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JULY/AUGUST 2018

# SkyNews

The Canadian Magazine of Astronomy & Stargazing

# MARS SPECIAL ISSUE

## THE RED PLANET AT ITS CLOSEST AND BRIGHTEST IN 15 YEARS!

When and how to view it

## MARS COLD-CASE SCIENCE

Looking for clues in ancient Martian ice

+

- M13: See the Gem of Hercules With Binoculars
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SIMULATED VIEW OF AN ICE-AGE MARS. COURTESY NASA/JPL/BROWN UNIVERSITY

JULY/AUGUST 2018
*Volume XXIV/Issue 2*

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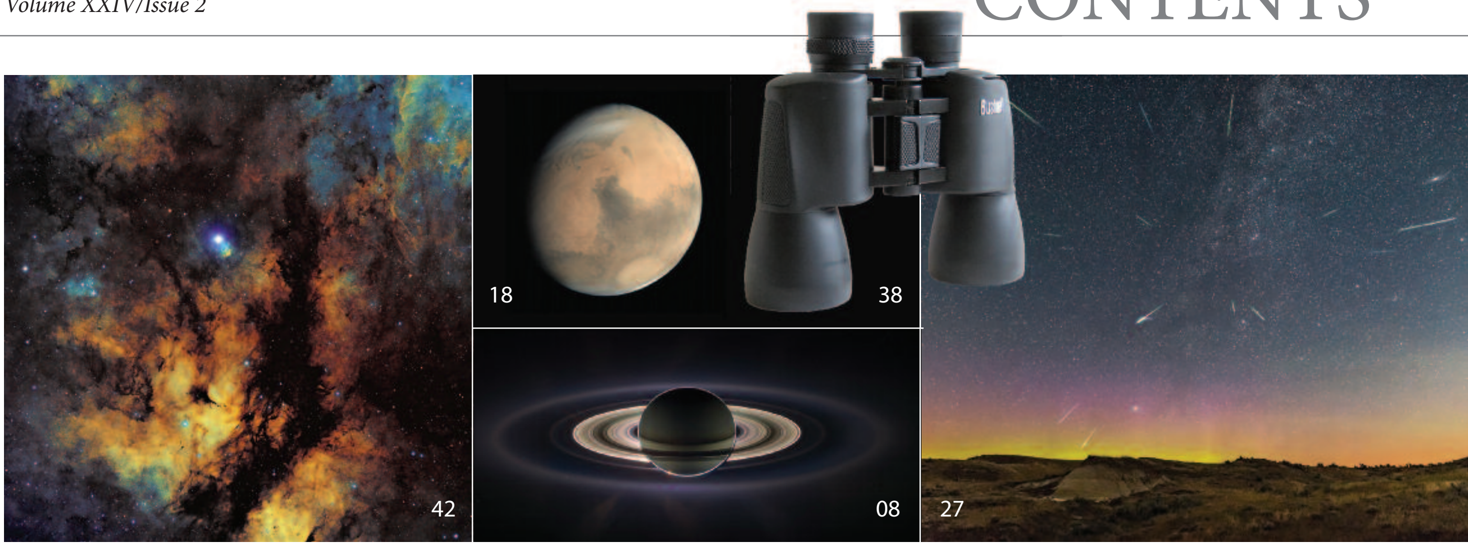


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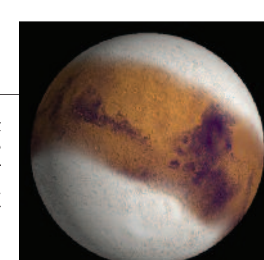

Mars has always loomed large in the imagination. Telescope users eagerly await the red planet's close approach—like the one occurring this summer—while researchers continue their work to discover whether Mars was once an abode for life. This illustration portrays Mars as it might have appeared in the distant past, when it sported expansive polar icecaps. COURTESY NASA/JPL/BROWN UNIVERSITY

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by GARY SERONIK

# MY MARTIAN CHRONICLES

Revisiting Mars stirs memories of past encounters and stokes anticipation

SOME OF MY FONDEST astronomical memories are of the red planet. The Mars of Giovanni Schiaparelli and Percival Lowell was the one that excited my youthful imagination. The idea that primitive plant life existed on Mars' parched, dusty surface seemed entirely plausible—indeed, *probable*. And who knew what may have existed in the remote past? Perhaps there never were Martians like those described by H.G. Wells or Ray Bradbury, but still . . . what if? When you're 10 years old, lots of things are possible.

I have to admit, though, I grew up in a bit of a time warp. My small town's library stocked books that weren't always of the most recent vintage, and much of what I learned about the solar system came from volumes published in the 1950s or earlier. I can still vividly recall the shock and disappointment that came over me when I first encountered a magazine showing Mariner 4 photos depicting a cruelly cratered, desolate, Moon-like Martian surface. In an instant, the Mars of Schiaparelli, Lowell, Wells, Bradbury and *Seronik* came crashing down to Earth.

My earliest recollection of seeing Mars for myself was during the favourable August 1971 opposition. My dad had probably heard a sensationalistic item on the radio about the planet being unusually close (some things never change), and he woke me in the middle of the night so that I could witness the "once-in-a-lifetime" spectacle. Unaware of the hype, I was, nonetheless, impressed by the brilliant, vividly orange beacon low in the southern sky. All close oppositions of Mars are notable, but some—such as that 1971 encounter—are more memorable than others.

It was during the 1988 summer opposition that I truly got to know Mars with a telescope. At the time, I was living in downtown Vancouver, British Columbia, and did most of my observing with a 6-inch reflector on my sixth-floor, southwest-facing apartment balcony—the scope's short (f/6) focal ratio made it ideal for such cramped confines. Even so, I had to coordinate my viewing sessions to start when Mars cleared the corner of the balcony directly above me. To my amazement, I discovered that during the quiet hours of the early morning, big-city seeing conditions can be surprisingly steady. Night after night, I peered into my scope's eyepiece, thrilling at the views and sketching what I saw.


Accompanying me for those pre-dawn vigils was my cat, Buzz, who never let an opportunity for a little nocturnal activity pass by. The fact that I'd sit motionless at the eyepiece for extended periods ensured my lap was a stable platform for catnaps. As the great opposition of '88 came and went, Buzz and I spent many happy hours together on that balcony—me scrutinizing Mars, Buzz quietly purring his approval.

Some of my most exciting Mars observing came during the 2001 close approach, when I was an editor at *Sky & Telescope* magazine, in Cambridge, Massachusetts. Being responsible for the observing section, I helped shepherd into production an article by noted planet observers Tom Dobbins and Bill Sheehan. Bill and Tom discussed short-lived specular flares—glints of sunlight reflecting off the Martian surface—that might be visible when conditions were just right. As their article described, there had been some credible flare observations in the 1950s, but the reality and nature of the phenomenon was far from certain.

Armed with a table of predictions, then editor-in-chief Rick Fienberg and I flew to the Florida Keys to take advantage of the region's famously steady seeing conditions. We set up our gear at Tippy D'Auria's house along with a few other observers, including Tom and ace planet imager Don Parker, who planned to record the hoped-for flares with video equipment attached to his telescope. To our great delight, on the third night of our Florida stay, we witnessed a succession of star-like flashes on the Martian surface—events that we were able to relive later when we reviewed Parker's video recording. It was a remarkable night that ultimately resulted in one of the few occasions my name has appeared in an *International Astronomical Union Circular*.

So here we are on the eve of another great opposition. For just the fourth time in my life, Mars will come within 60 million kilometres of Earth. I'll be out with my scope every clear night this summer getting reacquainted with my old friend. At some point, I'm sure I'll pause to reflect on how much has happened since our first meeting in 1971. I'm a much more experienced observer now, with half a lifetime under my belt, while Mars has been extensively mapped and explored by numerous robotic probes since Mariner 4's initial visit, in 1965. But in spite of everything, I know that when I peer into the eyepiece at that peachy orange Martian disc, looking back will be the same mysterious world that sparked so much excitement in me decades ago. ✦

*SKYNEWS* ILLUSTRATION BASED ON SCHIAPARELLI 1877-86 MARS MAP

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## EXTREME ASTRONOMY

You probably don't think of astronomy as an extreme sport, but a *bimarathon* is just that. It involves running a marathon (42.2 kilometres) *and* observing at least 110 deep-sky objects (like a regular Messier marathon)—all in a single sunset-to-sunrise span.

The idea is to encourage some of the zillions of people who run regular marathons to give amateur astronomy a try. Even if only a tiny fraction of marathoners attempt the astro version, the result will be a significant boost in the number of stargazers.

I ran my first bimarathon in Hawaii, where I observed all the Messier objects (well, 109 of them, actually, since I feel it necessary to include the aptly named Running Man Nebula in the 110-object total). I recently completed my second bimarathon in the Australian outback. Training for that event required me to improve my knowledge of the southern sky, since I had to locate the 110 deep-sky targets reasonably quickly—or risk not having enough time for the running portion of the event.

I'd encourage enthusiasts looking to boost both their observing skills and their fitness level (and have fun doing so) to try a bimarathon. I've posted a video and several tips at my website: www.warrenfinlay.com/bimarathon.html.

*Warren Finlay*
*Edmonton, Alberta*

**OUTBACK MARATHON** Warren Finlay is at the eyepiece of his telescope near the end of his Australian bimarathon event. At this point, he had completed his observing but still had 16 kilometres left to run. COURTESY WARREN FINLAY

## STEVE HAWKING?

I enjoyed "A Light Named Steve" in the March/April 2018 issue (page 12), but I'm wondering whether the phenomenon described in Ivan Semeniuk's article could use a name change. How about "Stephen," in memory of Dr. Stephen Hawking?

This might be a great opportunity to honour this amazing scientist with a lasting memorial—a cosmic wonder that will remind us of Dr. Hawking, who devoted his life to the study of the cosmos.

The current name, from the 2006 animated movie *Over the Hedge*, and the acronym STEVE (Strong Thermal Emission Velocity Enhancement), assigned by NASA scientists, lack dignity, meaning and importance to most people.

The name Stephen, on the other hand, would require only a one-word explanation: Hawking. And I suspect Dr. Hawking would have enjoyed lending his name to a beautiful dancing display of energy.

*Kalene Louise Bourque*
*Salmon Arm, British Columbia*

**TOTALLY CAPTURED** This view of totality was made by combining 230 individual video frames. Regulus is the star at lower left.

## VIDEO ECLIPSE

My wife and I watched the August 21, 2017, total solar eclipse—our first—from the "Solartown" campground, a little north of Madras, Oregon. It turned out to be a wonderful location to experience this amazing spectacle. I had planned to follow the advice of many experienced eclipse chasers and just watch the event rather than take photographs. But wanting my own eclipse souvenir, I figured a nice compromise would be to shoot a simple video. I managed to capture the final 30 seconds of totality—it would've been longer, but I was so enraptured with the view, I forgot to start recording!

Once home, I used Wondershare Video Editor software to grab the sharpest individual frames from the video, which I aligned manually (very time-consuming), stacked and processed with Photoshop Elements 2.0. I then combined the frames using easyHDR's Smart Merge feature. Final colour and contrast adjustments and cropping were done with easyHDR and Elements.

I am especially pleased with the resulting image, since it demonstrates what can be achieved using inexpensive equipment and software and relatively simple image-processing techniques.

*Doug Luoma*
*Ottawa, Ontario*

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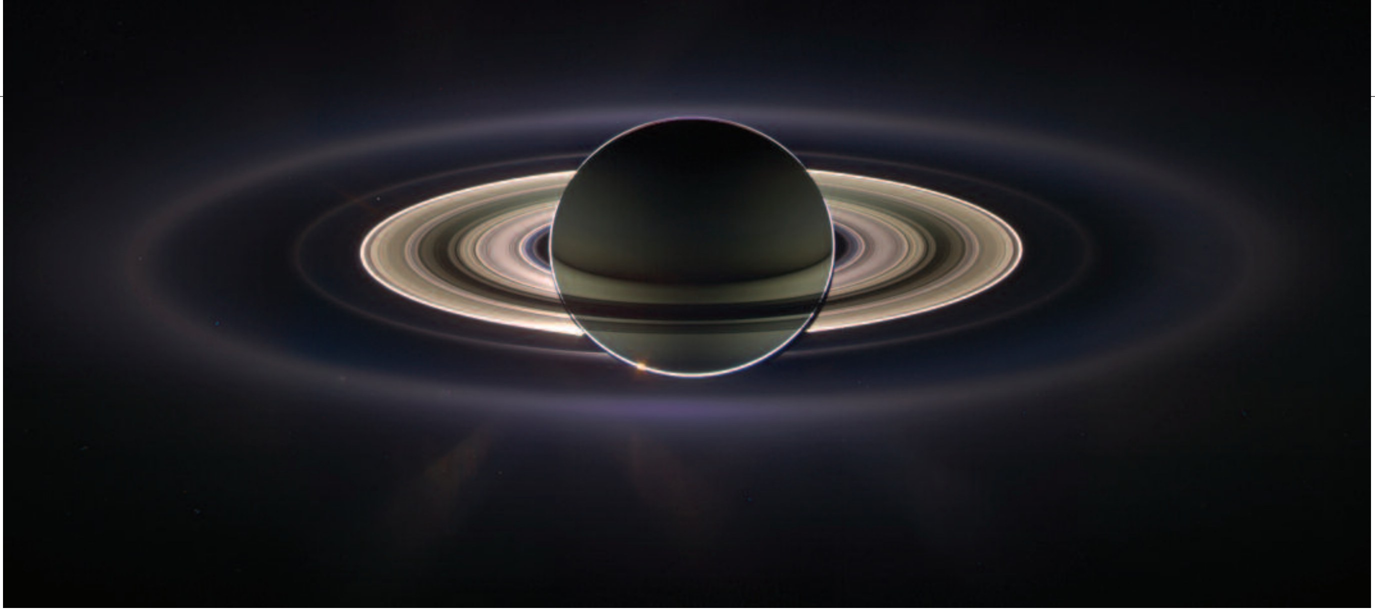


# AN AGE-OLD RING MYSTERY SOLVED?

**RINGS AGLOW** Captured while the Cassini spacecraft was in Saturn's shadow, this colour mosaic reveals the varying thicknesses of the planet's rings. The opaque band in the centre of the rings is the B ring, the thickest and most massive of those encircling Saturn. COURTESY NASA/JPL-CALTECH/SPACE SCIENCE INSTITUTE

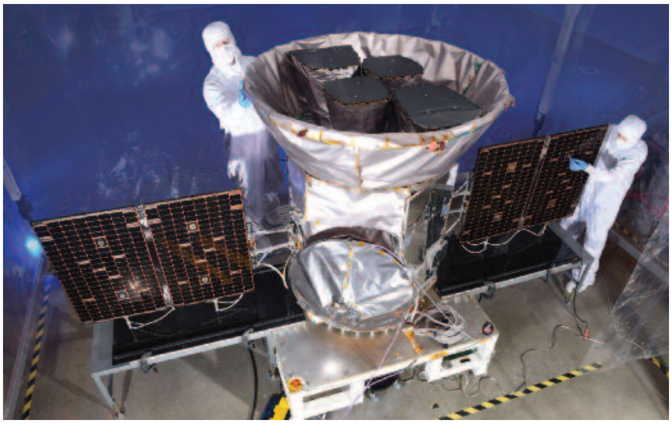
DURING ITS 13 YEARS orbiting Saturn, the Cassini spacecraft accumulated a wealth of data that may have answered a question that has long puzzled astronomers: How old are Saturn's rings?

In their search for a solution, researchers pursued two lines of inquiry. The first relates to ring brightness. Over time, infalling micrometeorites from the edge of the solar system darken the water-ice particles in Saturn's rings. As a result, bright rings imply youth. The second approach focuses on the mass of the rings. It was only during the birth of the solar system that a sufficient quantity of comets, planetesimals and other debris was available to create massive Saturnian rings. Therefore, greater mass implies greater age.

Cassini's Cosmic Dust Analyzer spent 12 years measuring the infall of tiny particles onto the rings and found the quantity to be 10 times higher than pre-Cassini estimates. Clearly, if the rings are truly old, they should be much darker than they appear today. As the Cassini mission came to its dramatic conclusion, the spacecraft dove between the planet and its rings, allowing scientists to estimate the mass of the rings by measuring their gravitational pull. Preliminary results indicate that the rings contain roughly 0.4 times the mass of the Saturnian moon Mimas—less than the estimates obtained when twin Voyager spacecraft flew past Saturn in 1980 and 1981.

These two findings lead to an inescapable conclusion: The rings are not 4.6 billion years old, as was largely believed. Instead, they may have formed as recently as 100 to 300 *million* years ago, during the age of dinosaurs. Now astronomers are faced with a new mystery: how to explain the relative youth of Saturn's signature feature.

# TESS NOW SEEKING STRANGE NEW WORLDS



**FOUR EYES** TESS undergoes a final check before being prepared for launch on board a SpaceX Falcon 9 rocket. The satellite's four wide-field cameras (mounted in the conical sunshade) give TESS a field of view covering 85 percent of the sky. COURTESY NASA

THE SEARCH FOR PLANETS beyond our solar system entered a new phase on April 18, 2018, with the successful launch of NASA's Transiting Exoplanet Survey Satellite (TESS). Sixty days after launch and following instrument testing, the satellite began its initial two-year mission.

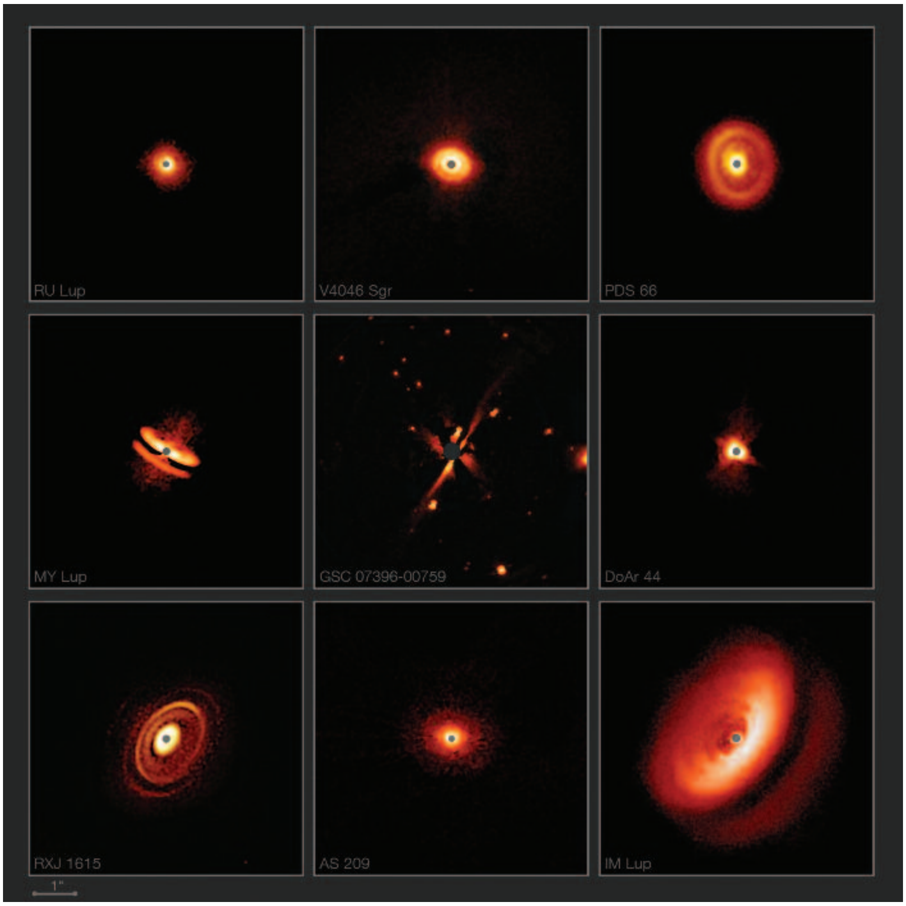
Like the Kepler spacecraft before it, TESS is monitoring stars for tiny dips in luminosity caused by transiting extrasolar planets. While Kepler had a narrow field of view, TESS is surveying nearly the entire sky, concentrating on stars less than 300 light-years away and 30 to 100 times brighter than Kepler's targets. This will enable easier follow-up observations with ground- and space-based telescopes.

