobilis*, is a source of sea silk. This silk came from the byssus, a bundle of threads that attached the bivalve to rocks.

Hill commented that his constellation was "between Antinous, the Serpent [Serpens], and Sagittary [Sagittarius]." Antinous, formed from some of Aquila's stars, was said to have been a lover of the Roman Emperor Hadrian. It did not survive as a separate constellation.

Although you'll have a hard time finding the shape of a pen shell in the stars that Hill assigned to his constellation, you can at least see where it was in October's evening sky. The stars Eta (η) Scuti and 12 Aquilae formed the byssus of the mollusk while Alpha (α), Beta (β), Delta (δ), and Epsilon (ε) Sct fashioned the shell itself. Hill also referred to a star where the byssus joined the shell; it seems to correspond to the position of the well-known variable star R Sct.

# STAR DOME

## HOW TO USE THIS MAP

This map portrays the sky as seen near 30° south latitude. Located inside the border are the cardinal directions and their intermediate points. To find stars, hold the map overhead and orient it so one of the labels matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

The all-sky map shows how the sky looks at:

10 P.M. October 1
9 P.M. October 15
8 P.M. October 31

Planets are shown at midmonth


## MAP SYMBOLS

- Open cluster
- Globular cluster
- Diffuse nebula
- Planetary nebula
- Galaxy

## STAR MAGNITUDES

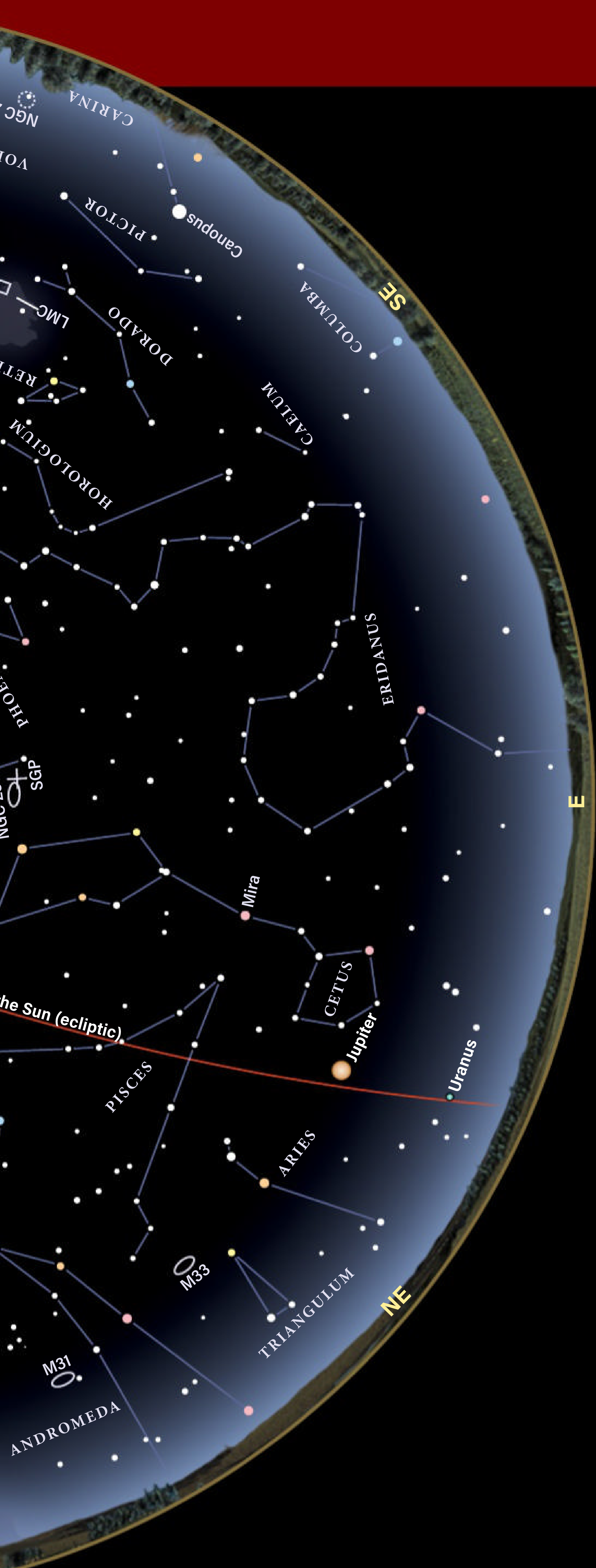
- Sirius
- 0.0
- 1.0
- 2.0
- 3.0
- 4.0
- 5.0

## STAR COLORS

A star's color depends on its surface temperature.

