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SEPTEMBER/OCTOBER 2013

SkyNews

The Canadian Magazine of Astronomy

AMAZING COSMIC PHOTOS

RARE EVENT FOR
JUPITER

A triple-shadow transit
in early October

page 26

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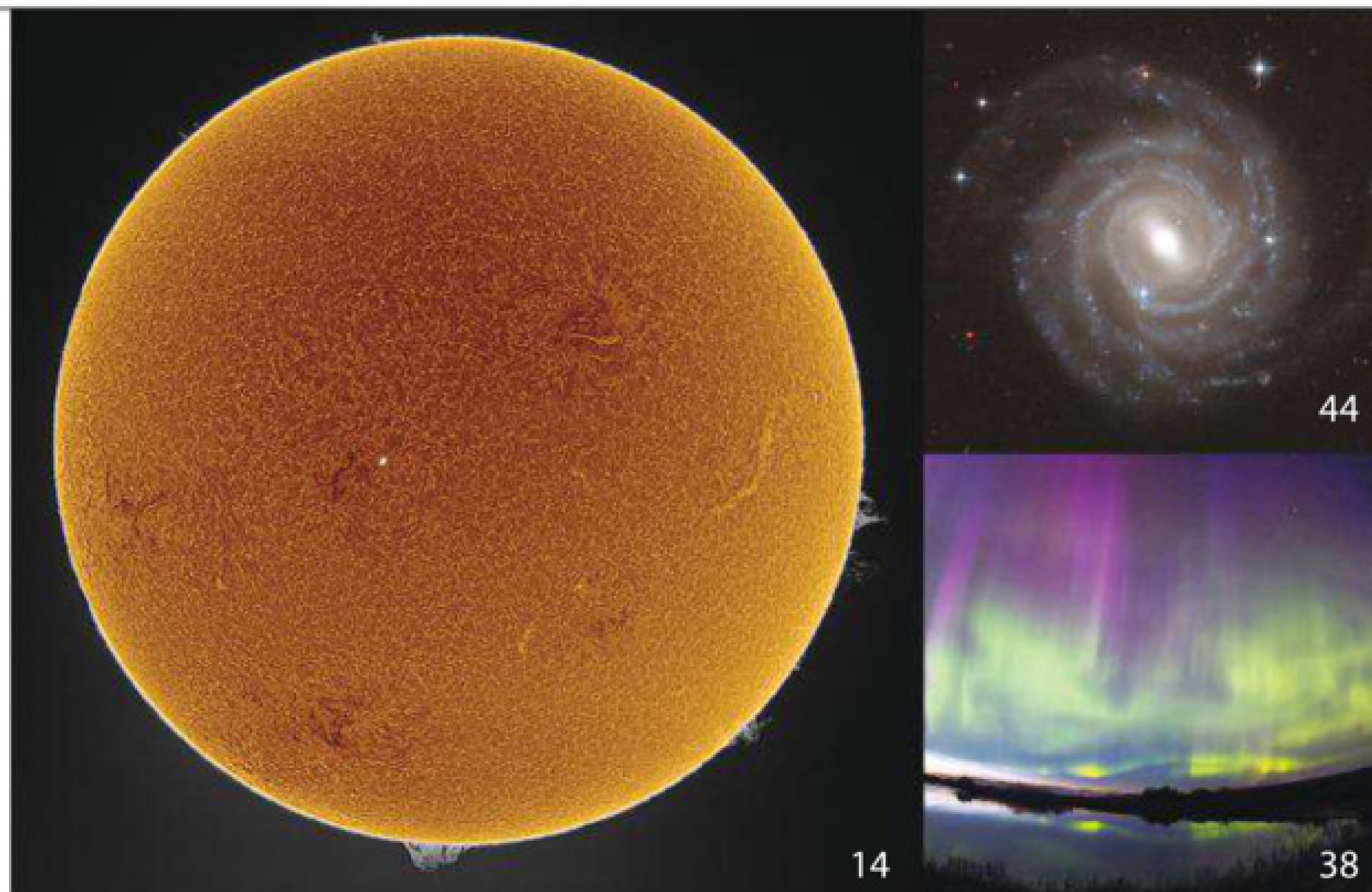
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COVER: In a new Hubble Space Telescope view of the Ring Nebula (M57), in the constellation Lyra, previously unseen details are revealed in the glowing shroud around a dying Sun-like star (see page 12).
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Founding Publisher Canada Science and Technology Museum
 Editor Terence Dickinson
 E-mail address editor@skynews.ca
 Fax 613-377-1080
 Art Director Janice McLean
 Associate Editor Alan Dyer
 Assistant Editors Todd Carlson, Christine Kulyk
 Editorial Assistant Jody Morgan
 Production Manager Susan Dickinson
 Contributing Editors Randy Attwood, Glenn LeDrew, David H. Levy, Peter McMahon, Ivan Semenik, Gary Seronik, Ray Villard, Ken Hewitt-White
 Contributing Astrophotographers Lynn Hilborn, Yuichi Takasaka

Publisher Greg Keilty
 Associate Publisher Colleen Moloney
 Advertising Sales Greg Keilty 613-966-6225
 Customer Service Denise Havers 1-866-759-0005
 service@skynews.ca

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Auroras, Supermoons and Dark Skies



SPLENDOUR IN THE HEAVENS

So far this year, more auroras have danced in Canadian skies than at any time since 2004, and more are expected in the coming months. The so-called supermoon (right)—the full Moon closest to Earth each year—is a minor astronomical event that is disproportionately hyped by the media.

PHOTOS BY ALAN DYER (LEFT), COLIN CHATFIELD (RIGHT)

SEPTEMBER IS MY FAVOURITE month for outdoor astronomy. The sky darkens much earlier than in June or July, the Milky Way is at its best, mosquitoes are largely gone, and the air often seems more transparent than in mid-summer. And this year, there are reasons to expect a bonus of displays of northern lights—auroras—above most of Canada.

AURORA MAX THIS FALL?

The primary predictor for auroras is solar activity: sunspots and related magnetic storms, flares and eruptions on the Sun. As a general rule, an active Sun equals more auroras. We are now entering the height of the 11-year solar-behaviour cycle that is expected to peak during the next 12 months or so, making this prime time for auroras.

While this is aurora season, according to the 11-year solar cycle, there is a caveat:

This particular cycle is proving to be the weakest maximum since the 1920s. Unless solar activity boils over unexpectedly in the next several months, we will probably witness fewer examples of the most impressive all-sky/all-night shows seen at the last peak (2000 to 2004). Having said that, what skywatchers really want to know is *what evening* to watch, even if it is a modest display.

The best source to check for the likelihood of a visible aurora display is the website operated by the U.S. National Oceanic and Atmospheric Administration (NOAA): www.swpc.noaa.gov/pmap. If the Activity Level given is 9 or above, there is a good chance that southern Canada is experiencing something worth seeing away from urban lighting.

NOAA's forecasts of aurora activity are based on readings provided by polar-

orbiting satellites in the form of regularly updated polar maps, the most relevant of which are shown on Aurora Watch, accessed on the home page of our website (www.skynews.ca).

However, all these satellite-based predictions have their uncertainties. There is only one way to be sure—go out and have a look. Establish a regular routine of stepping outside every evening, like walking the dog. Of course, this won't work in a city environment festooned with streetlights or under a significant regional light-pollution pall. But a habitual scan of the night sky every clear night is traditionally part of being an amateur astronomer and can be your real-world aurora check.

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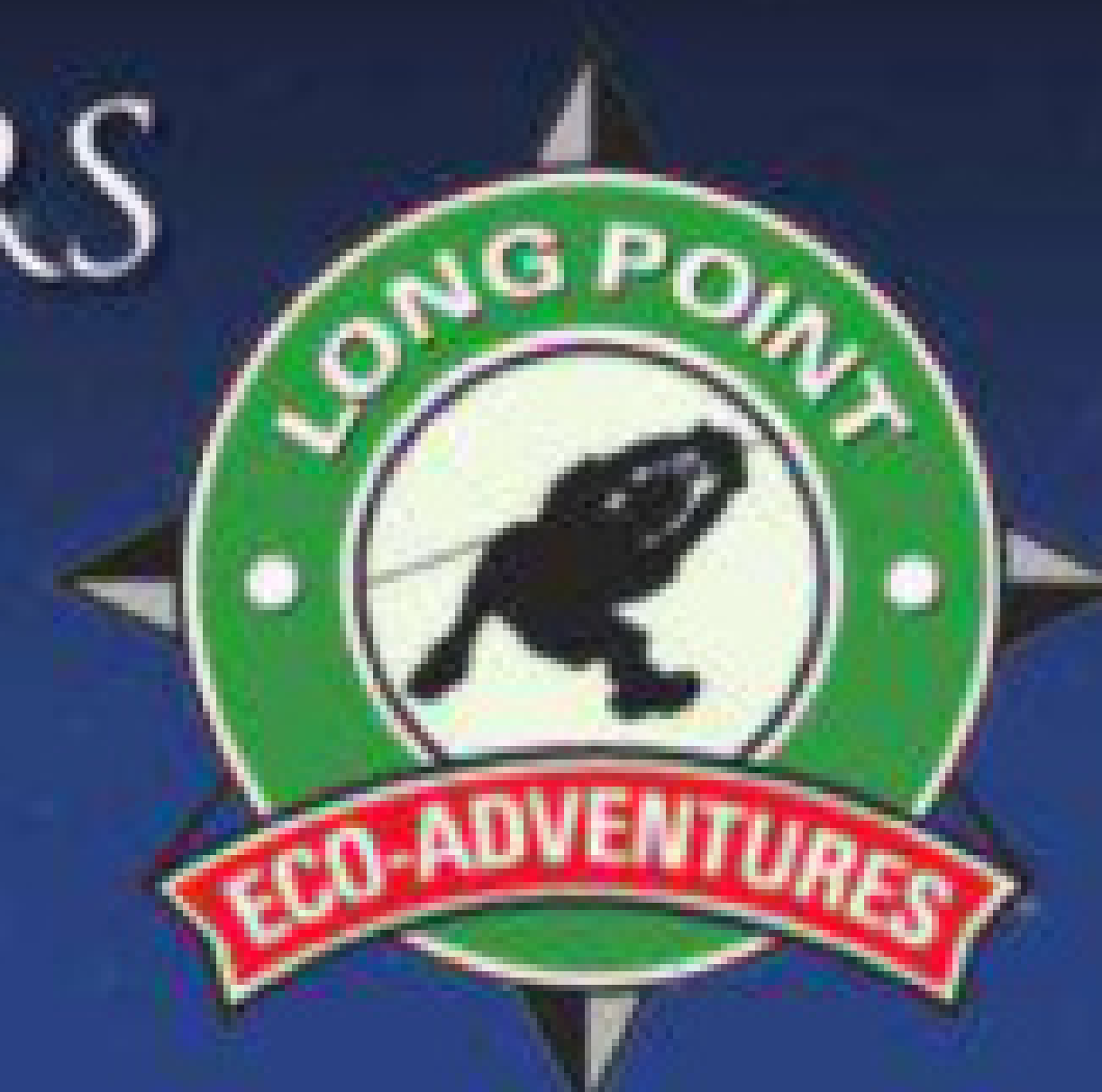
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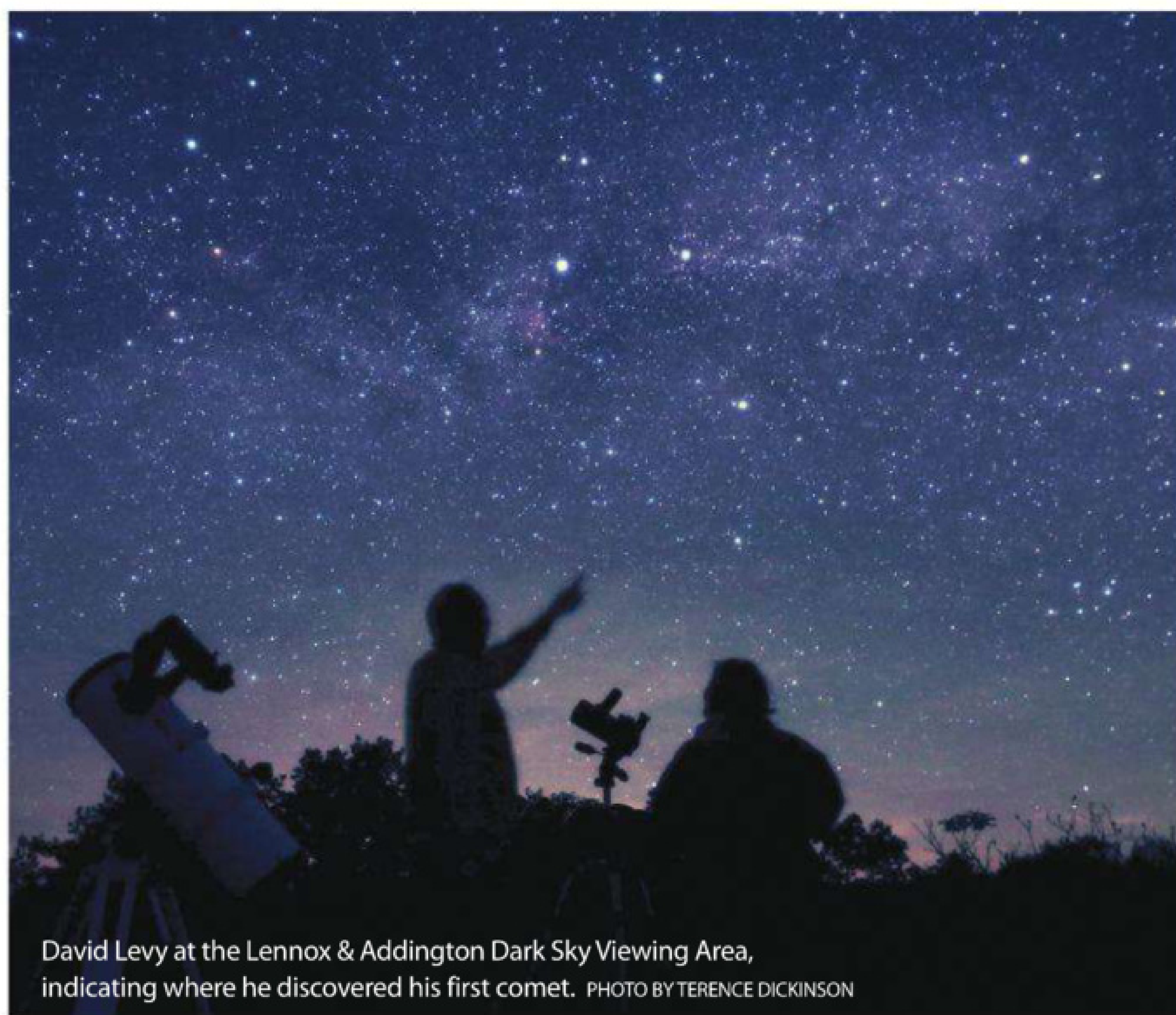
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David Levy at the Lennox & Addington Dark Sky Viewing Area, indicating where he discovered his first comet. PHOTO BY TERENCE DICKINSON

the aurora easy. Modern digital sensors are far more sensitive to low light levels than film ever was. In particular, if you own a DSLR (digital single-lens reflex) camera, you can clearly catch subtle auroral curtains that are barely perceptible to human vision.

Use your widest-angle lens at its lowest f-stop (typically between f/2.8 and f/3.5), and set the ISO to 800 or 1600 and the exposure to between 10 and 25 seconds. You'll need a camera tripod to keep the camera steady during the exposure and a location away from light pollution. Yes, the last factor—escaping light pollution—is often the hardest one. But a fine aurora portrait is easier to capture than ever before.

Non-DSLR cameras, usually called compact digital cameras, are less capable of taking aurora shots but are worth trying if tripod-mounted. Check the user's guidebook to see whether you can set the compact camera to a manual mode that allows up to a 15-second exposure around f/3.5, a setting that should record an aurora.

SUPERMOON AND THE MEDIA

For the most part, I appreciate the news media for disseminating reports and images of newsworthy events on a 24-hour cycle. But some days, I appreciate the coverage less than others. Take the so-called supermoon, the most recent one occurring on Sunday, June 23.

The reporters who prepare and broadcast news favour sound bites that, in a few words, create an instant picture in the minds of the viewers/listeners. The supermoon fits this mould perfectly: "Tonight is the night of the *supermoon*, the largest full Moon of the year."

Now I am all for informing folks of visible celestial events, and I suppose that looking at the full Moon is better than not looking at all. But the supermoon is not so super. As the nearest and brightest full Moon of the year, it is only 7 percent larger and 15 percent brighter than an average full Moon—a difference completely undetectable to unaided eyes.

DAVID LEVY STOPS BY

During a break in his eight-city lecture tour in Ontario and Quebec in June, renowned comet hunter and *SkyNews* contributor David Levy stopped by the Lennox & Addington Dark Sky Viewing Area north of Napanee, Ontario. A former resident of Quebec and Lennox & Addington County, Levy wanted to see the night sky as he remembered it from deep-sky observing and comet hunting during the 1960s and 1970s, when he lived in Canada.

"It is one of the darkest skies I've ever seen from southern Ontario," he says of his June visit (photo above), "exceeding even the sites I used when I was a Queen's student in the late 1970s." ♦

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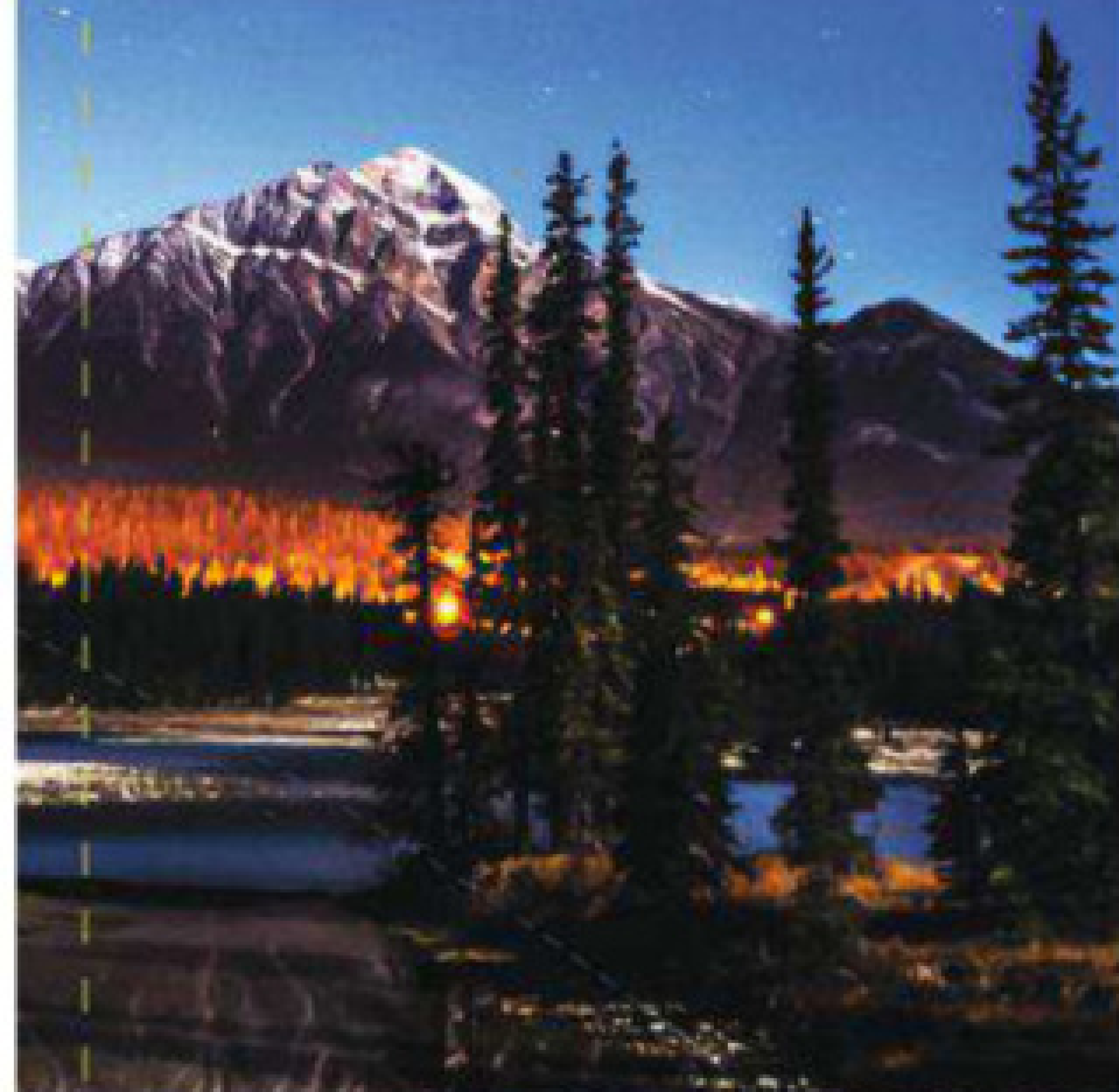
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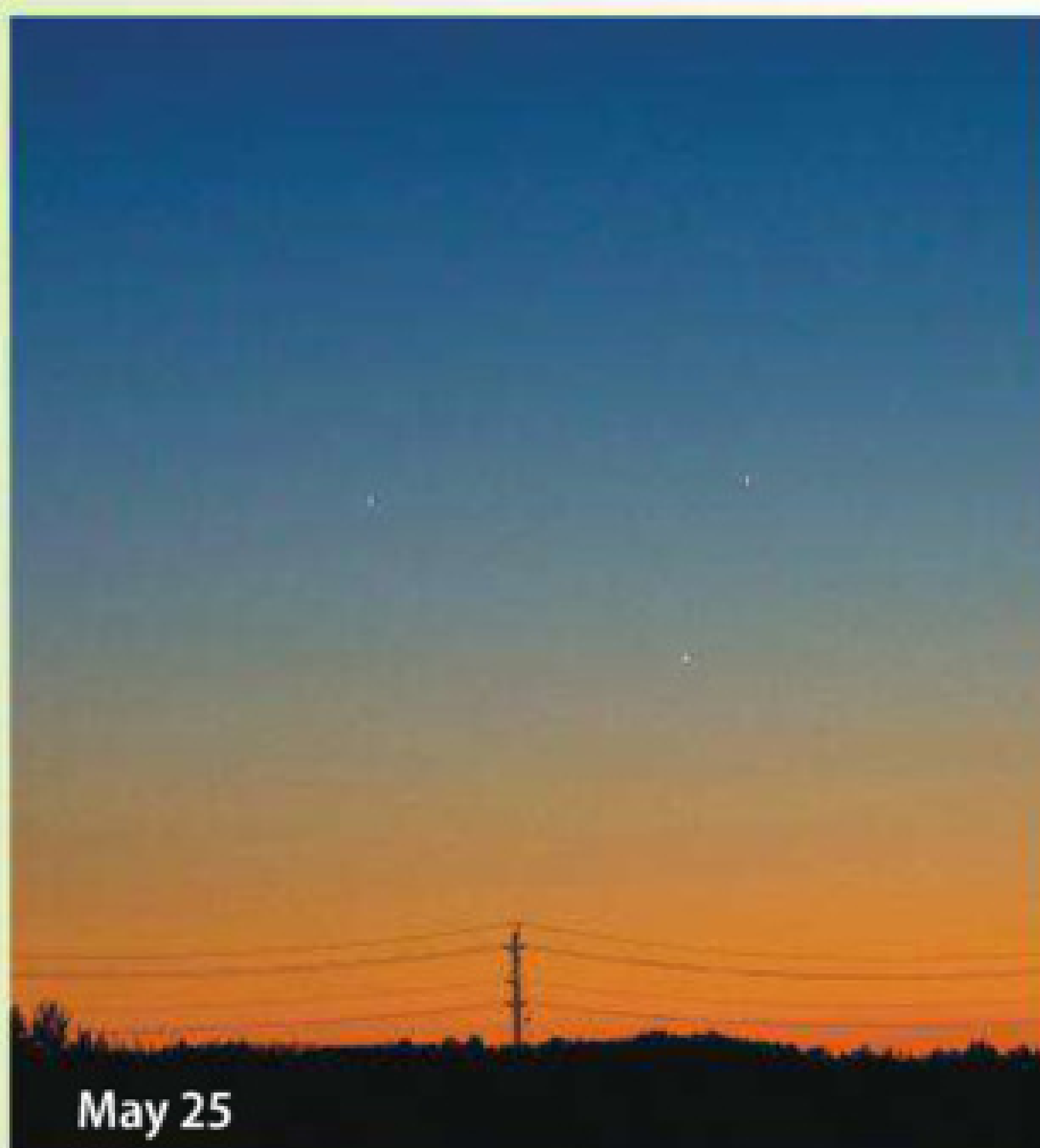
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LETTERS

PLANET TRIO AT DUSK

I took this pair of images of the Jupiter-Venus-Mercury conjunction on May 25 and 26. This was the best observation of Mercury I've ever seen. I was surprised at how high it was in the sky. Both photos were shot with a Nikon D7000, using an 18-200mm lens at about 90mm. Venus is brightest and Mercury highest in both images. Planetary orbital motion is obvious.

*Robin Dhillon
Uxbridge Ontario*



BOO, HISS!

For the first time ever, I had to censor a *SkyNews* issue to make sure that my 10-year-old daughter, a blossoming astronomy buff, did not read Ken Hewitt-White's article about the constellation Hydra (May/June 2013). I did not want my daughter, who is a herpetophile, to read an article that expressed so much disdain for one of her favourite creatures. I did not want her to be turned off astronomy or *SkyNews* because of such uninformed opinions.

Mr. Hewitt-White might be a herpetophobe, but he should keep unprofessional comments from his astronomy writing, such as: "Likewise, its namesake animal probably isn't on anyone's top-10 list"; "Our highest-ranking constellation is a lowly reptile—a snake, for heaven's sake"; and "Hooray for Herc!" (referring to the destruction of the Hydra). He is disparaging not only snakes but also any readers who love and respect these animals.

My daughter would have been greatly insulted by these words, and this insult might have reflected poorly on your magazine and on astronomy enthusiasts in general. Many people appreciate and love rep-

tiles and their mythological counterparts. Reptiles are hardly lowly. They are highly evolved creatures, perfectly adapted to many environments around the world, including some of the harshest. Many people fear them, not because they are lowly but because some can be deadly to us and our livestock. But snakes provide essential services in the environment, keeping pests, such as mice, rats, grasshoppers and locusts, in check. We would be far worse off if we did not have snakes to devour these food-crop-destroying creatures.

