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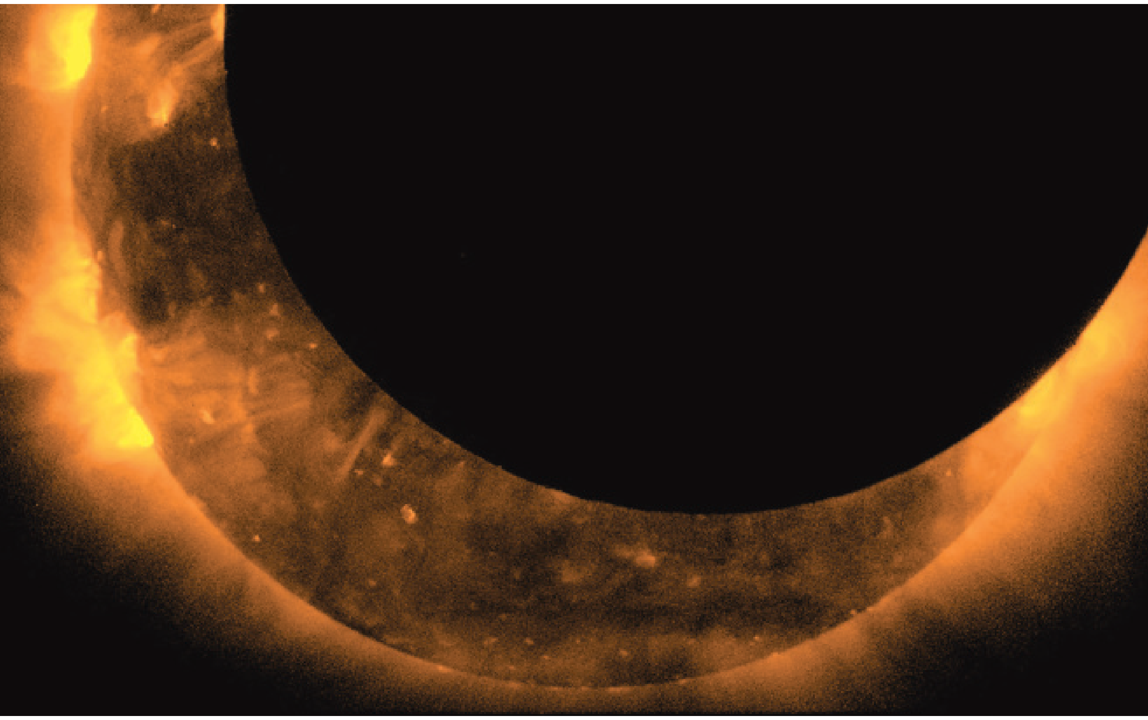

Year in shadows

In 2021, a trio of eclipses darken Canada's skies, the Perseids peak when the Moon is nearly new, and the planets provide their regular meetups. **Brian Ventrudo** has the details.

30

DEPARTMENTS

FEATURES

ON THE COVER

Using an X-ray telescope, the Japan Aerospace Exploration Agency solar satellite Hinode took this image as the Moon and Sun lined up on May 20, 2012. The annular eclipse was visible from the western United States and Southeast Asia. (JAXA/Hinode)

By Allendria Brunjes

"I wonder what they're thinking in Andromeda tonight," Saskatchewan folk singer and Juno-award winner Connie Kaldor asks in her song about the iconic galaxy. Pictured here, Rob Lyons captured this image of our galactic neighbour after collecting 28 hours of exposures from downtown Vancouver in October 2020.

Turning fiction into reality

JUST YESTERDAY, I concluded a six-month entanglement with the Vorkosigan Saga, a science fiction collection by Lois McMaster Bujold that took me through about 20 novels, novellas and short stories and countless worlds. In true space opera fashion, the series details humanity's expansion through the galaxy, depicting civilizations in distant star systems and colonization workarounds on air-thin planets and space stations.

It was a literary adventure that also got me even more excited about research here on Earth than I already am.

I started reading about Tau Ceti's proximity to our Solar System and its dust disk that could be home to planets in the habitable zone. I spent some time reading about wormholes, or Einstein-Rosen bridges, which I didn't know are consistent with Albert Einstein's general theory of relativity.

I'm certainly not the only one moved to investigation by artistic representations of space and astronomy.