"If an astronomer finds a planet in a star's habitable zone, will it be interesting from a biologist's point of view?" asks TESS principal investigator George Ricker of the Massachusetts Institute of Technology. "We expect TESS will discover a number of planets whose atmospheric compositions, which hold potential clues to the presence of life, could be precisely measured by future observers."

# A DISC ZOO

FOR DECADES, astronomers have assumed that when a massive cloud of gas and dust collapses to create a new sun, the leftover material ends up in a disc surrounding the protostar and eventually forms planets. Detecting such discs around young stars has always been challenging, but thanks to SPHERE (the Spectro-Polarimetric High-contrast Exoplanet REsearch instrument attached to the Very Large Telescope on Cerro Paranal, in northern Chile), a variety of dusty discs are coming into view.

SPHERE uses direct imaging to find giant exoplanets orbiting nearby stars. It does this by blocking the star's light, which would otherwise swamp the much dimmer glow from any planets. The same technique can be used to image dusty discs surrounding young stars. So far, astronomers have found a wild variety of disc shapes and sizes. Some contain bright rings, some have dark rings, and some even resemble hamburgers! These discs can also differ dramatically in appearance, depending on their orientation. Face-on examples appear circular, while those viewed edge-on form narrow streaks. Perhaps one disc in this vast collection resembles what our solar system looked like 4.6 billion years ago.




**THE SHAPE OF THINGS TO COME**
The dusty discs surrounding nearby young stars are revealed in greater detail than ever before in these images from SPHERE.
COURTESY ESO/H. AVENHAUS ET AL./E. SISSA ET AL./ DARTT-S AND SHINE COLLABORATIONS

# DARK MATTERS

IF YOU'RE LOOKING for something that *should* be present but is invisible, how can you tell whether it's really there? That is the challenge facing astronomers in their search for dark matter. Fortunately, dark matter and galaxies go hand in hand, with dark matter acting as the glue that holds the visible matter in galaxies together. So astronomers were in for a bit of a shock when they found a galaxy apparently devoid of dark matter.

NGC1052-DF2 defied all expectations. "We thought all galaxies were made up of stars, gas and dark matter mixed together, with dark matter always dominating," says Roberto Abraham of the University of Toronto, who coauthored the discovery paper. "Now it seems at least some galaxies exist with lots of stars and gas but hardly any dark matter." By measuring the velocities of 10 globular clusters in DF2, the researchers found at least 400 times less dark matter than predicted for a system of its size.

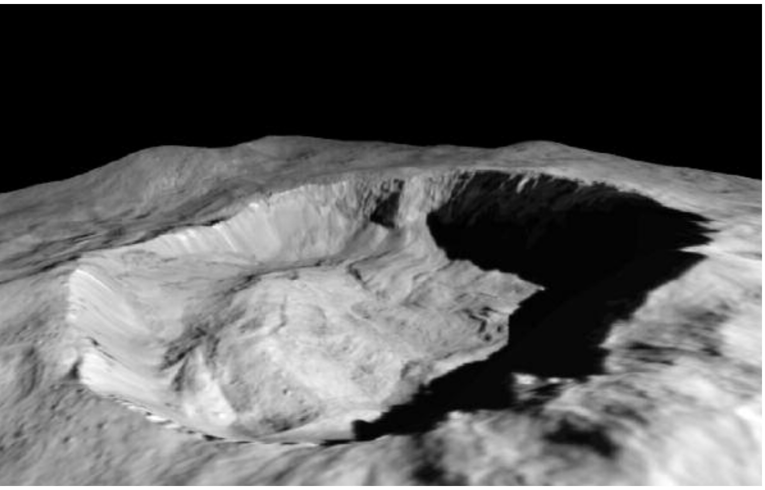
**SEE-THROUGH GALAXY** As large as the Milky Way Galaxy, NGC1052-DF2 (the amorphous glow in the centre of this image) has only 0.5 percent the number of stars. Indeed, it's so sparse that background galaxies are visible through it. COURTESY NASA/ESA/PIETER VAN DOKKUM/ROBERTO ABRAHAM

"If there's any dark matter at all, it's very little," explains the paper's lead author, Pieter van Dokkum of Yale University. "The stars in the galaxy can account for all the mass, and there doesn't seem to be any room for dark matter."

How can this be? DF2 resides 65 million light-years away, in a collection of galaxies dominated by the giant elliptical NGC1052. Van Dokkum wonders whether the initial growth of NGC1052 billions of years ago played a role in DF2's dark-matter scarcity. Now the hunt is on for more galaxies like it.

# MADE IN THE SHADE

EVER SINCE NASA's Dawn spacecraft arrived at Ceres in March 2015, it has been detecting signs of water ice. Minerals containing water are widespread on the dwarf planet, and its tenuous atmosphere contains water vapour. Dawn's Visible and Infrared (VIR) Mapping Spectrometer found water ice at a dozen sites, including craters situated above 42 degrees north latitude. A recent study also revealed a patch of ice on the shadowed northern wall of Juling, a 20-kilometre-diameter crater located midlatitude in the southern hemisphere. More intriguingly, follow-up observations with the VIR spectrometer showed that the amount of ice there had increased.



From April to October 2016, Andrea Raponi of the Institute of Astrophysics and Planetary Science in Italy and his colleagues measured the icy patch on the crater wall and saw an increase in area from 3.6 to 5.5 square kilometres. "This is the first direct detection of change on the surface of Ceres," says Raponi. But he doesn't think the growth of ice on the almost vertical rocky cliff is caused by internal processes (subsurface brine leaking out of the crater wall) or from landslides exposing ice already present.

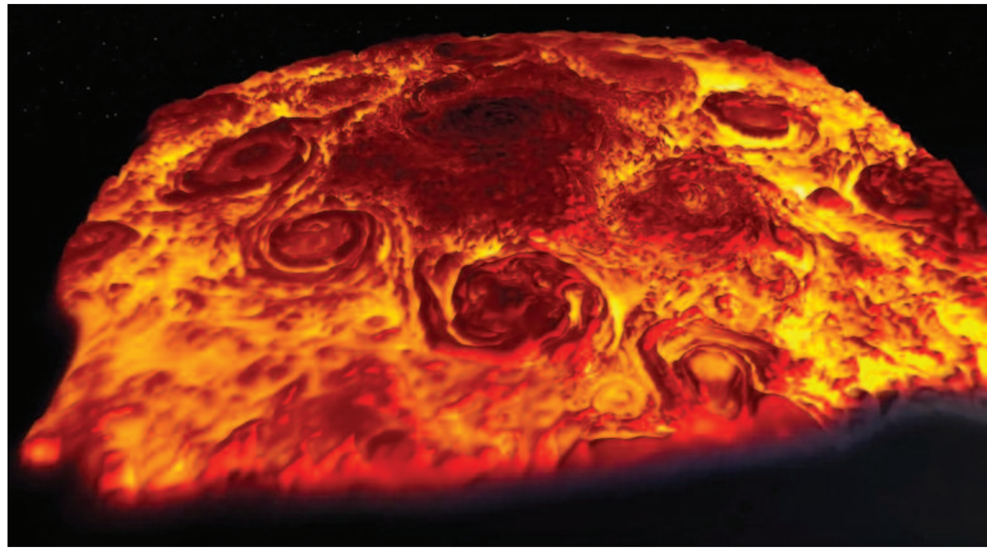
Instead, Raponi favours the idea that solar heating of the crater floor is causing near-surface ice to change directly from a solid to a gas. "The combination of Ceres moving closer to the Sun in its orbit along with seasonal change triggers the release of water vapour from the subsurface," he suggests, "which then condenses on the cold crater wall, causing an increase in the amount of exposed ice."

**LURKING IN DARKNESS** Ice has been detected in the shaded northern wall of Ceres' 2.5-kilometre-deep crater Juling, portrayed in this simulated perspective view made using image data from the Dawn spacecraft. COURTESY NASA/JPL-CALTECH/UCLA/MPS/DLR/IDA/ASI/INAF by PAUL DEANS

# NINE CYCLONES

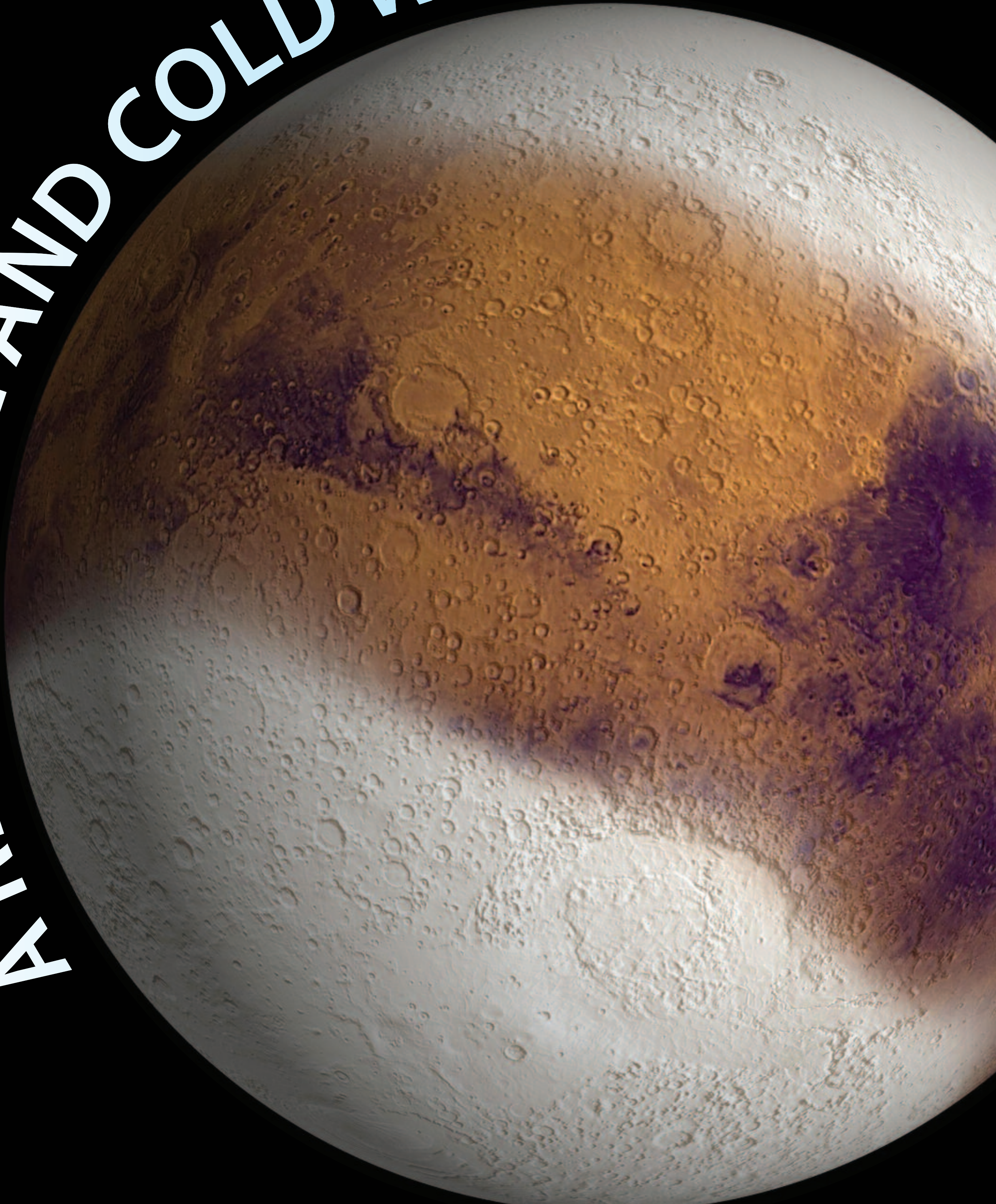
FROM THE CLOUDTOPS DOWN, increasing depth on Jupiter means increasing temperature. On board NASA's Juno spacecraft, which is currently orbiting the giant planet, the Jovian InfraRed Auroral Mapper (JIRAM) captures high-resolution images of Jupiter's atmosphere at infrared wavelengths. By using temperature measurements of the clouds as a stand-in for depth, the Juno mission scientists have generated a three-dimensional view of the Jovian north pole.

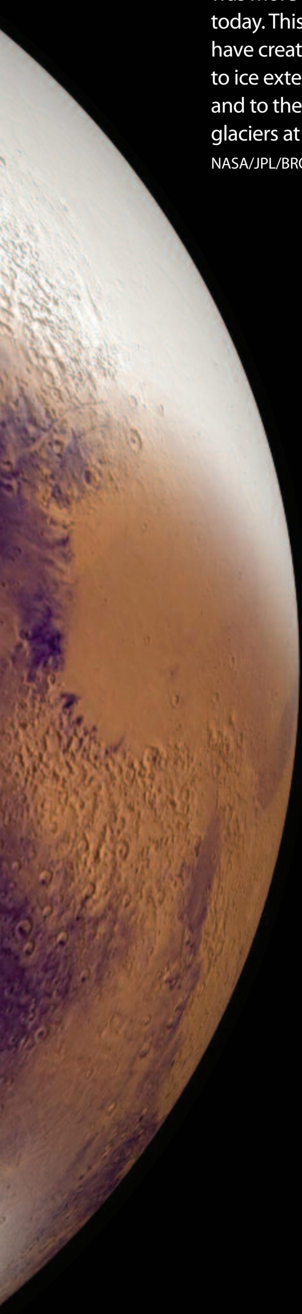
The pole is dominated by a central cyclone surrounded by eight circumpolar cyclones, with diameters ranging from 4,000 to 4,600 kilometres. "Each of the northern cyclones has very violent winds, reaching speeds as great as 350 kilometres per hour in some cases," notes Alberto Adriani, Juno coinvestigator from the Institute for Space Astrophysics and Planetology, in Italy. "Perhaps most remarkably, they are very close together and enduring. We know of nothing else like it in the solar system. The question is, Why do they not merge?" ✦



**JOVIAN TURBULENCE** In this three-dimensional infrared view of Jupiter's north pole, the bright yellow areas are deeper and warmer (–13°C) than the dark red regions (–83°C).
COURTESY NASA/JPL-CALTECH/SWRI/ASI/INAF/JIRAM

# A RED, WHITE AND COLD WORLD





**BIG CHILL** In this simulated view of Mars, we see the planet as it might have looked 2.1 million to 400,000 years ago, when its rotational axis was more steeply inclined than it is today. This extreme orientation would have created conditions favourable to ice extending toward the equator and to the formation of extensive glaciers at midlatitude locations. NASA/JPL/BROWN UNIVERSITY

Ten years after the first polar landing on Mars, scientists are gaining a new appreciation for the planet's icy personality by IVAN SEMENIUK

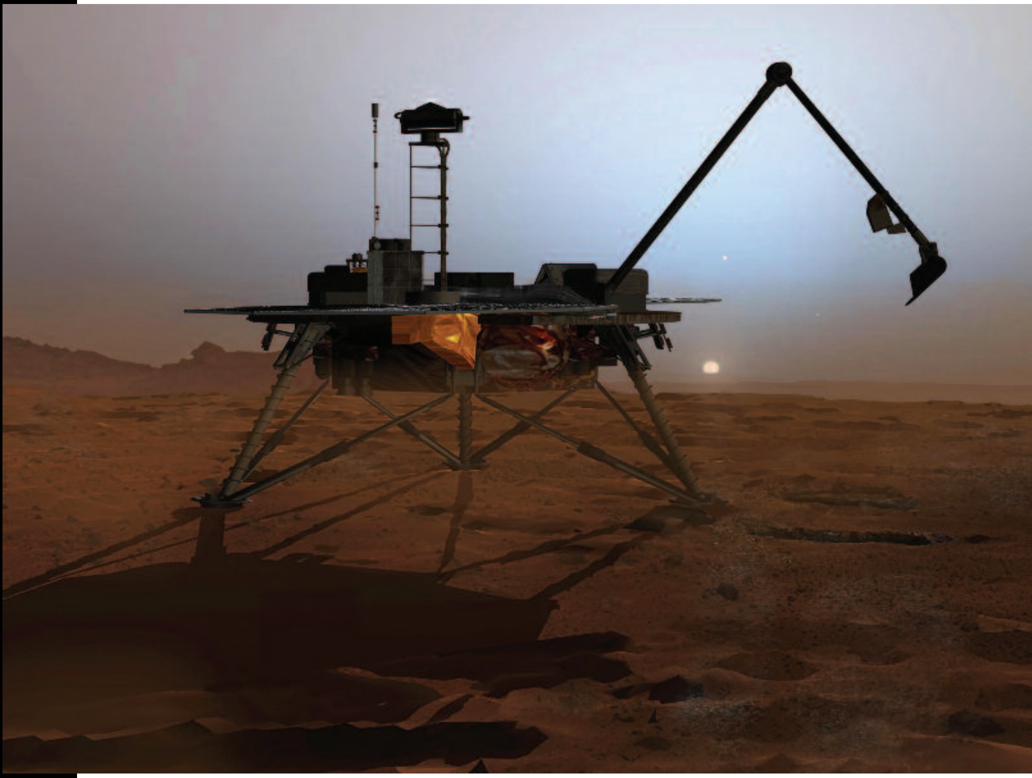
ISAAC SMITH STILL REMEMBERS THE EXCITEMENT he felt in 2008 when the Phoenix Mars Lander scraped away at the ground with a robotic scoop and revealed a hard, white floor of ice covered by mere centimetres of brick-red soil.

"It was so close to the surface and so pure, you could imagine going there with a bucket and a shovel to get what you need," says Smith, a researcher with the Planetary Science Institute in Lakewood, Colorado. A decade ago, he was just beginning graduate school and was soon put to work analyzing data from the Phoenix lander.

## SOLID SIGNS OF WATER

While all other successful missions to the surface of Mars, including NASA's Curiosity rover, have focused on hunting for clues about the red planet's wetter and possibly warmer early history, Phoenix is the sole lander to physically touch water (in solid form) on present-day Mars.