In many places in the world, snakes are threatened with extinction. Perpetuating these outmoded beliefs will do nothing to help us prevent these extinctions. My daughter now has her own subscription to *SkyNews* through her RASC membership. I hope you do not publish any more articles that cast dispersions on readers who might have a different opinion on the subject matter than yourselves. There is room in this world for all kinds of interests. Please don't publish content that insults someone for his or her interest in a subject.

*Matthew West
Saint John, New Brunswick*

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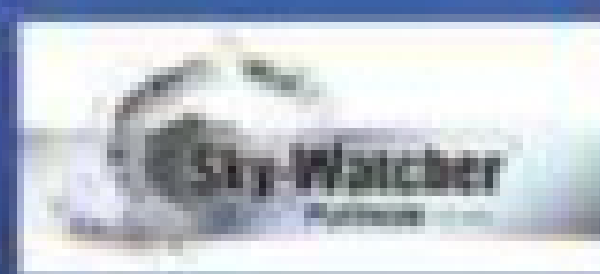
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SERENDIPITOUS PHOTO OP

While reading the July/August *SkyNews*, I was impressed by the image of the aurora and bolide taken by Shannon Bileski (page 18). It was described as a case of being at the right place at the right time and push-

ing the shutter button at the right time too. This reminded me of a similar experience.

In May 2012, I was taking an evening flight from Ottawa back home to Calgary. The Sun was setting as we left Ottawa. It was a clear night, and I was enjoying

watching the cities and towns roll by below. I had my camera handy when a large city came into view—I found out later it was Winnipeg—and I thought I would take some photos of it. As one of the images appeared on the DSLR's screen, I happened to notice a streak on it. I quickly looked up and saw that it was a bright meteor traveling near horizontally. I was able to snap one more quick photograph before it disappeared.

So here's my "right place/right time" photo moment.

Jeff Zambory
Calgary, Alberta



SUBMITTING LETTERS AND PHOTOS TO THE EDITOR

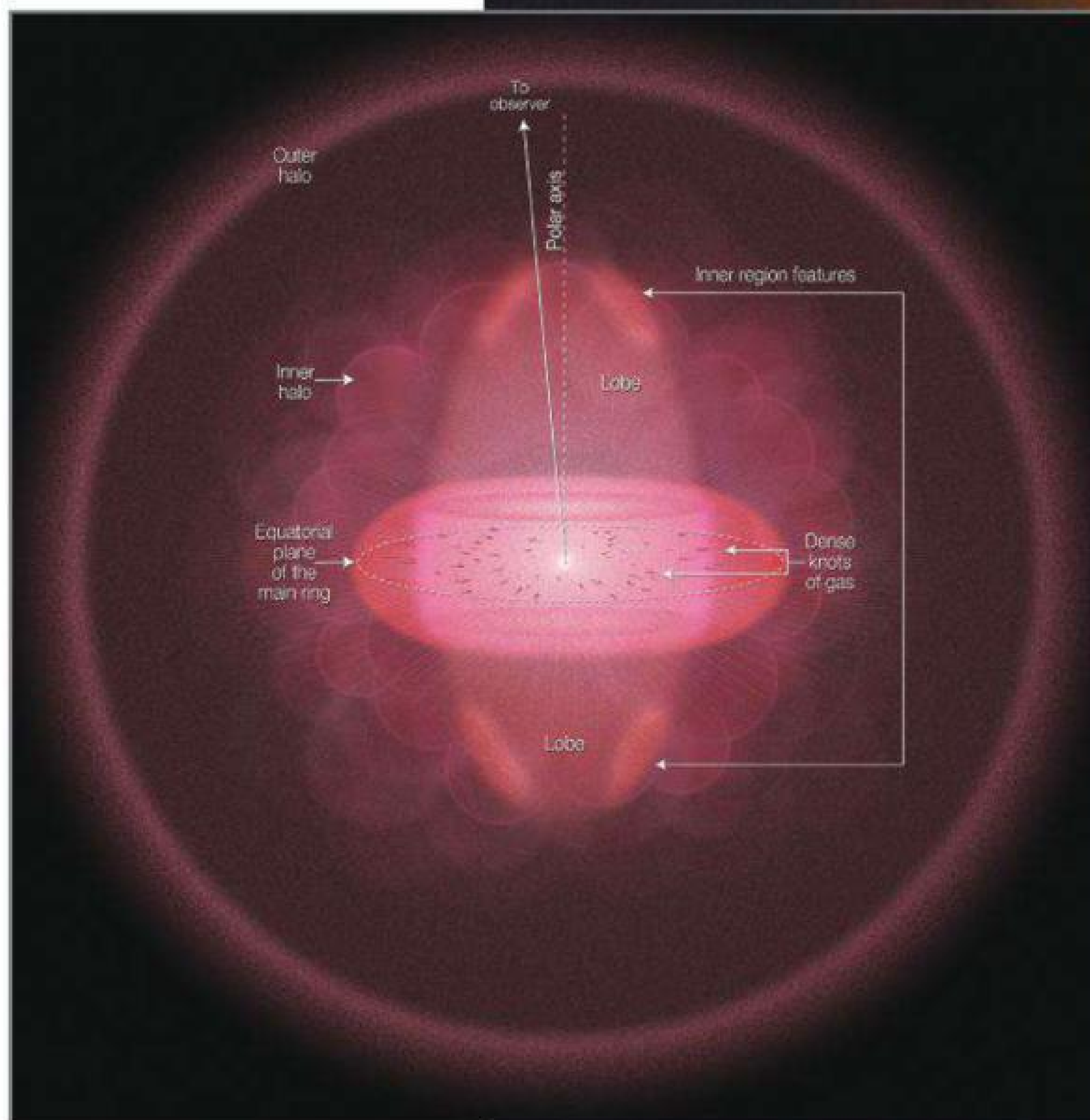
SkyNews editor Terence Dickinson welcomes your letters about your astronomical observing activities and your comments about anything you read in the magazine. Submission of photos as attachments is encouraged (please include details of location and equipment used). Photos should be in jpeg format up to 2MB jpeg file size; limit two pictures per submission. Send to: editor@skynews.ca

NEW PORTRAIT OF THE RING NEBULA

Along with several ground-based telescopes, the Hubble Space Telescope was used to obtain the best view yet of the iconic one-light-year-wide nebula by Terence Dickinson

ITS DISTINCTIVE SHAPE makes the Ring Nebula one of the night sky's finest deep-sky targets for backyard telescopes and a popular illustration for astronomy books. This new, more detailed Hubble Space Telescope image shows previously unseen nebular structure and a completely different shape (see illustration below) than has been assumed historically for this classic nebula.

About 2,300 light-years from Earth, the Ring Nebula measures roughly one light-year across. Previous observations by several ground-based telescopes had detected the gaseous material in the ring's central region. But the view by Hubble's Wide Field Camera 3 suggests that the ring wraps around a blue football-shaped structure. Each end of the football protrudes out opposite sides of the ring (identified as lobes in the illustration). The bagel-shaped main nebula is tilted almost exactly toward Earth ("to observer" in the diagram) so that astronomers see the ring face-on. In the Hubble image, the blue structure is the glow of helium. Radiation from the white dwarf star in the centre of the ring is exciting the helium to incandescence. The white dwarf is the stellar remnant of a Sun-like star that has shed its outer layers of gas. Irregular knots of dark, dense gas embedded along the inner rim of the ring formed when expanding hot gas pushed into cool gas previously ejected by the doomed star. All of the visible nebula was expelled by the central star about 4,000 years ago. It will continue to expand for another 10,000 years, a short phase in the lifetime of a star. The nebula will become increasingly fainter until it merges with the interstellar medium. Studying the Ring Nebula's fate should provide insight into the Sun's ultimate demise in another six billion years.





SkyNews

11th ANNUAL

PHOTO of the WEEK Contest Winners

For our 11th annual photo contest, the SkyNews editors have selected these outstanding celestial images

Determining the winners of this contest is no easy task, but it continues to be a distinct pleasure for our five-member judging panel, as the quality of submissions steadily escalates each year. Astro-imaging is now a major component of amateur astronomy for two reasons: digital imaging equipment is better than ever and is available at increasingly competitive prices. And here's a tip: If you want to break in to astrophotography, try the tripod-mounted unguided category. Typically, a 20-second exposure with a normal DSLR camera takes the category first prize.

—Terence Dickinson, Editor

GRAND PRIZE

Winner: From his observatory in Saint-Roch-de-l'Achigan, Quebec, Daniel Borcard imaged a remarkable sequence of portraits of Jupiter over more than three hours, recording the transit of the planet's moon Io and the passage of its shadow across the Jovian clouds. In particular, the middle horizontal row shows Io to the left of its shadow as it passes just above the famous Red Spot, appearing light pink in front of a dark belt and copper-hued when crossing the white gap between the spot and the belt—just as seen visually. The judges noted exceptional detail and colour evident throughout the sequence, usually associated with a telescope larger than Borcard's 9.25-inch Schmidt-Cassegrain. A Tele Vue 2.5x Powermate and a DBK 21AU618 CCD camera were used. Each individual image is a stack of 400 to 600 individual frames. Universal times on November 15, 2012, are given.



05:28



06:51



08:01

GRAND PRIZE
MallinCam Universe
CCD imager

MALLINCAM

mallincam.com



06:06



06:26



07:11



07:31



08:21



08:46

Storemags.com



Category: Best deep-sky with digital SLR or webcam-type imager

Prize: Sky-Watcher 127mm Maksutov-Cassegrain telescope with AllView mount

Sky-Watcher®

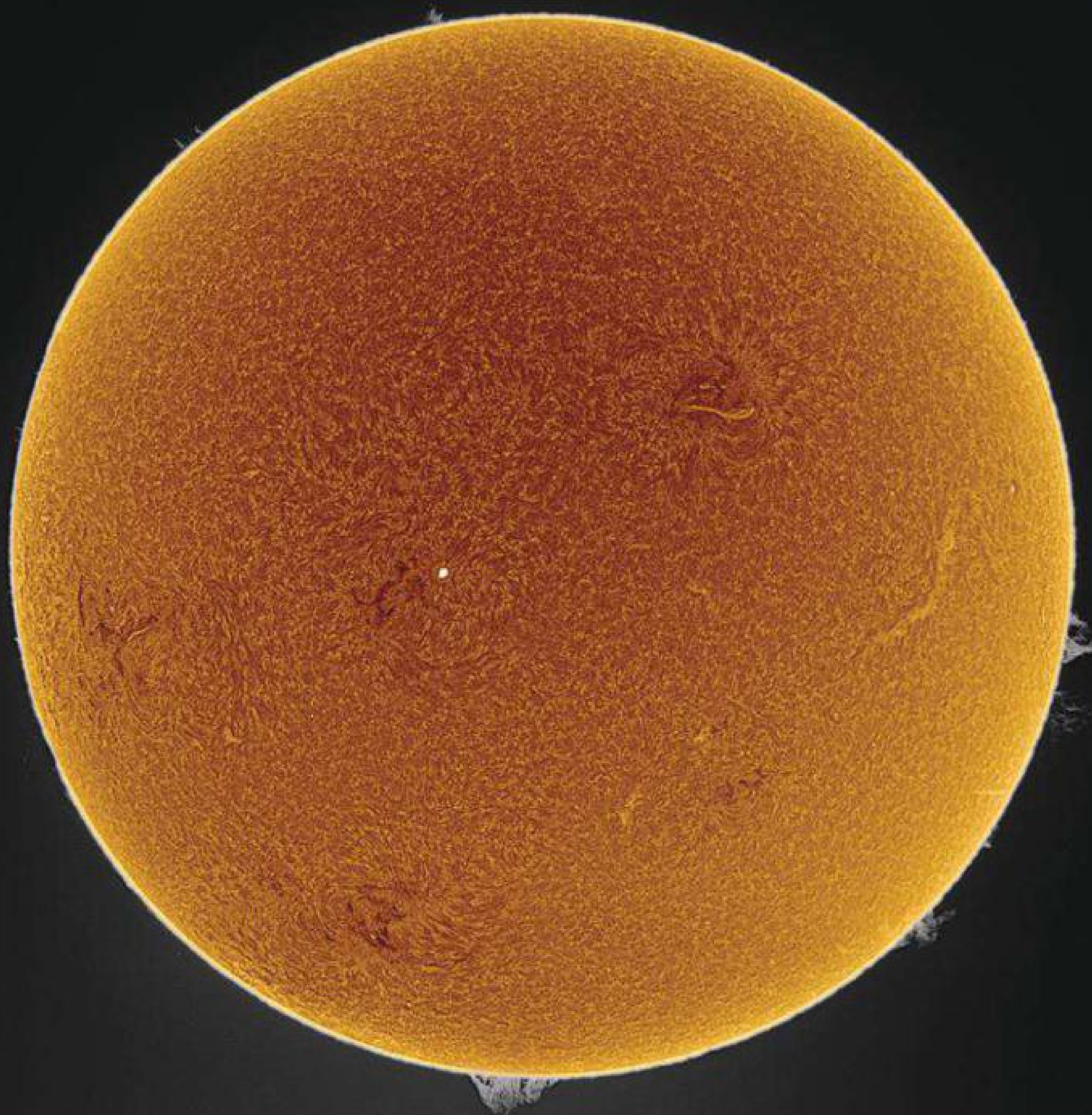
www.skywatchertelescope.net

BEST DEEP-SKY WITH DIGITAL SLR OR WEBCAM-TYPE IMAGER

Winner: The annual Geminid meteor shower in December is often the most active meteor display of the year. Ottawa's Pierre Martin travels to wherever he needs to be to record the best meteor shower. For the 2012 Geminids, on the night of December 13-14, he arranged to use the Cincinnati Astronomical Society's dark sky site near Peebles, Ohio, to shoot hundreds of images (30-second exposures for meteors; 4.5 minutes for star background). This digital stack of 98 Geminids was captured between 9 p.m. and 6 a.m. Canon 7D with 17mm f/2.8 at ISO 400.

Honourable Mentions: *Below left:* Last October, Adam Moncrieff of Kanata, Ontario, drove to the Lennox & Addington Dark Sky Viewing Area to shoot a Milky Way panorama. This image of the Cygnus region is one of the frames, a 2-minute exposure with a Canon 60Da, 35mm lens at f/2.8, ISO 2000. *Below right:* Mark Viol of Huntsville, Ontario, used a Celestron 11-inch Schmidt-Cassegrain with an f/6.3 reducer to record the pencil-thin edge-on spiral galaxy NGC7814 with a filter-modified Canon T1i. Stack of ten 5-minute exposures at ISO 1600.





Category: Best digital-camera photo/lunar and planetary

Prize: iOptron iEQ30 German equatorial mount

iOptron
iOptron.com

BEST DIGITAL-CAMERA PHOTO/LUNAR AND PLANETARY

Winner: During what turned out to be a cloudier than normal October last year, Daniel Borcard waited for a mostly cloudless day (October 17) to, as he says, “steal about two sunny hours” to image the Sun in Hydrogen-alpha light from his observatory near Saint-Roch-de-l’Achigan, Quebec. He used a Lunt LS60THa solar telescope and a DMK 31AF03 camera. In this five-image mosaic, each layer is the result of a stack of 421 frames. The monochrome image was inverted and colorized, with the prominences left in grey.



Honourable Mentions: Another fine Daniel Borcard solar image, *left*, shows a close-up view on June 5, 2012, during the last transit of Venus this century. Equipment: Meade 10-inch LX200-ACF, DMK 21AU04 CCD camera, Baader solar filters. Above: This multiple exposure of a moonrise over Edmonton was taken on the evening of January 27, 2013. Using carefully judged exposures as cloud banks blocked portions of the full Moon, Alister Ling created this time-lapse effect of the Moon’s trajectory. Camera: Canon 10D, f/6.3, ISO 200, 105mm lens.

PHOTO *of the* WEEK CONTEST WINNERS



Category: Best deep-sky digital high-resolution imagery

Prize: Celestron NexStar 8SE telescope

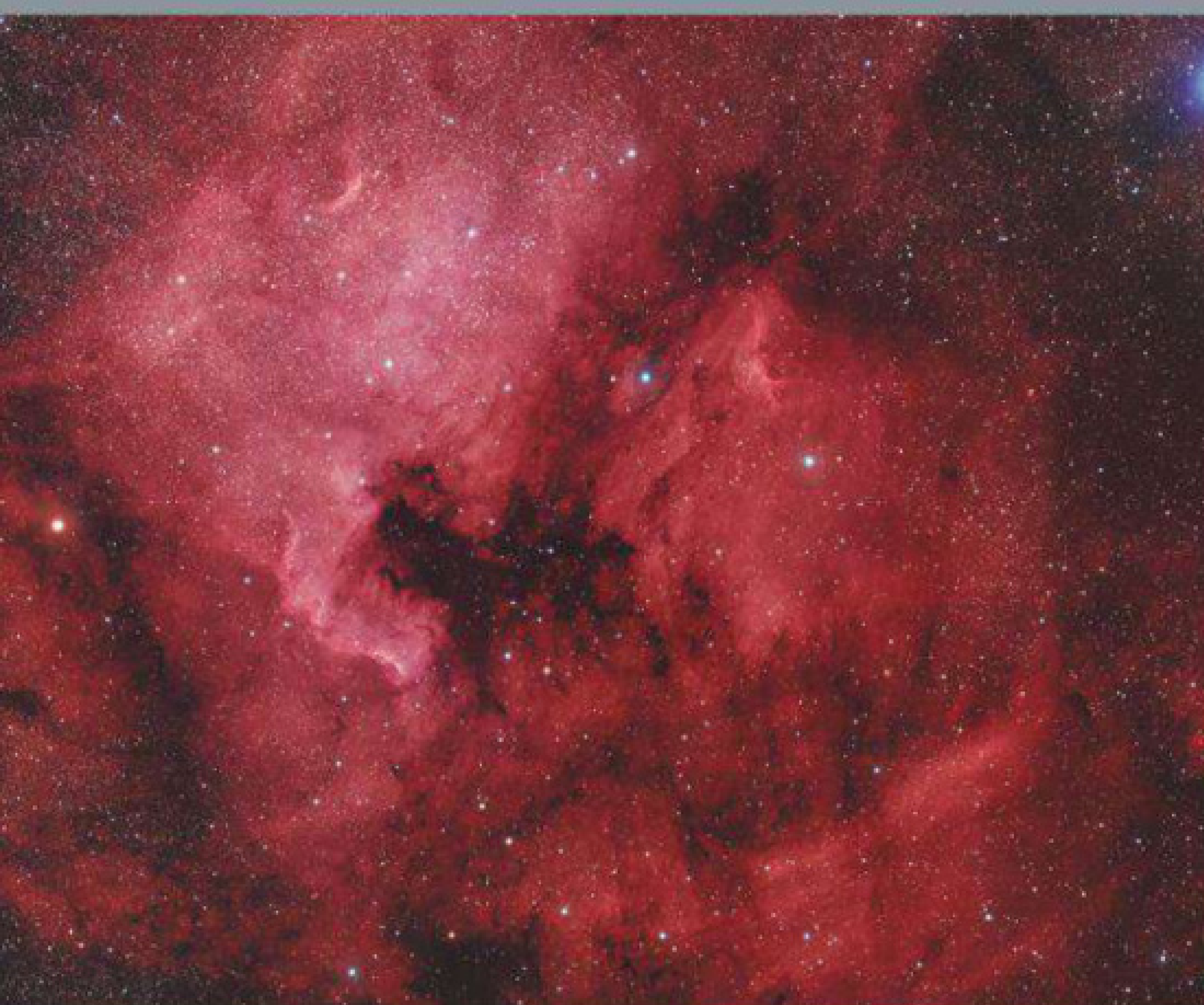


celestron.com

BEST DEEP-SKY DIGITAL HIGH-RESOLUTION IMAGERY

Winner: More than 12 hours of imaging over seven nights from his observatory in the Okanagan region of British Columbia rewarded Howard Trottier with data to produce this outstanding image of the reflection nebula NGC7129, in Cepheus. He used a PlaneWave 17-inch Corrected Dall-Kirkham telescope and an Apogee U16M CCD camera.

Honourable Mentions: *Below left:* The North America Nebula (NGC7000) and adjacent Pelican Nebula (IC5070), in the constellation Cygnus, were imaged from Quebec City by Jean Guimond using an SBIG STL-11000M CCD camera on a Takahashi FSQ 106mm apo refractor focal reduced to f/3.6. *Below right:* Popularly called the Jellyfish Nebula, IC443 (lower right)—a supernova remnant in Gemini—is another Jean Guimond image taken with the same CCD camera, this time on a Takahashi 150mm apo refractor at f/5.6. To its right is the larger Sh2-249, an unrelated and somewhat more distant nebula.





Category: Best tripod-mounted unguided photo

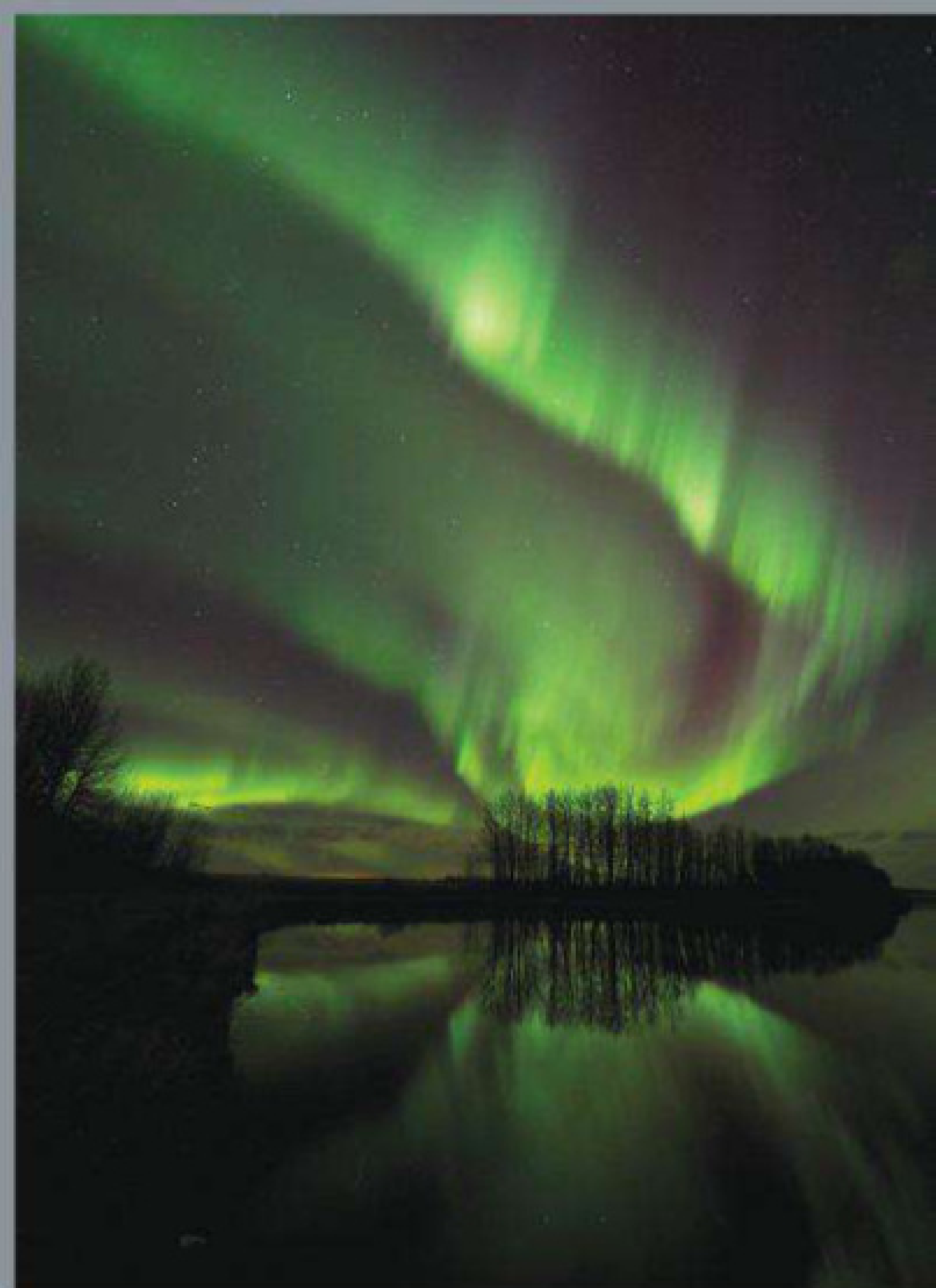
Prize: Meade Series 5000 24mm ultrawide eyepiece



BEST TRIPOD-MOUNTED UNGUIDED PHOTO

Winner: Along with some local RASC members, Shannon Bileski drove to Patricia Beach Provincial Park, on the shore of Manitoba's Lake Winnipeg, on April 30 to see a predicted aurora. "While waiting for the aurora to erupt," she says, "I took a few shots and got quite a surprise. We saw a bright flash with green explosions—it was a bolide meteor! I was lucky enough to catch the whole thing on camera." It was a perfect case of being at the right place at the right moment. Nikon D800 with 24mm lens at f/3.2, ISO 800, 8-second exposure.

Honourable Mentions: *Below left:* An abandoned prairie homestead east of Edmonton is a haunting presence in this aurora portrait taken by Warren Finlay of Edmonton. Nikon D7000, 14mm lens, ISO 1600, f/2.8, 20-second exposure with flash fill. *Below right:* On Thanksgiving evening, October 8, 2012, Stan Cholak captured a classic multi-curtain aurora display from near Willingdon, Alberta. He used a Nikon D3S with a 15mm wide-angle lens and a 6-second exposure at f/2.8, ISO 1250.



Kouchibouguac National Park: New Brunswick's dark sky ocean paradise

On a really clear day, you can see Prince Edward Island... and the North America Nebula

THE MOONLESS SUMMER MILKY WAY reveals the North America Nebula, a continent-shaped cloud of star birth, soaring over the ocean, with shapes that correspond to Mexico and its great gulf, Florida and Hudson Bay, with the Maritimes in between.

Here, on the Acadian shores of the Atlantic, one of the most magical astronomy parks in North America (the terrestrial one) awaits.

Kouchibouguac (pronounced koo-she-BOO-gwack) National Park lies a half-hour south of Miramichi, New Brunswick, and less than an hour from Moncton. In 2009, this oasis of sand dunes, salt marshes and barrier islands was designated a dark sky preserve by The Royal Astronomical Society of Canada (RASC).