Last summer, I watched a session of Insider's Guide to the Galaxy on "Science Fiction in the Stars," hosted by astronomy educator and *SkyNews* writer Chris Vaughan and RASC outreach co-ordinator Jenna Hinds (the replay of the session is available at **youtube.com/RASCanada**). Viewers brought up their favourite canons, including *Star Wars*, *Firefly*, *2001: A Space Odyssey*, *The Expanse*, *Battlestar Galactica*, "anything by Larry Niven" — the list goes on.

Delving into the fictional universes, Jenna and Chris pointed out stars from famous shows on a star chart while mentioning asterisms — like the "Stargate" near HIP 61466 — and speaking about different types of systems with exoplanets, like TRAPPIST-1. They spoke about Bayer designations; Menkar or Alpha Ceti, for instance, was called Ceti Alpha in *Star Trek II: The Wrath of Khan* when Khan Noonien Singh was marooned there.

Personally, these truths in the fiction draw me into these subjects in reality. And for some, these depictions of science can lead to species-advancing inspiration.

Robert H. Goddard — the name behind NASA's Goddard Space Flight Center — is considered the father of modern rocket propulsion. He had just read H.G. Wells' *War of the Worlds* when he climbed his family's cherry tree, looked at the sky and he felt inspired to build a device that might reach the Moon or even Mars and decided to devote his life to the task.

In another famous example, the Milwaukee School of Engineering gave James Doohan — the actor who played *Star Trek*'s Montgomery "Scotty" Scott — an honorary doctorate after half their students said in a survey that his character inspired them to choose engineering as a career.

And 2018, the *MIT Technology Review* wrote that scientists had studied the way researchers involved in human-computer interaction use science fiction in their work, finding not only that science fiction plays a significant role, but that its impact is on the increase.

I've still got a lot of sources of inspiration on the shelves to get through. Next up: *Contact* by Carl Sagan and *Dune* by Frank Herbert.

What are your favourites — any suggestions? Send them to me at **editor@skynews.ca**, and I'll compile a list to share on our website. ✷

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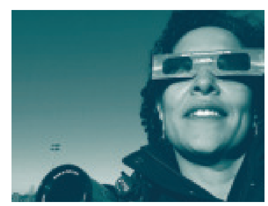
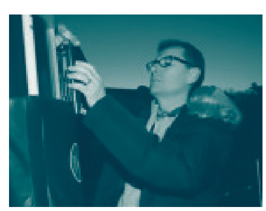
Chris Gainor is a historian and writer specializing in spaceflight and astronomy. He is editor of *Quest: The History of Spaceflight Quarterly* and his latest book tells the story of the Hubble Space Telescope.



Nicole Mortillaro can be found looking up at the night sky appreciating the marvels of our universe. She is the editor of the *Journal of The Royal Astronomical Society of Canada* and the author of several books.

When **Ivan Semeniuk** is not writing about the latest astronomical research for *SkyNews*, he reports on science for *The Globe and Mail*. He is a life member of The Royal Astronomical Society of Canada.



Chris Vaughan is a planetarium presenter and an astronomy public outreach and education specialist at AstroGeo, and an operator of the historic 74-inch David Dunlap Observatory telescope.

Brian Ventrudo is a writer and long-time amateur astronomer. An erstwhile laser physicist with degrees in astronomy and applied physics, he now writes about astronomy and stargazing at his blog CosmicPursuits.com.

I live in a lakeside subdivision about an hour's drive northeast of Lloydminster, Saskatchewan/Alberta. Our cabin owners' association normally holds a yearly gathering for an afternoon of games and picnic which attracts about 40 or so owners and families. Some years ago, it was our family's turn to create the games and run each event. Some were physical, some were cottage skills, some were just fun and some were mental.

The one of interest here was naming star constellations of the night sky. I fully expected with cottagers so often sitting around fire pits almost every night in July and August there should be a good knowledge of the night sky. I used some black tar paper and glued on little white stars to represent various constellations, mostly the common ones such as the Big Dipper, Little Dipper, Orion, Cassiopeia, etc. The fun began, and to my dismay, only one little boy about six or seven years old excitedly shouted, "I know that one! I know that one!" Pointing to Orion, he said, "That's O'Brian!" (I gave him the marks.)

The sad fact was of all the people, young and old, who participated in that event, only he could identify any of the constellations! I was truly shocked.