Smith, who later this year will join the faculty of Toronto's York University, is part of a growing community of scientists eager to tap into Mars' frozen record to



**LIGHTS OUT** The Phoenix landing site, as seen in this artist's depiction, became progressively colder and darker as the mission ended and the long Martian winter set in. The probe was eventually buried under carbon dioxide frost. Despite the availability of water ice, future astronauts are unlikely to target such a harsh location. NASA/JPL-CALTECH/UNIVERSITY OF ARIZONA find out what it might reveal. "We've learned so much on Earth by drilling into ice, we should absolutely do the same on Mars," says Wendy Calvin, a geologist with the University of Nevada, Reno. Calvin adds that a drilling mission to Mars is a long-term goal. Scientists must first ascertain how ice is distributed under the planet's surface and where it can be most easily accessed.

"The only way to do that is with ground-penetrating radar," says Gordon Osinski, a planetary scientist at Western University, in London, Ontario. Osinski is the lead researcher on a Canadian proposal that could set the stage for exploring icy Mars.

Working with partners in the aerospace industry, Osinski recently completed a concept study for the Canadian Space Agency. The result details the design and operation of a Mars radar instrument made to reveal the vast reservoir of subsurface ice thought to exist at the planet's midlatitudes. Such an instrument would greatly assist climate studies conducted on Mars. Data from the radar would be used to pinpoint sites where ice could be easily accessed by a lander for climate studies or even to search for signs of frozen microbial life. In addition, this effort would serve as a crucial step for any human missions to Mars—because water is obviously necessary for life support. Just as important, the hydrogen and oxygen locked away in the ice will be needed to make rocket fuel for the return trip. "Ice is the oil of Mars," says Smith. "You can't go home without it."

## ICE AGES

Long before the Phoenix mission, scientists knew there was ice on Mars. Some of it can be seen in telescopes in the form of the north and south polar caps. These features endure even as more expansive blankets of frozen carbon dioxide come and go with the seasons. Since the 1970s, scientists have also been accumulating indirect evidence for much larger ice deposits far from the poles.

The telltale signs include ridges and grooves on the floor of some Martian channels plus "lobate debris aprons" that have the appearance of thick, flowing material captured in a freeze-frame. On Earth, similar features are associated with ice-rich terrain. "A lot of it, we suspect, is due to buried glacial ice or ice sheets," says Osinski. "But we're not entirely sure how it got there."

Sometimes, subsurface ice can be observed directly when a meteorite impact excavates a fresh crater on the Martian surface. In those instances, the ice may linger for months before it sublimates into the extremely thin air. Recently, a team of U.S. researchers working with images from the Mars Reconnaissance Orbiter (MRO) found eight locations where layers of ice can be seen along the eroding sides of steep-walled escarpments. At some locations, the ice layers add up to a thickness of more than 100 metres and are capped by barely a metre or two of dirt and rubble.

An influential paper published in 2003 in the journal *Nature* by James Head and his colleagues at Brown University, in Rhode Island, suggested that periodic cycles in Mars' axial tilt and orbital characteristics could create ice ages during which glaciers slowly advance to within 30 to 35 degrees of the equator—a latitude on Earth equivalent to northern Egypt or Texas. Today, the glaciers would become unstable if exposed to direct sunlight. In many places, however, they could persist under a sufficiently thick blanket of soil.

Any large volumes of buried ice on Mars may date back to this glacial period and are therefore likely to be only a few hundred million years old, says Osinski. "Determining how that ice got there will hopefully unlock the climate history of Mars."

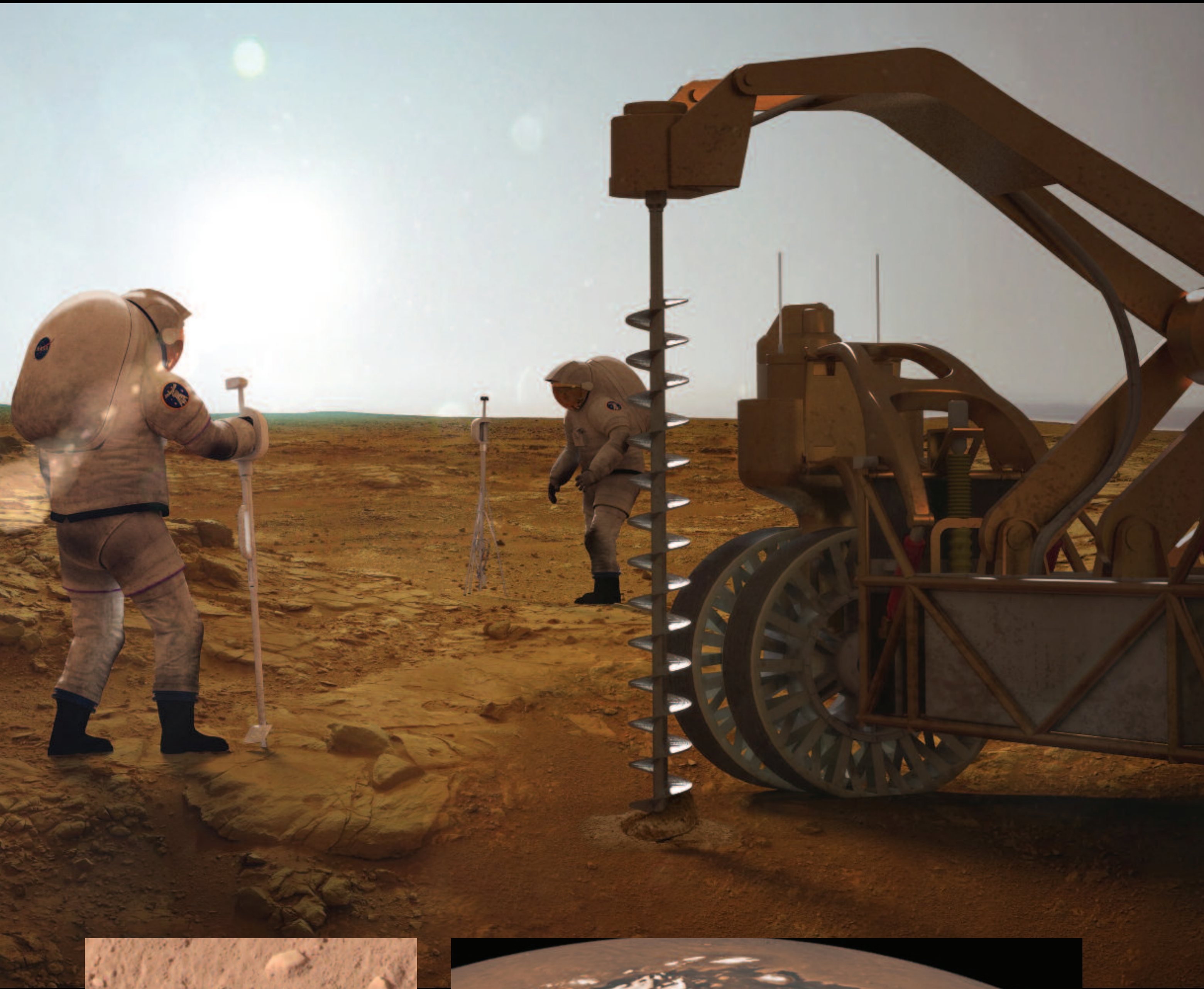
## SHOVEL-READY

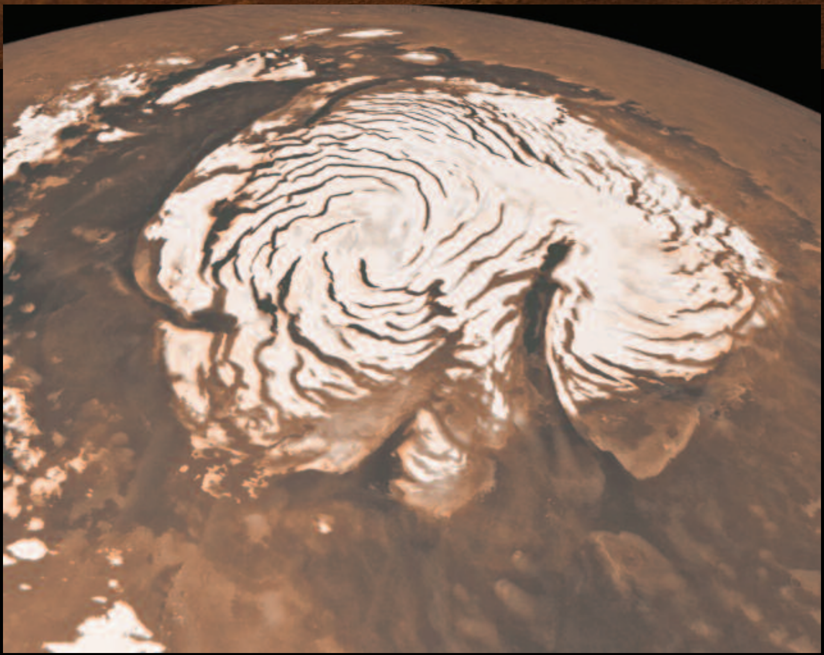
While Phoenix confirmed the presence of ice on Mars, its landing site at 68 degrees north latitude is both difficult to reach and covered with frozen carbon dioxide during Martian winter. Researchers are trying to determine how far from the poles the ice extends and, most critically for human explorers, how close to the surface it can be found.

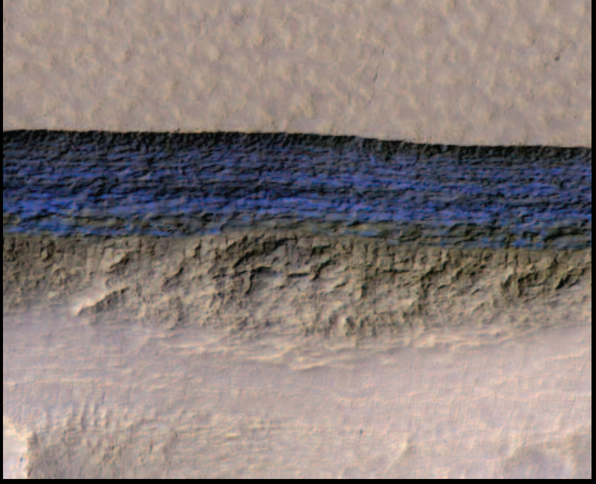
As on Earth, latitudes nearer the equator on Mars receive more energy from the Sun, which means any ice found where the planet is warmest will likely be deep underground. This presents a potential problem for robotic drills—and for future astronauts counting on finding frozen water to survive. "You wouldn't want to send astronauts there with a shovel," says Smith, "if what they really need is a bulldozer."

Unfortunately, astronauts can't venture to higher latitudes, where ice is nearer the surface, because a spacecraft requires significantly more fuel to get there. "If you can't land below 50 [degrees latitude], then it becomes really expensive," says Smith. "The push is to get below 40 degrees."

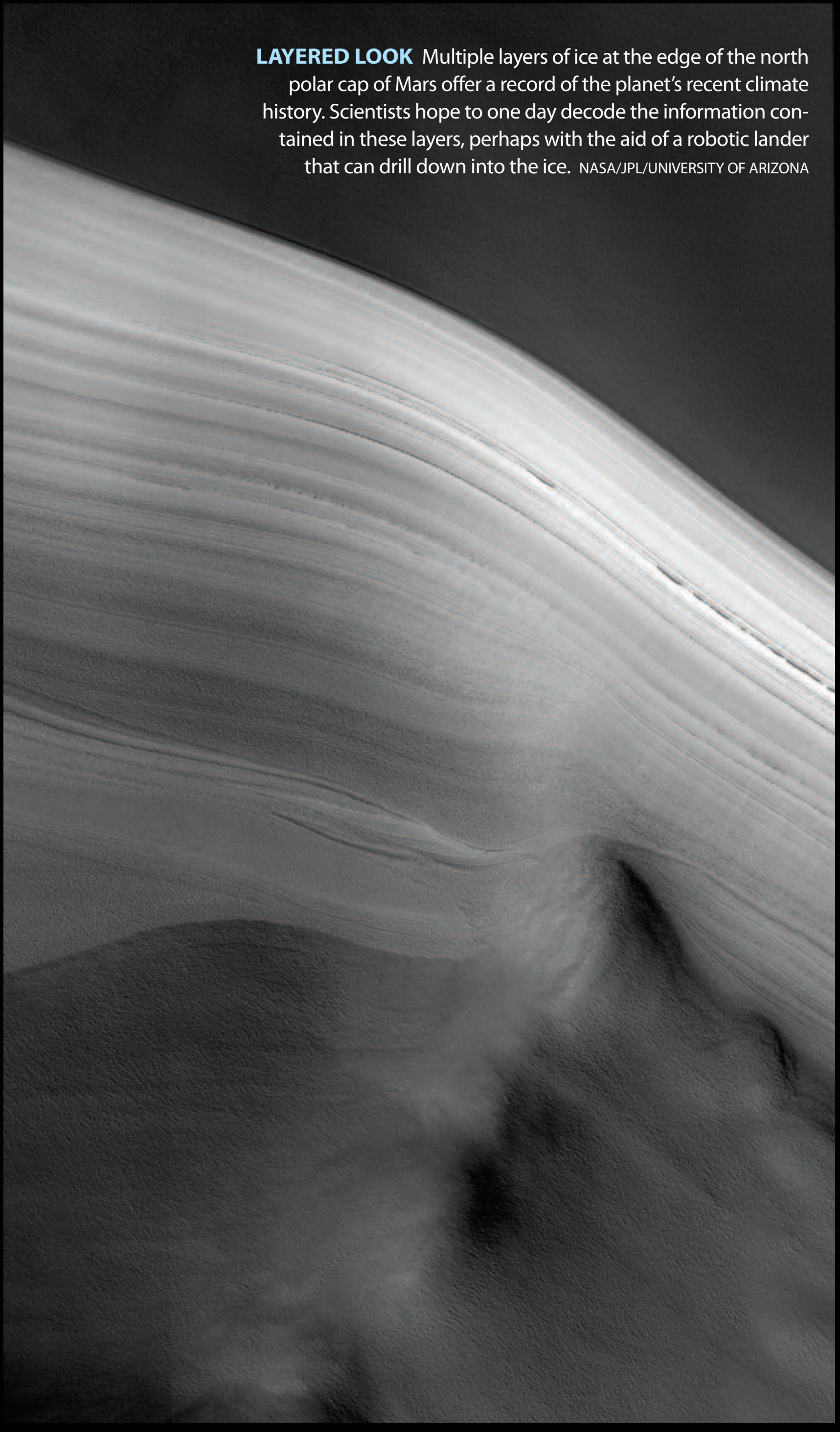
**ICE FOR LIFE** Above: Concepts for future human missions to Mars anticipate that astronauts will need to find and extract subsurface ice near their landing site for life support and to generate rocket fuel. Right: On June 15, 2008, three weeks after landing on Mars, the Phoenix spacecraft used its robotic scoop to dig a shallow trench, which exposed a whitish substance that proved to be water ice just below the surface. Far right: The ice that forms the north polar cap of Mars is cold enough to remain frozen even at the surface. The cap is approximately 1,000 kilometres across and two to three kilometres deep. ABOVE: NASA LANGLEY ADVANCED CONCEPTS LAB/ ANALYTICAL MECHANICS ASSOCIATES. RIGHT: NASA/ JPL-CALTECH/UNIVERSITY OF ARIZONA/TEXAS A&M UNIVERSITY. FAR RIGHT: NASA/JPL-CALTECH/MSSS







**THIN BLUE LINES** This steep escarpment in Mars' southern hemisphere is one of several places where scientists have spotted multiple layers of ice (rendered blue in this colour-enhanced image) that would otherwise be hidden beneath the surface. NASA/JPL-CALTECH/UNIVERSITY OF ARIZONA/USGS



**LAYERED LOOK** Multiple layers of ice at the edge of the north polar cap of Mars offer a record of the planet's recent climate history. Scientists hope to one day decode the information contained in these layers, perhaps with the aid of a robotic lander that can drill down into the ice. NASA/JPL/UNIVERSITY OF ARIZONA

The next step, ahead of selecting a landing site, is to use radar to better understand the distribution of ice. The technique has already had some success. In 2016, Osinski and several colleagues showed that data from SHARAD (a radar instrument aboard MRO) indicated an extensive cache of ice beneath a region called Utopia Planitia. The deposit contains enough water to fill Lake Superior, and its location lies between 40 and 50 degrees north latitude.

## RADAR LOVE

In some places, radar has also been used to estimate the thickness of Martian ice deposits. At the Phoenix landing site, for example, the layer is about 15 metres thick. A much tougher challenge is to figure out how far below the surface the deposit lies. This measurement requires radar using centimetre wavelengths, rather than the metre wavelengths SHARAD utilizes. It's here that Osinski says Canada has an opportunity to make a significant contribution by providing a global map of ice depth precise enough to guide future landers.

Although Osinski was able to secure funding for his Mars radar concept study, NASA has other priorities in mind. The agency has budgeted for a robotic sample-return mission to bring back evidence that Mars enjoyed a watery—and potentially habitable—period more than three billion years ago. Smith thinks that at least 15 years will elapse before NASA sends a lander to follow up on the ice investigations begun by Phoenix.

In the meantime, there could be other ways for a Canadian radar to hitch a ride to the red planet. One would arise if NASA opts to launch a small, low-budget orbiter in addition to its sample-return mission. Another would be to find an alternate partner that plans to send a probe to Mars, such as India or the United Arab Emirates.

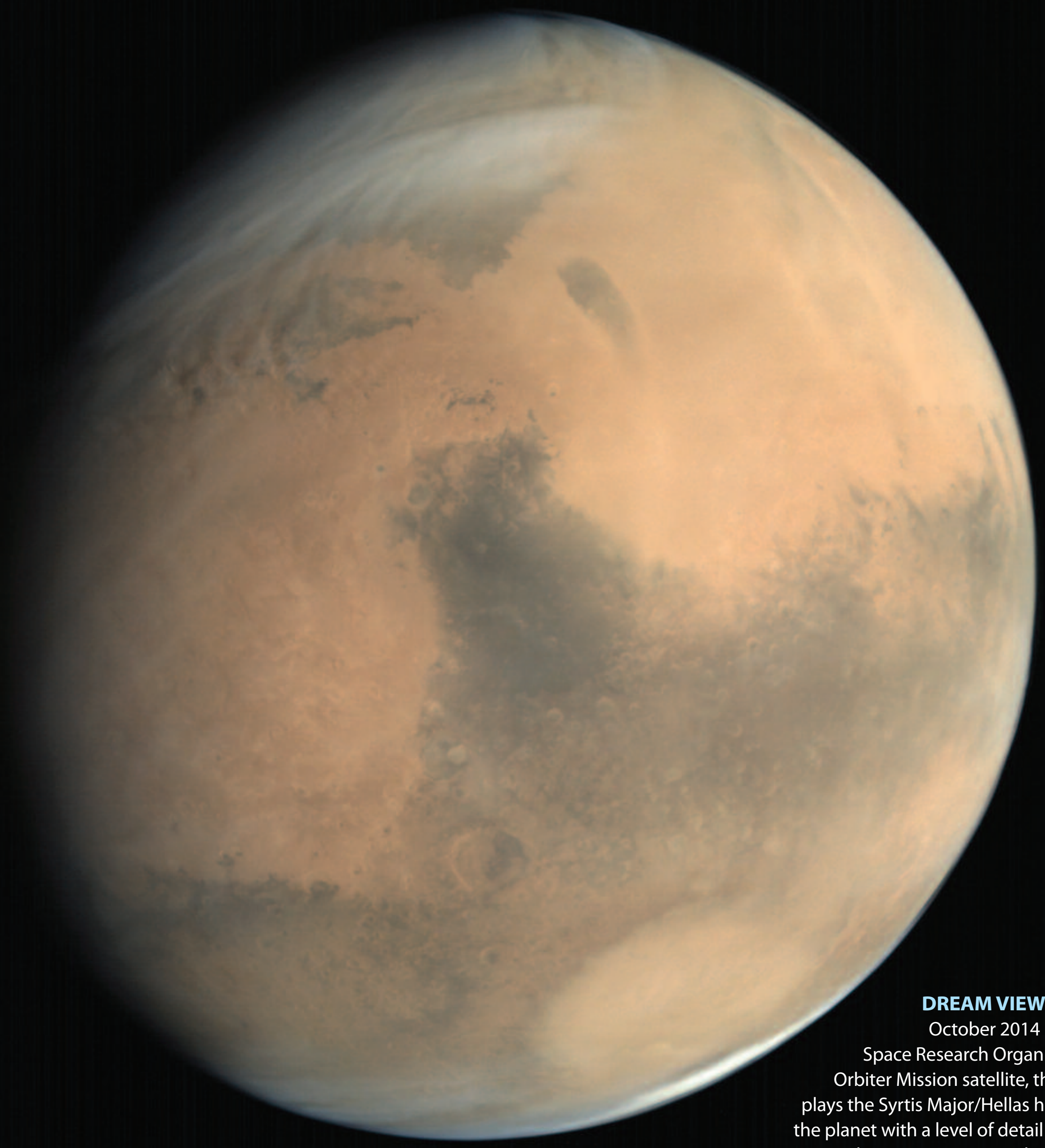
But the search for subterranean water ice on the red planet is bound to resume eventually. And because accessible ice is considered vital to human exploration, it may come to dominate the Mars agenda in the long run.