ACADIAN SKIES

Each year, RASC New Brunswick Centre members and park staff collaborate to host Kouchibouguac Star Fest, a weekend star party for the general public (the next one is June 6-8, 2014).

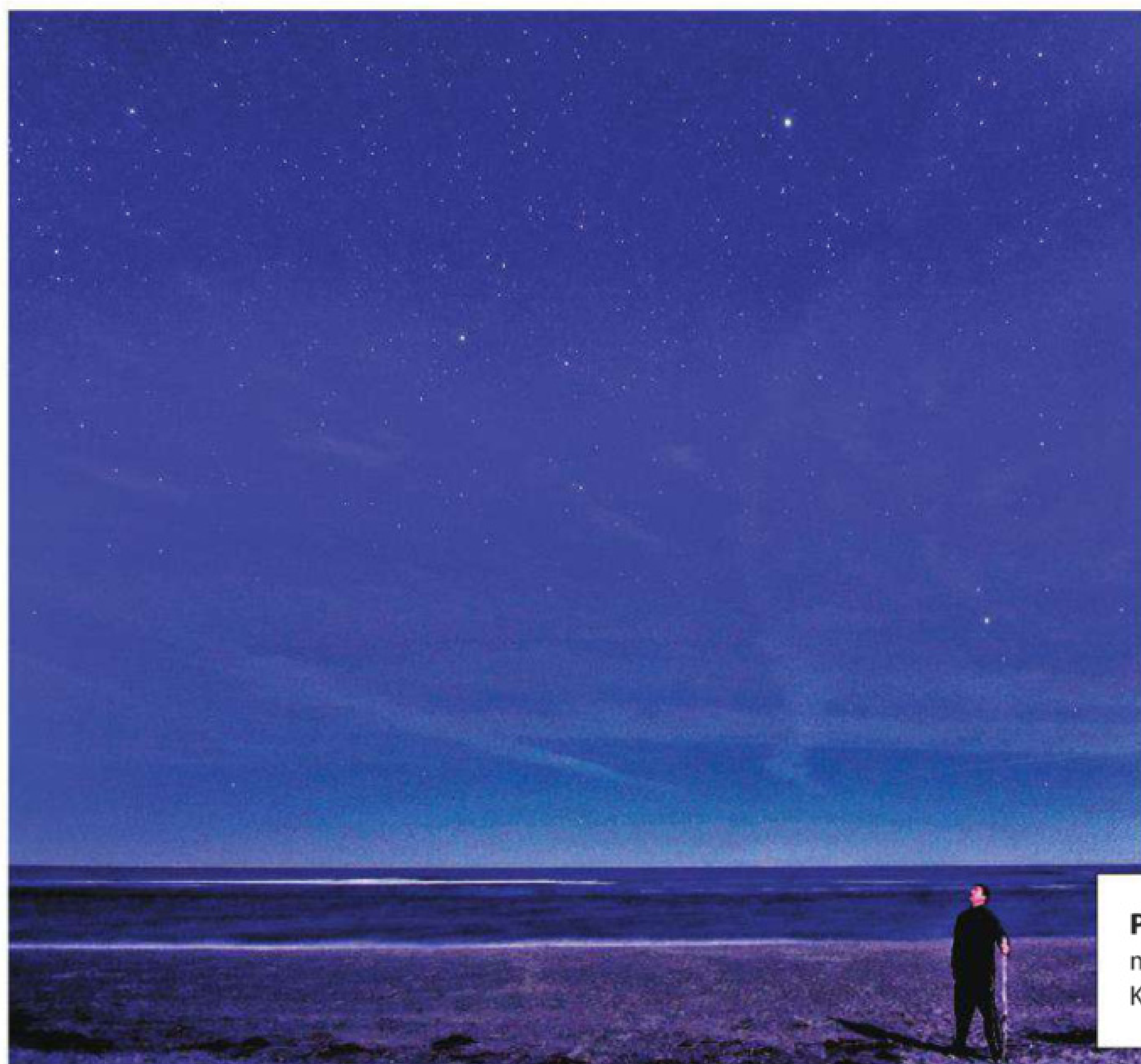
Evening stargazing is paired with public presentations on everything from summer astronomy in the Maritimes to choosing the right telescope. "We've even heard of campers buying telescopes as a result," says park visitor experience staffer Camilla Vautour, who currently oversees the park's astronomy portfolio.

"We hope that such events—and even the dark sky designation itself—will help raise the awareness we need to make the area even darker."

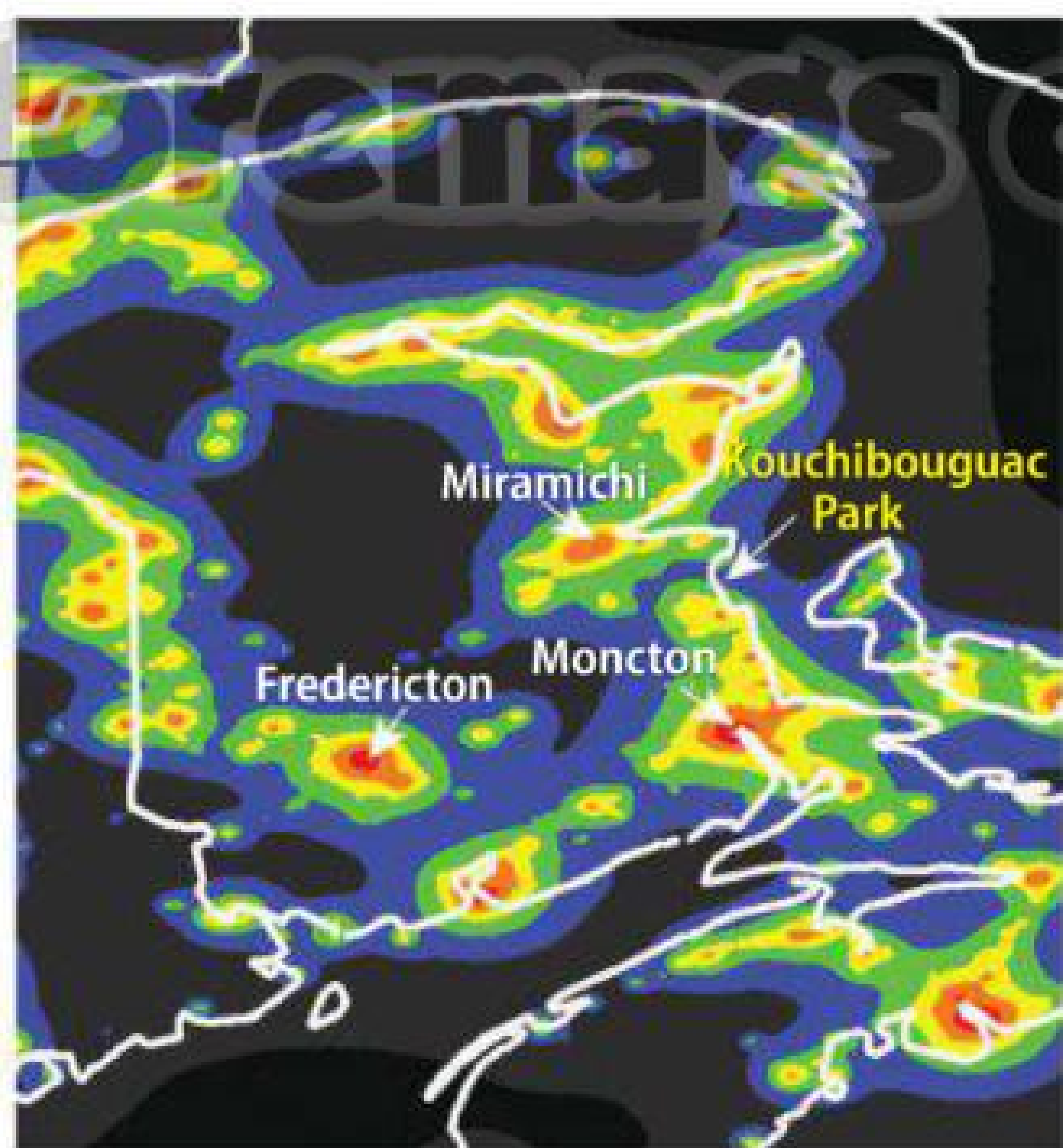
WHERE TO WATCH: KELLYS BEACH

By far, the most amazing views in the park are from Kellys Beach, part of a vast barrier island inhabited by piping plovers and accessible via boardwalk from the nearby campground.

While Kouchibouguac—and its best observing locale—borders the Atlantic Ocean to the east and a few settlements to the west, seaside fishing towns, such as Pointe-Sapin to the north, present a small amount of light pollution. A hoped-for changeover to dark-sky-friendly lighting in these areas will make a good thing here even better.



PETER AT KELLYS BEACH Acadian starry skies in moonlight illuminate Kellys Beach in New Brunswick's Kouchibouguac National Park. PHOTO BY PETER MCMAHON



NEW BRUNSWICK LIGHT POLLUTION

Tucked in a low-light-pollution sector of the province (code blue), Kouchibouguac is the regional stargazing destination. COURTESY P. CINZANO, ET AL

WHERE TO STAY: IN THE PARK AND BEYOND

If you're up for the tenting or RV experience, reserve a spot in South Kouchibouguac Campground, the park's most popular camping site and the closest to the Kellys Beach boardwalk. Indoor accommodations are available outside the park at a number of nearby bed-and-breakfasts, as well as at the Kouchibouguac Resort. Full-service hotel accommodations are available 25 minutes to the north, in and near Miramichi.

WHERE TO EAT

While the park itself isn't saturated with restaurants, Kellys Beach Canteen offers burgers-and-fries fare from mid-spring to early fall. Just outside the park on Highway 11, near the small village of Kouchibouguac, you can enjoy some of the freshly made breads, pies, cakes and entrees at La Fiouk, one of the only places here that still serves traditional Acadian food.

From *poutines râpées* (a sensational dish not to be confused with the Québécois-style gravy and cheese on fries) and *crêpes râpées* to local fish cakes, such earthly delights are a perfect pairing with the feast for your eyes that awaits when darkness descends in this magical ocean paradise. ♦

For more photos from Kouchibouguac and further details on food, accommodations and stargazing events, check out Peter's site at wildernessastronomy.com.

CAMBRIDGE

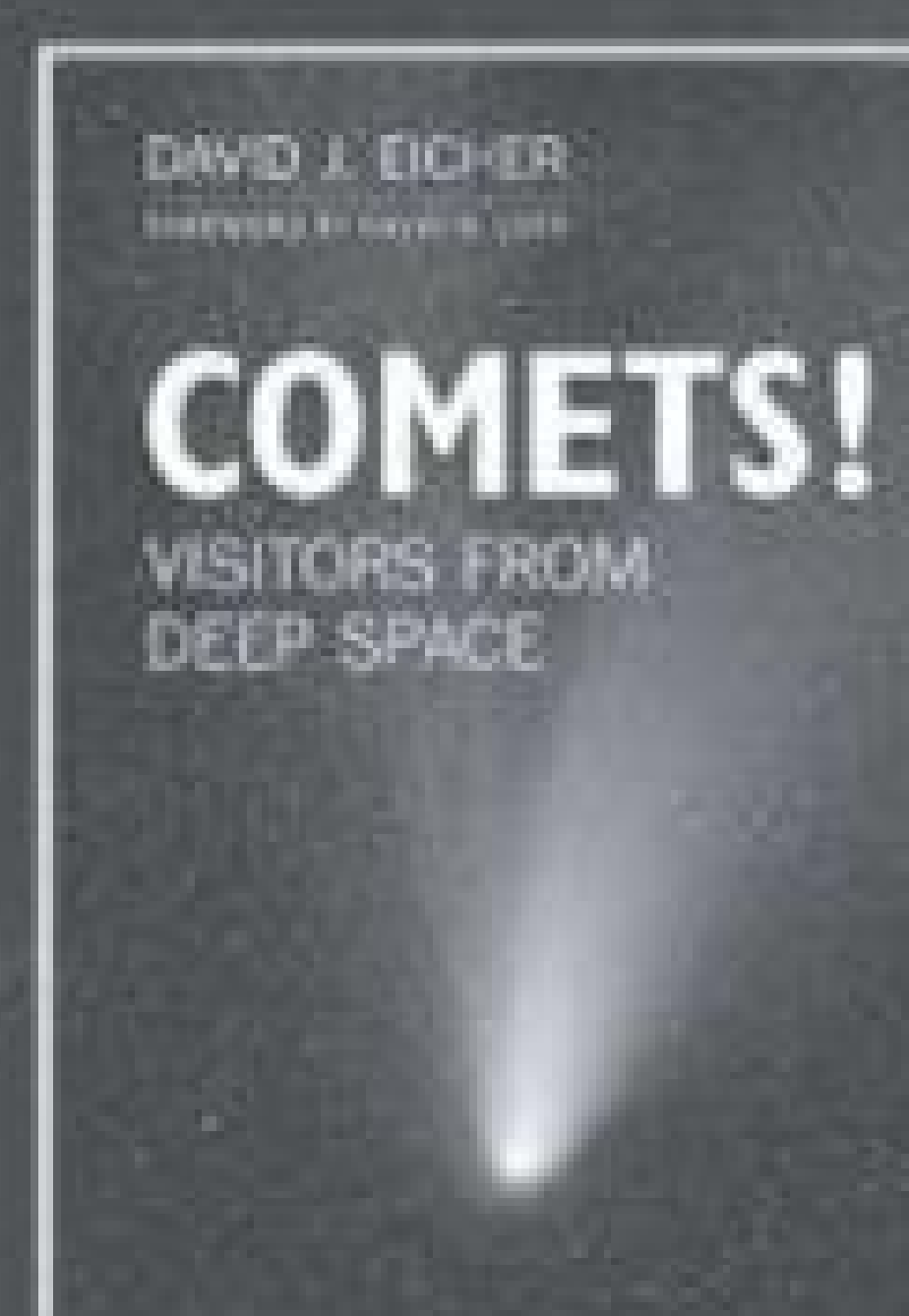
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COMETS!

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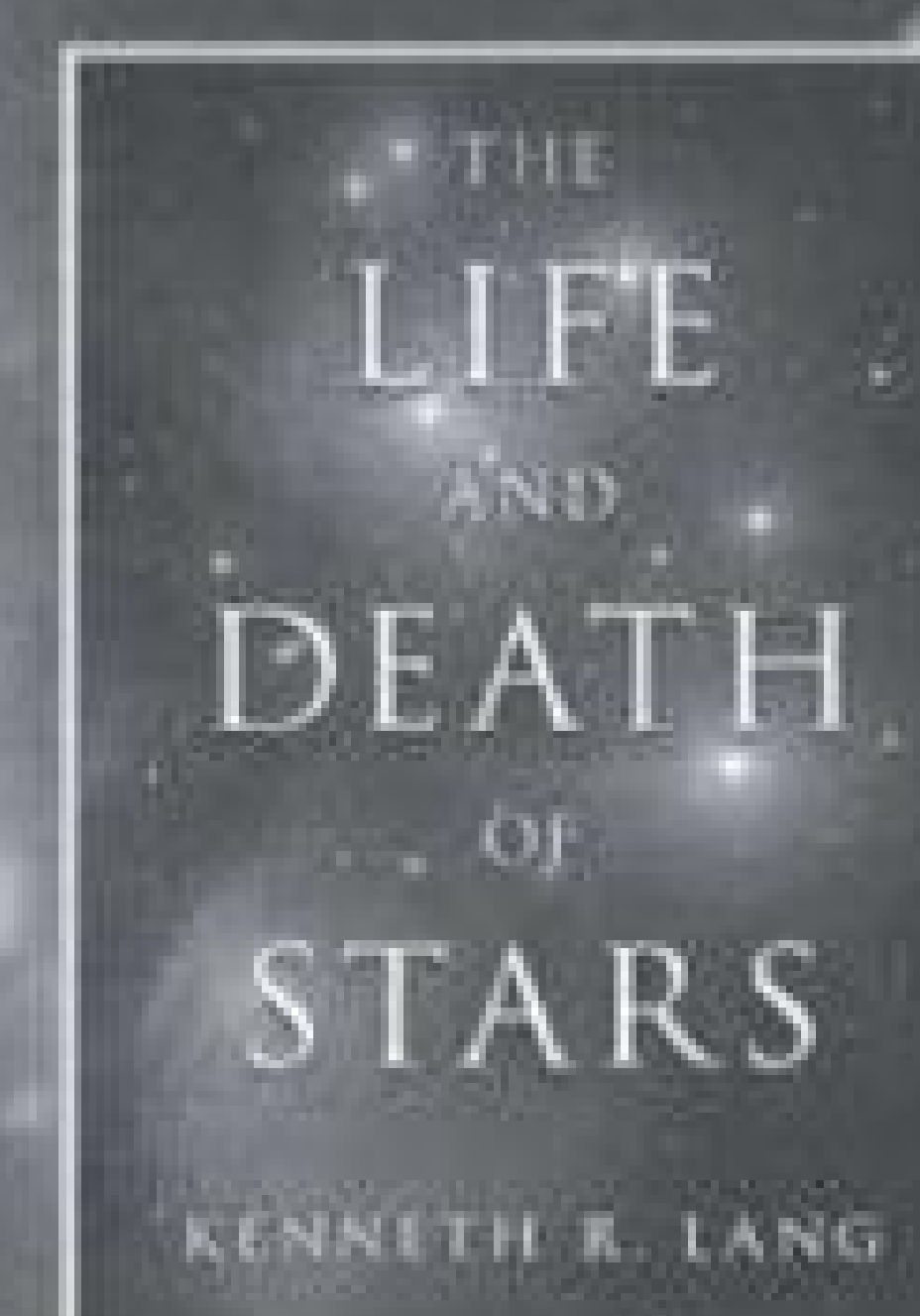
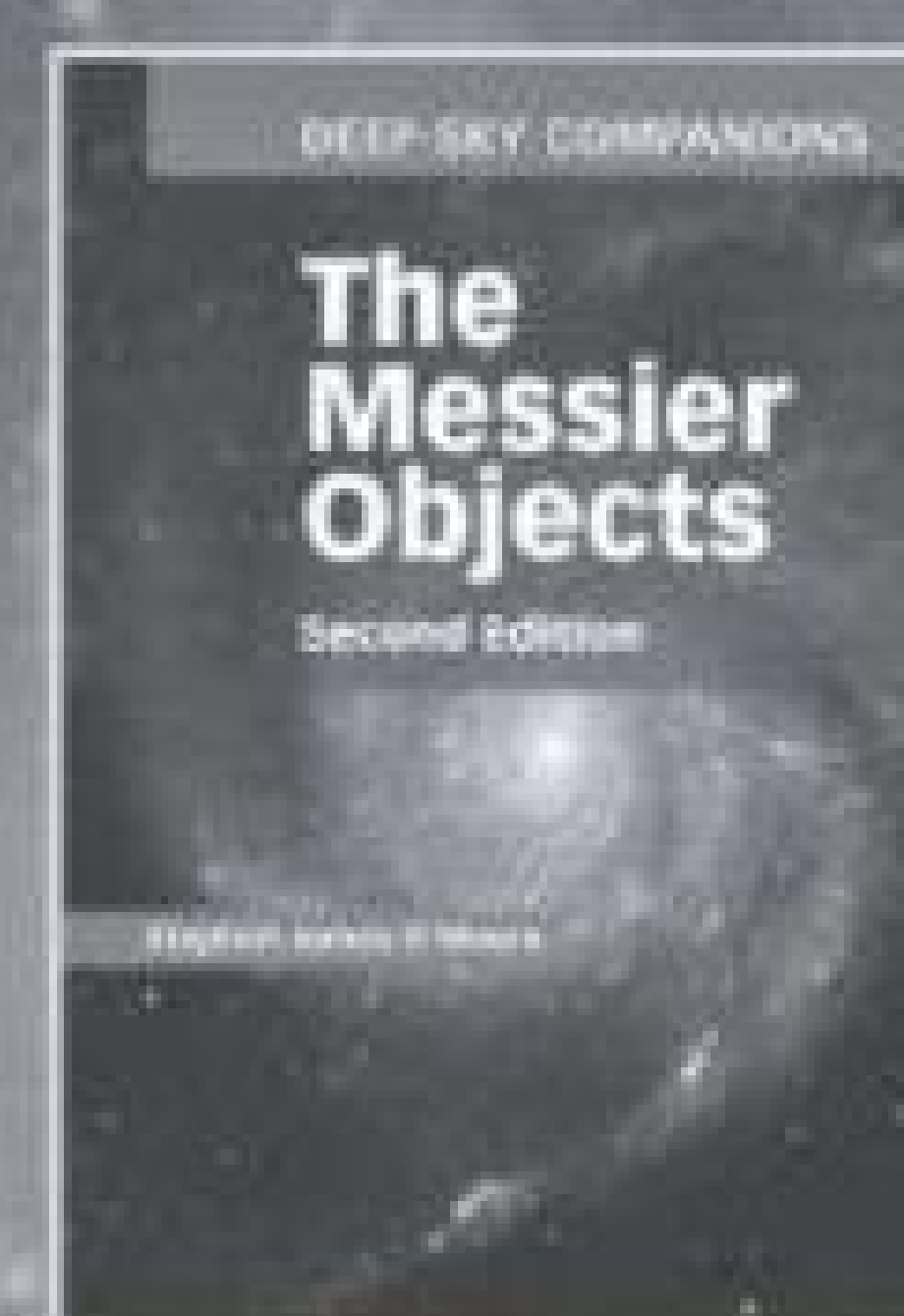
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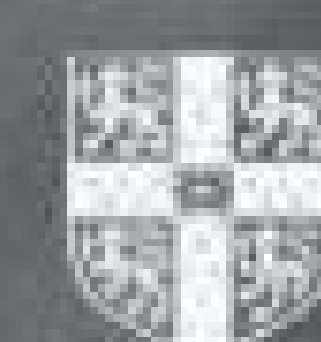
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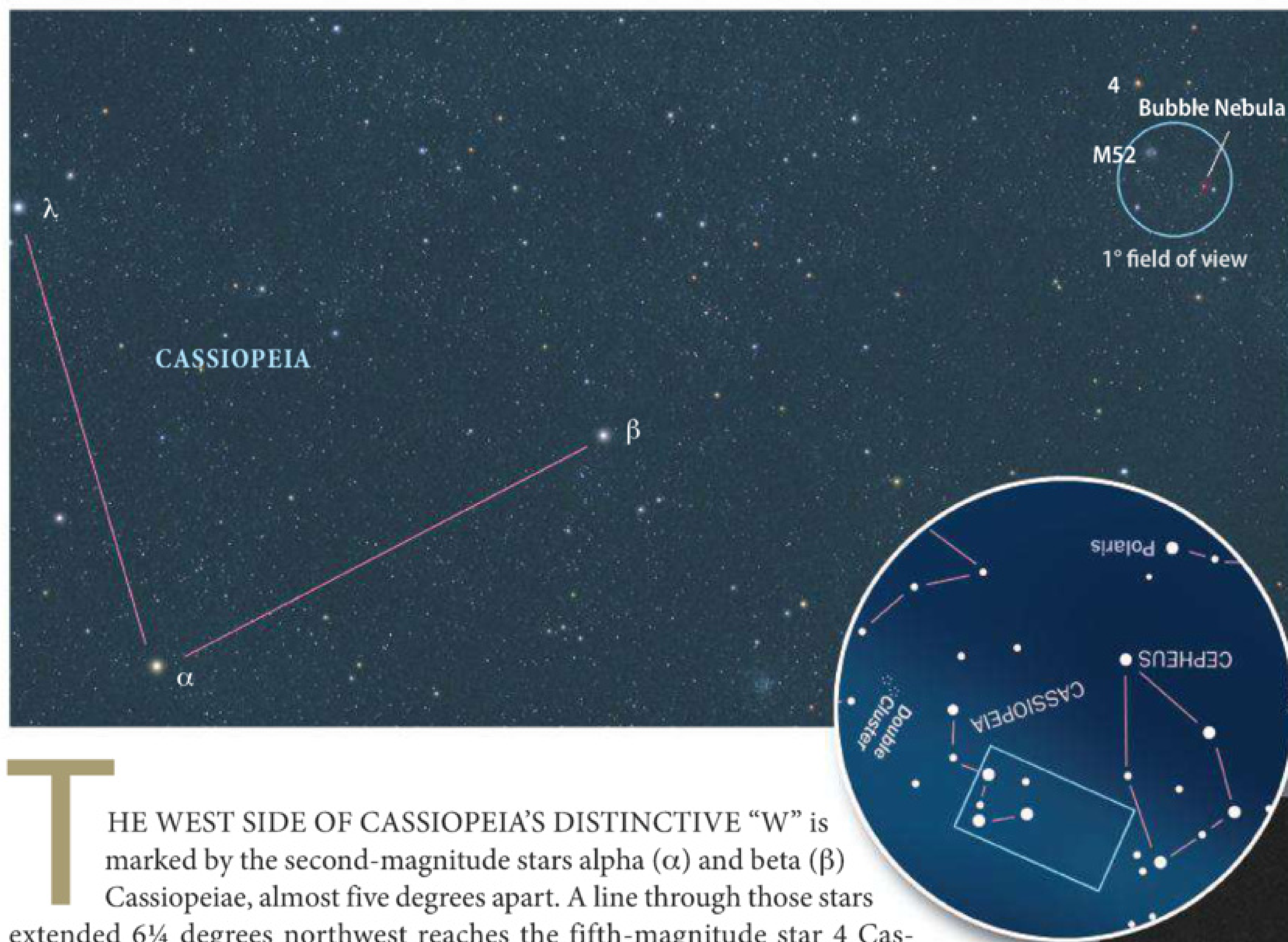
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BUBBLE AND SQUEAK

Looking for a pair of strongly contrasting deep-sky objects? Consider the glittery star cluster M52 and the tiny Bubble Nebula, half a degree apart in Cassiopeia by Ken Hewitt-White



COSMIC ODD COUPLE

Obvious and colourful in long-exposure telescope images, the Bubble Nebula is fainter and smaller than M52, its celestial partner star cluster. However, finding the duo is relatively easy using alpha (α) and beta (β) Cassiopeiae as pointers. A finderscope should show M52, but a telescope is needed for sighting its individual stars (see sketch below). For tracking down the Bubble Nebula, a very dark sky is required.