Is knowledge of the night sky that limited in our society? Or do we spend far too much time staring into the bottom of our drinks, rather than leaning back and just looking up at the wonders of the night sky?

Wayne F. Brown
Peck Lake, Saskatchewan

I wish to thank you for the great efforts you and the team put into the publication. Bravo!

I would also like to second the comments made by one of your readers in the July-August 2020 edition on the way many images are presented which differ significantly from what one sees in the eyepiece visually. As a seasoned observer of 46-plus years at the eyepiece, doing outreach and teaching new RASC members how to learn to observe the sky properly, I feel strongly that often astrophotography endeavours to get the maximum details in an image, and that there's NO one out there trying to capture a more realistic view one might see at the eyepiece.

This is not an easy task, despite sounding fairly straightforward. Cameras are very sensitive and pick up a lot more than our eyes can see. However, if many of your more seasoned readers who excel in AP are up to the challenge, I think that a huge number of members starting out would get a much better handle on WHAT to expect when out at the eyepiece. I also personally would love to see examples of wider field shots that simulate various binocular fields of view as well, which can show many newer members and enthusiasts the wonders they CAN see even with their eyes only in the optic!

Visual astronomy is starting to become a lost art of sorts, and I think it important for those who DO this endeavour to be able to pass on our wisdom and knowledge in a sustainable way to future generations of enthusiasts. If you could start up a "making it real" contest for AP folks to try to capture a more "realistic" view, including even the use of nebulae filters like an OIII on the lens or system, this would be VERY helpful to assist the beginners in getting a better handle of what they are searching for during their progression forward in exploring the night sky. I see another benefit: Being able to capture darker skies and then similar views from suburbia to SHOW how bad light pollution has become for everyone in this activity. Might be a huge benefit to the RASC dark sky initiatives as well.

Keep up the great work!

Darren Hennig, M.Sc.
RASC Winnipeg Center

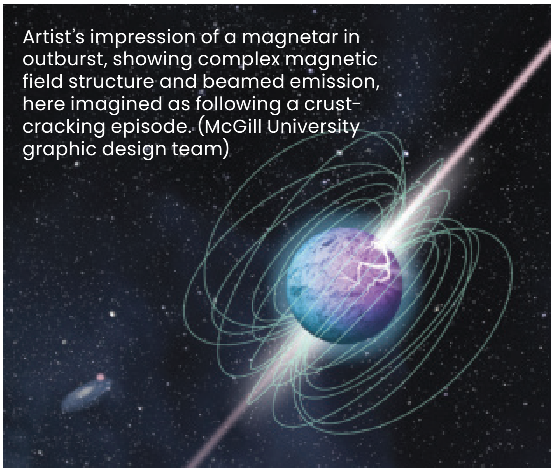
I would like to share my experience of trying to find the planet Uranus with a telescope during summer 2020.

After checking with the star finder, I couldn't figure out why I couldn't find it. Doing a little research on the origin of this planet, I learned that in March 1781, William Herschel saw Uranus for the first time. Its discovery was not immediate.

During my first sightings, I thought it was a star. It was the same result as William Herschel. He also originally believed it was a star or even a comet. In 1783, after a few years of analysis, he confirmed that it is indeed a planet, and that Uranus is part of our Solar System.

Additionally, I would like to share my appreciation of *SkyNews* magazine. What a pleasure to receive your magazine by post. It is like a gift when you open the mailbox.

Alexander Viau
Brossard, Quebec



Artist's impression of a magnetar in outburst, showing complex magnetic field structure and beamed emission, here imagined as following a crust-cracking episode. (McGill University graphic design team)

Canada CHIMEs in

A CANADIAN-LED TEAM OF ASTRONOMERS has found evidence that magnetars — a type of neutron star thought to have a powerful magnetic field — may be the source of some fast radio bursts (FRBs).

Publishing their findings in the journal *Nature* on November 4, researchers stated they used the Canadian Hydrogen Intensity Mapping Experiment (CHIME)/FRB project to detect "an extremely intense radio burst" from the magnetar SGR 1935+2154.

The CHIME website states that FRBs are brief (few millisecond) bursts of radio waves coming from beyond the Milky Way galaxy.

"The phenomenon was first reported in 2007 and as of mid-2017, roughly two dozen have been reported," it states. "Their origin is unknown. However, they are ubiquitous: current best estimates suggest these events are arriving at Earth roughly a thousand times per day over the entire sky."