Ten years after Phoenix landed, the hunt for ice on Mars is just starting to heat up. ✦

*Ivan Semeniuk is a science reporter for* The Globe and Mail *newspaper and recipient of the 2017 Simon Newcomb Award from The Royal Astronomical Society of Canada.*

# MARTIAN SIGHTS ON SUMMER NIGHTS

Take advantage of this summer's unusually close encounter and get to know the famous red planet by MURRAY D. PAULSON

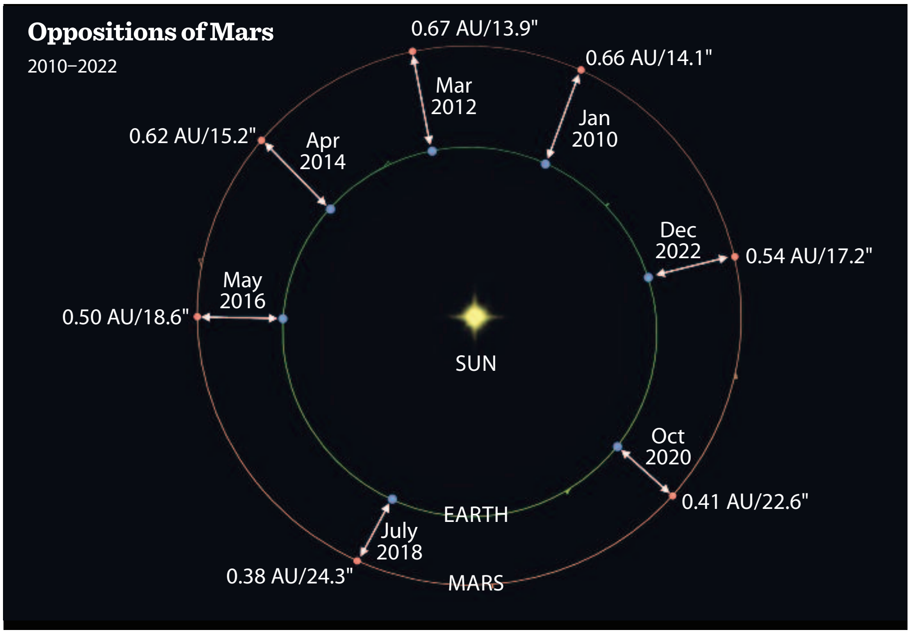


**DREAM VIEW** Recorded in October 2014 by the Indian Space Research Organisation's Mars Orbiter Mission satellite, this image displays the Syrtis Major/Hellas hemisphere of the planet with a level of detail Earth-bound telescope users can only dream about.
ISRO/ISSDC/EMILY LAKDAWALLA

MARS HAS A SPECIAL PLACE IN MY HEART. Thanks to our extensive robotic exploration of that cold desert world, I can picture a long-ago era when volcanoes erupted, rivers and lakes brimmed with water and possibly life itself flourished.

And Mars excites me as a telescopic sight. For a few months every other year, Mars lines up opposite the Sun in our sky and its distance from Earth decreases significantly. I always look forward to these opposition years. Sadly, though, not all oppositions are created equal. Because of Mars' eccentric orbit, the approaches vary from 55 million kilometres to 102 million kilometres over a roughly 15-year cycle. During our adult lives, the famous red planet comes really close only four or five times. This is one of them.

**ORBITAL MATTERS** The minimum distance in astronomical units (AU)—the average Sun-Earth distance—and the maximum disc size in arc seconds (") are given below for each opposition from 2010 to 2022. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP.




## BEACON IN THE SOUTH

On the night of July 26/27, when Mars is at opposition, it will lie a mere 58 million kilometres away and shine at magnitude −2.8, much brighter than any star. Its disc will span a generous 24.3 arc seconds, the largest it's been since its record close approach in 2003. Indeed, the disc diameter will exceed 20 arc seconds from June 27 to September 5, giving us at least two fair-weather months to observe Mars at its best.

For the duration, the orangey red planet will be looping through southwestern Capricornus, with a declination between −23 and −26 degrees below the celestial equator. On July 26/27, observers in Nova Scotia and southernmost Ontario will see Mars climb barely 21 to 22 degrees above the south horizon. Across western Canada, the planet will be several degrees lower. Unfortunately, the increased haze and turbulence near the horizon can badly blur telescopic images.

And don't forget that even at its largest, Mars is a very small celestial object. You'll need lots of magnification to view surface features, but the brilliant disc takes magnification well. If the atmosphere is reasonably steady, don't be afraid to apply 150× to 300× or more, depending on the aperture of your telescope.

## GETTING IN GEAR

Every type of telescope has its pros and cons, especially with respect to high-power planetary observing. Good optical quality is obviously important, as is a steady mount, preferably one having slow-motion controls or, better yet, a tracking motor to keep the planet centred in your eyepiece. When considering what scope to use—or buy—there are numerous other factors too.

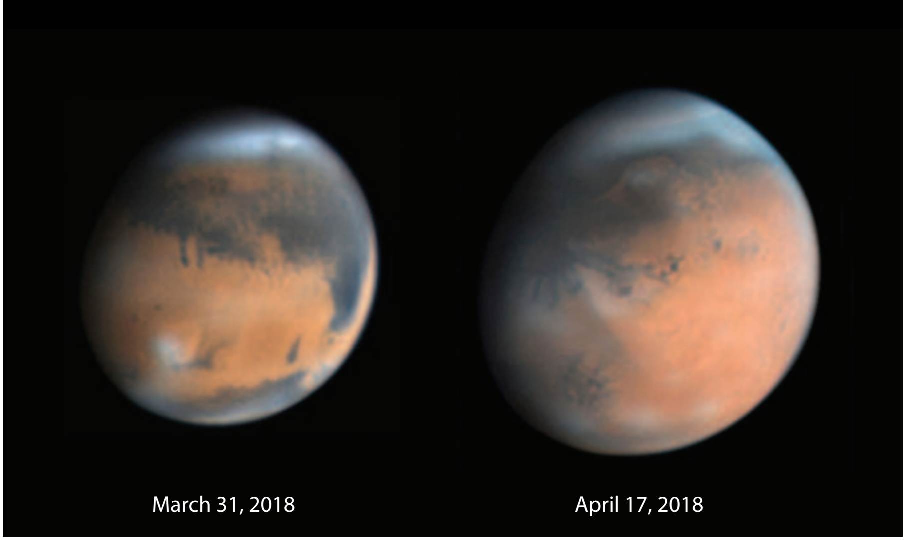
On a Newtonian reflector, the optics

**OPTICS COUNT** To get clear views of Mars this summer, you'll need steady atmospheric conditions and a telescope with excellent optics. The author uses this Takahashi Mewlon-250 catadioptric instrument to photograph the red planet. COURTESY MURRAY D. PAULSON need to be collimated properly to ensure the sharpest possible images. Refractors don't require collimation, but achromatic models operating at high magnification produce false colour—a deficiency sure to taint Mars' delicate ochre hue and blur fine detail. Apochromatic refractors solve this problem beautifully, but at a hefty price. Schmidt-Cassegrain and Maksutov-Cassegrain telescopes also tend to be expensive, but these compact catadioptric (lens/mirror) instruments can show planets well.

Most important, though, is the size of the main light-collecting element—the telescope's *aperture*. Large apertures deliver brighter images, higher resolution and more planetary detail. Yet bigger is not always better. When atmospheric seeing is poor, a small scope can perform just as well as a bigger one, but without the added weight and bulk. This summer, even an inexpensive entry-level scope should reveal Mars' bright, white south polar cap and a few darkish surface markings. You may feel your instrument isn't the finest, but the telescope you have is always better than the one you don't have!

The same goes for eyepieces. But if you do upgrade your eyepiece collection, there are a few things to consider. A short-focal-length (high-magnification) model with a relatively narrow field of view is a drawback if your mount isn't motorized. A better choice for a nontracking telescope is a wide or an ultrawide ocular (admittedly expensive), which will give you plenty of time to scrutinize Mars as it drifts across the field of view. Either way, eyepieces are the vital connection between telescope and eyeball. Ensure that the exposed lens surfaces are free of dirt and dust. You don't want detail-robbing "scatter" compromising the point where Mars meets your eye.

One last important bit of advice: Get your telescope outside soon after sunset (if you have a shady spot, place it there before sunset) to let the entire unit cool down. Optics that are warmer than the surrounding air produce soft images. This is particularly true for reflecting telescopes and the various Cassegrain models, which can require more than an hour to fully acclimate, even on a mild summer's night.




**2018 MARS** Although Mars was still months away from closest approach, Damian Peach was able to record an impressive amount of detail in this pair of images taken early in the current apparition. (South is up in both photos.) Without a doubt, this summer's opposition will result in the finest Mars images yet captured by amateur astronomers all over the world.

## LET'S EXPLORE

It's nightfall, and you're at your scope. Do you know which part of Mars is facing you? Mars takes about 38 minutes longer than Earth to complete one rotation on its axis. Each successive night at a given hour, a surface feature reaches the central meridian on the planet's disc 38 minutes later. Six weeks hence, the feature returns to the same position at the same hour. Over that period, all the visible markings—polar caps excepted—rotate off the disc, then on again.

The south polar cap is this year's marquee feature. Mars' southern hemisphere is currently tipped Earthward. It's spring there, and the enlarged polar cap will be the first thing you notice in your telescope. The unmistakable polar cap will slowly shrink over the coming months. As it does, watch for clouds developing along its periphery. And there might be surprises in store. Partway into the exceptional 2003 apparition, I saw the cap divided into two sections.

By studying our Mars map and consulting the table on the facing page, you can determine what features are well placed each night. The most prominent dark mass is Syrtis Major, located in the equatorial region. If your telescope presents an inverted image, with south at the top, Syrtis Major (when it's on the disc) will show below the polar cap as a vaguely Africa-like blot.

Between Syrtis Major and the south polar cap is a light-coloured oval depression named Hellas. The thick frost or haze that occasionally forms over this impact basin can cause it to become so bright, it might fool you into thinking it's the polar cap. I know Mars pretty well, yet on nights of poor seeing, I've mistaken Hellas for the south polar cap.

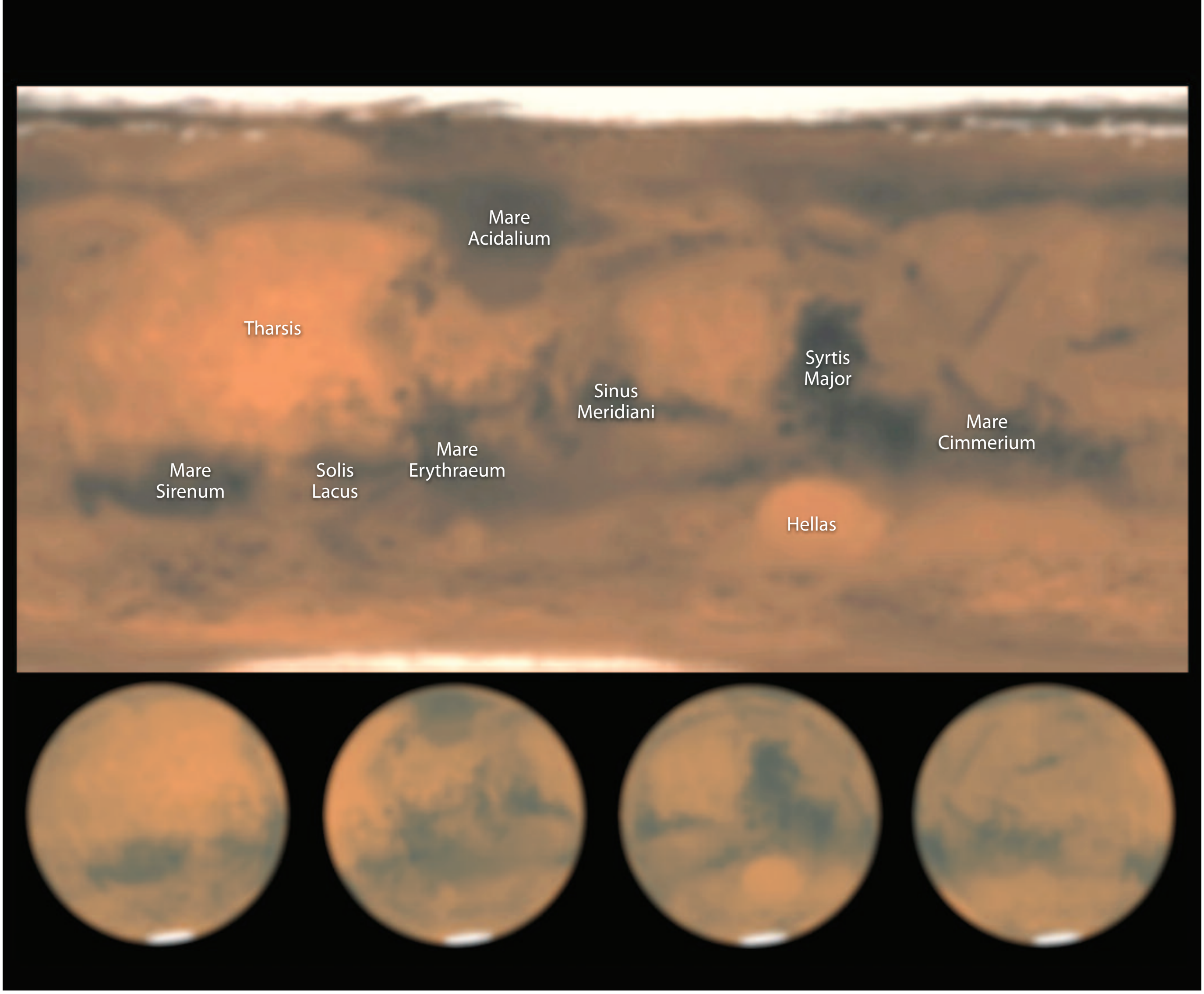
Extending westward along the equator from Syrtis Major is the "arm" of Sinus Sabaeus, which terminates in fingerlike Sinus Meridiani. Farther west is a blotch called Aurorae Sinus, and sharply southwest of that is a broader formation known as Mare Erythraeum. Slightly farther west is Solis Lacus, a small but fairly prominent dark patch inside a whitish arc.

Northwest of Solis Lacus, just north of the equator, are the great shield volcanoes of the Tharsis Ridge. Under exceptional conditions, I've detected the largest volcano, Olympus Mons, as a tiny, pale spot. It's isolated on the "empty" side of Mars, which claims few high-contrast landscapes. However, south of that bland area, toward the polar cap, is a pair of adjoining dusky bits known as Mare Sirenum and Mare Cimmerium. Together, they're roughly crescent-shaped.

## STORM WARNING

The telescopic features I've described stand out better through certain colour eyepiece filters. For example, a Wratten #21 orange filter strengthens the contrast between the dark maria and the light, rusty pink deserts. A red filter is stronger, but it dims the image considerably, so it's better suited for a large telescope. A green filter enhances ground haze and frost (in the Hellas Basin, for instance), while blue and violet filters can reveal cloud formations. Always check the morning (trailing) limb or evening (leading) limb of the disc for transient clouds—you might be surprised at what you find.

Light or dark, filtered or not, many of the features of the Martian disc are subtle sights. At first, you might not recognize anything more than the gleaming polar cap




in your telescope. My advice is to grab a chair, sit down at the eyepiece and wait for those precious moments of steady air that will reward you with the finer details. Patience is the byword of Mars observers.

A final caution: Even the most obvious markings can become obscured should one of the notorious Martian dust storms break out. The bad weather often develops in the southern hemisphere soon after Mars' perihelion (on September 16, this apparition). Amazingly, a major dust storm can spread right around the globe in a matter of days. Witnessing this happen in real time is exciting—until all the neat stuff disappears.