CARTOGRAPHY BY GLENN LEDREW;

SKETCH (BELOW) BY JOHN KARLSSON

THE WEST SIDE OF CASSIOPEIA'S DISTINCTIVE "W" is marked by the second-magnitude stars alpha (α) and beta (β) Cassiopeiae, almost five degrees apart. A line through those stars extended $6\frac{1}{4}$ degrees northwest reaches the fifth-magnitude star 4 Cassiopeiae. Just south of that orangey dot, well inside the Milky Way, is the open cluster **Messier 52**. Hardly close (almost 5,000 light-years from Earth) or prominent (seventh magnitude), M52 nevertheless rewards patient study.

M52 contains some 200 stars, the brightest of which are about magnitude 10.5. Observing it from my suburban yard with tripod-mounted 8x56 binoculars, I perceive a small, pallid, grainy patch with a single eighth-magnitude pinpoint on its west flank. (The star is in front of the cluster and not a member.) My $4\frac{1}{4}$ -inch f/6 Newtonian reflector at 93x produces a $\frac{1}{4}$ -degree-wide, fairly concentrated mass "detached" from the Milky Way, but the scope resolves only a dozen or so blue-white suns. The eighth-magnitude foreground star glows reddish yellow.

When I use a bigger scope away from town, my appreciation of M52 improves—a lot. In my 10-inch f/5.5 Dobsonian at 58x, the brighter cluster members form a triangular, or wedgelike, concentration, with the previously noted eighth-magnitude sparkler dominating its west side. All of M52's most prominent points are east and north of that colourful star. However, while the star marks "the edge of the wedge," averted vision picks up a coarse scatter of much

fainter stars to the west and south. To my eye, that dim scatter represents fully one-third of the cluster. Within the wedge, I see a steep drop in magnitudes from northwest to southeast. Like most star clusters, M52 is a Rorschach test of bright points and dark lanes. John Karlsson's drawing of M52, above right, conveys the bright/dim arrangement, plus several starless voids and lanes.

Our second object, a half-degree hop southwest of M52, is roughly twice the dis-

tance of the cluster, barely one-fifth its apparent size (not quite three arc minutes wide) and ghostly pale. The **Bubble Nebula** is a spherical structure inside NGC7635, a large emission nebula being sculpted by powerful winds emanating from a massive, ultrahot star deep inside it. Enveloping that star (yet not centred on it) is the Bubble, an expanding gaseous shell perhaps 10 light-years across. Its sharply defined circumference is evidence of an immense shock

wave plowing into the surrounding field of ionized hydrogen. Images of NGC7635 capture its spectacular complexity, but deep-sky hunters beware: The alluring Bubble Nebula is a minute and subtle telescopic target requiring a seriously dark sky and a nebula filter.

With the aid of an Ultra High Contrast (UHC) filter, all I see of the Bubble in my 10-inch Dob at 58x is a compact, diffuse cloud enveloping the 8.7-magnitude star that powers the invisible mass of NGC7635. Thankfully, the filter partly attenuates the glaring star, plus a seventh-magnitude field star just six minutes westward. Changing to a doubly ionized oxygen (O-III) filter blunts the starlight even more while allowing the minuscule nebulosity to become noticeably asymmetric. Tripling the power, O-III in place, I can resolve the uneven haze into opposing parts: a fairly bright patch fanning northwestward from the star and a faint, narrow wisp trending southward. That cirruslike streak is all I can detect of the Bubble's slim, dim rim.

My 17.5-inch f/4.5 Dobsonian provides a small but satisfying increase in detail.



CELESTIAL BUBBLE The faint and elusive detail shown in the sketch of the Bubble Nebula at right is a good depiction of how subtle this object can be. This observing target mandates a very dark sky and one or two nebula filters. PHOTO (LEFT) BY LYNN HILBORN; SKETCH (RIGHT) BY JOHN KARLSSON



Viewed through a UHC filter at between 222x and 285x, the fanlike fuzz becomes a comet whose "tail" issues westward from the "nucleus" (the 8.7-magnitude star), then curls northward. Opposite, the cirruslike streak sharpens into a slender arc, or hook, extending southward before dissolving shy of a 13th-magnitude star. (A 12th-magnitude star shines inside the Bubble.) In all, I can trace almost one-quarter of the shell's circumference. These features can be seen

in John's sketch, above right, made with his 15-inch f/5 Dob and a UHC filter.

Which filter makes the best Bubble buster? For me, it's a UHC, because I want that enhanced nebulosity *and* those dim field stars. Experiment to see what works for you. ♦

Contributing editor Ken Hewitt-White has observed deep-sky fuzzies over southern British Columbia for four decades.

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STAR CHART *for Early Autumn*

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

EARLY SEPTEMBER: 11:30 P.M.; LATE SEPTEMBER: 10:30 P.M.

EARLY OCTOBER: 9:30 P.M.; LATE OCTOBER: 8:30 P.M.

THE EDGE OF THE CHART represents the horizon; the overhead point is at centre. 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 ecliptic is the celestial pathway of the Moon and planets. The star groups straddling this line are known as the zodiac constellations. The Moon is shown for selected dates.

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 the 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.

THE PLANETS

MERCURY reaches its greatest angle away from the Sun in the evening sky on Oct. 9. However, this is a poor appearance for northern latitudes, with Mercury always low.

VENUS can be sighted low in the west this autumn, as it continues its unfavourable evening apparition. On Sept. 8, the waxing crescent Moon shines less than 2° from Venus near Spica. Venus brightens from magnitude -4 to -4.5 through September and October but drops closer to the horizon, becoming more difficult to see.

MARS shines as a 1.5-magnitude reddish "star" in the east in the hours before dawn. This season, Mars travels east along the ecliptic from Cancer into Leo. It passes through the Beehive star cluster on Sept. 8 and above Regulus on Oct. 15. Mars remains too small to reveal much detail on its four- to five-arc-second-wide disc.

JUPITER is the most obvious planet this season, though it doesn't rise until 2 a.m. in early September. By the end of October, Jupiter is well up by 11 p.m. Jupiter now appears as a brilliant object (magnitude -2.2) in Gemini, not far from Castor and Pollux. It passes just six arc minutes north of delta Geminorum on Oct. 4.

SATURN appears low in the southwest at the start of September, shining as a faint 0.7-magnitude object above Venus. Saturn drops lower each night and is near Venus from Sept. 16 to 19. By the end of October, Saturn is lost in the twilight as it heads toward a conjunction behind the Sun on Nov. 6.

URANUS reaches opposition on Oct. 3, when it rises at sunset and shines due south at local midnight. Look for it as a 5.7-magnitude object in southern Pisces, about 4° south of the 4.5-magnitude star delta Piscium.

NEPTUNE can be found in the southern sky in the early evening as a 7.8-magnitude object in central Aquarius, about 2° west of the fifth-magnitude star sigma Aquarii.

CELESTIAL CALENDAR

SEPT. 2 Waning crescent Moon 6° below Mars in morning sky

SEPT. 4 Zodiacal light bright in predawn sky for next two weeks

SEPT. 5 New Moon, 7:36 a.m., EDT

SEPT. 8 ☾ Waxing crescent Moon less than 2° south of Venus, both 4° east of Spica low in evening sky; Mars within M44 (Beehive cluster) in morning sky today and tomorrow

SEPT. 9 Waxing crescent Moon 5° south of Saturn low in evening sky

SEPT. 12 First-quarter Moon

SEPT. 16 Venus and Saturn less than 4° apart for next four nights

SEPT. 19 Full Harvest Moon, 7:13 a.m., EDT; Moon 4° from Uranus

SEPT. 22 Equinox, 4:44 p.m., EDT (autumn begins)

SEPT. 26 Last-quarter Moon

SEPT. 28 Waning crescent Moon 5° below Jupiter in morning sky

OCT. 3 Uranus at opposition (rises at sunset, sets at sunrise); zodiacal light bright in predawn sky for next two weeks

OCT. 4 New Moon, 8:34 p.m., EDT; Jupiter just six arc minutes north of 3.5-magnitude star Wasat (delta Geminorum)

OCT. 6 Very thin waxing Moon 1.5° above Mercury and 2.5° below Saturn very low in evening sky

OCT. 7 Draconid meteor shower peaks in moonless sky; waxing crescent Moon 7° north of Venus very low in evening sky

OCT. 8 Waxing crescent Moon 7° above Venus near Antares very low in evening sky

OCT. 9 Mercury at greatest elongation (25°) away from Sun very low in evening sky

OCT. 11 ☼ Rare triple-shadow transit on Jupiter, visible east of Alberta (11:32 p.m. to 12:37 a.m., CDT); first-quarter Moon

OCT. 15 Mars 1° north of Regulus in morning sky

OCT. 16 Venus 1.5° above Antares very low in evening sky

OCT. 17 Double-shadow transit on Jupiter (6 a.m. to 7:27 a.m., MDT) visible west of Manitoba

OCT. 18 Full Hunter's Moon, 7:38 p.m., EDT; penumbral eclipse of the Moon (visually undetectable) at moonrise or early evening

OCT. 18 ☼ Double-shadow transit on Jupiter (11:25 p.m. to 1:27 a.m., PDT) visible across Canada; Comet ISON appears closest to Mars (1°)

OCT. 20 Orionid meteor shower peaks (poor moonlit conditions)

OCT. 26 Last-quarter Moon; double-shadow transit on Jupiter (1:37 a.m. to 3:31 a.m., PDT) visible across Canada

OCT. 29 Waning crescent Moon 6° south of Mars in morning sky

☼ Impressive or relatively rare astronomical event



Cartography and design by Roberta Cooke. Base chart data derived from maps drawn by Roy Bishop for the *Observer's Handbook*, published by The Royal Astronomical Society of Canada.



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 counter-clockwise 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.

SHADOW DANCING JUPITER

ON

The season brings a rare triple-shadow transit on Jupiter. Venus and Saturn shine at dusk, Uranus peaks at midnight, and Mars appears at dawn.

by Alan Dyer

WHILE ALL FIVE NAKED-EYE PLANETS are visible this season, the best by far is Jupiter. As it moves along its orbit, the giant planet is making the transition from an autumn planet to a winter one. So this September and October, it doesn't rise until late at night, as the winter constellations come into view.

The highlight of the season comes on October 11, when shadows from three of Jupiter's moons cross its disc at once. Those in eastern Canada have the best view of this rare event, though the season brings other chances to see pairs of moon shadows on Jupiter.

Venus passes Saturn in the evening sky, while Mars moves among the stars of Cancer and Leo in the morning sky. On September 8, Mars appears superimposed on one of the best star clusters in the sky, the Beehive.

JOVIAN SHADOW TRIO

Mark the night of Friday, October 11, on your calendar. Late that night and into the wee hours of Saturday, October 12, you'll have a chance to see a rare sight on Jupiter. For just over one hour, the big planet's cloudy disc will be spotted with the inky shadows of three of its four Galilean moons.

They will appear as dark spots on the cloudtops, each with a different size and intensity. Europa's shadow should look the smallest, Callisto's will be the largest, though less well defined, and Io's should look the most intensely black and sharply defined.

The last time we saw three Jovian moon shadows at once was on March 28, 2004. Before that, the previous triple-shadow transit was November 11, 1997. I missed the 2004 event, but I remember the 1997 triple transit well. I was impressed at just how different each shadow looked when you could compare three on the disc at the same time.

Due to the orbital periods of the Galilean moons, it is impossible for Io, Europa and Ganymede to line up well enough to cast their shadows onto the planet simultaneously.

JUPITER IN TAURUS Last year, Jupiter shone above Aldebaran and the Hyades star cluster in Taurus, as seen here near centre. At this year's apparition, Jupiter has moved one zodiac constellation to the east to shine in Gemini through the fall and into the winter and spring of 2014.

PHOTO BY ALAN DYER



Triple-Shadow Transit

VIEW FROM EARTH, OCTOBER 11-12



MOON SHADOW TRIO This is the view at 11:40 p.m., CDT (12:40 a.m., EDT; 1:40 a.m., ADT), on the night of October 11/12, a few minutes after the shadow of Io enters the Jovian disc to join the shadows of Europa and Callisto for a rare triple-shadow transit. In Canada, the event is best viewed from locations east of Alberta.

COURTESY THESKYX™/SOFTWARE BISQUE

Any triple-shadow transit always involves outermost Callisto, though with various paired combinations of the other three inner satellites.

To appreciate the view, you will need a telescope with an aperture of at least 80mm. To coax the best performance out of your optics, the telescope should be set up outside at least a half-hour in advance

to allow the optics to cool to the ambient night-air temperature. No need to leave the city—you should be able to get a good view from just about anywhere, provided you are not looking over a source of local heat (your own house, for example), which will create image-blurring heat waves.

The kicker is your longitude. From British Columbia, Callisto's shadow leaves the

disc before Jupiter rises, so those on the West Coast see only the remaining two moon shadows on the disc by the time Jupiter comes up. From Alberta, Callisto's shadow is still on the disc (just!) at Jupiter-rise, but the planet will be so low, the view won't be very sharp.

Observers east of Alberta get the best view, with those in eastern and Atlantic Canada ideally placed. However, taking in the event means a late night, as the three-shadow show begins with the entry of Io's shadow onto the disc at 12:32 a.m., EDT (1:32 a.m., ADT), on October 12. Be careful about marking your calendar, because some listings may give this event as happening on October 12. For eastern time zones, it *does* occur on the 12th—in the

Views from SPACE

Using the superb Mac OS/iOS solar system simulator Cosmographia (www.cosmographia.info), we can fly out to Jupiter and view the triple-shadow transit from different perspectives within the Jovian system.

OUT BY JUPITER (1) Here, we orbit on the nightside of Jupiter, looking back at Earth and the Sun. In the distance, on the sunward side of Jupiter, the three moons are clustered in a line, casting their shadows onto the planet. (2) Now we are hovering above the sunward side of Callisto, the outermost of Jupiter's four large Galilean satellites. In the distance, the inner moons Io and Europa and their shadows are crossing the disc of Jupiter. (3) From a vantage point below the south pole of Jupiter, we can see Callisto's shadow grazing a polar cloud belt while Io's elongated shadow creeps onto the cloudtops at the start of the triple transit. COURTESY COSMOGRAPHIA.INFO (ALL THREE)

(1) VIEW FROM JUPITER LOOKING BACK TO EARTH



(2) VIEW FROM CALLISTO



(3) VIEW FROM BELOW JUPITER



TRANSIT DUOS October presents several opportunities to see a pair of moon shadows on Jupiter. Their timing makes some better suited to certain regions of the country.

DOUBLE-SHADOW TRANSITS (1) Making up for the poor view that western Canada has of the October 11 event, Alberta and British Columbia get the best view of a double-shadow transit before dawn on October 17. This view is for 6:20 a.m., MDT (5:20 a.m., PDT). (2) All of Canada can see this transit of Io's and Europa's shadows on the night of October 18/19. From eastern Canada, both shadows are on the disc from 2:25 a.m. to 4:27 a.m., EDT, on October 19. This view is for 3 a.m., EDT (midnight, PDT). (3) Even from the West Coast, this event begins in the wee hours. From eastern Canada, times are three hours later, from 4:37 a.m. to 6:31 a.m., EDT, with Jupiter in the western sky at dawn. This view is for 5:30 a.m., EDT (2:30 a.m., PDT). COURTESY THESKYX™/SOFTWARE BISQUE (ALL THREE)

(1) OCTOBER 17, 6 A.M. TO 7:27 A.M., MDT



(2) OCTOBER 18, 11:25 P.M. TO 1:27 A.M., PDT



(3) OCTOBER 26, 1:37 A.M. TO 3:31 A.M., PDT



very early morning—but if you wait until the evening of October 12 to see it, you will have missed it!

The show doesn't last long. All three shadows are on the disc together for only 65 minutes. By 1:37 a.m., EDT (2:37 a.m., ADT), Callisto's shadow is moving off the southern polar region of the planet, leaving the shadows of Europa and Io to carry on. Europa's shadow leaves the disc 25 minutes after Callisto's shadow does.

If you miss this triple transit, you won't have to wait too long until the next one. On January 23, 2015, the shadows of these same three moons will once again cross the Jovian disc in an event well timed for all of North America. As a bonus, both the disc then the shadow of faster-moving Io will pass across the shadow of Callisto, an exceptionally rare sight.

SHADOW DUOS

If this shadow transit piques your interest, take note of three other events visible to Jovian moon-shadow chasers in North America. Each involves a pair of shadows. The illustrations above provide details on the timing.

The October 17 event is best for Alberta and British Columbia, in part mak-

JUPITER'S MOONS

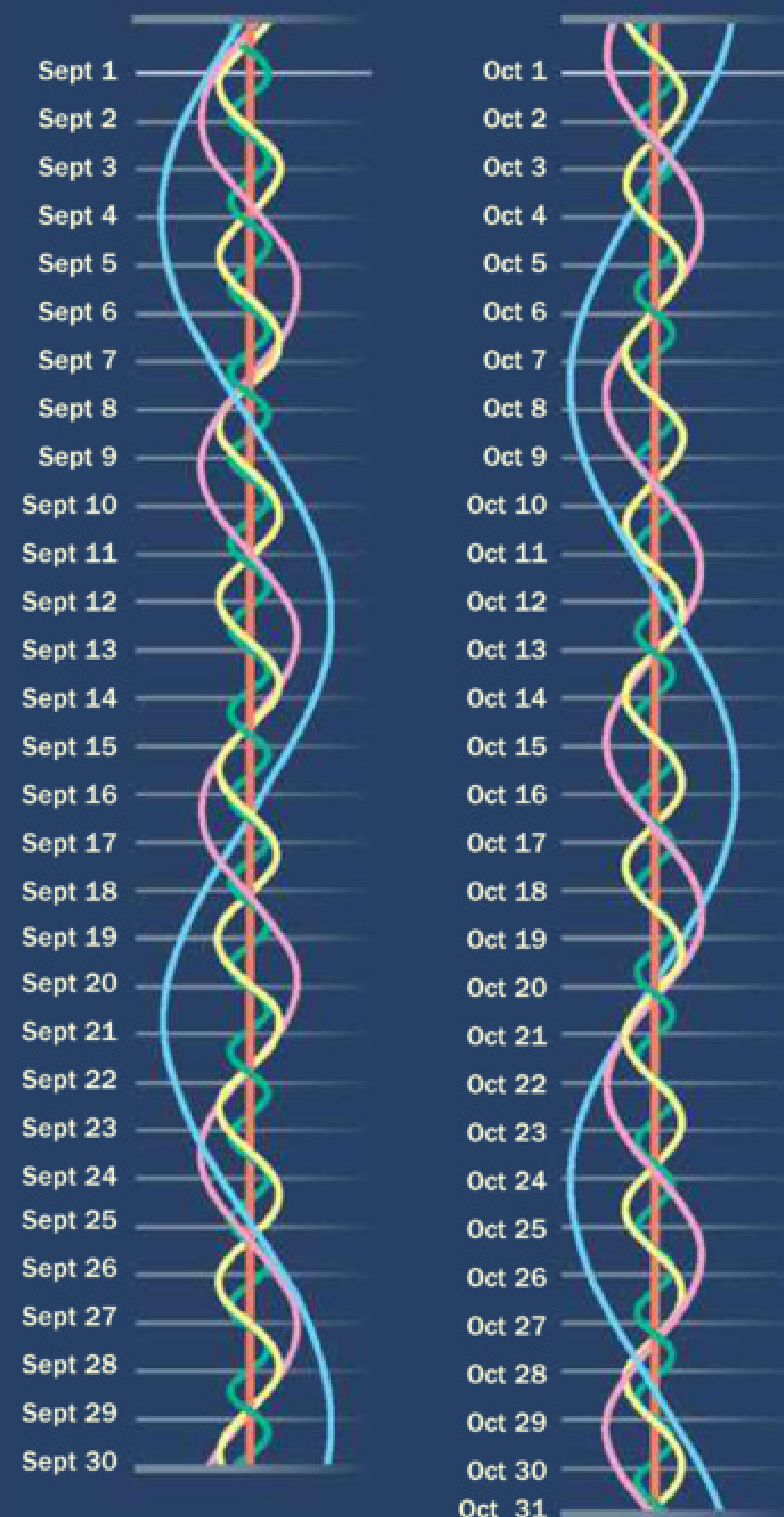
September and October 2013



The positions of Jupiter's four largest moons are shown for each night of the two-month period. Jupiter is represented by the central vertical shaft, while the moons are the four wavy lines. The horizontal lines mark 8 p.m., EDT, on the dates indicated. Time flows from top to bottom, so look proportionately below the line for later times on a particular date. East is to the left, and north is at the top, as seen in binoculars. From closest to farthest, the moons are Io, Europa, Ganymede and Callisto. Orbital periods are 1.8, 3.6, 7.2 and 16.7 days, respectively.

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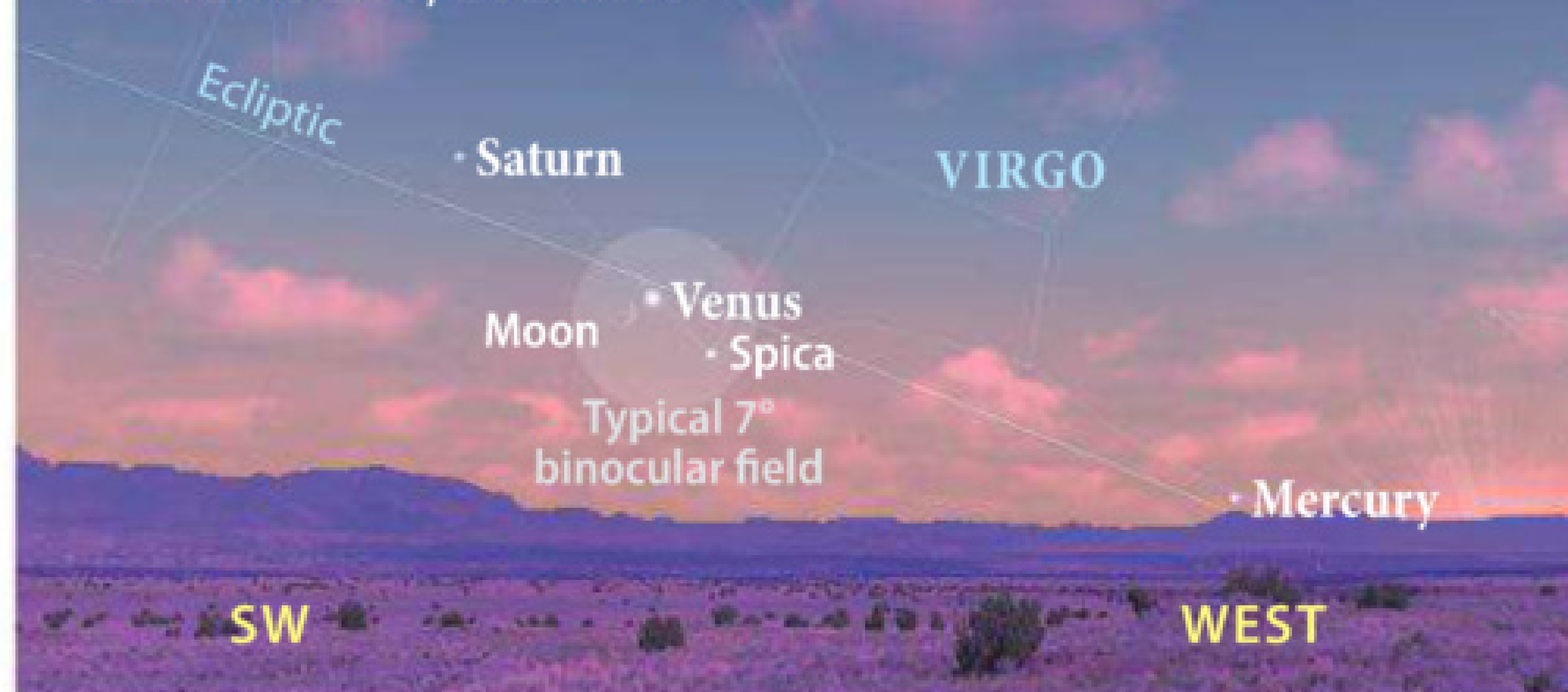
Io Europa Ganymede Callisto



EVENING MOON AND PLANETS DANCE Venus is bright enough at dusk to be a guide to these scenes in September and early October. At midnorthern latitudes throughout this autumn, Venus remains near the horizon at dusk—a situation astronomers call an unfavourable apparition. Sighting Mercury in October will be tough, even with the aid of binoculars.

Moon Near Venus

SEPTEMBER 8, EVENING



Moon Near Saturn

SEPTEMBER 9, EVENING



TWILIGHT PASSAGES The evening of September 8 brings a close conjunction of the waxing Moon and Venus near Spica, in Virgo, although the pair is low and shining in bright twilight. The next night, the crescent Moon has moved higher to pair with Saturn. You might also catch a glimpse of Mercury, beginning a low appearance in the evening sky.

Venus Near Saturn

SEPTEMBER 18, EVENING



PLANET PAIRING AT DUSK As Venus moves away from the Sun and Saturn drops closer, they are near each other in the early evening on September 18. While Venus shines at magnitude -4.2 , Saturn is dim, at magnitude 0.7 , making it difficult to see in the bright twilight sky with unaided eyes.

Moon Near Mercury and Saturn

OCTOBER 6, EVENING



LOW IN THE GLOW From Canadian latitudes, you'll have a tough time seeing this meet-up of Mercury and Saturn with the thin waxing Moon. All three are so low and set so soon after the Sun that it will take a very clear sky and a low horizon to spot them.

COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (ALL FOUR)

ing up for the poor show they got on October 11. Seeing this event, however, requires getting up before dawn to catch Jupiter when it is due south before sunrise.

The October 18 and 26 transits can be seen from across Canada, although only the October 18 event occurs at a respectable hour, at least for western Canada.

VENUS AND SATURN AT DUSK

Venus is swinging out from behind the Sun, moving toward its greatest angle away from the Sun on November 1. Normally, this would place Venus high in our evening sky. However, an elongation at this time of year means Venus stays close to the horizon as it tracks the ecliptic, now angled low in our Canadian evening sky.

Nevertheless, we do get a couple of fine

conjunctions of Venus near the waxing crescent Moon: a very close conjunction on September 8 and a more distant meeting on October 8. On both dates, the low altitude of the Moon and Venus will offer some fine photo opportunities with the pair above a well-chosen landscape feature.

Saturn disappears behind the Sun this season. As it does so, Saturn meets Venus, with the two worlds passing each other on September 18.