The team included researchers from McGill University and the McGill Space Institute. A release from the university states that on April 28, 2020, the CHIME/FRB team detected an unusually intense radio burst coming from a nearby magnetar located in the Milky Way.

"We calculated that such an intense burst coming from another galaxy would be indistinguishable from some fast radio bursts, so this really gives weight to the theory suggesting that magnetars could be behind at least some FRBs," said Pragya Chawla, one of the co-authors on the study and a senior PhD student in the Physics Department at McGill.

— Allendria Brunjes

An artistic rendering of NASA's OSIRIS-REx mission readying itself to touch the surface of asteroid Bennu. (NASA/Goddard/University of Arizona)

OSIRIS-REx collects sample

NASA'S ORIGINS, SPECTRAL INTERPRETATION, RESOURCE IDENTIFICATION, SECURITY, REGOLITH EXPLORER (OSIRIS-REX) mission has successfully collected and stored its sample of the asteroid Bennu.

A NASA press release states that the spacecraft unfurled its robotic arm October 20, 2020, briefly touching the asteroid to collect dust and pebbles from the surface for delivery to Earth.

Another release stated that on October 28, the mission team sent commands to the spacecraft, instructing it to close the capsule, marking the end of that phase of the mission. Images had shown that the spacecraft collected "more than enough material" to meet the mission's goal of collecting at least 60 grams.

"Together a team comprising industry, academia and international partners, and a talented and diverse team of NASA employees with all types of expertise, has put us on course to vastly increase our collection on Earth of samples from space," said NASA administrator Jim Bridenstine.

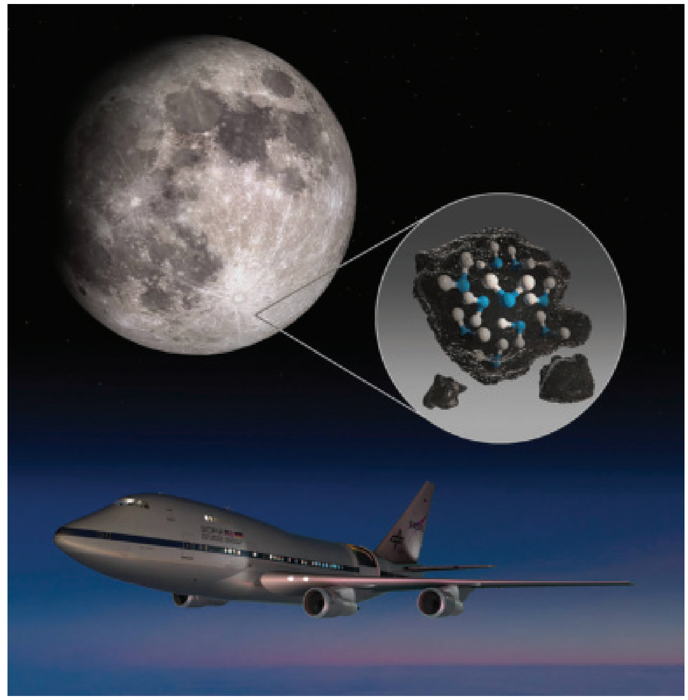
Launched in 2016, OSIRIS-REx has been surveying Bennu since December 2018. The Canadian Space Agency's OSIRIS-REx Laser Altimeter — OLA — surveyed Bennu's surface, helping to build a detailed three-dimensional map of the asteroid. Even though its low-energy laser transmitter stopped working in 2020, OLA had already completed all of its principal requirements for the OSIRIS-REx mission. In exchange for contributing OLA, Canada is set to receive a portion of the precious sample of Bennu.

"Here, we're going to be able to unravel the history of the Solar System in labs in Canada," Tim Haltigin — CSA senior mission scientist in planetary exploration — in December 2019. "The way I like to think about it — there are kids in grade school and in kindergarten and people that haven't been born yet that are going to be working on these samples."