And, of course, cloudy nights here on Earth can ruin our observing plans. So, weather permitting on both planets, get out your scope and enjoy the Great 2018 Mars Show while you can! ✦

*Murray D. Paulson has been the author of the planets section of the RASC* Observer's Handbook *since 2008. An avid planetary observer and imager, he lives in St. Albert, Alberta.*

**MARS MAP** The most conspicuous surface features visible in a telescope are indicated in this Mercator projection map of the red planet, top. The series of illustrations above shows one complete rotation of Mars at six-hour intervals. The planet's direction of rotation carries features on the disc from left to right. Because a Martian day is slightly longer than an Earth day, Mars presents the same face to telescope users 38 minutes later each night. North is up in these depictions.
*SKYNEWS* ILLUSTRATION

## WHAT'S ON MARS TONIGHT?

(Features visible at 11:59 p.m., EDT)

| | |
|---|---|
| **July 1** | Sinus Meridiani on meridian; Syrtis Major rotating off |
| **July 6** | Syrtis Major near meridian; Sinus Meridiani rotating on |
| **July 11** | Hellas near meridian; Mare Cimmerium rotating off |
| **July 16** | Mare Cimmerium on meridian; Syrtis Major rotating on |
| **July 21** | Mare Sirenum on meridian; Mare Cimmerium rotating on |
| **July 26** | Mare Sirenum rotating on; Solis Lacus rotating off |
| **July 31** | Solis Lacus on meridian; Mare Erythraeum rotating off |
| **Aug. 5** | Mare Erythraeum on meridian; Solis Lacus rotating on |
| **Aug. 10** | Sinus Meridiani on meridian; Syrtis Major rotating off |
| **Aug. 15** | Syrtis Major near meridian; Sinus Meridiani rotating on |
| **Aug. 20** | Hellas and Syrtis Major near meridian |
| **Aug. 25** | Mare Cimmerium near meridian; Syrtis Major rotating on |
| **Aug. 30** | Mare Cimmerium near meridian; Mare Sirenum rotating off |

# AROUND THE RING

Summer is the time to visit the Ring Nebula, Lyra's glamour resident

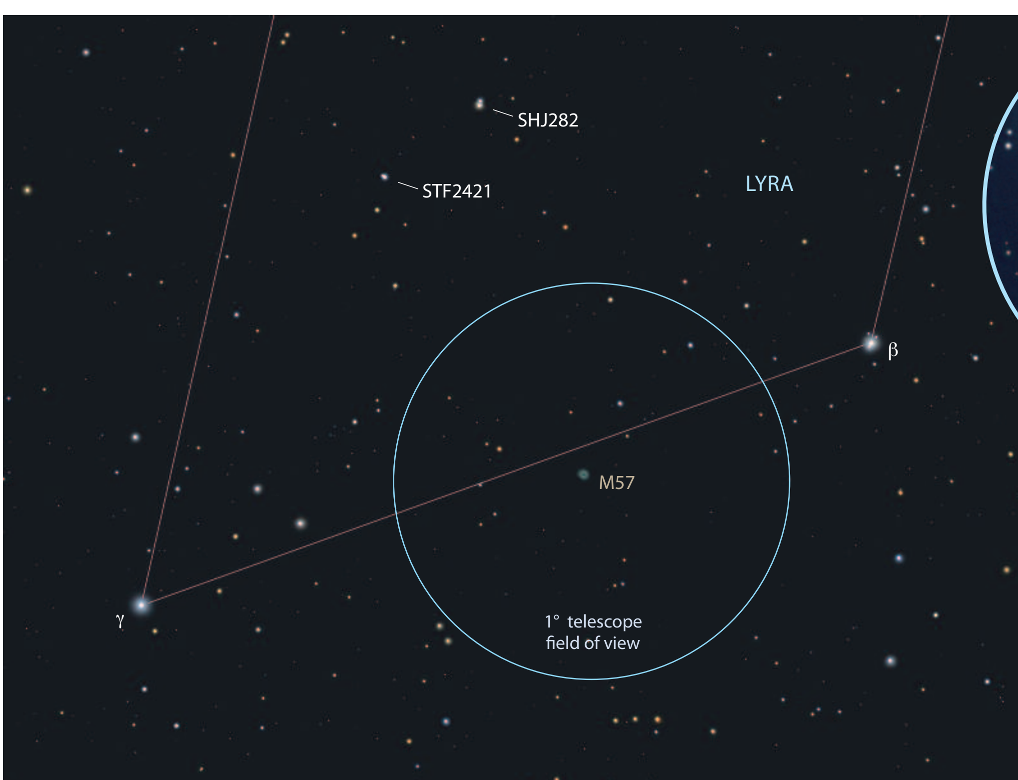
ALLURING, distinctive and visible in any backyard telescope, the Ring Nebula, **M57**, is undoubtedly one of the most widely observed planetary nebulas in the heavens. But don't stop there—the Ring's immediate neighbourhood is worth exploring too.

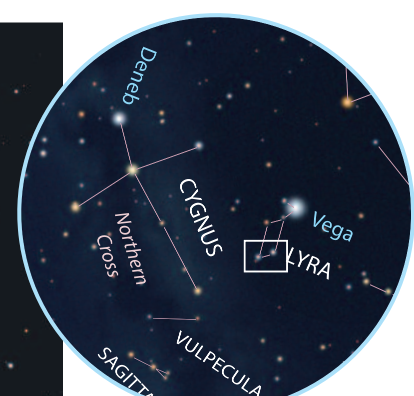
Our target area is two degrees across and includes the naked-eye stars **Gamma** (γ) and **Beta** (β) **Lyrae**. Gamma shines steadily at magnitude 3.2, but Beta is a celebrated variable star. An extremely compact eclipsing binary system, Beta cycles from magnitude 3.4 down to 4.3 and back again every 12.94 days. On nights when Beta is at peak luminosity, you'll notice that it rivals Gamma in brightness.

The famous Beta binary will always appear single in your telescope, but the tightly bound system holds a distant 6.7-magnitude companion 46 arc seconds away that's easy to spot at low power. After Beta, aim your telescope slightly more than one degree northeastward, where a dimmer double, catalogued as **SHJ282**, sports 6.1- and 7.6-magnitude elements as widely spaced as those of Beta. And, in the same low-power field, ¼ degree southeast of SHJ282, is a third binary, called **STF2421**, whose 8.1- and 9.3-magnitude components are 24 arc seconds apart, which is half the separation of Beta. Each of these pairs resolves in my 4¼-inch f/6 Newtonian reflector at just 22×.

Our main prize is the Ring Nebula, M57. A modest item in terms of brightness (magnitude 8.8) and size (80 by 60 arc seconds), the Ring lies a little less than halfway from Beta to Gamma. I can fit both of those stars, the two fainter doubles described above and the nebula in my wide-angle 22× eyepiece. But a low-power view of the nebula is underwhelming. When I use averted vision, M57 manages to catch my attention as a minuscule, ghostly disc; however, if I look directly at the wee thing, it disappears. More magnification is needed. Bumping up to 54× produces a larger disc that sports a tiny central hole. At 72×, I imagine a diminutive doughnut dusted with icing sugar. Viewed at 108×, the doughnut holds up, even in my grey suburban sky.

My 10-inch f/5.5 Dobsonian provides much better definition. Working at 200×, the bigger scope reveals a mildly elongated annulus with ends dimmer than its sides. The hole now appears dusky dark instead of black. Threading a mild light-pollution filter onto the eyepiece improves the contrast between M57 and the sky. A more powerful Ultra High Contrast (UHC) nebula filter works even better, as does a




**DISTANT DOUGHNUT**
Approximately 2,000 light-years from Earth, the tiny Ring Nebula (M57) is conveniently located between the neighbouring (and much nearer) naked-eye stars Beta (β) and Gamma (γ) Lyrae.
CHARTS BY GLENN LEDREW

by KEN HEWITT-WHITE

doubly ionized oxygen (O-III) filter. But such accessories aren't essential for a decent view of the Ring Nebula.

M57 exudes an ethereal character in my 7.1-inch f/15 Maksutov-Cassegrain telescope. At 300×, unfiltered, the Ring is huge, elliptical and faint. Cupping my hands around the eyepiece, I notice the subtly attenuated ends blending into the background sky; indeed, it's a broken ring—two opposing crescents of nebulosity not quite joined together. A UHC filter allows me to reconnect the fragile ends.

On the next clear, moonless night, grasp the Ring—and don't be afraid to slap on the power. ✦

*Associate editor Ken Hewitt-White first viewed the Ring Nebula through a 60mm refractor telescope 52 summers ago.*

**THE RING'S THE THING** The planetary nebula M57 is a ballooning cloud of gas ejected by a dying star. The bipolar nebula appears somewhat elongated because we view it not quite end-on. Whether you see it as a Cheerio, a Life Saver, a Froot Loop or a tiny doughnut, the Ring Nebula is an unmistakable telescopic sight.
PHOTO BY RAPHAËL DUBUC

**OUR CHART SHOWS** the major stars, planets and constellations visible from Canada and the northern United States within one hour of these times:

## EARLY JULY: 11:30 P.M.; LATE JULY: 10:30 P.M.
## EARLY AUGUST: 9:30 P.M.; LATE AUGUST: DUSK

**THE EDGE OF THE CHART** represents the horizon; the overhead point is at centre. The faintest stars depicted shine at magnitude 5.0—a little brighter than what you can see under ideal conditions. On a moonless night in the country, you will see more stars than are shown here; deep in the city, you will see fewer. (The planets, when visible, are plotted for the middle of the date range covered by the chart.)

**USING THE STAR CHART OUTDOORS:** The chart is most effective when you use about one-quarter of it at a time, which roughly equals a comfortable field of view in a given direction. Outdoors, match the horizon compass direction on the chart with the actual direction you are facing. Don't be confused by the east and west points on the chart lying opposite their location on a map of Earth. When the chart is held up to match the sky, with the direction you are facing at the bottom, the chart directions match the compass points. For best results when reading the chart outdoors, use a small flashlight heavily dimmed with red plastic or layers of brown paper. Unfiltered lights greatly reduce night-vision sensitivity.


## CELESTIAL CALENDAR

**JULY 5** ◑ Last-quarter Moon

**JULY 9** Venus 1° north of Regulus in evening sky

**JULY 10** Waning crescent Moon passes just north of Aldebaran low in dawn sky (see page 27)

**JULY 11** Jupiter stops retrograde motion

**JULY 12** ● New Moon, 10:48 p.m., EDT; partial solar eclipse (Australia and Antarctica); Mercury at greatest elongation from Sun (26°) low in evening sky, below Venus

**JULY 15** 👁 Waxing crescent Moon ½° above Venus low in evening sky (see page 28)

**JULY 19** ◐ First-quarter Moon

**JULY 20** Waxing gibbous Moon 3° above Jupiter in evening sky

**JULY 24** Waxing gibbous Moon 2° above Saturn

**JULY 26/27** 👁 Mars at opposition (see page 28)

**JULY 27** ○ Full Moon, 4:20 p.m., EDT (smallest full Moon of 2018); total lunar eclipse from eastern hemisphere (not visible from North America); full Moon 7° above Mars

**JULY 31** 👁 Mars at its closest to Earth (57,590,000 km) and biggest (24.3") since 2003

**AUG. 4** ◑ Last-quarter Moon

**AUG. 11** ● New Moon, 5:58 a.m., EDT; sunrise partial solar eclipse for northern Newfoundland and Labrador and eastern Nunavut (see page 29)

**AUG. 12/13** 👁 Perseid meteor shower peaks tonight (see page 29)

**AUG. 14** Waxing crescent Moon 6° above Venus in evening sky

**AUG. 16** Double shadow transit of Io and Europa on Jupiter (visible from eastern Canada); Jupiter ½° north of Alpha Librae

**AUG. 17** Venus at greatest elongation from Sun (46°) in evening sky

**AUG. 18** ◐ First-quarter Moon

**AUG. 20** Waxing gibbous Moon 4° northwest of Saturn

**AUG. 23** Waxing gibbous Moon 8° northeast of Mars; double shadow transit of Io and Europa on Jupiter (visible from western Canada)

**AUG. 26** ○ Full Moon, 7:56 a.m., EDT; Mercury at greatest elongation from Sun (18°) in dawn sky (see page 29)

**AUG. 28** Mars stops retrograde motion

👁 *Impressive or relatively rare astronomical event*

## THE PLANETS

**MERCURY** briefly appears very low in the evening sky in mid-July. A better opportunity to sight the innermost planet comes at the end of August, when it's moderately high in the east at dawn. Mercury is at greatest elongation on August 26.

**VENUS** remains prominent as the evening "star" all summer and brightens slightly, from magnitude –4.1 at the start of July to –4.6 by the end of August. Venus reaches greatest elongation on August 17; however, the shallow angle the ecliptic makes with the horizon on summer evenings places Venus low in the west during twilight. Look for the waxing crescent Moon near Venus on July 15 and again on August 14.

**MARS** is unmistakable as a brilliant reddish orange beacon in the south on summer nights. It brightens to magnitude –2.8 by the end of July, noticeably outshining Jupiter. The red planet reaches opposition on the night of July 26/27, but it's closest to Earth (and largest in telescopes) a few nights later, on July 31. Mars spends July and most of August retrograding in Capricornus.

**JUPITER** is nearing the end of its current apparition yet is still a conspicuous evening-sky object (magnitude –2.2) situated in western Libra. On August 16, the gas giant passes only ½° north of the 2.7-magnitude double star Alpha Librae (Zubenelgenubi).

**SATURN** and its glorious rings are visible all night low in the south in Sagittarius. Throughout July and August, the zero-magnitude planet slowly drifts westward toward M8 and M20 but stops just short of the nebula pair before reversing direction in September.

**URANUS** shines at magnitude 5.8 in the predawn sky and is positioned roughly 4½° northeast of fourth-magnitude Omicron Piscium.

**NEPTUNE** rises late in the evening and is visible as a 7.9-magnitude dot 1½° west-southwest of 4.2-magnitude Phi Aquarii.

**For additional details or late-breaking information, visit our website (skynews.ca). Also consult the *Observer's Handbook*, published by The Royal Astronomical Society of Canada (www.rasc.ca or 888-924-7272).**


**ROTATING NIGHT SKY:** During the night, the Earth's rotation on its axis slowly shifts the entire sky. This is the same motion that swings the Sun on its daily east-to-west trek. The rotational hub is Polaris, the North Star, located almost exactly above the Earth's North Pole. Everything majestically marches counterclockwise around it, a motion that becomes evident after about half an hour.

**CONSTELLATIONS:** The star groups linked by lines are the constellations created by our ancestors thousands of years ago as a way of mapping the night sky. Modern astronomers still use the traditional names, which give today's stargazers a permanent link to the sky myths and legends of the past.

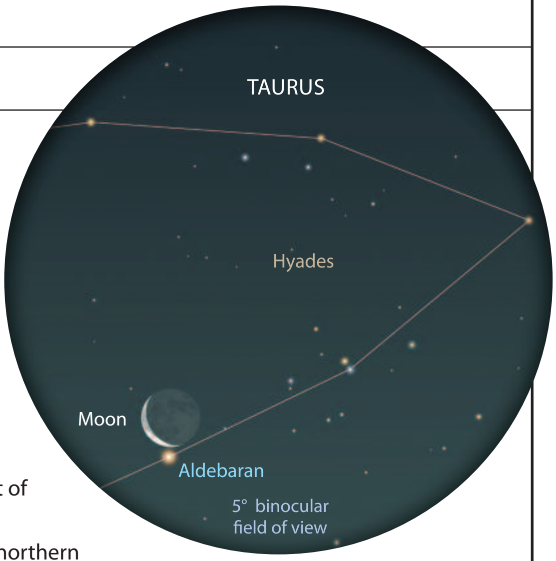
Cartography by Glenn LeDrew

# MARS AND METEORS AT THEIR BEST

The red planet gleams, while Perseid meteors streak through a moonless sky by ALAN DYER

MARS GRABS THE HEADLINES this summer as it makes its closest approach to Earth since 2003. Peaking at magnitude –2.8 in late July, the planet is second in brightness only to brilliant Venus. The other highlight is the annual Perseid meteor shower, which is at its best in August during one of the prime, moonless star party weekends.

| DATE: **TUESDAY, JULY 10** | TIME: **DAWN** |
|---|---|
| TYPE: **CONJUNCTION** | |
| VIEW: **BINOCULARS** | |



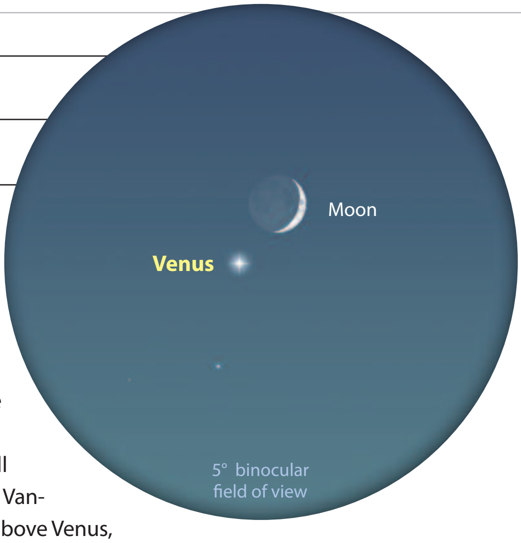

## A NEAR MISS (AND HIT) OF ALDEBARAN

Two of July's finest celestial sights involve the crescent Moon. First up is a spectacular dawn conjunction featuring a waning lunar crescent and the Hyades cluster, in Taurus. As it slowly makes its eastward trek through the Hyades, the Earthlit Moon passes north of first-magnitude Aldebaran. That's what observers across most of Canada will see.

However, if you live in Manitoba or northern Ontario, you'll also be able to watch the Moon eclipse Aldebaran, but only just! From Winnipeg, the lunar disc passes in front of the star at approximately 3:31 a.m., CDT—mere minutes after the Moon rises, at 3:20 a.m. Aldebaran emerges roughly 30 minutes later, at 4:01 a.m. You'll need a site with a flat prairie horizon to take in this tricky occultation.

**PERSEIDS APLENTY** Alan Dyer recorded the 2017 Perseid display from Dinosaur Provincial Park, Alberta. This composite combines several frames and illustrates the location of the shower's radiant, in Perseus. Each 15-second exposure was captured with a Nikon D750 DSLR camera (set to ISO 3200) and a Sigma 20mm Art lens working at f/2.2.

| | |
|---|---|
| DATE: **SUNDAY, JULY 15** | TIME: DUSK |
| TYPE: CONJUNCTION | VIEW: BINOCULARS |




## THE MOON MEETS THE EVENING 'STAR'

The Moon's second July highlight is a close encounter with brilliant Venus (magnitude –4.1). At dusk, the waxing crescent sits close to the evening "star." This is the best conjunction between the two objects during Venus's current apparition. From eastern Canada, the Moon will lie roughly two degrees west of Venus—a splendid naked-eye sight. Binoculars will enhance the view, especially during bright twilight or even full daylight. Once you've located the Moon, you should have little trouble spotting Venus in your binoculars.

Skywatchers in western Canada will get the best view, as the Moon's eastward motion will have carried it even closer to Venus by the time dusk arrives in that part of the country. From Vancouver, British Columbia (as shown at right), the lunar crescent will be positioned ½ degree above Venus, close enough for the pair to be enjoyed together in a small, low-power telescope.


| | | |
|---|---|---|
| DATE: **JULY 26/27** | TIME: ALL NIGHT | TYPE: OPPOSITION |
| VIEW: NAKED EYE, TELESCOPE | | |

## MARS AT ITS BEST

On the night of July 26/27, the famed red planet is at opposition while it's also near perihelion, creating a rare close approach. If you want to be precise, opposition occurs at 1 a.m., EDT, on July 27 (10 p.m., PDT, on July 26). And while we're being picky, it's worth noting that Earth and Mars are actually closest to each other on July 31, when a mere 57,590,000 kilometres separate the two worlds.

Mars glows magnificently at magnitude –2.8 on opposition night. That's brighter than Jupiter and second only to Venus. Indeed, Mars hasn't reached this level of luminosity since its most recent perihelic opposition, in 2003.

Although the red planet will get lots of attention in telescopes, it's also interesting to track night to night with your unaided eye. On opposition night, the planet is situated in southern Capricornus and is slowly moving westward. It will continue on this retrograde path until August 28, when the planet briefly comes to a halt before reversing direction to head eastward again. This back-and-forth movement—part of a loop that lasts a month on either side of opposition—is the result of Earth catching up to, then passing, the slower-moving Mars. As all this occurs, the red planet is dimming from its opposition peak to magnitude –2.1 at the end of August.

For our complete guide to viewing Mars this summer, turn to page 18 .

**RED PLANET OVER BADLANDS** Mars is the brightest "star" in this image and is located among the stars forming the "head" of Scorpius. Alan Dyer captured this shot in May 2016 from Dinosaur Provincial Park, Alberta, during Mars' previous opposition.