URANUS AT MIDNIGHT

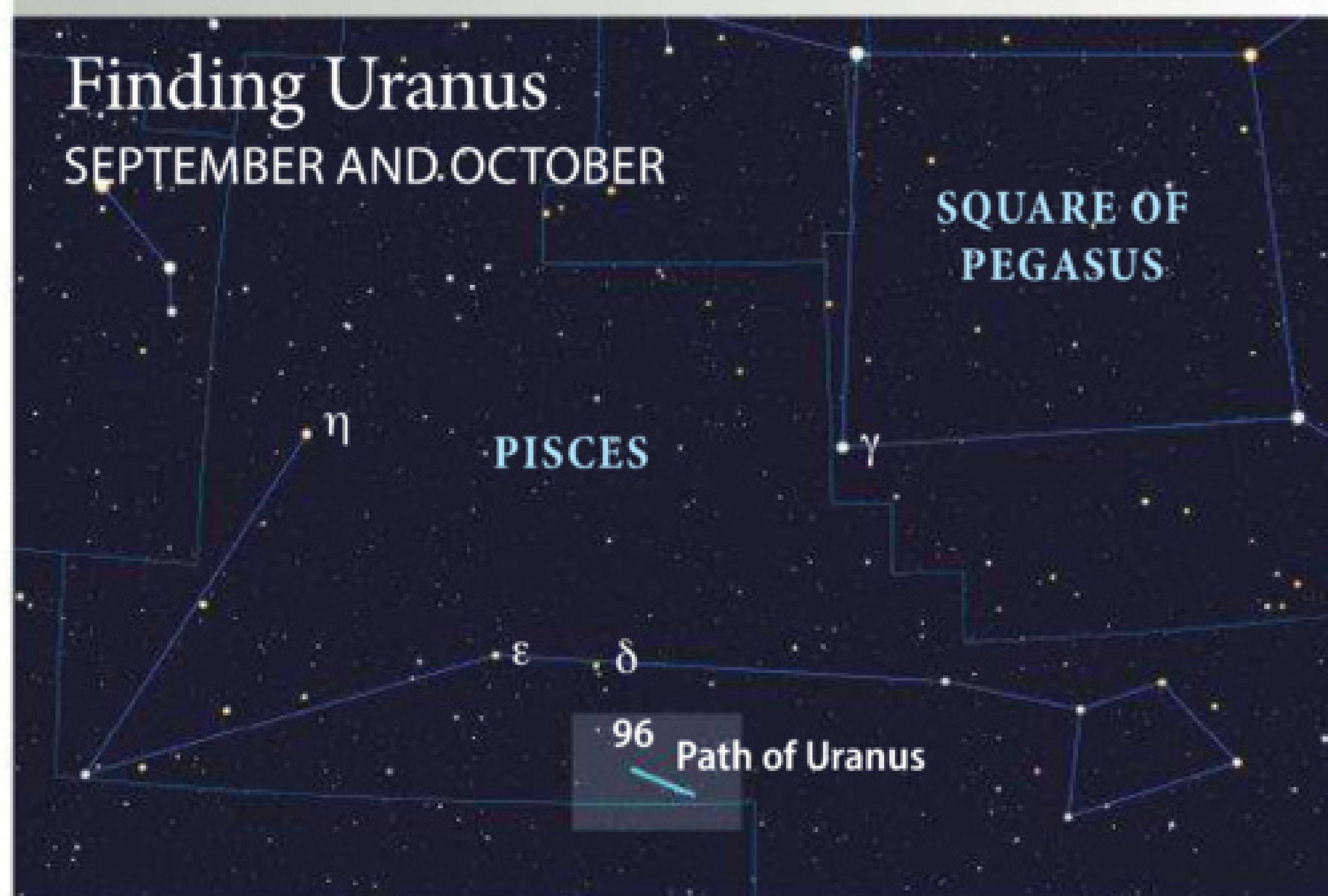
Uranus continues its slow trek through Pisces, in a rather star-poor, blank area of the sky. Its location deep in the “watery” constellations of autumn makes finding Uranus a challenge for those who like to star-hop to their targets. With Uranus

reaching opposition on October 3, the seventh planet is now as close and as bright as it gets for the year and is well placed for viewing. At opposition, a planet lies opposite the Sun, so Uranus sits due south in the middle of the night, about 1 a.m., local daylight time.

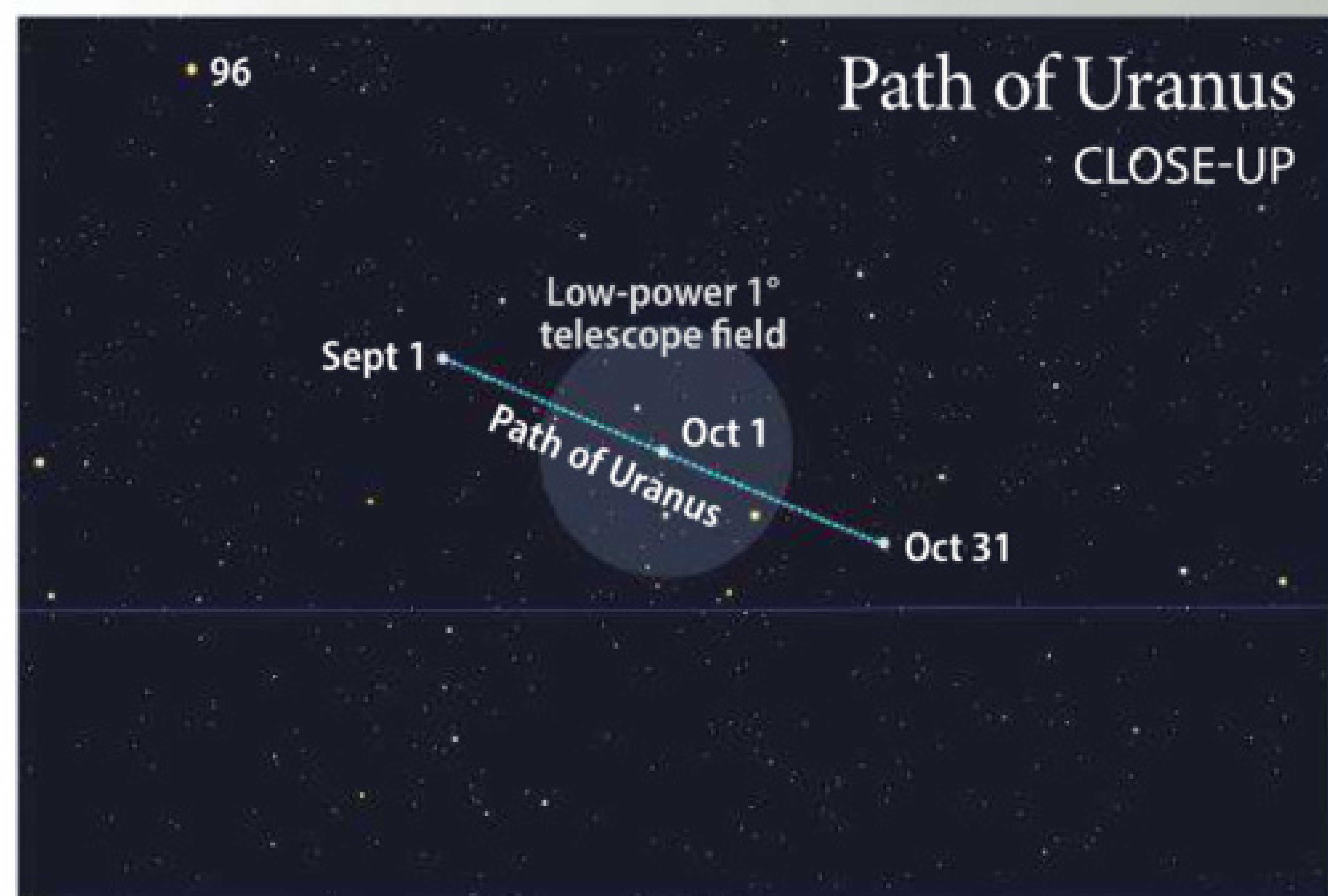
Zero in on the field with a telescope, look for a green “star,” then bump up the power to reveal a tiny disc, the giveaway that you have found a planet and not a star. It's what signalled to William Herschel in March 1781 that he had swept up something unusual. He believed it was a comet, never thinking that there might be more than the classic five naked-eye planets, plus Earth, in our solar system.

Take note of the 3.7-arc-second greenish disc of Uranus. That's what many tiny

SEEKING PLANET SEVEN Uranus reaches opposition on October 3, making this the perfect season for hunting down William Herschel's planet. Look for a 5.7-magnitude greenish "star," visible in binoculars but best viewed in a telescope, which will reveal the distant planet's tiny disc.



BELOW THE FISH Uranus is now located in a remote region of the constellation Pisces. Use gamma (γ) Pegasi, a corner star of the Square of Pegasus, to hop down into Pisces and the fourth-magnitude naked-eye stars epsilon (ε) and delta (δ) Piscium. From there, hop down to sixth-magnitude 96 Piscium, a star almost identical in brightness to Uranus.



TREKKING THROUGH PISCES Uranus is now moving westward in retrograde motion through Pisces, away from the guide star 96 Piscium. A finderscope will frame both 96 and Uranus, allowing you to home in on the field. Or use a GoTo telescope, and look for a greenish "star"—its 3.7-arc-second disc becomes apparent only at high power. COURTESY THE SKYX™/SOFTWARE BISQUE (BOTH)

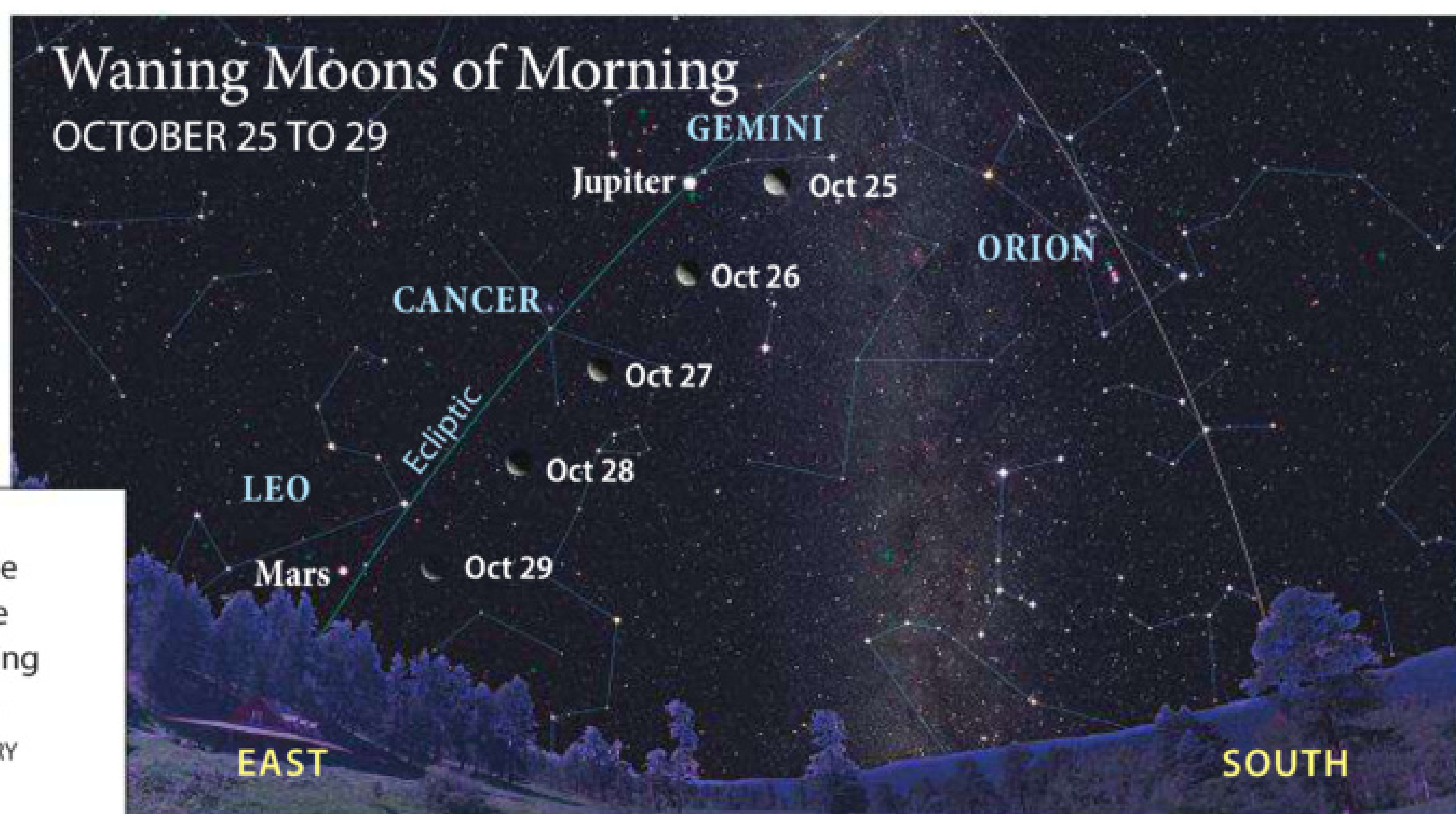
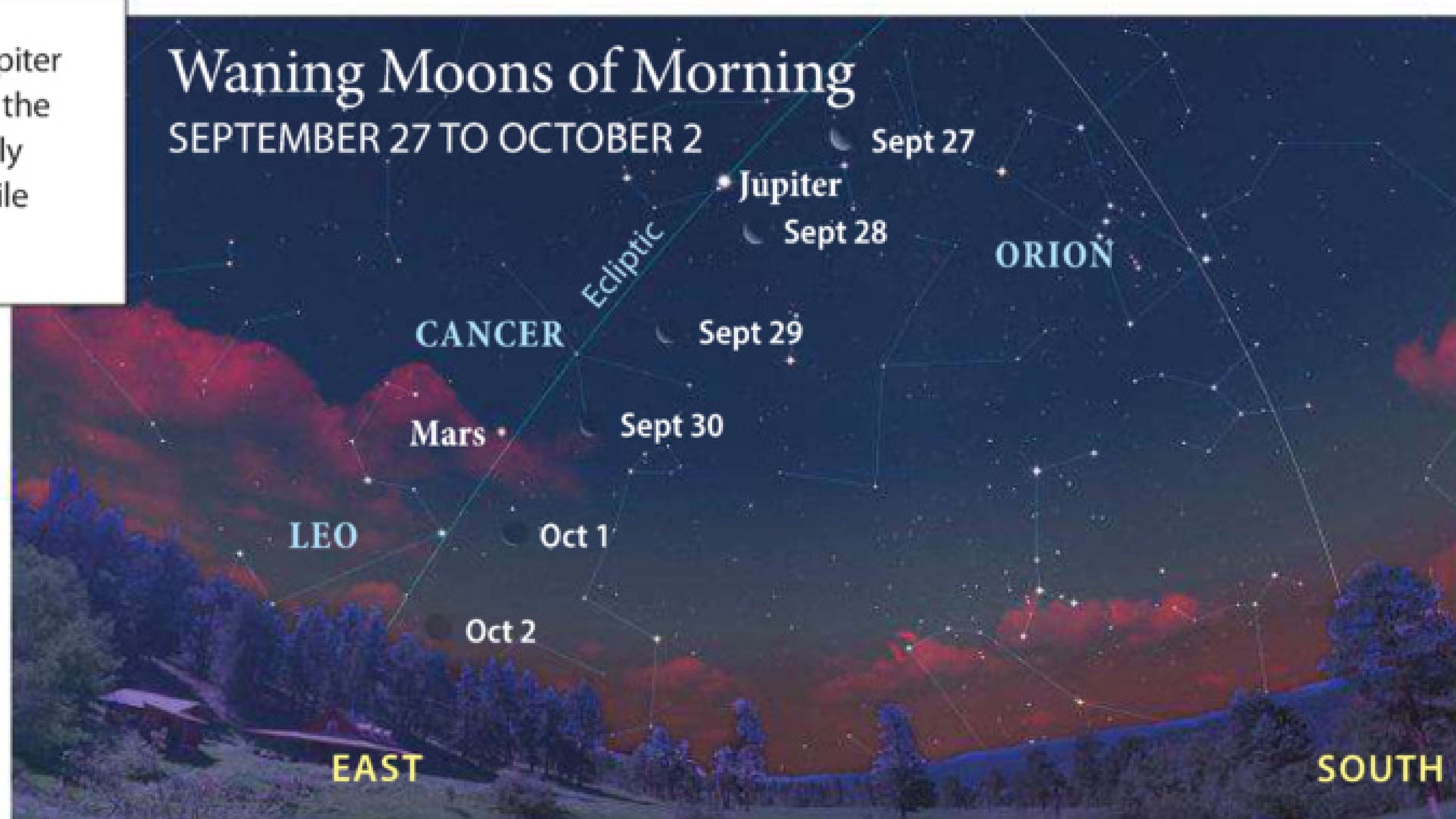
THE WANING MOONS OF SEPTEMBER Jupiter and Mars adorn the predawn sky, pairing up with the waning crescent Moon in late September and early October. This season, Jupiter shines in Gemini while Mars moves from Cancer into Leo.

planetary nebulas look like, which is why that class of deep-sky object was so named. Those circular green-blue nebulas reminded early observers of Uranus and Neptune through a telescope.

MARS AT DAWN

Like Uranus, Mars now has a very small disc, just 4.1 to 4.9 arc seconds across, no bigger than Uranus. The difference is that Mars can get closer and larger, which it will do over the next few months, until it reaches opposition in early April 2014. For now, however, Mars remains a disappointing telescopic target, with a disc too small to reveal much detail.

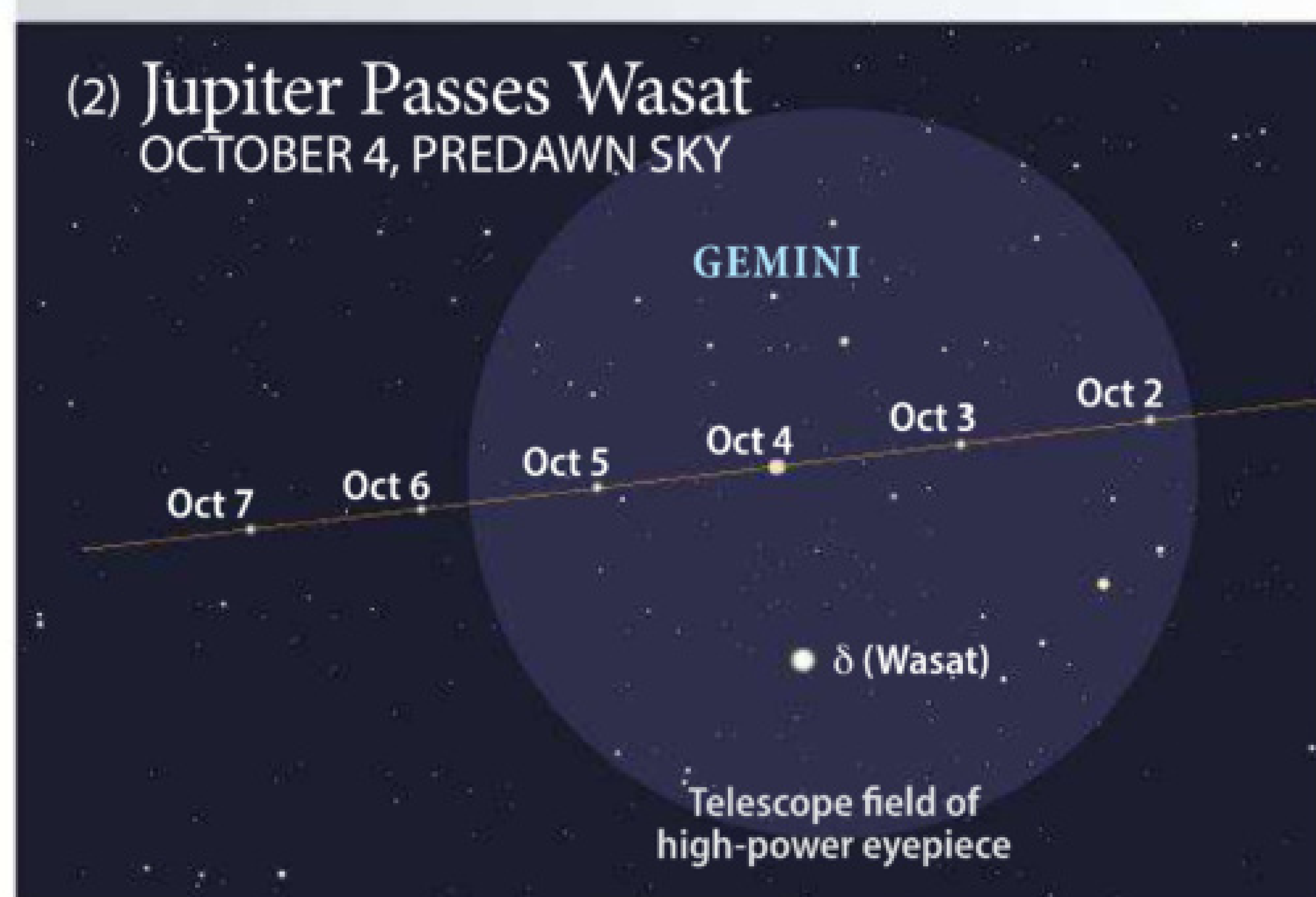
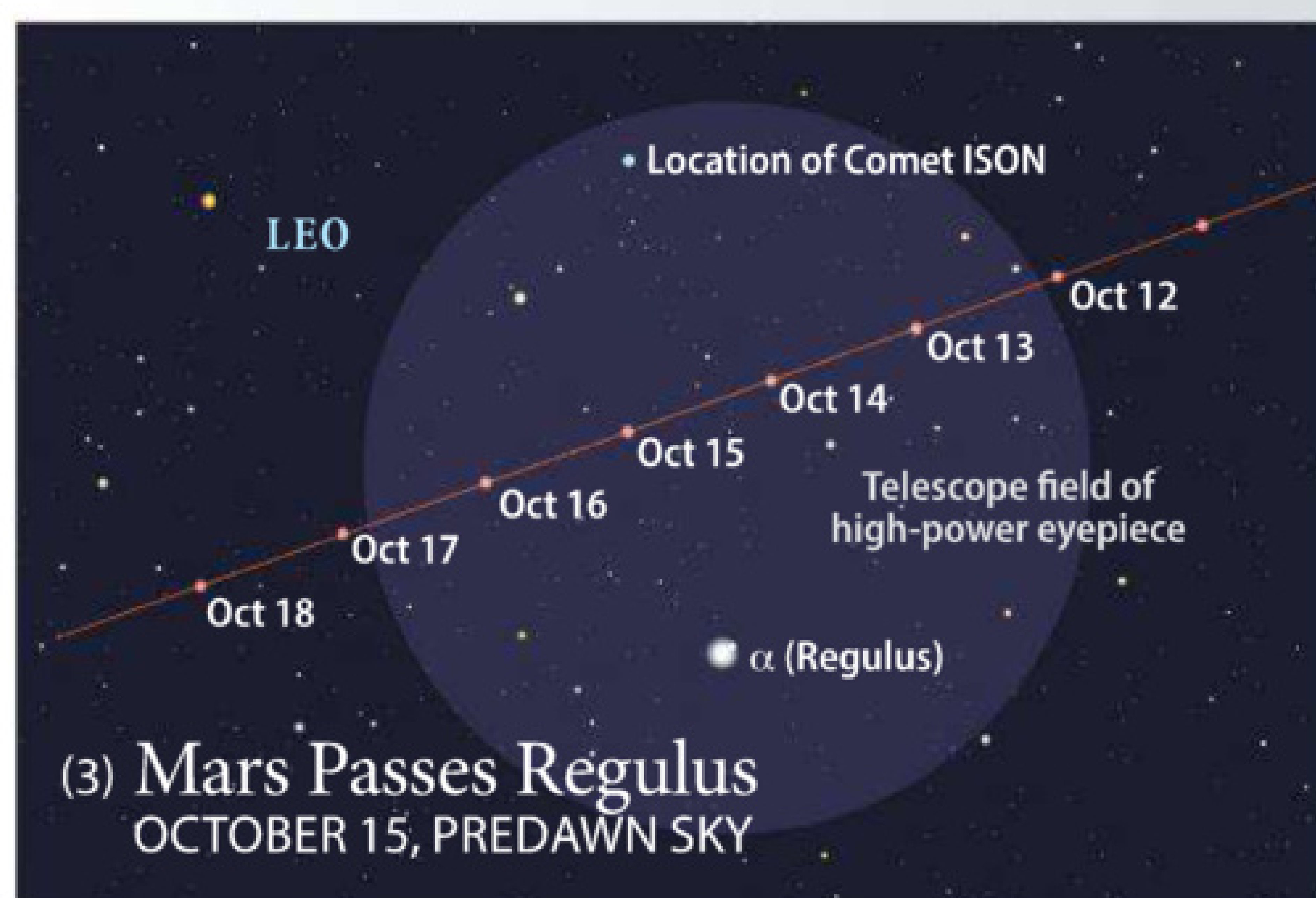
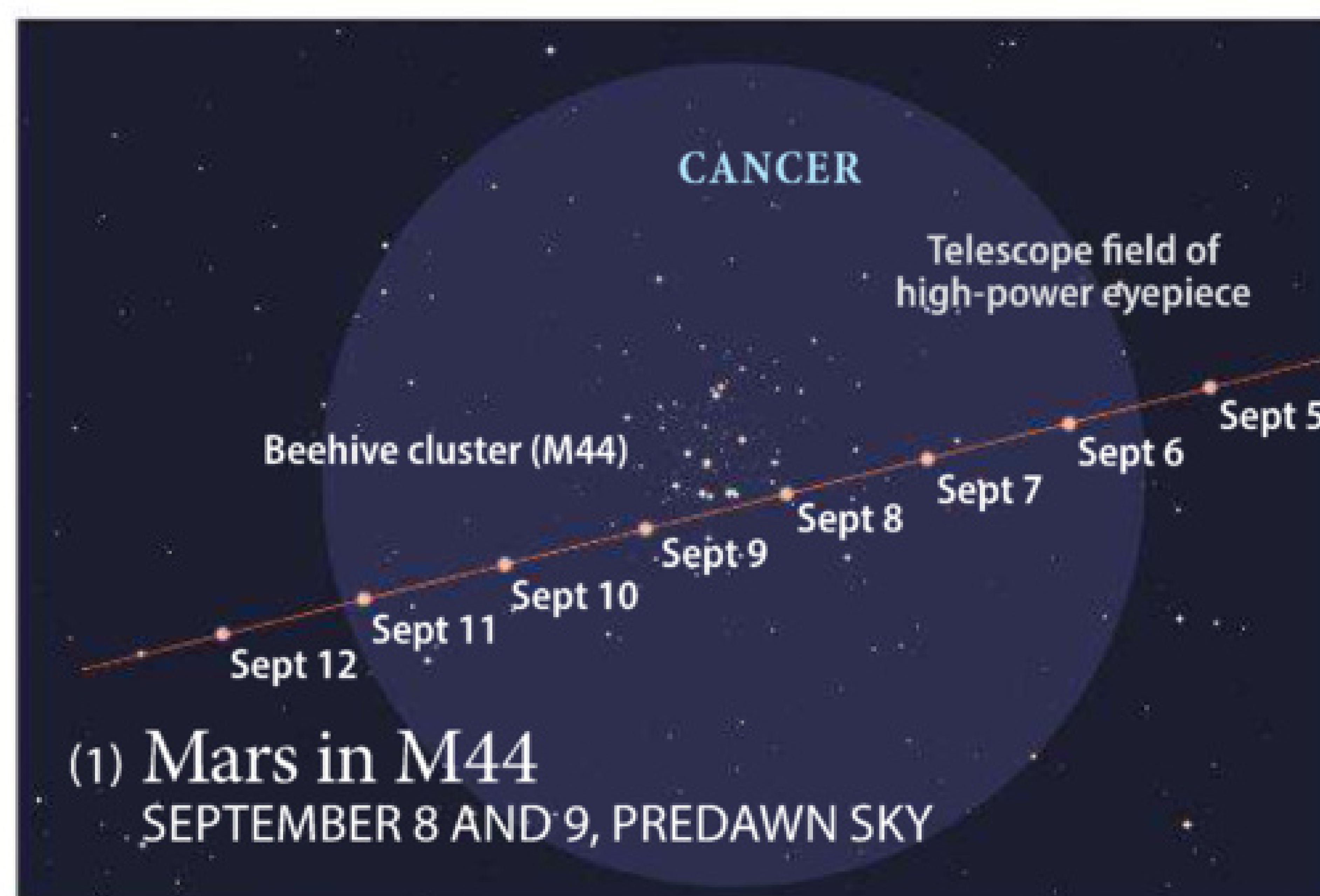
But viewing Mars is not without its attractions this autumn. On September 8



THE WANING MOONS OF OCTOBER By late October, Jupiter and Mars rise in the middle of the night and are shining in a dark sky when the waning crescent Moon again comes calling for respective conjunctions on October 25 and 29. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (BOTH)

PLANET PASSAGES This season, both Mars and Jupiter experience close encounters with bright stars. Mars shoots through the Beehive star cluster in September, then passes near Regulus in October. Also in October, Jupiter comes very close to the bright star delta Geminorum (Wasat).