- The hottest stars shine blue
- Slightly cooler stars appear white
- Intermediate stars (like the Sun) glow yellow
- Lower-temperature stars appear orange
- The coolest stars glow red
- Fainter stars can't excite our eyes' color receptors, so they appear white unless you use optical aid to gather more light

BEGINNERS: WATCH A VIDEO ABOUT HOW TO READ A STAR CHART AT **www.Astronomy.com/starchart.**




# OCTOBER 2023

| SUN. | MON. | TUES. | WED. | THURS. | FRI. | SAT. |
|---|---|---|---|---|---|---|
| 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 | | | | |

ILLUSTRATIONS BY ASTRONOMY: ROEN KELLY

**Note: Moon phases in the calendar vary in size due to the distance from Earth and are shown at 0h Universal Time.**

## CALENDAR OF EVENTS

**1** Asteroid Pallas is in conjunction with the Sun, 16h UT

**2** The Moon passes 3° north of Jupiter, 3h UT

Asteroid Amphitrite is at opposition, 7h UT

The Moon passes 3° north of Uranus, 17h UT

**6** Last Quarter Moon occurs at 13h48m UT

**10** The Moon is at apogee (405,425 kilometers from Earth), 3h42m UT

Venus passes 2° south of Regulus, 5h UT

The Moon passes 6° north of Venus, 10h UT

**11** Pluto is stationary, 0h UT

**14** New Moon occurs at 17h55m UT; annular solar eclipse

**18** The Moon passes 0.8° north of Antares, 14h UT

**20** Mercury is in superior conjunction, 6h UT

**22** Orionid meteor shower peaks

First Quarter Moon occurs at 3h29m UT

**23** Venus is at greatest western elongation (46°), 23h UT

**24** The Moon passes 3° south of Saturn, 8h UT

**26** The Moon passes 1.5° south of Neptune, 1h UT

The Moon is at perigee (364,872 kilometers from Earth), 3h02m UT

**28** Full Moon occurs at 20h24m UT; partial lunar eclipse

**29** The Moon passes 3° north of Jupiter, 8h UT

**30** The Moon passes 3° north of Uranus, 2h UT

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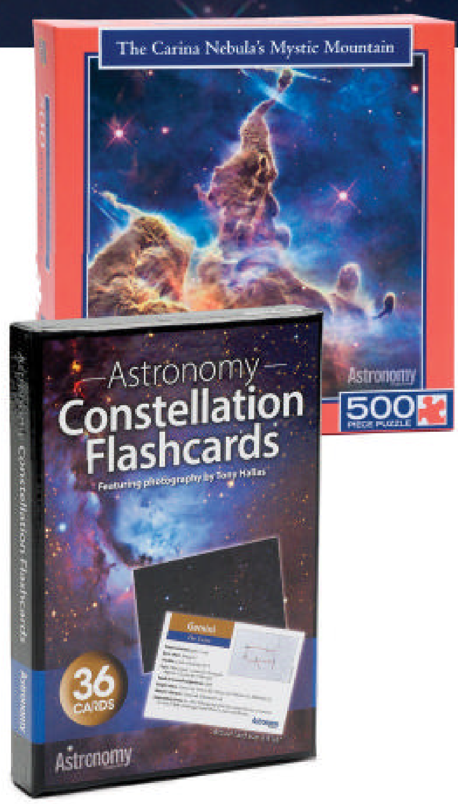


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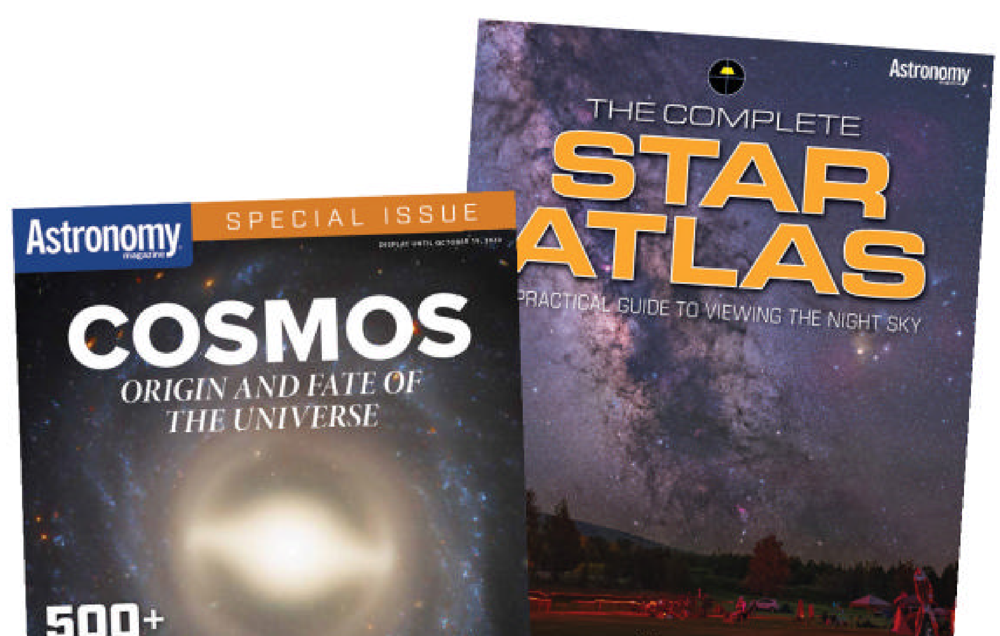


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