ALL CHARTS BY GLENN LEDREW UNLESS OTHERWISE NOTED


**Maximum Eclipse**
HAPPY VALLEY-GOOSE BAY, LABRADOR

**DATE: SATURDAY, AUGUST 11**

**TIME: SUNRISE**

**TYPE: SOLAR ECLIPSE**

**VIEW: FILTERED TELESCOPE**

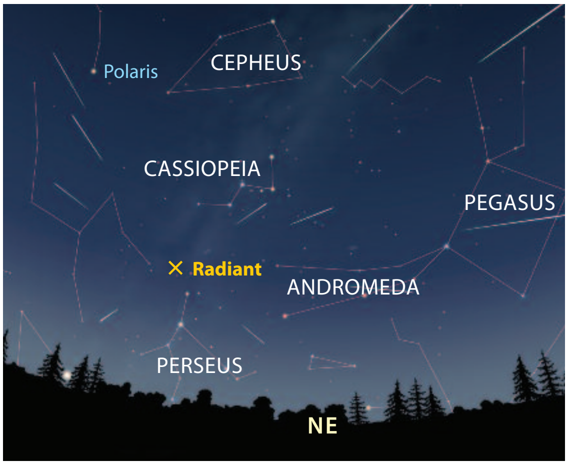
## A DAWN PARTIAL ECLIPSE

Of the three eclipses (two partial solar and one total lunar) this summer, only the August 11 solar eclipse can be seen from Canadian soil, and then just barely. Observers in northern Newfoundland and Labrador and in eastern Nunavut have the chance to see the Moon take a small bite out of the solar disc at sunrise.

From Happy Valley-Goose Bay, Labrador, the lunar disc covers 6 percent of the Sun (shown above) as the pair rises at 6:09 a.m., NDT. For those watching in Iqaluit, Nunavut, maximum eclipse (26 percent of the Sun covered) occurs at 5:44 a.m., ADT, about 22 minutes after local sunrise.

| | |
|---|---|
| DATE: AUGUST 12/13 | TIME: ALL NIGHT |
| TYPE: METEOR SHOWER | VIEW: NAKED EYE |

## PERSEIDS PEAK

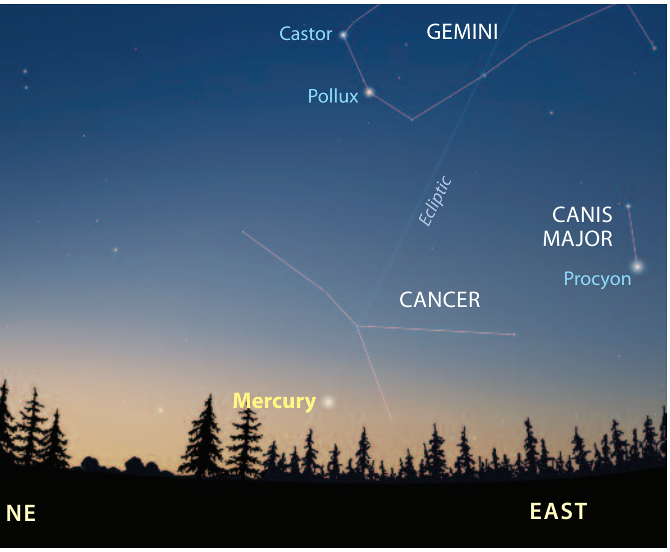



This is a great year for the annual Perseid meteor shower. The Moon is new on August 11, and in North America, the shower peaks during the evening of the 12th. From a dark site, expect to see 50 to 80 meteors per hour through Sunday night (August 12) into the predawn hours of Monday morning. If you're attending a star party that weekend, extend your stay to include this spectacular meteor show.

Meteor showers are best enjoyed from the comfort of a reclining lawn chair. Lie back and take in the show while the Milky Way arches overhead and Saturn and Mars adorn the south. Perseids streak away from the radiant point in the northeast (shown in the chart above) but can appear anywhere in the sky. In general, the meteors farthest from the radiant produce the longest streaks. Keep your binoculars handy to inspect any persistent trains left behind by especially bright Perseids.

If you want to photograph the Perseids, use a sturdy tripod and a fast, wide-angle lens (such as a 14mm f/2.8). Set your camera to ISO 3200 or greater, and use an intervalometer set to continuously fire off exposures in the 30- to 60-second range. The key is to keep the gap between exposures as short as possible—you don't want to miss a real stunner because your camera's shutter is closed.

You can aim your camera pretty much anywhere in the sky and catch meteors, but if you're shooting with a fixed tripod and plan to make a stacked composite later, it's a good idea to include Polaris in the frame as an alignment aid. Shooting with a motorized tracker makes it easier to align and stack frames, no matter what part of the sky the camera sees. With luck, your harvest of hundreds of frames will yield a few dozen prominent Perseids.




| | |
|---|---|
| DATE: SUNDAY, AUGUST 26 | TIME: DAWN |
| TYPE: ELONGATION | VIEW: NAKED EYE |

## MERCURY IN THE MORNING

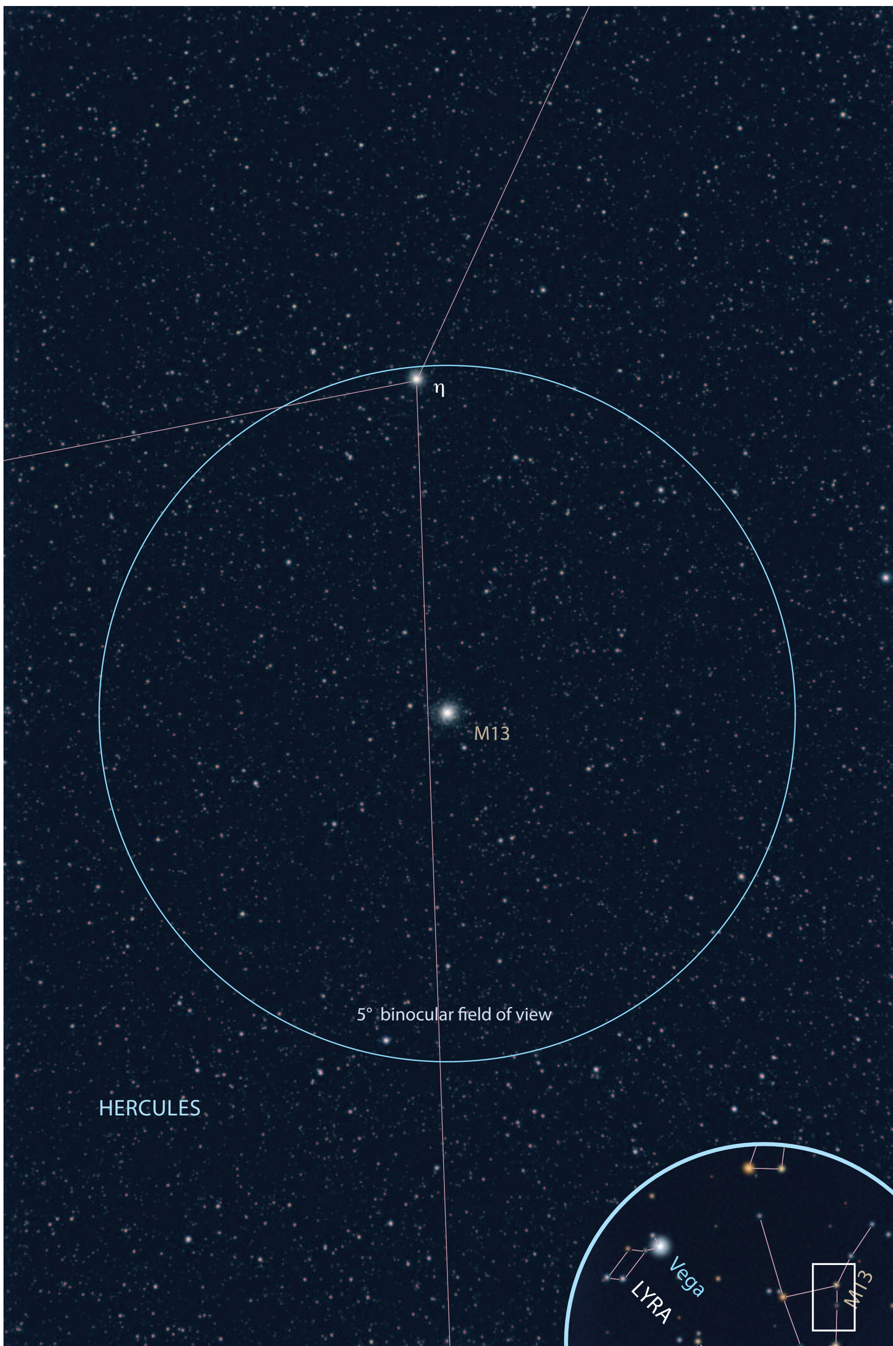
If you miss Mercury during its July evening appearance (and it's easy to miss!), the elusive planet is much better positioned at dawn on August 26. That's when Mercury reaches greatest elongation at a time of year when the ecliptic is favourably tilted in the morning sky, placing the planet higher above the horizon. This will be your best chance to enjoy Mercury until mid-December.

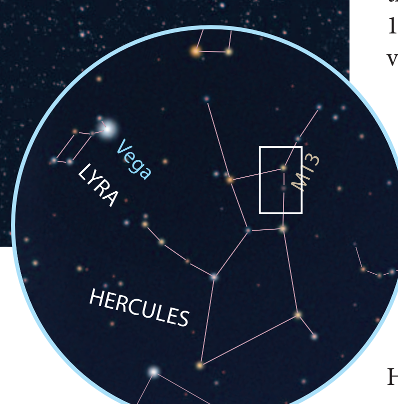
Mercury shines at magnitude –0.5 and rises roughly 1½ hours ahead of the Sun, which should make spotting the innermost planet reasonably easy, especially if you use binoculars to aid your hunt. And while you're up, look around and admire Orion and the bright stars of winter, now climbing in the east. Their return is a reminder that summer is winding down and cool weather is on its way. ✦

by GARY SERONIK

# A GEM IN HERCULES

The brightest globular cluster in the northern sky is well positioned for early-evening viewing




**KEYSTONE CLUSTER** M13 is both bright (magnitude 5.8) and easy to find, as it's situated less than 2½° south of 3.5-magnitude Eta (η) Herculis, one of four stars making up the Hercules Keystone asterism. PHOTO BY GARY SERONIK

ORDINARY BINOCULARS are a wonderful tool for enjoying big, bright celestial sights. But small and faint? Not so much. The instrument's combination of limited light grasp and low magnification gets in the way. However, once you develop an eye for these tiny targets, you'll be surprised by how many of them binos can pick up, so long as the objects are not too dim. The best way to become accustomed to the small image scale provided by binoculars is to start off with something easy. The globular cluster **M13**, in the constellation Hercules, is a great example.

At magnitude 5.8, M13 is the second brightest globular in the northern sky. (M5 is magnitude 5.7.) Indeed, M13 can be detected with the naked eye under pristine conditions. If you check M13's dimensions in a catalogue, you'll see a figure of around 16 arc minutes or greater, which means that it should appear roughly half the size of the full Moon. How is that *small*? Although the listed diameter is technically correct, in binoculars (or a small telescope), you see only the cluster's luminous central core—the tip of the proverbial iceberg.

Even so, binoculars should make finding M13 a snap, right? Yes and no. It's bright enough to be seen in a suburban sky. However, identifying the cluster can be a bit tricky, especially if you're expecting to see a glittering ball of starlight, as the cluster appears in photos. Remember, 10×50 binoculars operate at 10×, which is very low power. If you have 7×50s, the globular appears smaller still and presents a greater challenge.

Apart from its brightness, M13's other virtue is that its location is easy to pin down. Look along the west edge of the constellation's famed Keystone asterism, as indicated in the chart at left. Draw an imaginary line between the stars Eta (η) and Zeta (ζ) Herculis, and scan roughly one-third of the way from Eta. Make sure your binoculars are accurately focused (Eta is good for this task), then examine the field. You shouldn't have much trouble picking out M13. The key is to keep your expectations in check. You're searching for something that resembles a slightly out-of-focus dot of light.

I have little difficulty spotting M13 in my 7×50s, and it's a snap with my image-stabilized 10×30s. But the best binocular view I've had is with my 15×45 image-stabilized binos—the extra 5× really makes a difference. With the 15×45s, M13 just begins to hint at its telescopic splendour.

Typical of most deep-sky objects, there's more here than meets the eye. As you gaze at M13, consider that you are viewing the combined light of some several hundred thousand suns, glowing at a distance of roughly 21,000 light-years. What's more, the stars in M13 are ancient. While our Sun is roughly 4.6 billion years old, the stars populating globular clusters like M13 are among the oldest in the universe—they've been shining for nearly 12 billion years! ✦

**STAR CITY** Although easy to identify in binoculars, globular clusters such as M13, shown here, reveal their true beauty in telescopes and long-exposure photographs, like this one taken by Erich Krause of Calgary, Alberta.

Text and photography by TONY PUERZER

# IMAGE-STACKING BASICS

Combining multiple frames into a single photo is the secret to noise-free astro-images

WELL-EXPOSED, detail-rich astrophotos are a joy to behold. Such images have creamy-smooth tonal transitions and respond well to postprocessing. However, achieving these results can be difficult if you're working from a single frame. The main enemy is noise generated by the camera's light-sensitive detector and internal electronics.

The root of the problem is that many targets we're trying to capture are so faint, they struggle to rise above a DSLR's noise floor. One obvious solution is longer exposure times to record more of the desired "signal." Unfortunately, this isn't always practical. If, for example, you're using a fixed tripod and wish to avoid star trails, exposures generally can't exceed 30 seconds, even with a wide-angle lens. And there are also limits for longer exposures made on a tracking mount. What about cranking up your camera's ISO setting instead? It's an option, but one that has the undesirable effect of increasing the visibility of digital noise.

If you dream of decorating your home with poster-sized prints of your astronomical artwork, pictures that look rougher than 80-grit sandpaper aren't going to cut it. And noisy images aren't just unattractive, they also don't stand up to even modest postprocessing and editing.

Fortunately, there's a simple way to obtain great results with short exposures shot at high ISO settings. It's called *image stacking*.

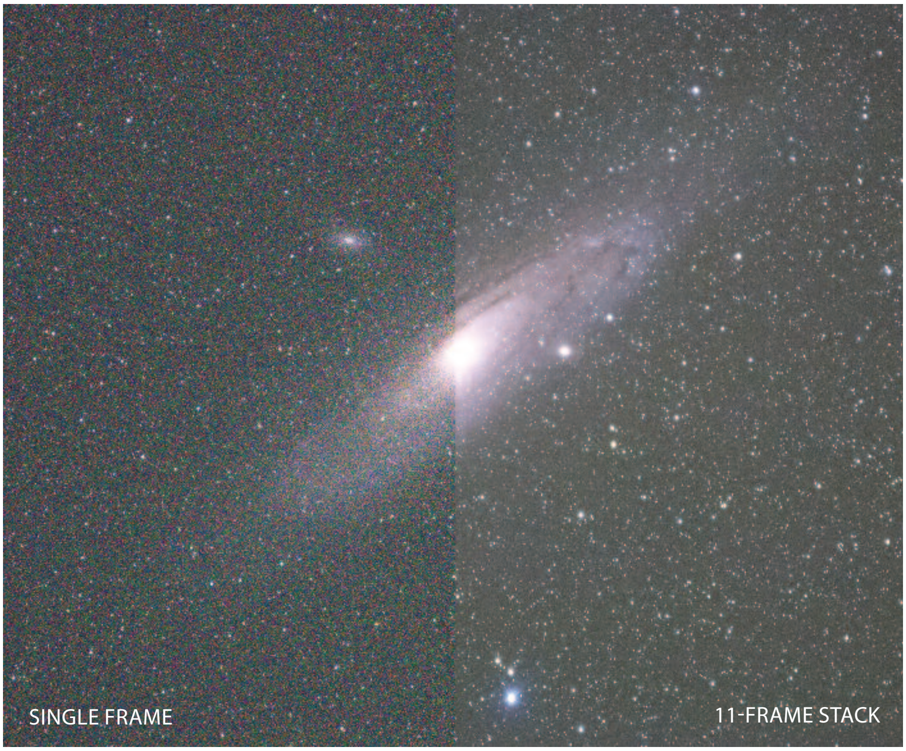
## IT ALL ADDS UP

Essentially, the procedure is to capture multiple shots of the same subject, then blend them together during postprocessing. Image stacking succeeds because the "signal" (light from the galaxies, nebulas and stars you want to record) is left untouched, while random "noise" (a confetti-like background) is averaged out. Think of image stacking as a form of astrophotographic noise reduction. The improvement is often quite dramatic.

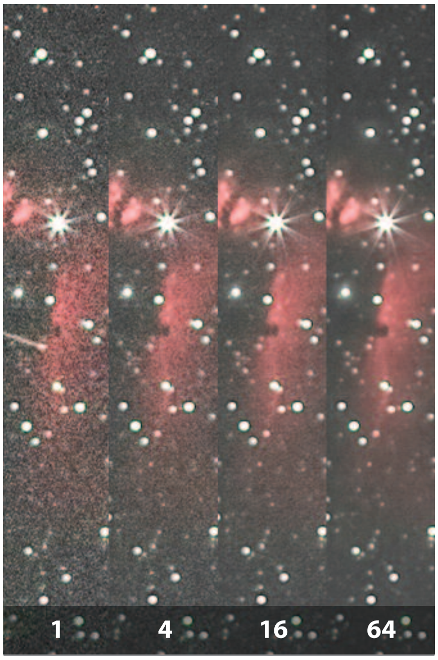
To see image stacking in action, look at the series of images on the next page that are cropped from a wide-field portrait of Orion. The leftmost panel is a single 30-second exposure displaying a fair amount of digital noise. Moving to the right, each subsequent frame shows what happens when 4, 16 and, finally, 64 images are stacked together. Impressive, right?

In theory, there's no limit to the number of exposures that can be combined, but eventually, we reach a point of diminishing returns. Each incremental improvement in noise reduction requires *double* the number of shots. So going from four to eight exposures, for example, will provide a distinct improvement, but you'll need to double it again—for a total of 16 images—to get an additional equivalent bump in quality. Want an even smoother background? Now you're talking 32 or 64 frames. Most agree that there's little to be gained by stacking more than this.