WHEN TO WATCH (1) Get up before dawn to see Mars shining amid the stars of the Beehive star cluster (M44) on the mornings of September 8 and 9. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (2) On October 4, Jupiter passes a scant six arc minutes (0.1 degree) north of the 3.5-magnitude star delta Geminorum, a.k.a. Wasat, from the Arabic for “middle.” (3) On the morning of October 15, Mars is closest to Regulus, passing a degree north of Leo’s brightest star. Comet ISON is then just one degree north of Mars. COURTESY THESKYX™/SOFTWARE BISQUE (BOTH)



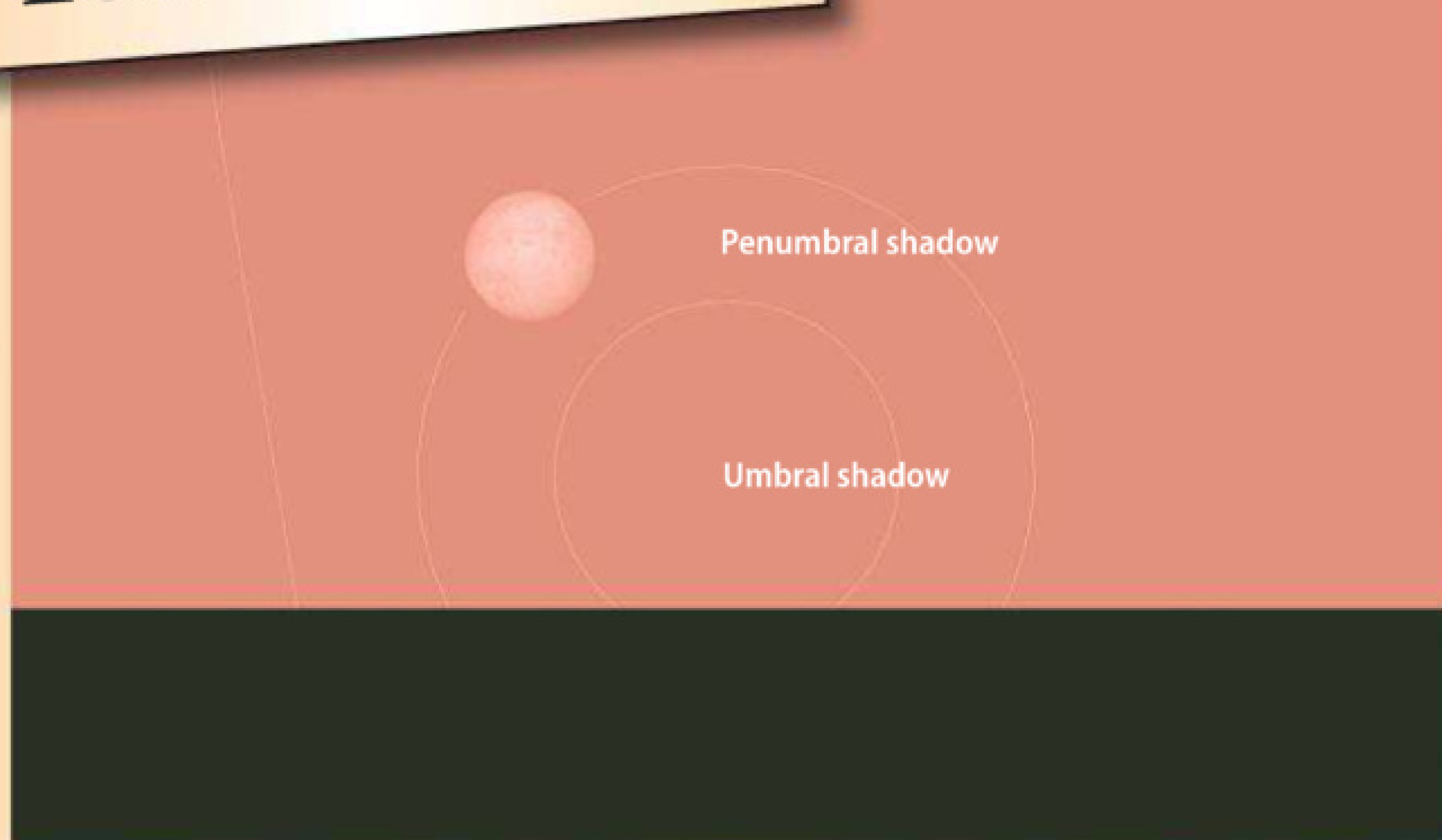
and 9, get up before dawn to see the red planet embedded in the Beehive star cluster. Then look that evening to see Venus near the crescent Moon.

By October, Mars has moved from Cancer into Leo, where it will pass just one degree above Regulus on October 15. At the same time, Comet ISON (C/2012 S1) is also travelling through Leo and appears close to Mars in our sky.

Contrary to the case at most conjunctions, Comet ISON doesn't merely appear close to Mars, it actually is close to the planet in real space. On October 1, Comet ISON lies just 10.8 million kilometres from Mars and may become an observing target of the various Mars spacecraft.

This is not to be confused with Comet Siding Spring (C/2013 A1), which will come 40 times closer to Mars on October 19, 2014—within 240,000 kilometres! For a time, chances looked good that this comet might, in fact, hit Mars. If it were to collide with Mars, it would blast out a crater about 40 kilometres across. But with more observations, astronomers refined their orbital data, and such a cometary impact has since been all but ruled out. ♦

Penumbral LUNAR ECLIPSE



MOONRISE, OCTOBER 18 The Hunter's Moon rises on the evening of October 18 with the full Moon partially embedded in the outer penumbral shadow of our planet. While the eclipse will dim the Moon slightly, the difference is detectable only in photographs. To the eye, the full Moon will look no different. Mideclipse—when the penumbral darkening is greatest, such as it is—occurs at 7:50 p.m., EDT (5:50 p.m., MDT). From Alberta, the Moon is already within the penumbral shadow when it rises, as shown here.

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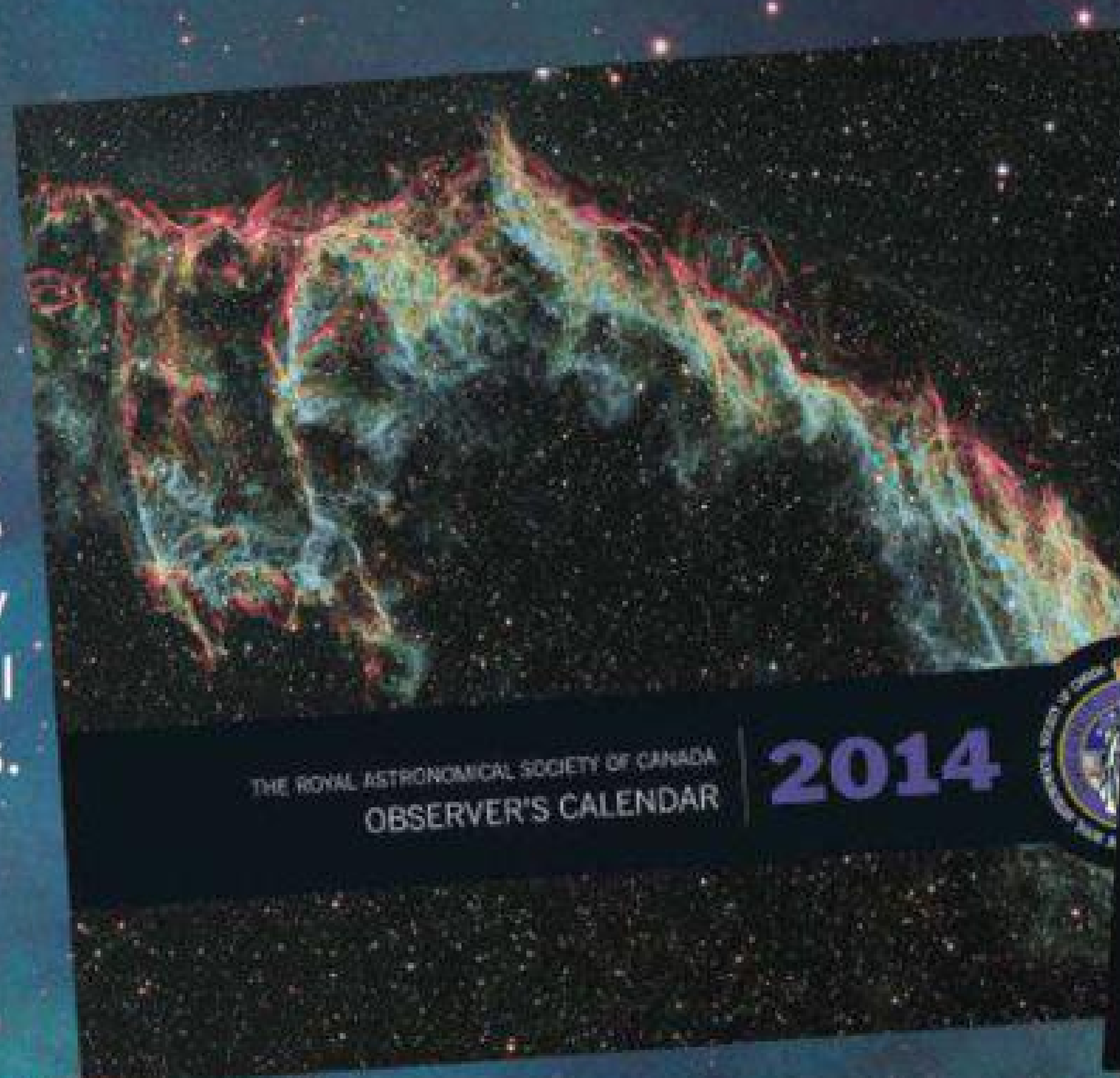
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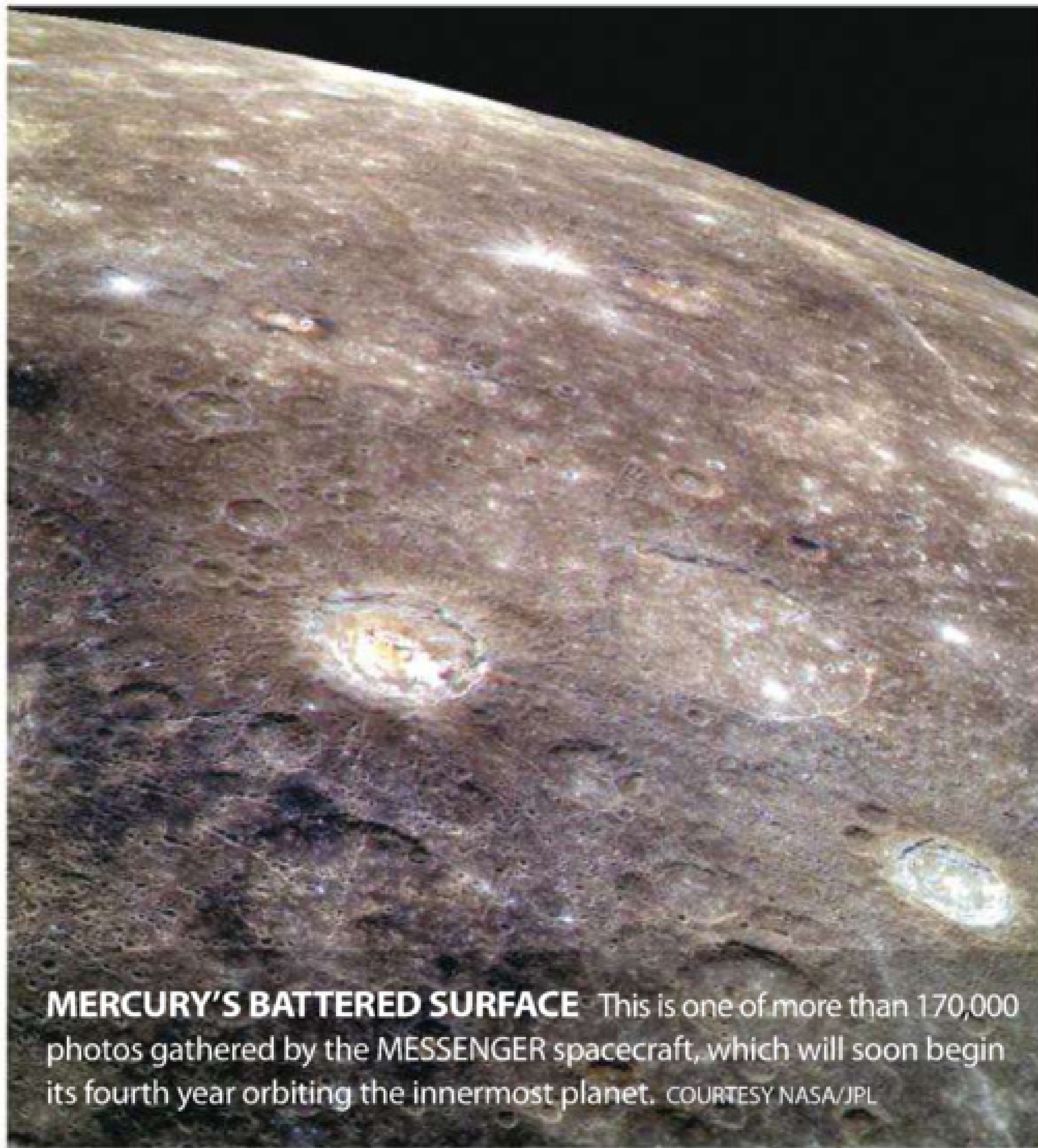
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RECENT ROBOTIC



MERCURY'S BATTERED SURFACE This is one of more than 170,000 photos gathered by the MESSENGER spacecraft, which will soon begin its fourth year orbiting the innermost planet. COURTESY NASA/JPL

MERCURY

Orbiting Mercury since 2010, the MESSENGER spacecraft has recently completed its two thousandth circuit. It has fulfilled its prime mission objectives plus a one-year extension. Among its accomplishments, MESSENGER has imaged 100 percent of the planet's surface, including all areas not seen by Mariner 10 in the mid-1970s. NASA is currently considering a second mission extension during which MESSENGER will image areas of scientific interest at higher resolution.

MOON

A puzzling lunar feature first discovered during the 1968 Apollo Moon missions has now been explained using data from NASA's completed Gravity Recovery and Interior Laboratory (GRAIL) mission, which flew two identical space probes (nicknamed Ebb and Flow) over the lunar surface to measure the Moon's gravity. Mass concentrations, or mascons, under the lunar surface tugged at the Apollo Moon-orbiting spacecraft, affecting their trajectories.

Combining data from GRAIL's twin spacecraft with high-resolution images of the lunar surface taken by the Lunar Reconnaissance Orbiter, NASA scientists have determined that the mascons were created when large asteroids and comets impacted a much younger and hotter Moon. Mascons found on Mars and Mercury would have been formed in the same way.

The largely unheralded robotic space program continues to expand the frontiers of space exploration

by Randy Attwood

MARS

When Mars passed behind the Sun this spring at solar conjunction, the two active rovers on the red planet, Curiosity and Opportunity, were temporarily parked and out of communication with Earth. They resumed exploration—and communication—in May.

The Mars Science Laboratory mission, with its rover Curiosity, celebrated one year on the planet in August and has accomplished one of its objectives: to determine whether the environment on Mars was ever able to support small life-forms called microbes. The Mars rock powder Curiosity analyzed this spring revealed that the landing site had conditions favourable for microbial life in the distant past. Curiosity obtained a second sample from a different site, and the results on this sample are pending.

Curiosity is now trundling toward its prime objective, the base of Mount Sharp, eight kilometres away. By studying the rock layers visible in Curiosity's images of the mountain, scientists hope to learn more about the early Martian environment.

Meanwhile, Opportunity—the remaining functioning rover of a pair launched in 2003 as part of the Mars Exploration Rovers mission—will celebrate 10 years on Mars in January. Having travelled



LONG DESERT TREK AHEAD The Curiosity Mars rover, the largest and most capable wheeled vehicle on Mars, will propel itself across this rock-strewn landscape during the coming months. COURTESY NASA/JPL

SPACE VENTURES

36.2 kilometres since landing on the red planet in 2004, Opportunity continues to rove the surface and transmit information to scientists at mission control in Pasadena, California. The twin rovers were expected to last for three to six months on the Martian surface. Spirit ceased operations during the Martian winter in 2010.

PLUTO

On July 14, 2015, NASA's New Horizons will hurtle through the Pluto system, becoming the first spacecraft to visit a solar system body beyond Neptune. The flyby will occur more than 50 years after space probes from Earth began visiting other objects in the solar system.

The discovery of two new moons of Pluto in July 2011 and July 2012 led to concerns regarding the amount of dust that might be present in the Pluto system. Collisions with dust and debris could disable New Horizons, which is travelling at 14 kilometres per second. Since science observations are recorded for later playback, mission controllers wanted to ensure that New Horizons survives the flyby. After a year of study, NASA has announced that the risk of collision is small and that the original trajectory will be used. This is good news, because years of preparation have gone into maximizing every second of the flyby, which will last for only a few hours.

Meanwhile, the public was invited to vote on names for Pluto's newly discovered fourth and fifth moons. The winners: Styx, the mythological goddess who ruled the underworld's River Styx, and Kerberos, a many-headed dog that guarded the entrance to the underworld.

ROBOTIC REFUELLING MISSION UPDATE

Communications satellites are technically very sophisticated and are expensive to build and launch. Put into geostationary orbits, they circle Earth about 36,000 kilometres above the equator, maintaining their position by deploying small rocket jets. They rarely break down, and their lifetime is dictated by how long their fuel lasts. It may, therefore, be cost-effective to send robotic refuellers into geostationary orbit to visit these satellites and top up their tanks. NASA and the Canadian Space Agency are working together to develop the technology to robotically refuel and repair satellites.

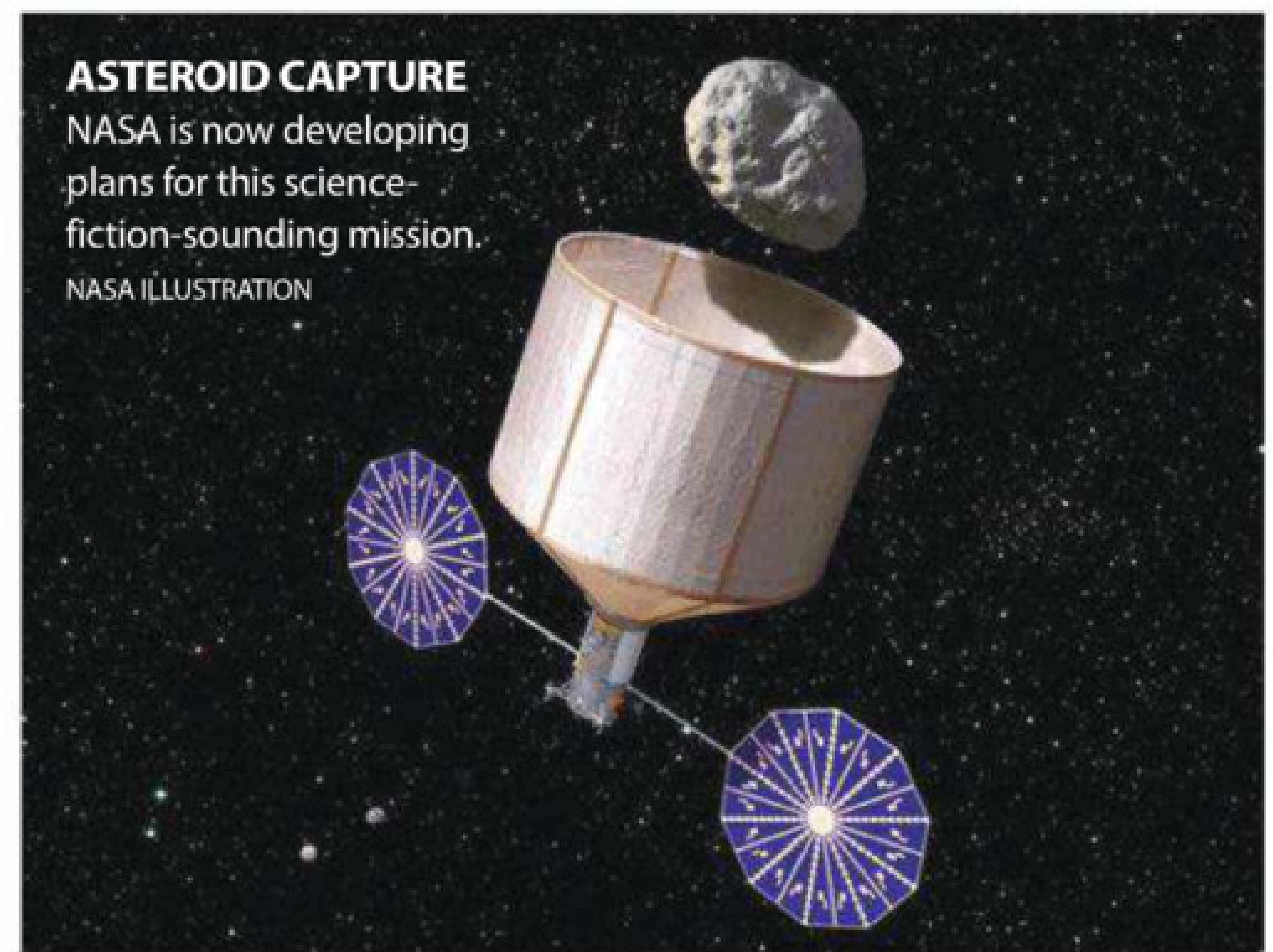
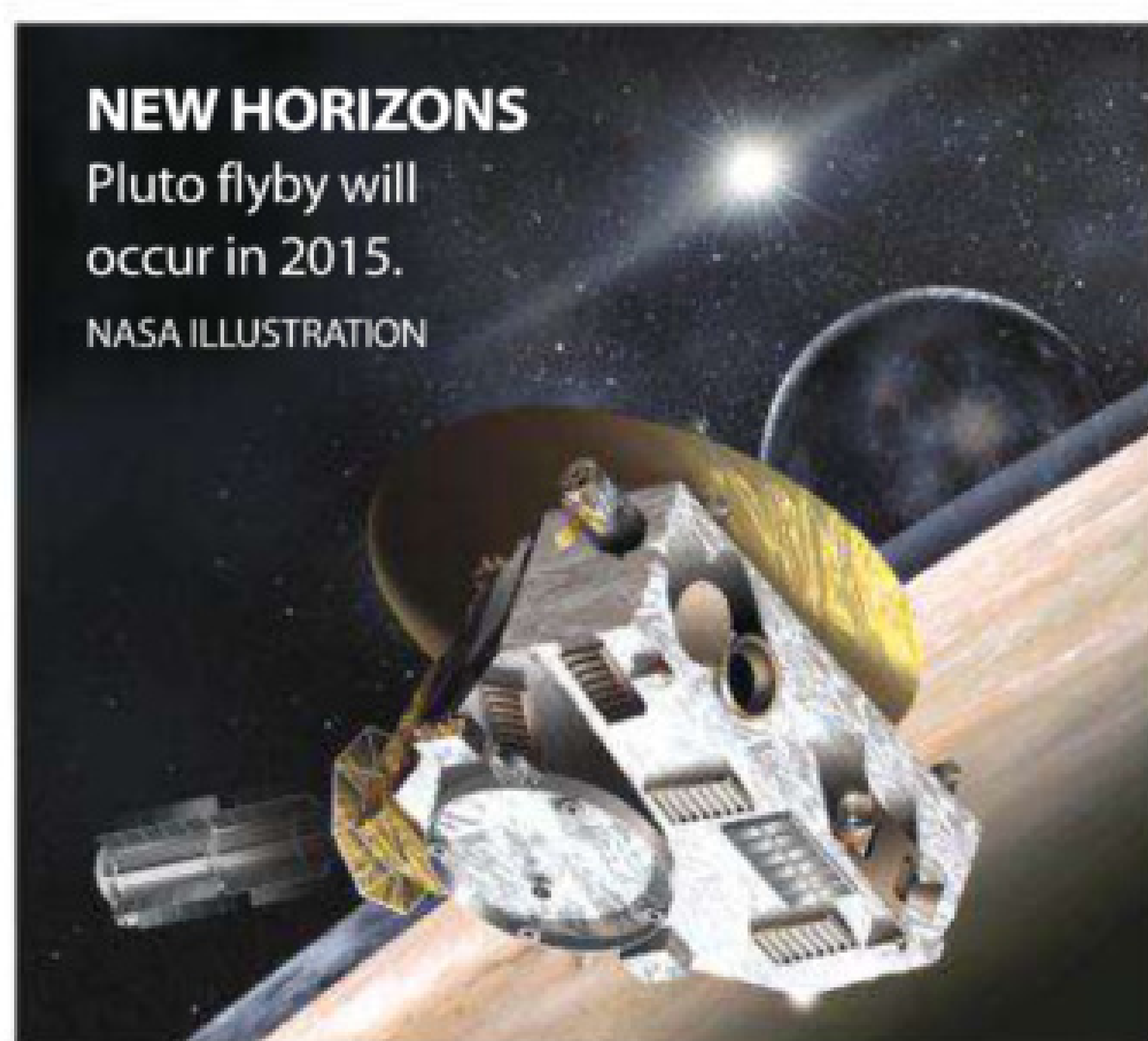
The Canadian-built robotic arm (Canadarm) on the International Space Station (ISS) and the Special Purpose Dexterous Manipulator (Dextre), a dual-armed robotic handyman, were used to work on a module launched to the ISS on the final flight of the space shuttle in 2011. Best described as the equivalent of a Fisher-Price activity centre for robotics, the cube-shaped module is equipped with four special tools for Dextre to use on a mock-up of valves, caps, wires and protective blankets that must be unscrewed, moved, cut and attached to refuel a satellite. It even contains 1.7 litres of ethanol to simulate the actual refuelling process. The first phase of tests was successfully completed in May. Further tests are scheduled for later this year and in 2014.