OSIRIS-REx is currently more than 330 million kilometres from Earth. NASA stated the team is now focusing on preparing the spacecraft for the next phase of the mission: "Earth Return Cruise." A release stated the departure window opens in March 2021 for OSIRIS-REx to begin its voyage home, and the spacecraft is targeting the Sample Return Capsule's return to Earth on September 24, 2023. →

— Allendria Brunjes

NASA discovers water on Moon's sunlit surface



This illustration highlights the Moon's Clavius Crater with an illustration depicting water trapped in the lunar soil there, along with an image of NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) that found sunlit lunar water. (NASA/Daniel Rutter)

SCIENTISTS WORKING WITH NASA'S STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA) have found the unambiguous signature of water — H2O — on the sunlit surface of the Moon, which can reach scorching temperatures of 120 C (or 250 F).

Making the announcement at a press conference October 26, NASA representatives said the detection occurred at the massive Clavius Crater, which is easily visible through binoculars and telescopes.

NASA's astrophysics division director Paul Hertz said this is the first time ordinary water molecules have been confirmed outside of the permanently shadowed regions at the poles of the Moon.

"This is exciting, because the expectation is that any water present on a sunlit surface of the Moon would not survive the lunar day," he said.

Water may be there, but don't expect to see ponds or streams. Lead author Casey Honniball —postdoctoral fellow at NASA's Goddard Space Flight Center in Greenbelt, Maryland — said that between 100 to 400 parts per million of water molecules were found on the "very surface of the Moon." That's not a lot, amounting to about one 12-ounce glass of water per cubic meter of lunar regolith.

"To be clear, this is not puddles of water, but instead water molecules that are so spread apart that they do not form ice or liquid water," she said. "What's interesting is that without a thick lunar atmosphere, water on any hot, sunlit surface of the Moon should be lost in space or find its way to the lunar polar cold trap."

Honniball said researchers think the water is trapped within glass beads in the soil that form during micro-meteorite impact.

"These glass beads are about the size of a pencil tip, and protect the water from the harsh lunar environment," she said. "Understanding the source of water and its retention helps piece together the broader history and role water plays in the inner Solar System and on other airless bodies like asteroids, and may have implications for human exploration."

The discovery suggests a greater distribution of water across the Moon, a world that astronomers in centuries past thought might have surface water and a world that Apollo-era science suggested was bone dry. Since then, new laboratory techniques have cracked open previously unstudied Apollo samples and found water molecules. Meanwhile, missions to the Moon over the past three decades found evidence of lunar water ice in permanently shadowed regions of the Moon, clustered around the poles.

The discovery clarifies that ordinary water — not the "drain cleaner" version, hydroxyl — is present on the Moon's surface during the lunar day.

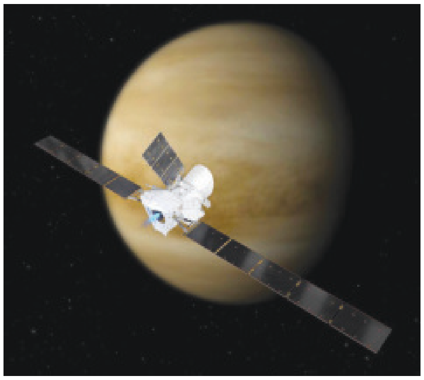
SOFIA is a modified Boeing 747SP carrying a 2.5-metre telescope to make observations in flight, high enough that nearly all the Earth's water vapor is below the airplane.

Naseem Rangwala, project scientist for the SOFIA mission — which is based in NASA's Ames Research Center in California — said that SOFIA had never been used for lunar water studies, but that a test in 2018 "far exceeded our expectations." Researchers found infrared radiation re-emitted at six microns — in other words, a clear signal of ordinary water molecules on the hot, barren lunar surface.

Honniball said the study was "a snapshot of one location at one time on the Moon." Further flights are planned to increase coverage, potentially yielding a water map of the entire nearside, across all lunar phases.

The international focus on the Moon has quickened with the discovery of lunar water ice in permanently shadowed regions of the Earth's satellite. Hertz said with the Artemis program, NASA aims to land the first woman and next man on the Moon by 2024, and establish a sustainable human presence by the end of the decade.

— Christopher Cokinos



An artistic rendering of BepiColombo's first Venus flyby on the way to Mercury. (ESA/ATG Medialab)

ESA-JAXA mission flies by Venus

BEPICOLOMBO, a joint mission of the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA), conducted the first of two Venus flybys needed to get it to Mercury — and it got some extra data while doing it.