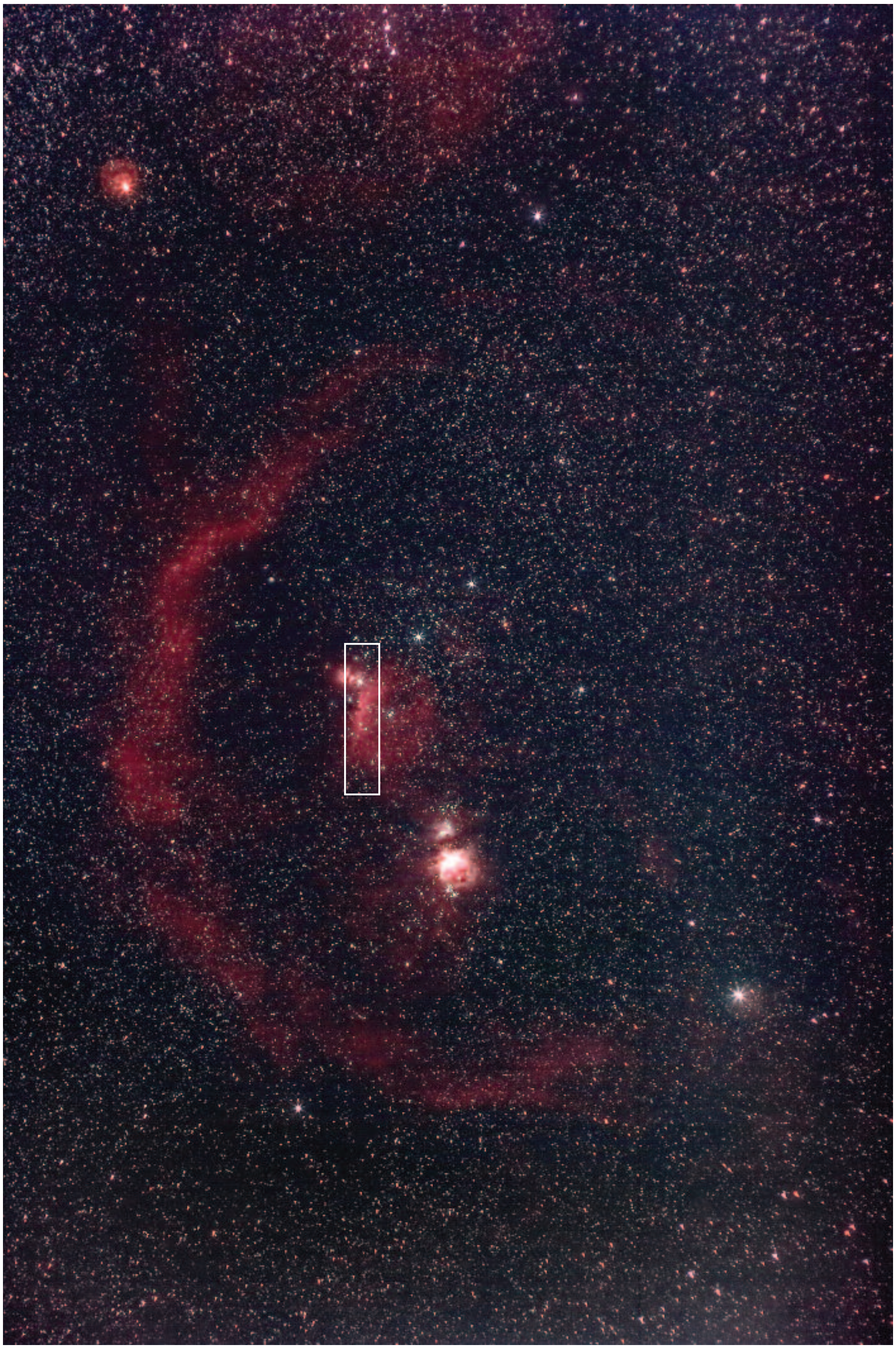
Regardless of the number of images you




**STACKING THE DECK** This split-screen portrait of the Andromeda Galaxy illustrates the benefit of image stacking. Notice how the right side of the image exhibits very little noise and, consequently, features subtle tonal gradations in the galaxy compared with the single frame on the left side. All the individual, unprocessed 30-second exposures used in this comparison were shot at ISO 16,000 with a Canon EOS 80D DSLR camera and a Canon 300mm f/4 lens riding on an iOptron SkyTracker mount. Facing page: The splendid Lagoon and Trifid Nebulas, M8 and M20 in Sagittarius, were imaged last summer during the Mount Kobau Star Party, in British Columbia. The stack of six 300-second exposures was captured at ISO 1600 using a modified Canon EOS 60D DSLR and a Canon 300mm f/4 lens fitted with an Astronomik CLS filter. Digitally combining a series of exposures yields buttery smooth tonal transitions that lend themselves to considerable additional processing.




**ORION TEST STRIP** Each test strip above is a tiny portion from an image of the constellation Orion, at right. This clearly illustrates how increasing the number of stacked frames further reduces digital noise, even when a moderate ISO 800 setting is used. (The number of frames stacked in the test strips is indicated.) The 30-second tracked exposures were made with a modified Canon EOS 60D DSLR camera and a Canon 50mm lens set to f/2.



plan to stack, it pays to start with the most noise-free frames you're able to produce. Some cameras are better than others in this regard, but even the time of night or the season of the year comes into play. Not surprisingly, the test strips of Orion shown above were captured during the winter on an evening when the temperature was near freezing. The chilly air helped keep the camera's sensor cool, which, in turn, resulted in images that were relatively free from noise. In summer, your best bet is to wait until well after nightfall or, better yet, shoot during the predawn hours, when the ambient air is typically coolest.

## CAPTURING PHOTONS

To begin taking individual images for stacking, set your camera to RAW mode and use a Manual exposure setting. It's critical to hold the exposure and ISO settings constant, since the random noise is the only thing we're trying to eliminate. If this is your first attempt, record at least a dozen shots of the same target. This should give you a reasonable set of photos for experimentation. You can even capture images over several nights, assuming the sky conditions and framing remain constant.

You may ask: "Why go to the bother of shooting so many frames? Can't I simply use my computer to make multiple copies of a single image?" Sadly, this won't work. Stacking relies on the fact that image noise is randomly distributed across *each individual frame*—something that wouldn't be true with multiples of a single image.

After you've downloaded your night's work into your computer, review each frame at 100 percent magnification and weed out those suffering from tracking errors or from passing aircraft, clouds or satellites. Although the software's averaging routine will eliminate or minimize some of these intruders, it's always best to start with a set of clean images. Also, resist the urge to perform any image editing at this point—save your processing for the final stacked image.

## LET THE MAGIC BEGIN

Frames can be stacked digitally by using one of a number of different software programs, including Affinity Photo, DeepSky-Stacker, Nebulosity and Sequator. Some of these will automatically align and stack all your frames. I'm most familiar with Adobe

**GLOBULAR GLORY** This image of M13 is a stack of just five individual photos, demonstrating that even a few extra frames can make a big difference in reducing digital noise. The 5-minute exposures at ISO 1600 were acquired using a Celestron C6 Schmidt-Cassegrain telescope and a modified Canon EOS 60D DSLR camera.

Photoshop CC, so I'll use that for my workflow example.

In Photoshop, click *File > Scripts > Load Files Into Stack*, then click *Browse* and select the images you want. Enable both the *Attempt to Automatically Align Source Images* and the *Create Smart Object After Loading Layers* check boxes.

The alignment option is important, even if you used a tracking mount, because each layer must be perfectly aligned with all the rest. (Sometimes, Photoshop fails to automatically align the images. If it does fail, your only option is to manually align all the layers—a tedious operation—or to try one of the other software packages.)

Once the layers are aligned and converted to a Smart Object in Photoshop, click *Layer > Smart Objects > Stack Mode > Median*. I choose "Median" rather than simply "Mean" because it discards "outlier" pixels on individual images (such as those from satellite trails), rather than averaging them into the final mix.

Don't be surprised if all this number crunching seriously taxes your computer's processing power. Depending on the number of frames you're stacking, it's not uncommon for each step to take several minutes—or a few hours. Instead of staring at your computer monitor while this is going on, hit Enter and walk away for a cup of tea.

After the computer has completed its work, the digital noise should be greatly reduced. You'll notice the extent of the improvement by comparing the stacked results with individual frames at 100 percent magnification. If you're happy with what you see, select *Layer > Flatten Image* before saving the file and exiting Photoshop.

I prefer to do most of my final tweaking using Adobe Lightroom rather than Photoshop (for my basic technique, see the January/February issue, page 18). No matter what program you employ, I'm sure you'll find your stacked results much easier to manipulate. They'll also withstand a lot of adjustment before starting to break down.

Although image stacking requires extra time and effort during capture, I believe the results more than justify it. Indeed, this may be the only case in which doing the same thing over and over again really does yield better results! ✦

*Tony Puerzer is a full-time professional photographer and part-time amateur astronomer living in Nanaimo, British Columbia.*

# APPRECIATING CRATER PEAKS

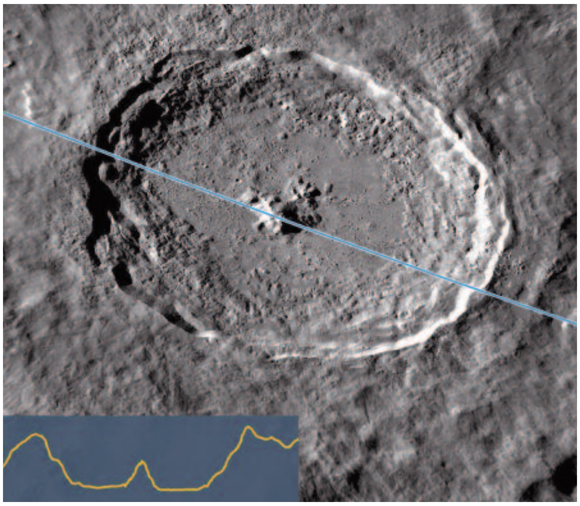
Powerful impacts created the most impressive mountains on the Moon

IF YOU'VE EXPLORED our nearest celestial neighbour with a telescope, you know that mountains on the Moon appear quite similar to those found on Earth. Lacking our home planet's mountain-building plate tectonics, however, lunar peaks are, instead, the product of tremendously violent impacts.

Among the most arresting lunar mountains are the enormous arcing ranges, like the Apennines and Alps ringing much of the eastern half of Mare Imbrium (remember that east and west on the Moon are opposite sky directions). Their proximity to the 1,300-kilometre-diameter feature isn't coincidental—both ranges are rim segments of the Imbrium Basin, which was blasted into existence some 3.85 billion years ago. Less powerful impacts yield smaller basins, but even these are encircled by impressive mountains. The Altai Scarp, which defines the southwest rim of the Nectaris Basin, is particularly eye-catching. But just as fascinating are the central peaks found in large craters.

The next time you're observing an eight-day-old waxing gibbous Moon, have a close look at 102-kilometre-wide Tycho. It's best known for its expansive collection of feathery rays, but if you inspect Tycho when the terminator is close by, you'll see that its centre is marked by a prominent peak. Same with nearby Moretus and with fellow rayed crater Copernicus. Indeed, if you look carefully, you'll notice lots of craters have conspicuous central mountain peaks or peak complexes.

My absolute favourite example belongs to 110-kilometre-wide Theophilus, the most northern in an arc of three craters west of Mare Nectaris. To my eye, this commanding peak complex resembles a mighty, clenched fist. The "fist" is most obvious when the Moon is waxing past first quarter. The highest point of the Theophilus group towers some 2.7 kilometres above the crater floor. I can't think of another near-side crater that possesses such a dramatically high peak. Even Tycho's doesn't quite match the imposing height of the Theophilus mountain.



**CRATER CROSS SECTION** The profile of Tycho at lower left was constructed using Lunar Reconnaissance Orbiter data. The blue line in the image indicates the chord across the crater that was used for the graphic. Note that the mountain at the centre of Tycho doesn't rise to the level of its rim. COURTESY NASA/LRO


**NECTARIS AND BEYOND** One of the most spectacular examples of a central peak is found adorning the crater Theophilus. This impressive massif rises roughly 2.7 kilometres above the surrounding terrain. The nearby Altai Scarp is a mountain range that forms part of the rim of the Nectaris impact basin. PHOTO BY GARY SERONIK

When the Sun angle is low, crater peaks cast extremely long, narrow shadows. This is especially true for expansive craters with smooth, flat floors. Viewing the first-quarter Moon recently, I was so struck by the shadow projecting from the mountain complex dotting Walther's centre, I was sure I'd found a rival to the Theophilus peak. To my surprise, I discovered that the topmost point in the Walther grouping rises 2.3 kilometres above the crater floor—noteworthy, but not quite as high as the one in Theophilus. I had been tricked by a shadow! But I took comfort in the knowledge that I wasn't the first to be deceived.

Crater peaks often produce shadows so long and pointed that in the pre-spaceflight era, space artists often depicted Moon mountains with proportions resembling a craggy Eiffel Tower. Scrutinizing the slender shadow cast by Walther's peak, I could easily understand why. And these early portrayals weren't completely unreasonable. The idea was that such stark forms could exist on the lunar surface because of the absence of weather, thus no erosion to wear down the terrain. Of course, a quick look at the Moon's limb puts this fanciful notion to rest—the mountains presented in profile there have the appearance of gently rolling hills, not fanglike protrusions.

But why do some craters sport central peaks while others don't? It all boils down to size. Crater morphology becomes progressively more complex as the amount of impact energy increases. Small craters (about 20 kilometres or less in diameter) have relatively simple bowl-like shapes. But the energy unleashed by more massive impacters produces bigger craters exhibiting additional features, such as terraced walls, secondary craters and central mountain peaks.

Like all rules, however, there are exceptions—some big craters aren't adorned with a central mountain. Look at 109-kilometre-wide Plato or 164-kilometre-diameter Ptolemaeus. Clearly, both formations are large enough to boast a full set of complex crater features. So what's going on here? If you examine Plato and Ptolemaeus with your telescope, you'll quickly realize that they have something in common: smooth, dark floors. These craters have been partially filled with lavas. In other words, it's not that they lack central peaks; it's just that the peaks are below the surface. And that leads to another interesting characteristic of central peaks—they never rise above the height of the crater's rim. Consider the profile of Tycho on the facing page. Notice how its peak maxes out well below the rim? Now imagine lavas seeping up through cracks in Tycho's floor, filling it almost completely to the brim. That's Plato. But if those same lavas only partly fill Tycho, you end up with something resembling Copernicus. ✦

*Gary Seronik is a dedicated lunaphile and this magazine's editor.*

# STARGAZING BINOCULARS FOR A RANGE OF BUDGETS

One of these moderately priced binoculars might be right for you

by GARY SERONIK and KEN HEWITT-WHITE

IN THE JANUARY/FEBRUARY 2018 issue (page 12), we noted that 10×50 binoculars represent a nearly ideal combination of light gathering and magnification. This configuration strikes an appealing balance between generous wide-field views and resolution sufficient to show detail in many night-sky objects. But there's another balancing act to consider: cost versus performance. Reviewed here are two models at different price points.

**COATINGS AND CUSHIONS** The Nikon Aculon A211 binoculars have effective optical coatings that optimize light throughput. Cushioned rims encircle the front of the objective lens barrels, providing protection from bumps and impacts. PHOTO BY GARY SERONIK

# NIKON ACULON A211 10×50 BINOCULARS


**STAR PERFORMERS**
The utility of 10×50s is widely appreciated, so for many stargazers, choosing binoculars comes down to finding a make and model that suit the observer's budget and expectations. The Nikon Aculon A211 binoculars are one very good option.
PHOTO BY GARY SERONIK

GENERALLY, THE MORE YOU PAY, the better the gear. But in the same way that 10×50 binoculars hit a performance sweet spot, I wondered whether there was a similar sweet spot balanced between stellar optics and a moderate price. When I saw the Nikon Aculon 10×50s on sale at a local retailer for $140, I purchased a pair to see whether they could achieve such a tricky balance.

## SPECIFICATION ANTICIPATION

On paper, the Aculons seem to have it all. Boasting multicoated lenses (including some aspherical elements) and BaK4 prisms and delivering a 6.5-degree field of view, there's a lot to like. Of course, specifications are one thing—actual performance is another. I was interested to see whether these binoculars would have a noticeable edge over the budget-priced Simmons ProSport 10×50s I evaluated in the January/February issue (page 34).

The Aculons weigh 911 grams, or 32 ounces, and have a solid feel to them—nothing creaked or felt loose. The adjustments are reassuringly firm, and the body of the binoculars is coated with a soft rubberized finish that has a nice "grippy" texture. I appreciate that the covering extends roughly ⅛ inch forward of the objective lens barrels, cushioning the optics from accidental knocks and bumps.

The eyepieces feature click-stop adjustable eyecups instead of the more common fold-down variety. Although Nikon specifies that the eye relief is just a shade under 12mm, I found I had to have the eyecups fully retracted to take in the entire field of view. If you wear glasses while observing, you may find the eye relief insufficient. I recommend trying a pair before purchasing.

The focus knob is large and deeply grooved, which is especially helpful when wearing gloves. Most important, the Aculons have a tripod socket concealed under a screw-on cap on the front of the binocular hinge. Because *steady* views are *detailed* views, the option to mount binoculars on a tripod (or other support) is a must-have in my book. Overall, I was very pleased with the mechanics and "fit 'n finish" of the Aculon A211s.

Initial inspection of the optics was favourable as well. Holding the binoculars at arm's length, I noted perfectly round, five-millimetre-diameter exit pupils that exhibited none of the squaring off or shading found on some binoculars. This indicated that the internal prisms are fabricated with BaK4 optical glass, as stated. A quick check also confirmed that the Nikons deliver the full light-gathering capabilities of their 50mm objective lenses. As I noted in my January/February review, the specifications printed on the box don't always match what's inside—some budget 10×50s (like the aforementioned Simmons and the Bushnells that Ken Hewitt-White evaluates on page 41) are functionally 10×40s.

## IN THE FIELD OF STARS

The Aculons are razor-sharp in the centre of the field of view, but the image begins to break down noticeably about halfway toward the edge of the field. This state of affairs is mostly due to an aberration called *eyepiece astigmatism*, which transforms stars from tidy points into short streaks. It's present to some degree in most binoculars I've tested, though compared with the Simmons binos, the Nikons are a bit sharper on-axis and retain good image quality across slightly more of the field of view.

To return to my original question: Are the 10×50 Nikons significantly better than the low-cost Simmons ProSport 10×50s? Yes—both optically and mechanically. Are they $100 better? That's a tougher call. The differences aren't exactly night and day, which is more a testament to how good the Simmons are, rather than a criticism of the Nikons. Casual users and beginners might be perfectly content with the less expensive option.

Remember that in the broader scheme of things, the Aculons are much closer to the budget end of the price spectrum than the premium end—you can certainly spend a great deal more on a pair of 10×50s. However, in my view, the Nikon Aculon A211 10×50 binoculars represent very good value for the money.

*—GS*

### NIKON ACULON A211 10×50 BINOCULARS

**Approximate retail price: $165**

**https://en.nikonsportoptics.ca**

**Summary:**
A quality, moderately priced binocular for stargazing

**PLUSES**
- Mechanically robust
- Good optics

**MINUSES**
- Eye relief tight
- Edge-of-field performance disappointing

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The Canadian Magazine of Astronomy & Stargazing

# BUSHNELL POWERVIEW 10×50 BINOCULARS

BUSHNELL'S POWERVIEW SERIES 10×50s are an economically priced porro-prism model, complete with lens caps and carrying case. On the box, the label "PowerView All-Purpose Binocular" (plus, for no apparent reason, the word "Extra") is supported by a trio of graphic icons indicating that these binoculars can be used for wildlife study, birding and nature hikes. To those three, I can suggest a rather obvious fourth application: stargazing!