ASTEROID RETRIEVAL

In June, NASA announced plans for an asteroid-capture mission that sounds as though it's been lifted right out of a science fiction story. Using a robotic spacecraft, mission controllers will capture a small near-Earth object and redirect it into an orbit around the Moon. Any asteroid that is 7 to 10 metres in diameter, is orbiting the Sun and occasionally comes relatively close to Earth is classified as a small near-Earth object.

To redirect the asteroid, the spacecraft will use solar electric ion propulsion, a technology used by spacecraft such as Dawn, which is currently exploring the asteroid belt. Once the asteroid is in lunar orbit, astronauts will visit it as early as 2025. Lessons learned from this mission will be applied to redirect asteroids that could collide with Earth and to future deep-space missions, perhaps to Mars. ♦

This new column by Canadian space-exploration expert Randy Attwood will appear from time to time with status reports and updates on current space missions.



Highs and Lows on the Moon

As any telescope will show, the lunar surface is a rough-and-tumble place dominated by an amazing array of deep craters and high mountains. But how deep and how high? Until the 2009 Lunar Reconnaissance Orbiter mission, no one knew with much precision.

ON OUR PLANET, elevation is measured with respect to sea level. The Moon, inconveniently for mapmakers, has no oceans, so there is no corresponding zero point from which the heights of mountains or the depths of craters can be referenced. Instead, lunar scientists utilize a sort of “dry” sea level—the Moon’s mean radius of 1,737.4 kilometres. Features higher than that are given positive elevation values; those lower have negative values.

Results from the Lunar Reconnaissance Orbiter (LRO), which NASA launched in June 2009, have yielded a topographic map of unprecedented detail, giving us the most complete picture of our nearest neighbour

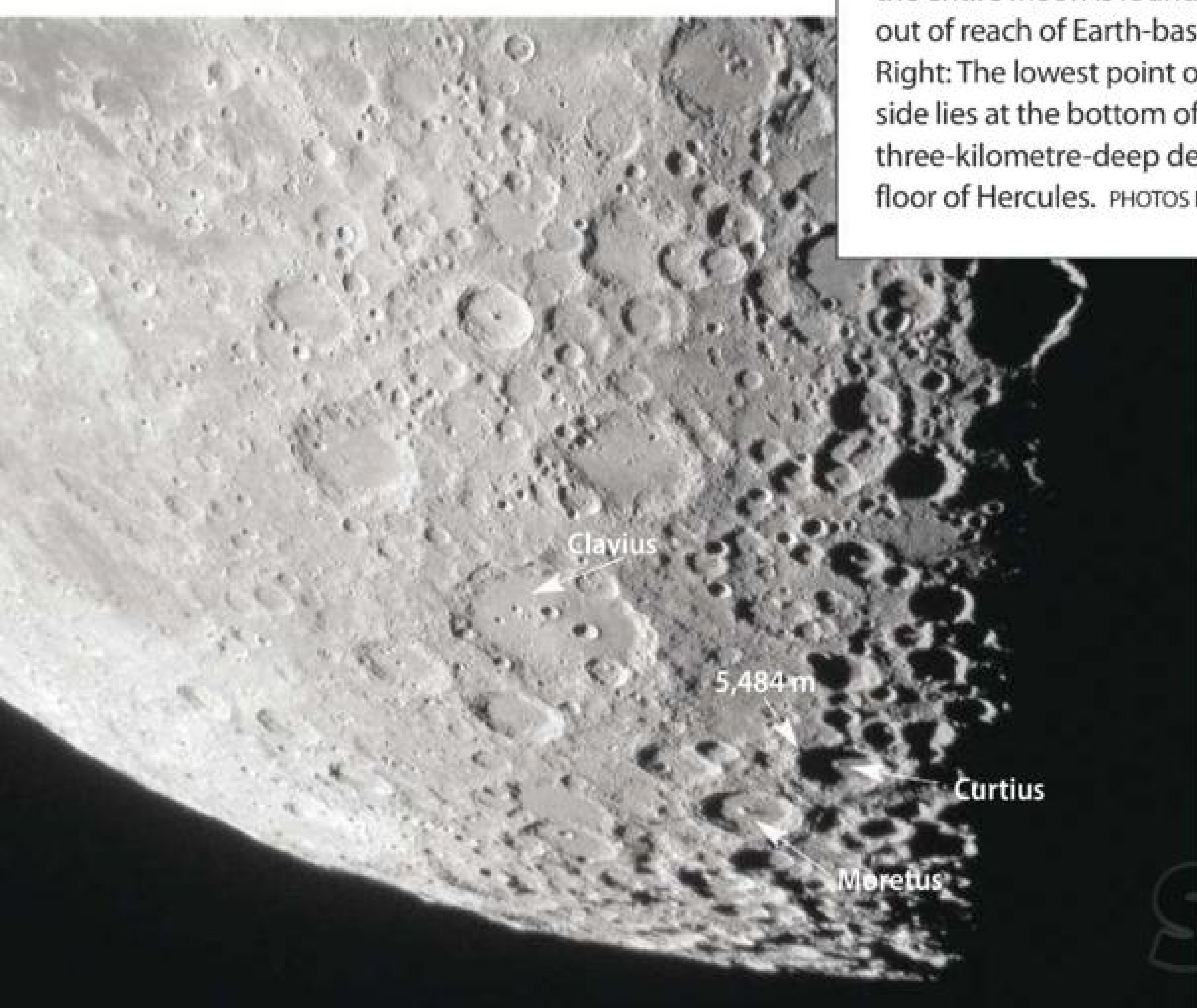
yet. Unfortunately for telescopic observers, the most dramatic topography is found on the Moon’s far side—permanently out of reach. And that includes the highest highs and the lowest lows. Indeed, the highest point on the entire Moon rises to an impressive elevation of 10,786 metres on an otherwise unremarkable patch of terrain near the rim of the 44-kilometre-wide crater Engel’gradt. For context, consider that the Earth’s tallest mountain, Mount Everest, rises some 8,848 metres above sea level—

nearly 2,000 metres lower than the lunar high point.

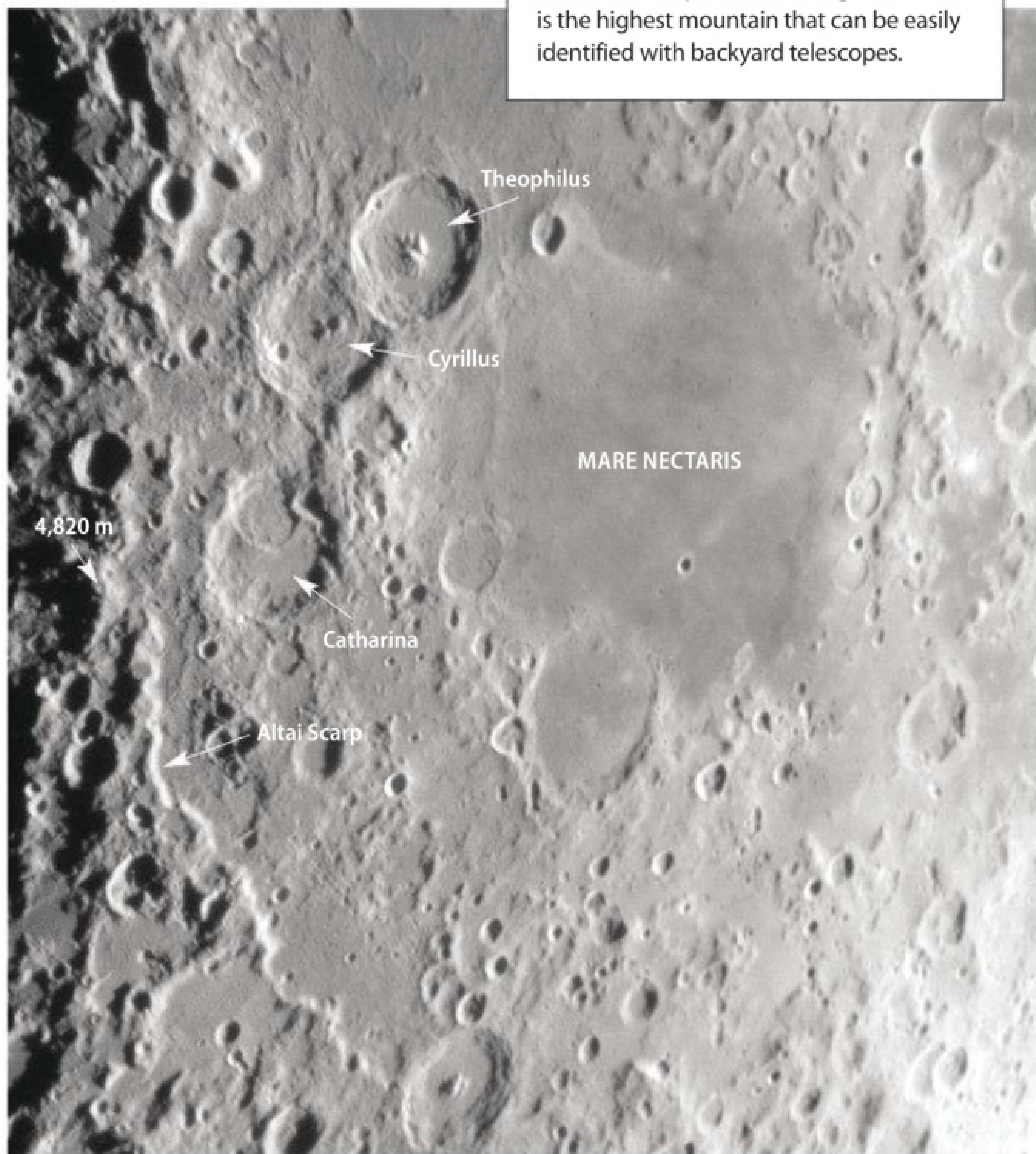
Leaving aside the far side of the Moon, let’s take a look at the hemisphere accessible in our telescopes. Here, we find the greatest elevation point on the northwest rim (keep in mind that east and west on the Moon are opposite sky directions): the 73-kilometre-wide crater Nobile. This piece of topography stands 7,025 metres above the lunar mean radius. But actually viewing this region is a challenge. Positioned along the Moon’s southern edge, Nobile is hard to identify with certainty even when libration favourably tilts this limb toward us. The highest point you can see without terrible difficulty lies northeast of the magnificent

LUNAR HIGHS AND LOWS

Left: Near the rim of 95-kilometre-wide Curtius lies the second highest point on the lunar near side. The highest point on the entire Moon is found on the far side, out of reach of Earth-based telescopes. Right: The lowest point on the Moon’s near side lies at the bottom of Hercules G, a three-kilometre-deep depression on the floor of Hercules. PHOTOS BY GARY SERONIK



RIM SHOT The most impressive lunar mountains are actually the rims of impact basins, like those encircling Mare Nectaris. A 4,820-metre peak in this range (indicated) is the highest mountain that can be easily identified with backyard telescopes.



111-kilometre-wide crater Moretus and near 95-kilometre-diameter Curtius. There, along the northwest rim of Curtius, is a 5,484-metre-high hill.

Perhaps the highest point on the near side that is most mountainlike is a peak forming part of the Altai Scarp, the main rim of the Nectaris Basin. The tallest summit in this impressive range is situated due west of the giant crater Catharina. But this mountain is only 4,820 metres high—less than half the elevation of the far side's record holder.

Fortunately, the Moon's deepest near-side point is quite easy to locate. Train your telescope northeast of Mare Serenitatis, and zero in on the crater pair of Atlas and Hercules. Look closely at the floor of Hercules, and you'll find the 14-kilometre-wide simple crater Hercules G. The bottom of this little bowl-shaped depression lies 6,571 metres below the Moon's mean radius. If

you were an astronaut standing on the rim of Hercules G, the crater floor would lie some three kilometres below, down a gently sloping crater wall. That is nearly twice as deep as Arizona's Grand Canyon.

When it comes to the absolute lowest of lows, however, we once again have to return to the Moon's far side. The bottom of a small depression inside the 143-kilometre-wide crater Antoniadi lies 9,094 metres below the lunar mean radius. But if it's any consolation, the view from the rim of that little crater wouldn't be as impressive as the one from Hercules G. The floor of the Antoniadi craterlet is only about 2,500 metres lower than its rim crest. At least in this one respect, the near side has it over the far side. ♦

Lunar observers will find a wealth of information at Gary's website: www.garyseronik.com.

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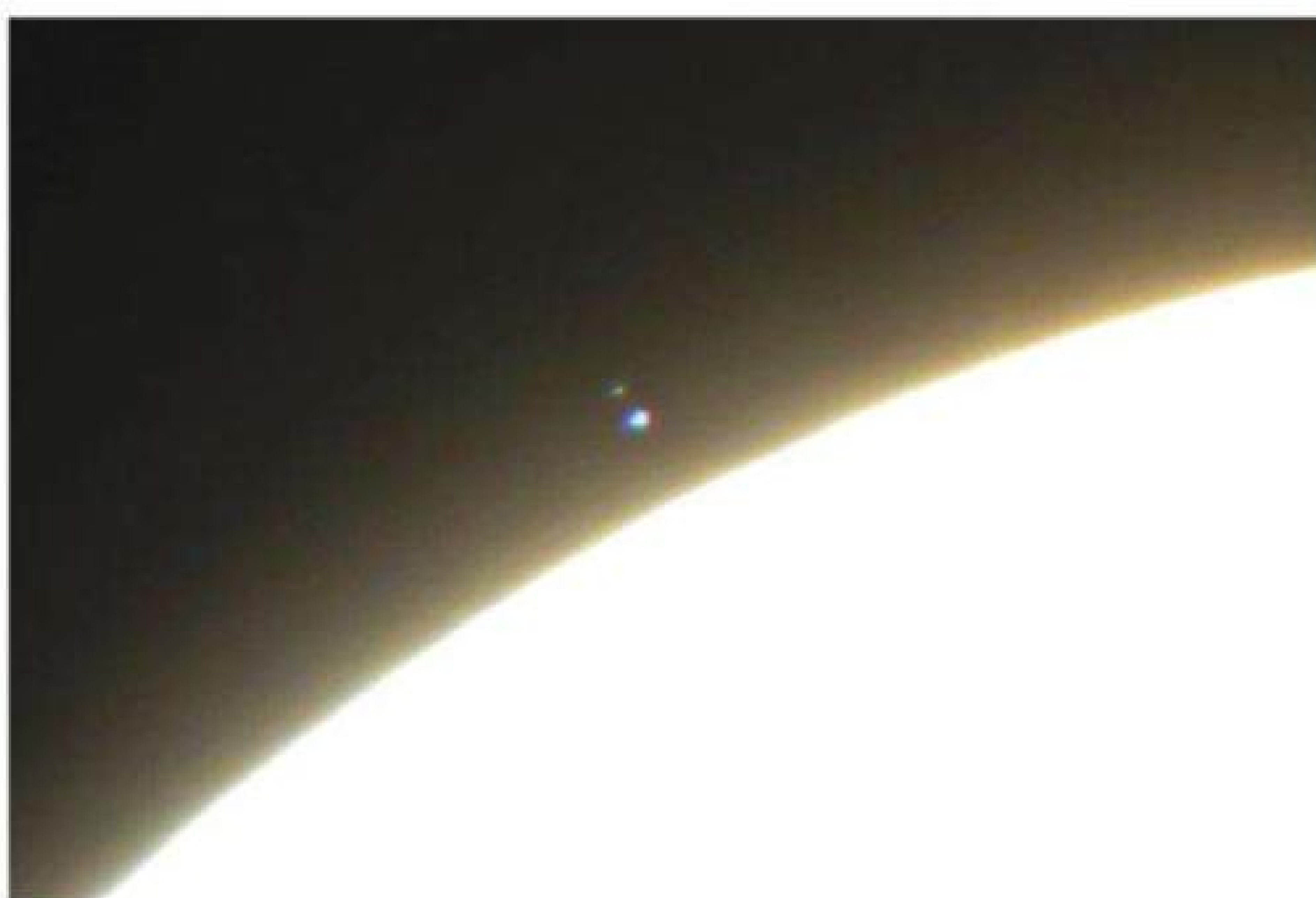
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SKY FALL

With auroras apparently on the upswing across Canada this year and the star clouds of the Milky Way now high in the evening sky, it is prime astrophoto season. Got an image we should consider? Send a jpeg along with camera and location details to editor@skynews.ca.



▲ **DOUBLE STAR OCCULTATION** On the evening of May 24, Dave Hackney of Mississauga, Ontario, was observing the full Moon and the emergence of the double star beta Scorpii from behind the Moon during an occultation when he took this ¼-second exposure at ISO 100. He recorded the event using a Nikon Coolpix S8000 point-and-shoot camera held at a 24mm wide-angle eyepiece on his Celestron 8-inch Schmidt-Cassegrain telescope.



◀ COMET PANSTARRS IN JUNE

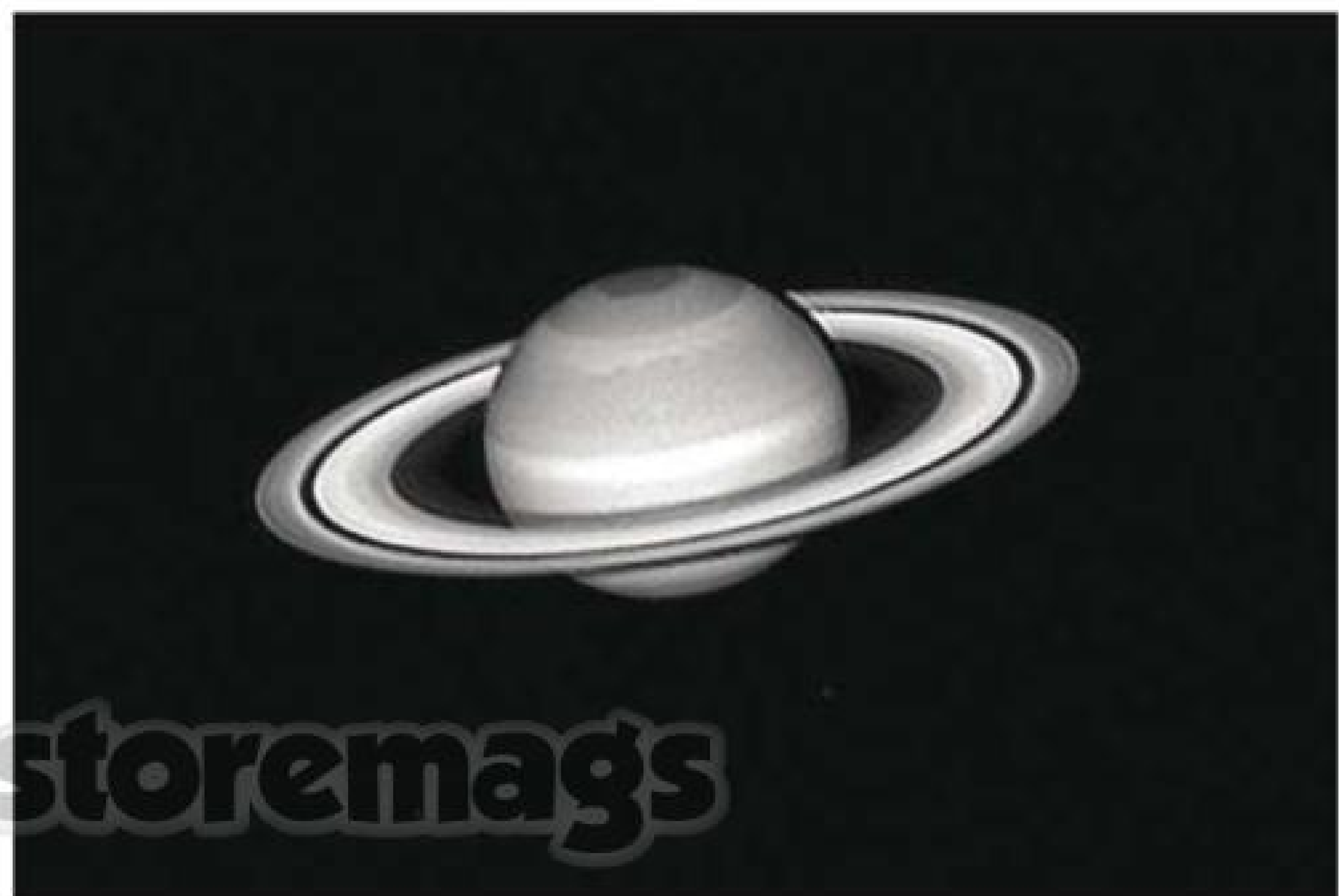
From his cottage near Plevna, Ontario, Gary Colwell used a Takahashi 106mm FSQ apo refractor at f/3.8 to reveal what looks like two tails on Comet PanSTARRS on June 14. Actually, there is only one broad fan-shaped tail, but it appears as two from the Earth's perspective. At the time this image was taken, the comet was about 10th magnitude and 300 million kilometres from Earth. This single 2-minute exposure was gathered with a filter-modified Canon XSi DSLR.



▲ **SASKATCHEWAN SKIES** One of the best places in the world for aurora watching, the Canadian prairies sometimes display multiple celestial treats. In this June 9 image, Colin Chatfield of Saskatoon captured not only a captivating aurora but also a bank of noctilucent clouds (at lower left) from beside a small lake 10 kilometres outside of town. A Canon 7D was used with a Tokina 10-17mm fish-eye lens at ISO 800 for the 15-second exposure at f/3.5.

► **SATURN'S ELUSIVE ENCKE GAP**

Rarely do images of Saturn taken by backyard astronomers reveal as much detail as shown in this May 23 portrait by Canadian Mike Wirths, a regular *SkyNews* contributor now living in northern Baja, Mexico. Note the narrow 320-kilometre-wide division known as the Encke gap located near the outer edge of the outermost ring, a feature notoriously difficult to record. A 2.5x Powermate and DMK 21AU04 CCD camera recording at 117 frames per second were used on an 18-inch Newtonian.





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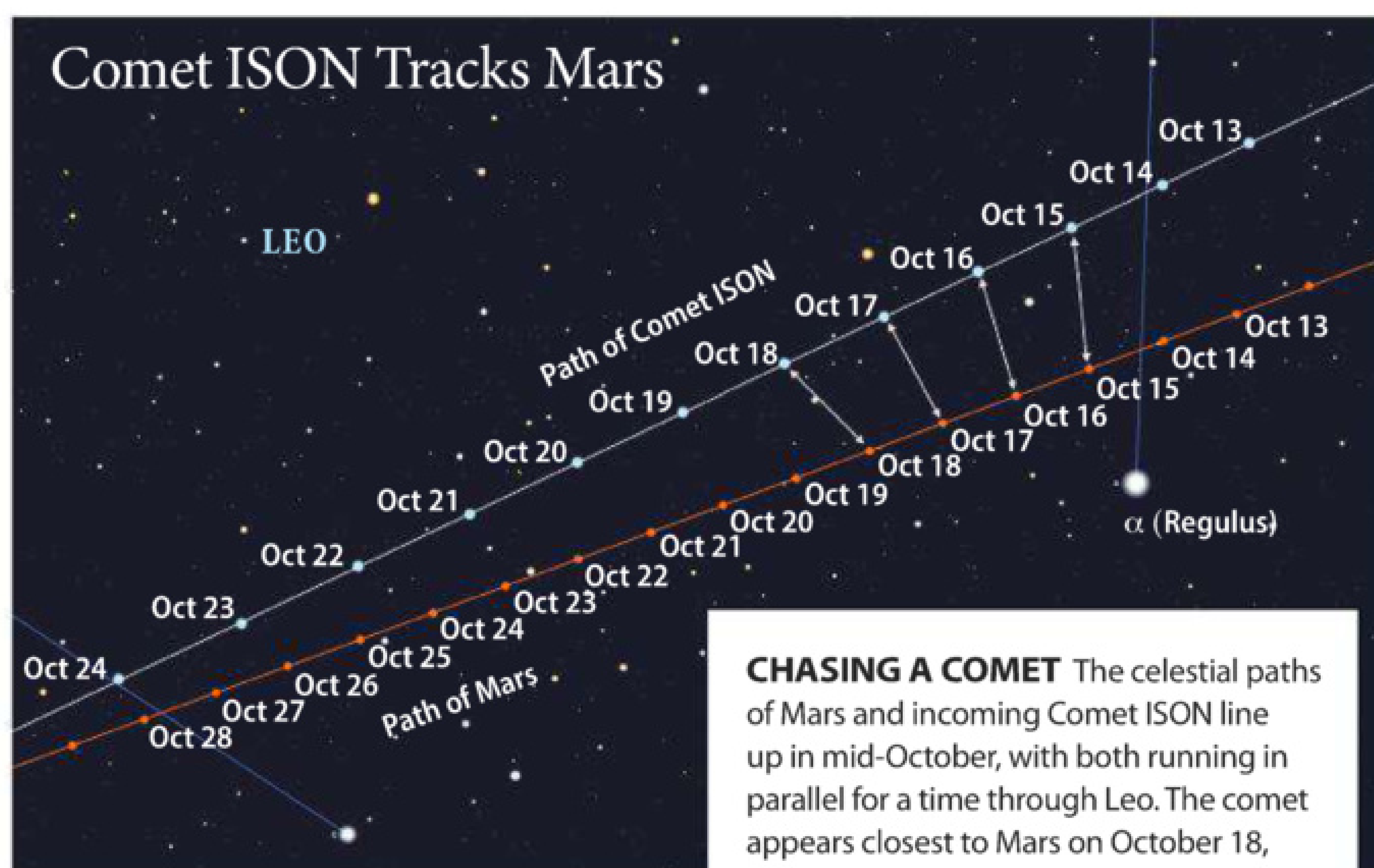
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PROSPECTS FOR COMET ISON

Comet ISON might be the brightest comet seen from Canada since 1997 (emphasis on 'might') *by Alan Dyer*



CHASING A COMET The celestial paths of Mars and incoming Comet ISON line up in mid-October, with both running in parallel for a time through Leo. The comet appears closest to Mars on October 18, when it passes one degree north of the planet. ISON is expected to then be hovering around magnitude 9, faint enough to require a telescope to see. Viewing will be hampered by the full Moon. Comet ISON will not brighten significantly until late November as it hastens to its November 28 hairpin passage around the Sun.