## GETTING A HANDLE ON THE GEAR

A fact table on the back of the box says this rugged pair weighs just 25 ounces, or 709 grams, though my handy kitchen scale places it close to 800 grams. Either way, the binos feel comfortable in my hands. A good thing, too, because the PowerView's "InstaFocus" lever works best when I use the fingers of both hands. Slightly nudging the teeter-totter focuser back and forth exposes a bit of slop, but otherwise, the mechanism operates smoothly and the actual focusing is easy. The multicoated 50mm objectives betray no significant reflections. At the eyepiece end, I measured exit pupils of 5mm and found the stated 10mm eye relief for each ocular comfortable.

Although not of critical importance, both parameters nicely accommodate my ageing eyes. The oculars have large rubber eyecups, but eyeglass wearers take note: They're too stiff to roll down easily. The right-hand eyepiece can be focused independently; unfortunately, the accompanying diopter scale is not highlighted for convenient reading—I didn't even notice it at first.

The 10×50 configuration yields a field of view advertised as 341 feet at 1,000 yards, which translates to a 6.5-degree true field. However, the binoculars' internal construction reduces the 50mm aperture by almost 10mm—meaning that these 10×50s are effectively 10×40s. Naturally, I wondered to what degree this deficiency would affect my enjoyment of celestial objects. On a moonless evening last spring, I found out.

## THE 10-POWER VIEW

Threading a right-angle tripod adapter into the provided socket, I mounted the binoculars on a camera tripod, then targeted the one-degree-wide Beehive star cluster. I'd prepared a chart identifying the brightness of 10 Beehive stars, from magnitude 6.6 down to 9.0. The observed limit turned out to be an 8.7-magnitude star, glimpsed on and off. The faintest cluster member I could hold steadily was magnitude 8.5—not bad for my light-polluted suburban sky. To put this in context, the entire Beehive was barely visible to my unaided eyes.

I also focused the Bushnells on zero-magnitude Arcturus. Provided it was near the centre of the field of view, Arcturus looked tack-sharp. When I shifted the binos in any direction—up or down, left or right—the star image began to suffer from eyepiece astigmatism, beginning about halfway toward the edge of the field. Close to the edge, the distortion was severe—admittedly, a common defect in all but the best-quality binoculars.

For comparison, I performed the same tests with my Nikon Aculon A211 10×50s (reviewed on page 39). With the full-aperture Nikons, I spotted all 10 Beehive stars on my chart. The faintest star (magnitude 9.0) was a difficult yet definite catch, so the pricier binos pushed approximately half a magnitude deeper. That said, the less efficient light grasp of the Bushnells did not greatly alter my appreciation of the dozen or so clusters and nebulas I observed that night.

On another occasion, I aimed my PowerViews at the waxing gibbous Moon. With the binos tripod-mounted and the Moon centred in the field, the image was fabulous. The Bushnells showed rugged mountain chains, smooth grey "seas," long rays and craters galore. After decades of astronomical observing, I'm still amazed at the wealth of lunar detail 10× binoculars can reveal.

Notwithstanding the limitations noted above, I can recommend these PowerView 10×50s for casual stargazing. Memo to the Bushnell people: Display that fourth icon! —*KHW*


**TEN-POWER STAR SEEKER** This reasonably priced 50mm binocular is fine for the one thing not promoted on its colourful display box: stargazing! The Bushnell "InstaFocus" lever is easy to manipulate, although slowly rocking the mechanism back and forth to find focus reveals a bit of slop and a dead spot between the two motions. PHOTO BY KEN HEWITT-WHITE

### BUSHNELL POWERVIEW ALL-PURPOSE 10×50 BINOCULARS

**Approximate retail price: $100**

**www.bushnell.com**

**Summary:**
A relatively inexpensive binocular suitable for casual stargazing

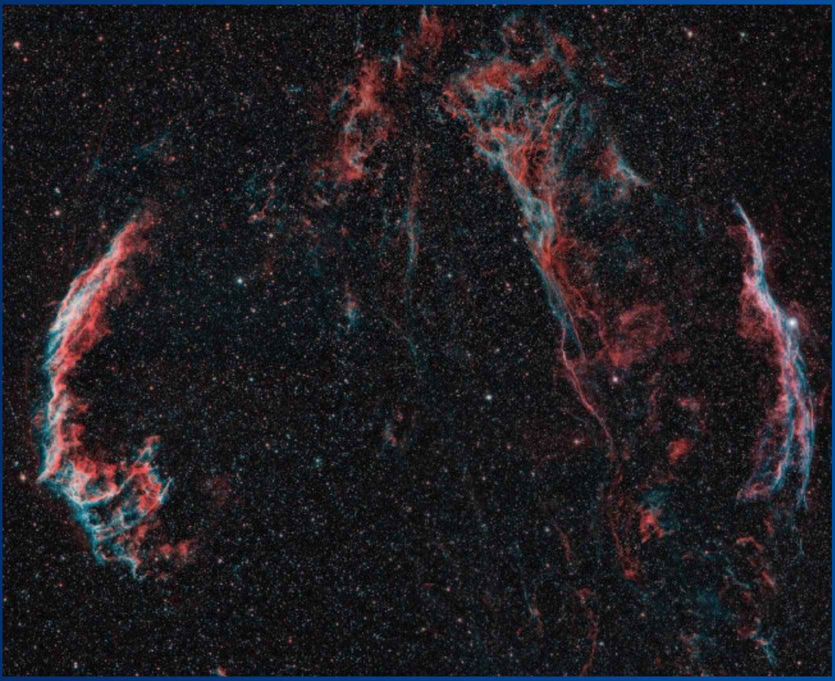
**PLUSES**
- Lightweight and comfortable
- Tack-sharp focus at centre of field

**MINUSES**
- Edge-of-field performance mediocre
- Aperture effectively only 40mm

# SWAN SONGS

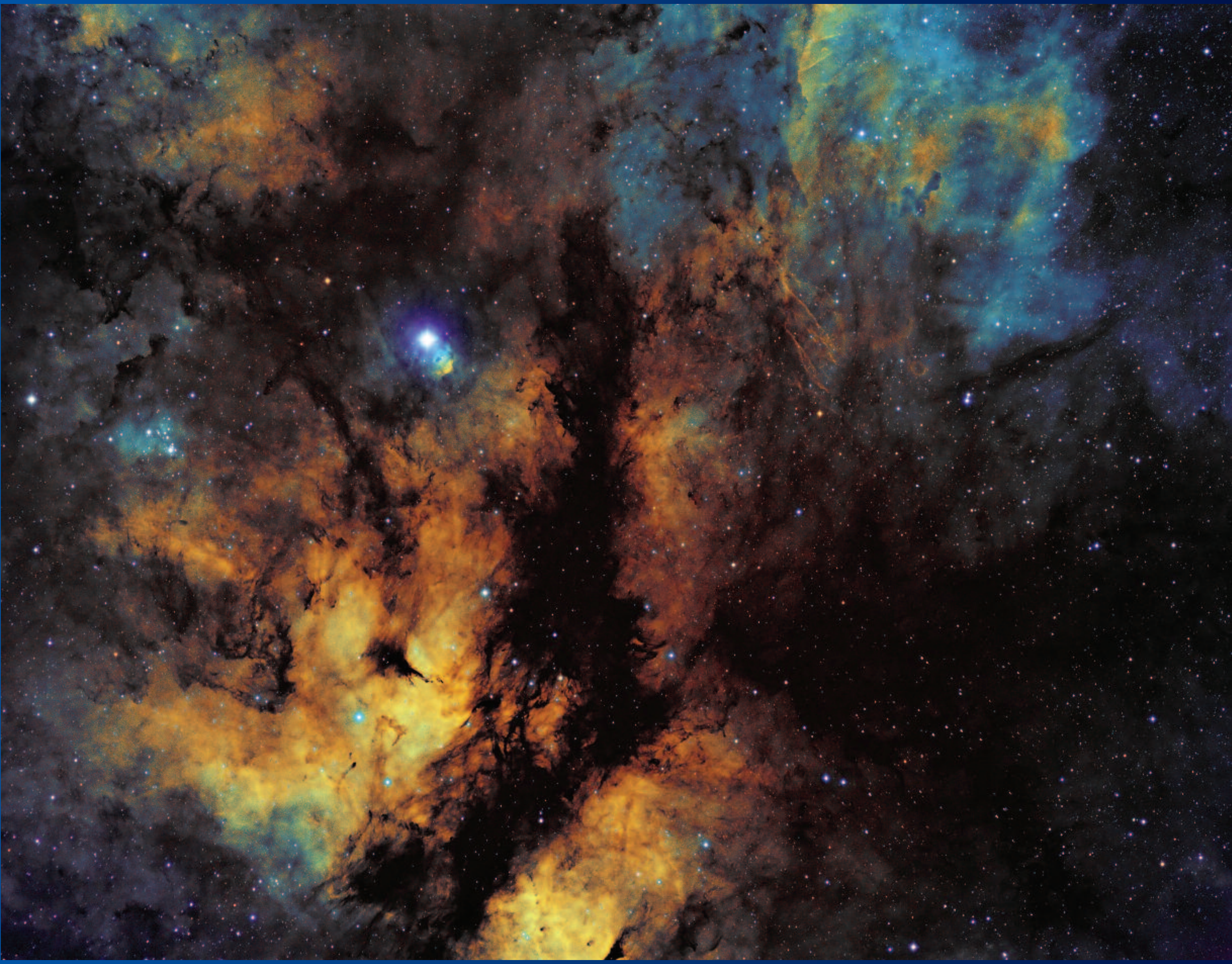
## Cygnus is home to a clutch of photogenic summer-sky targets

ONE OF THE MOST recognizable constellations of the season is Cygnus the swan, also known as the Northern Cross. Running the length of Cygnus, the summer Milky Way features several well-known nebulas. Despite their photographic prominence, these objects require dark country skies and specialized nebula filters to be seen well.



▲ **VEIL MOSAIC** Scott Champion of Haneytown, New Brunswick, combined four separate images to create this wonderfully detailed photo showing the entire three-degree-wide expanse of the Veil Nebula, in Cygnus. Each frame was captured with an Atik 383L+ monochromatic CCD camera attached to an Explore Scientific 102mm ED apochromatic refractor telescope working at f/5.6 with a Stellarvue 0.8× focal reducer.

▼ **CANADA IN SPACE** This famed sky region is situated near first-magnitude Deneb, the brightest star in Cygnus. The North America Nebula is catalogued as NGC7000, while the large patch of nebulosity on the right, known as the Pelican Nebula, is IC5070. Roman Kulesza recorded this exquisite view from the Township of Tiny, Ontario (40 kilometres north of Barrie), with a modified Canon EOS 6D DSLR camera and an Astro-Tech AT65EDQ 65mm f/6.5 refractor telescope. The final image is a stack of 30, 6-minute exposures at ISO 1600.



▲ **CRUX OF THE NEBULOSITY** Second-magnitude Gamma (γ) Cygni, also known as Sadr, marks the centre of the Northern Cross and is the brightest star in this image. Sadr is surrounded by nebulosity, most of which is catalogued as IC1318. Barry Schellenberg created this photo by combining more than 30 hours of image data shot through a trio of narrowband filters (O-III, S-II and H-alpha) with a QSI 683ws(–8) "full frame" CCD camera and a Borg 101ED (at f/4.1) refractor telescope from his home observatory north of Burlington, Ontario.

◀ **NORTHERN DELIGHT** One of the lesser-known treasures in Cygnus is the Cocoon Nebula, or IC5146, in the constellation's northeastern corner. Yanick Bouchard captured this portrait from the light-polluted environs of Mirabel, Quebec. Using a Celestron 925 EdgeHD 9¼-inch telescope with Hyperstar (for a focal ratio of f/2.3) and a ZWO ASI1600MC colour CMOS camera, he took a total exposure of 198 minutes.

by KEN HEWITT-WHITE

# SCORPIUS

## The scorpion crawls at the base of the sky each summer's night until, tail raised high, it darts below the horizon

THE SLENDER STAR PATTERN of Scorpius truly resembles the jointed nocturnal arachnid associated with arid regions the world over. The constellation is dominated by first-magnitude Alpha Scorpii, a red supergiant star better known as Antares ("rival of Mars"), which pinpoints the scorpion's luminous heart.

Northwest of Antares, a widely spaced vertical row of five second- to fourth-magnitude stars forms Scorpius's head. Chief among these are second-magnitude Delta, named Dschubba ("forehead"), and third-magnitude Beta, called Graffias ("claws"). Below Antares, a gentle stellar curve delineates the upraised tail. At the tip of the tail, two stars—third-magnitude Upsilon and second-magnitude Lambda, or Shaula ("sting")—mark the animal's poisonous stinger.

In Greek lore, the scorpion had been assigned to inflict a fatal sting on the unruly hunter Orion. Although Scorpius was rewarded with a home in the sky, it turned out to be an unfriendly neighbourhood. Sagittarius, the militant centaur next door, seemed bent on avenging Orion's death—the archer slew Scorpius with a single arrow.

Even now, Scorpius gets flattened by the local serpent bearer, Ophiuchus—a huge guy with big feet—when the two constellations set each night. Adding insult to injury, chart-makers long ago lopped off the scorpion's pincers and awarded those stars to the adjacent constellation, Libra the scales.


Scorpius and Orion were consigned to opposite parts of the sky so that they would never meet again. As Scorpius peeks over the southeast horizon, Orion retreats in the west—a never-ending cycle said to reflect the eternal conflict between good and evil.

This dichotomy was echoed in the mythology of the ancient Egyptians. They believed that when the Sun entered Scorpius, it signalled the demise of Osiris, god of the afterworld, who was identified with Orion.

Scorpius also plays a role in a Maori legend that describes the creation of two large islands. According to this myth, the god Maui cast a massive fishhook into the ocean and dredged up a "fish island" from the deep. Amazingly, the landmass emerged complete with vegetation, animals and people. Maui's fishermen cut pieces out of the "fish" until it split into the pair of islands we recognize today as New Zealand.

Meanwhile, Maui had thrown his hook into the night sky. New Zealanders can see Maui's Fishhook in the graceful curve of stars outlining Scorpius. ✦

IMAGE FROM ALEXANDER JAMIESON'S 1822 *CELESTIAL ATLAS*

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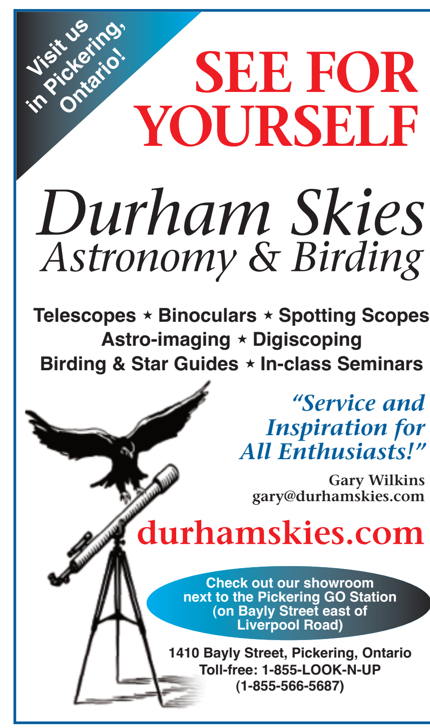




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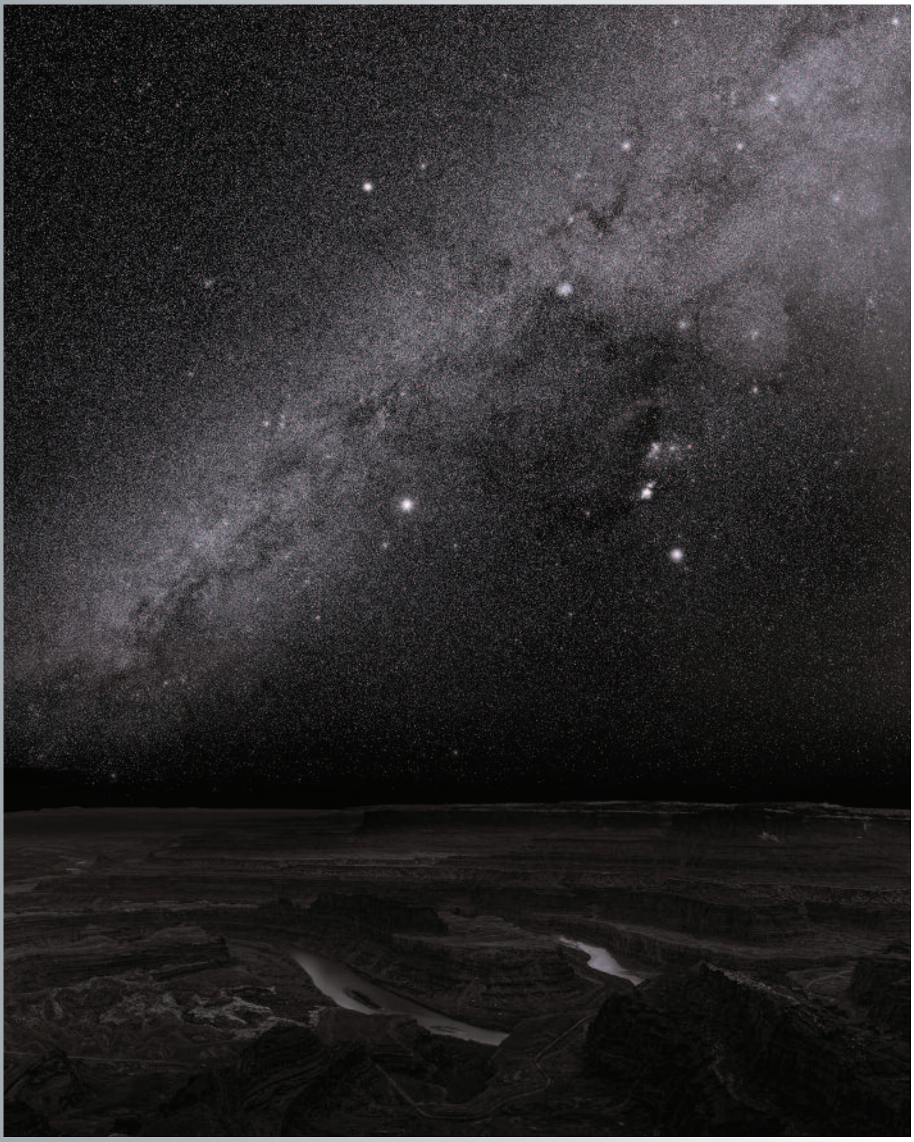
by DARREN FOLTINEK

# ORION AND FRIENDS



DEAD HORSE POINT STATE PARK includes a jagged finger of land jutting into the Colorado River canyon, in eastern Utah. In 2016, this location was designated an International Dark Sky Park by the International Dark-Sky Association.

During the day, the spectacular view 700 metres down to the river reveals layers of wildly eroded red, white and beige sandstone, but on moonless nights, the depths of the canyon are black. Standing at the cliff edge, I sense the invisible canyon as an immense void, but looking up, I see the arc of the Milky Way glowing amid the brilliant winter stars.

Several hours spent freezing in the dark taking photos gave me plenty of time to contemplate the immensity of the universe overhead as well as the eons the river took to carve the canyon below. I assembled this mosaic using 25, 120-second exposures shot at ISO 800 with a Canon EOS 6D DSLR camera and a 50mm lens set to f/2.8. ✦

*Darren Foltinek is a photographer based in Calgary, Alberta. Readers can see more of his images at his website: frontrange.ca.*