COURTESY THESKYX™/SOFTWARE BISQUE

WE CAN ONLY HOPE! The scene below is almost certainly overly optimistic, but if Comet ISON performs well, we might be treated to a view like this on early-December mornings. More likely, the tail will be much shorter and less obvious, requiring dark skies to see and photograph. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP.



DURING the next few months, all astronomical eyes—both human and robotic—will be turned to Comet ISON, watching how it behaves. Will it track predictions and brighten as we hope it will, promising a great performance in November and December? Or will it remain dim, fuelling pessimistic scenarios?

There will be more to report in the November/December *SkyNews*, but as of this writing in late June, this potentially “great comet” had not brightened as predicted. Instead, it was doing what many first-time cometary visitors to the inner solar system do, flatlining in its brightness increase after an initial outburst far from the Sun.

Comet ISON won't be visible in a dark sky until late this summer, but it may be well into October before we detect a clear trend on how it is brightening as it falls toward the Sun. Comet experts have been predicting that ISON may put on its best performance in the two weeks following its November 28 close perihelion passage around the Sun, when it emerges into the moonless dawn sky in early December. Comet ISON may then sport a beautiful tail rising up from the eastern horizon in the dawn twilight. But as with Comet PanSTARRS in March and April, you'll need to be in a dark sky to see ISON well and to get good photos.

In short, while ISON might surprise us and blossom into a comet bright enough to see from within city limits, *the more likely scenario is that we will get a comet that looks wonderful only to those who make the effort to travel to dark and clear skies on a cold December morning.*

By mid- to late December, when ISON has moved into our evening sky for more convenient viewing, it may have faded so much (to between magnitude 4 to 6) that it will be suitable only for binoculars or photographs and may not be naked eye. For more details about observing Comet ISON, see our regularly updated Comet ISON reports at the *SkyNews* website (www.skynews.ca) starting in September. For general background, see http://en.wikipedia.org/wiki/Comet_Ison.

With 21st-century urban light pollution and December's predawn weather, skywatchers have a challenge. ♦

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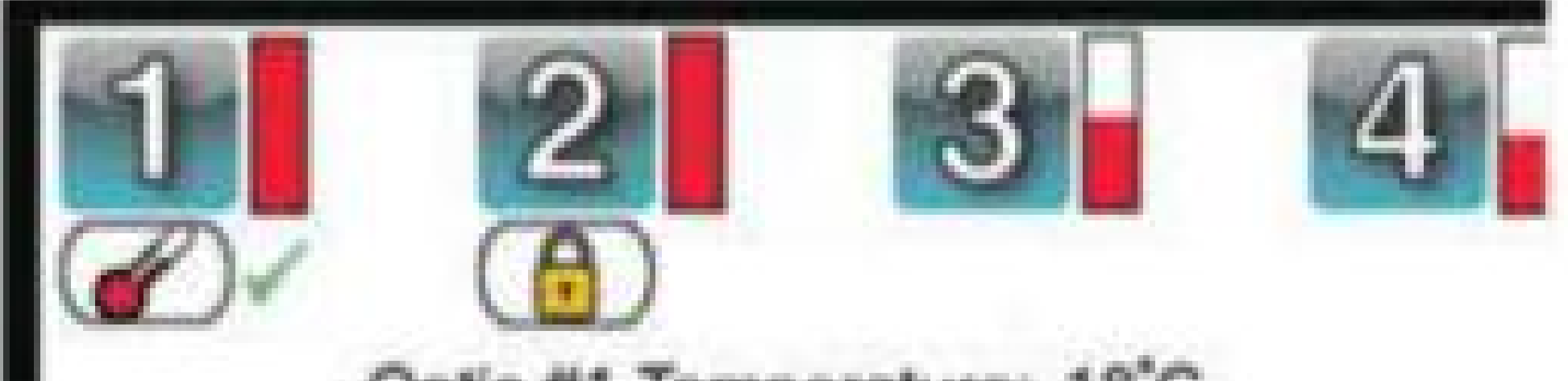


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Refining Our Place in the Milky Way

Using somewhat unscientific language in a news release in June, the National Radio Astronomy Observatory, in Charlottesville, Virginia, announced that 'our solar system's Milky Way neighbourhood just went upscale'

TODAY'S ASTRONOMY TEXTBOOKS ALL SHOW our Sun and solar system residing in a ho-hum distant suburb of the Milky Way Galaxy, far from the glowing downtown hub. We live more than halfway out from the galactic core in a region once known as the Orion Spur, nestled between two major spiral arms.

REVISED LOCAL ARM Because Earth is located inside our home galaxy, the Milky Way, the task of mapping the galaxy's structural details has occupied astronomers for well over a century. Today, the major spiral arrangement with its central bar is understood, but some details remain fuzzy. The latest revision in the ongoing mapping process is shown below at right, where the extent and position of our Local Arm has been added.

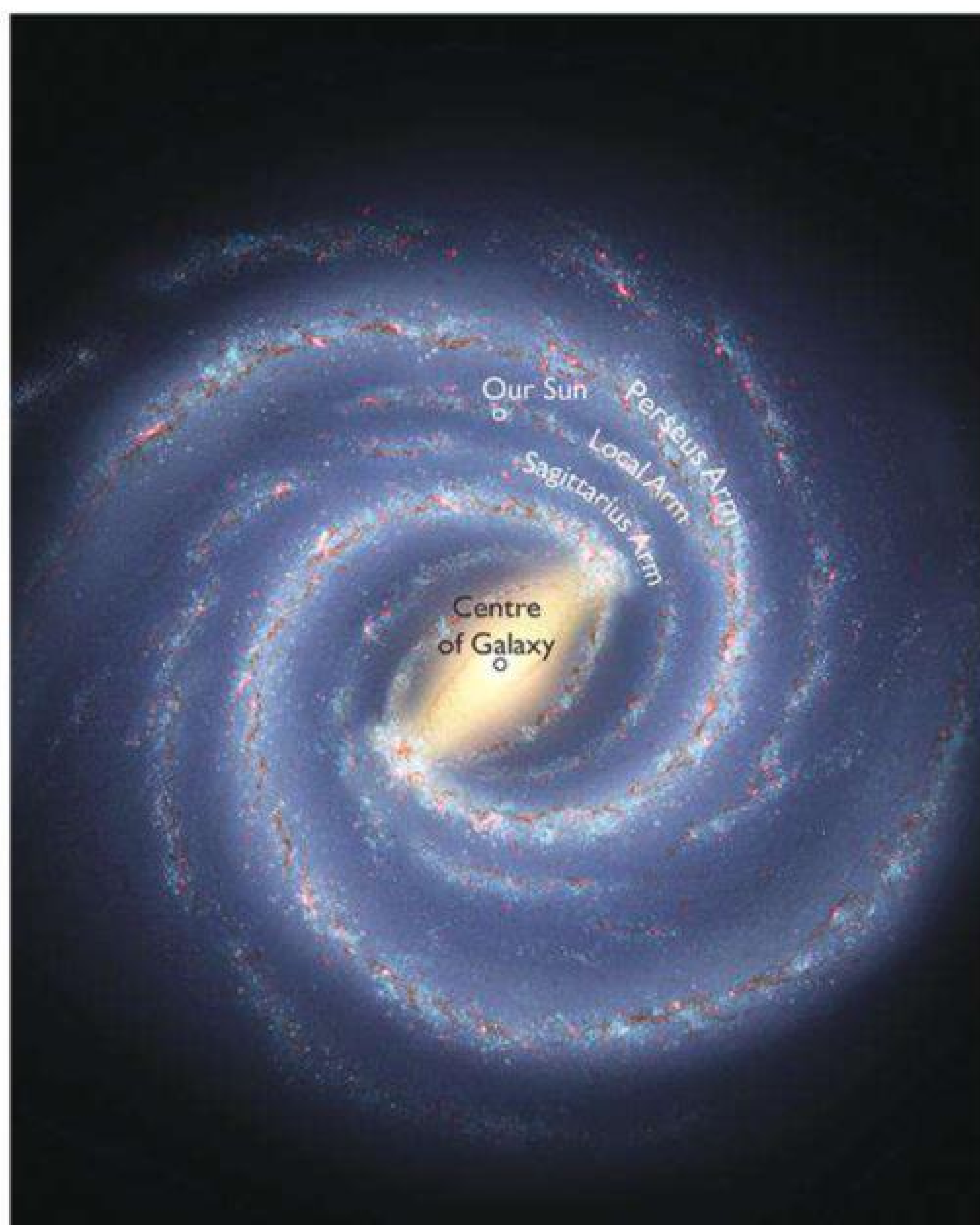
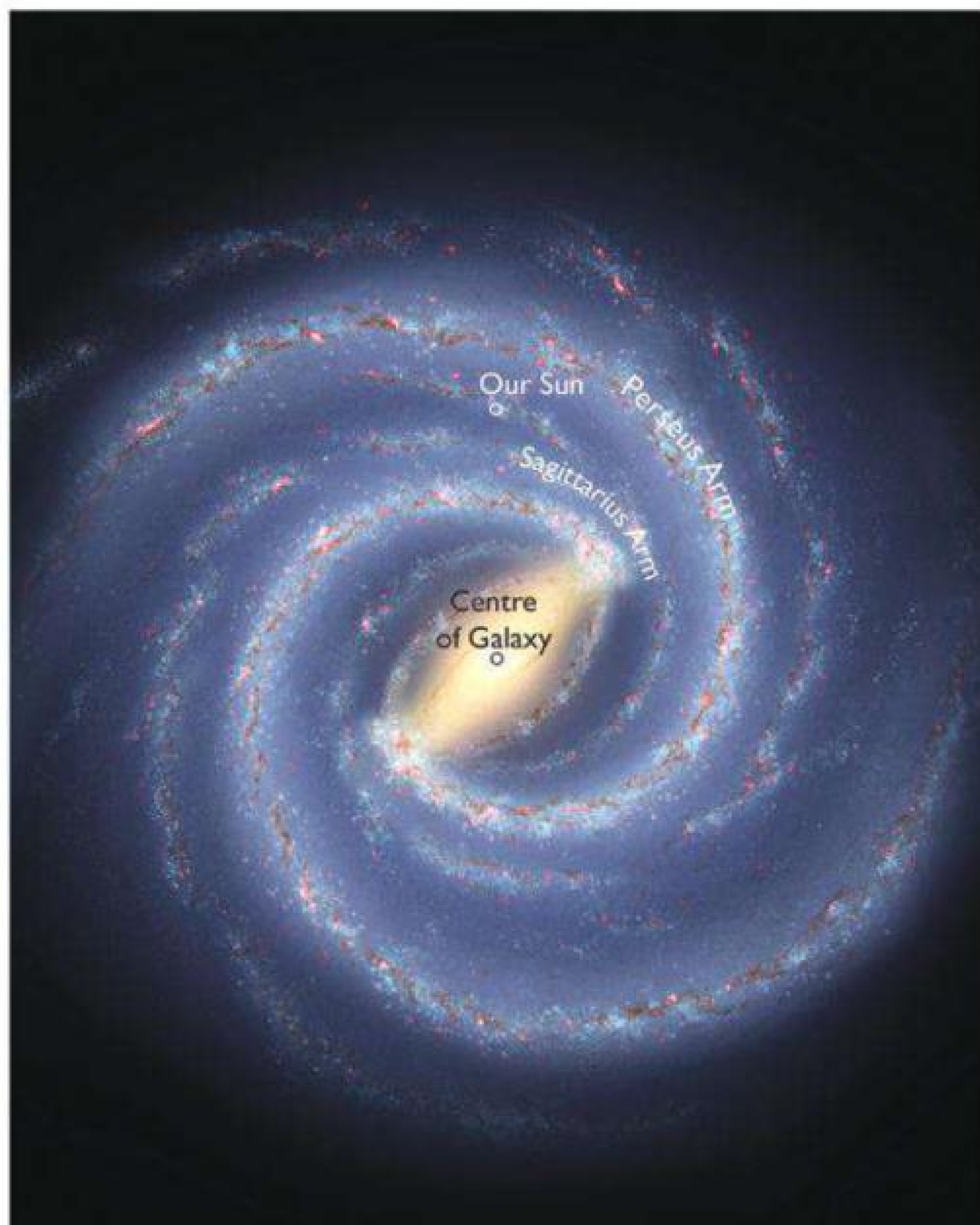
Compare with the previous version at left.

ILLUSTRATIONS COURTESY NRAO

A new high-resolution radio telescope study, which shows that the region where the Sun lives is actually part of a larger, previously poorly surveyed structure radio astronomers have dubbed the Local Arm, has led to a remapping of our sector of the galaxy. We're still tucked between the inner Sagittarius Arm and the beefy outer Perseus Arm, but our stellar byway has more muscle than we thought.

This has been a tricky bit of interstellar cartography because we reside inside the pancake-shaped Milky Way Galaxy, which is laden with dust clouds that block the view of much of the galaxy in visible light. But radio and infrared light can penetrate the dusty smog and let us see clear across the galaxy.

In 2008, infrared observations from NASA's Spitzer Space Telescope resulted in a re-





MIRROR GALAXY If we could view our home galaxy, the Milky Way, from afar, this Hubble Space Telescope portrait of UGC 12158 is probably very close to how it would look. Although UGC 12158 is 50 percent bigger, its shape and spiral structure bear a striking resemblance to the Milky Way Galaxy.

vised map of the Milky Way that showed two major arms—Centaurus and Perseus—attached to the ends of a thick central bar. (The Perseus Arm is labelled in the illustrations on the facing page; the Centaurus Arm is not but is easily identified emerging from the upper end of the galaxy's central bar.)

The major arms consist of the highest densities of both young and old stars. The minor arms are primarily filled with gas and pockets of star-forming activity.

From 2008 to 2012, radio astronomers mapped our galactic neighbourhood using the Very Long Baseline Array, 10 radio telescopes spanning more than 8,000 kilometres. The array yields images as sharp as what would be provided by a single continent-sized dish antenna. With this capability, astronomers were able to use simple trigonometric parallax (using the Earth's orbit as the baseline) to measure distances to nearby star-forming regions. The radio telescopes didn't look directly at stars but picked up emissions of water and methanol molecules in precursor star-birth nebulae that boost microwave frequencies.

As it plies its 250-million-year orbit about the galactic centre, the Sun is just passing through the Local Arm. The name "Local Arm" bothers me. It's as mundane

as "Local Group"—the name given to the small neighbourhood of galaxies that we inhabit.

As the mapping of the galaxy's spiral arms has developed over the past 70 years or so, the structure where our Sun resides has often been called the Orion Arm, or the Orion Spur, when it was thought to be a stump rather than a full arm. Now, because it appears to have more heft, Orion Arm seems more appropriate than Local Arm. But, for the present, we appear to be stuck with Local Arm.

Perusing the Hubble Space Telescope archive of galaxies, I found a look-alike cousin to our new picture of the Milky Way—a spiral in the constellation Pegasus catalogued as UGC 12158, above. Like the Milky Way, it has a small bar structure in the centre and an arrangement of several spiral arms. UGC 12158 is 140,000 light-years across, compared with the Milky Way Galaxy's 100,000 or so, and 400 million light-years distant. The light we are now receiving left UGC 12158 just as life was first crawling out of our oceans. ♦

Ray Villard is news director for the Space Telescope Science Institute at Johns Hopkins University, in Baltimore, Maryland.

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12TH ANNUAL

SkyNews photo of the week contest

RULES AND INSTRUCTIONS (See page 47)

CONTEST CLOSES JUNE 1, 2014.

There are no entry fees or entry forms.

Photos previously submitted to the SkyNews Photo Gallery, including those not published, are automatically eligible. Do not resubmit photos already sent. You may enter as often as you wish, but please don't send more than 10 of your best photos per entry.

Submit digital photos (prints and slides are no longer accepted) in JPEG format by e-mail to SkyNewsPOW@aol.com. Submit photos by mail to: SkyNews, 319 Berriedale Road, Burk's Falls, ON P0A 1C0. Digital images submitted by mail must be on disk in JPEG, GIF, TIFF or PICT format.

Winning photos will be published in the Sept./Oct. 2014 issue of SkyNews.

Composite images (for example, those with foregrounds added digitally) are not eligible.

Please include as many of the following details as possible: camera make, lens, focal ratio, exposure time, location and date. Put your name, phone number and address on your disk or include in your e-mail.

SkyNews is not responsible for loss of or damage to materials submitted. Mailed photos will be retained on file unless accompanied by a self-addressed envelope with sufficient postage.

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Voyager's Last Picture Show

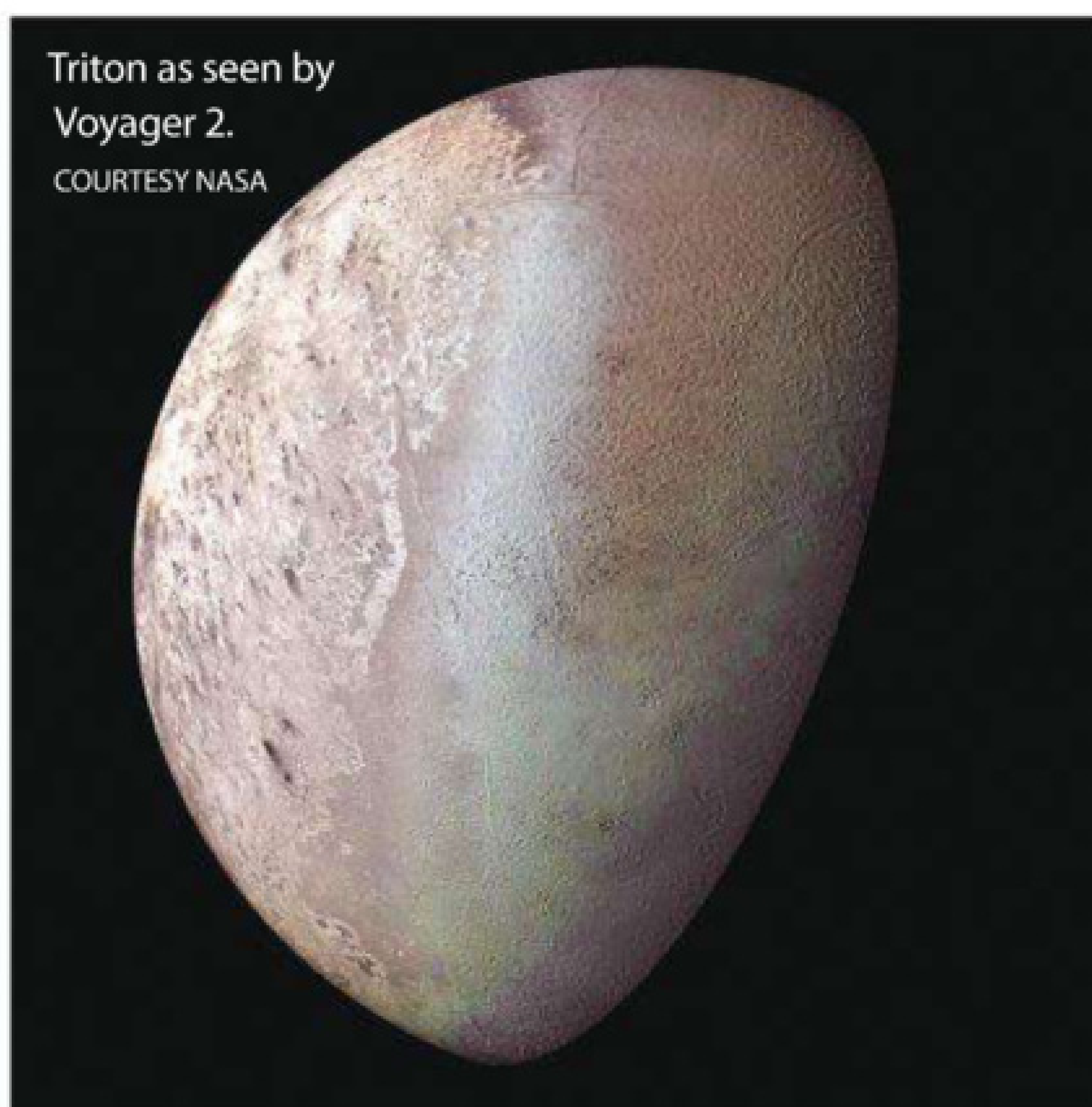
I've often quipped that my stories originate in odd places—even the supermarket. Well, I've been shopping again...

THIS TIME, I was in the produce section, sizing up cantaloupes. Examining an intricately textured specimen, I exclaimed, perhaps a bit too loudly: "Cantaloupe terrain! Triton looks just like this!" A woman beside me retreated to the relative calm of the cucumber bin.

The term "cantaloupe terrain" was coined by astonished planetary scientists in the summer of 1989. The interplanetary robotic spacecraft Voyager 2 had just completed its dozen-year Grand Tour of the four giant planets by flying past Neptune's big moon Triton. The experts were stumped by Triton's unique surface geology, one strangely bumpy portion being likened to the exterior of a cantaloupe. It was fitting that the jumbled topography seemed inscrutable; after all, Triton had been an enigma for 143 years.

It was soon after Neptune's discovery in 1846 that Englishman William Lassell found the 13th-magnitude dot we know as Triton. Lassell had no clear idea how large the satellite was, but he accurately determined that it completed a nearly circular orbit every 5.9 days. He also noted two unusual features: Triton's orbit was highly inclined, and the moon drifted *backwards*; that is, in a direction opposite to the rotation of Neptune on its axis. Astronomers concluded that Lassell's object was not an original member of the Neptune system but a captured body from the far reaches of the solar system.

Little more was known about Triton until the Voyager visit. The probe revealed that Triton is a sizable 2,706 kilometres in diameter, and it's *cold*, a Frigidaire extraordinaire whose temperature of -235°C makes it the frostiest place this side of Pluto. Triton's density, twice that of water, suggests a



mix of ice and rock. Its crust is an icy amalgam of nitrogen and methane, with patches of water ice and frozen carbon dioxide scattered across the bleak landscape. Yet strangely—almost unbelievably—this alien icebox holds a tenuous nitrogen atmosphere topped by a photochemical haze or smog. A cryogenic world, yes, but not inert.

A paucity of impact craters tells us that Triton's surface is not ancient and battered. Yet it's not smooth, either. Much of the globe is characterized by curved ridges and shallow depressions that collectively bear an uncanny resemblance to the skin of a cantaloupe, hence my exuberant remark that day in the grocery store. Triton's uniquely buckled terrain was most likely shaped by fluid materials upwelling from the interior. This idea is bolstered by the presence of crisscrossing fissures (similar to those on Jupiter's moon Europa) that probably formed when slush oozed through cracks in the crust. Several well-defined plains look as though they flooded out, then refroze like prairie lakes in the winter. Triton, the faraway deep-freeze, hasn't always

been a solid ball of ice. But why not?

Solving our Triton cold case involves the capture hypothesis I mentioned earlier. Voyager scientists posit that the rogue runaway initially fell into an extremely distorted orbit around Neptune. The wild variations in distance subjected the captive moon to an uneven gravitational strain called tidal flexing. The constant "massaging" led to internal friction that melted Triton's interior and obliterated its landforms. As Triton slowly settled into a circular path, additional periodic upheavals on its surface created the features we see today.

One Triton phenomenon shocked the experts more than any other.

Several dark plumes were discovered rising high into the rarefied air and drifting downwind like smoke. Dusky streaks on the surface were interpreted as fallout from previous plumes. Explaining this action isn't easy. Perhaps sunlight penetrates Triton's clear nitrogen ice to heat up subsurface material that then erupts in powerful geysers of ice and other particles.

If you've never glimpsed this surreal satellite in your own telescope, now is a good time to try. Currently in Aquarius, the Triton-Neptune duo is up at nightfall. Be aware that the eighth-magnitude planet and its 100-times-dimmer companion are never more than (gulp!) 17 arc seconds apart. You'll need a dark night, high magnification and patient staring.

Meanwhile, the next time you're at the grocery store, grab a cantaloupe and hold it up to the light. Slowly turn it in your hand. I'm sure you'll agree that this wrinkled fruit is a dead ringer for Triton. Just don't say it out loud! ♦

Contributing editor Ken Hewitt-White has seen Triton in a telescope exactly once.

12TH ANNUAL SKYNEWS EDITORS' CHOICE

photo of the week contest



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Please see page 45 or go to www.skynews.ca for contest rules, detailed instructions for submitting your photos and other information. To be eligible to win, submissions must be received at *SkyNews* by **June 1, 2014**. You may enter as often as you wish, but please don't send more than 10 of your best photos per entry. This contest is open to residents of Canada only.

THREE EASY STEPS:

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Step 3. The winning photos and honourable mentions will be published in the September/October 2014 issue of *SkyNews*.

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