An ESA press release states the flyby took place October 15 at a distance of about 10,720 kilometres from Venus' surface. Scientists used the opportunity to test BepiColombo's Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS), capturing images in two series: one from 1.4 million to 670,000 kilometres away from Venus, the other from 300,000 kilometres to 120,000 kilometres from the planet. In total, MERTIS was set to capture almost 100,000 individual images.

Launched October 20, 2018, the spacecraft needs nine gravity-assisted flybys to reach orbit around Mercury in 2025. Flybys use the gravitational pull of the planets to help alter the speed and direction of the spacecraft, adding to its own propulsion system. The October 2020 flyby transferred some of BepiColombo's kinetic energy to Venus in order to reduce its own speed, according to the German Aerospace Center.

— Allendria Brunjes

Canadian Space Agency astronaut David Saint-Jacques conducts his first spacewalk April 8, 2019, with NASA astronaut Anne McClain. (Canadian Space Agency/NASA)

The Canadian Space Agency wants your opinion

THE NEXT DECADE OR SO SHOULD BE AN EXCITING TIME FOR CANADA, if all goes to plan.

The Canadian Space Agency has signed on to send humans to the Moon in line with NASA's exploration plans, contributing the future Canadarm3 robotic arm to the endeavour.

Now the agency wants to hear your feedback on how to proceed. Until January 31, 2021, the CSA is looking for feedback from businesses, space enthusiasts and just ordinary Canadians interested in the future of the country.

"These daring missions and emerging space activities pose new challenges," the CSA's website states. "Canada and other countries are working to define the 'rules of the road,' a shared framework that will guide the safe and sustainable use of space beyond Earth's orbit."

Visit **skynews.ca/csa-feedback** for the link to the feedback page.

The CSA has also stated webinars will also be announced at a later date. ✳

— Elizabeth Howell

By Nicole Mortillaro

SCOPES FOR STARTERS


(Danil Nevsky/Stocksy)

THE HOLIDAYS ARE OVER. Perhaps you were lucky enough to get a gift card that you plan to spend on a new telescope, or you got one and you need essential accessories. Here are a few pointers.

What telescope should I buy?

In order to know what kind of telescope you'd like to buy, it's important to consider a few questions: What do you want to observe with it — just the Moon and planets, or do you want to see fainter deep-sky objects? Do you need something light that you can take with you to the cottage? And do you want to photograph celestial objects with it?

Let's look at the important things you need to know about telescopes.

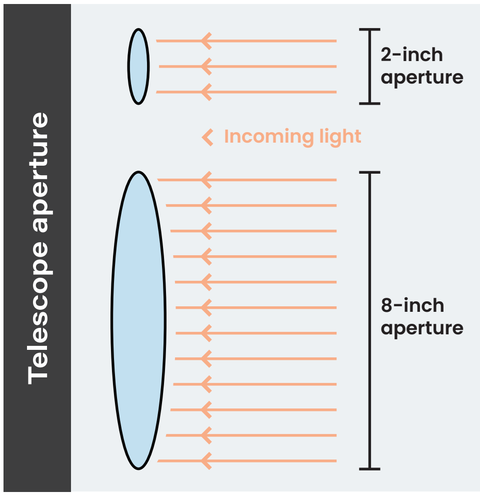
First is the **aperture**. This is the diameter of its main lens or mirror. Typically, aperture is expressed in millimeters or, for larger telescopes, in inches. Basically, the bigger the aperture, the more light-gathering potential, letting you see fainter objects.

Comparing the light-gathering power of two telescopes is done by calculating by the ratio of their diameters squared. Let's work through an example.

For a six-inch telescope, the diameter squared is 6 × 6 = 36. For an 11-inch (279.4-mm) telescope, the diameter squared is 11 × 11 = 121.

The ratio of the two diameters is 121 ÷ 36 = 3.36, so an 11-inch telescope gathers more than three times more light than six-inch telescope. A six-inch telescope performs 2.25 times better than a four-inch telescope.

The downside is that a larger aperture means a bigger telescope. If you're an urban dweller, it is more cumbersome to drag a large telescope outside the city — and if it's more cumbersome, chances are you're less likely to set it up.



Eyepieces are very important. Each eyepiece delivers a particular amount of magnification, so most people buy a range of focal lengths (that's the little number labelled on the eyepiece). Don't get hung up about extreme magnifying powers, like 500x. Due to the turbulence of Earth's atmosphere all telescopes have a limiting useful magnification that is 50 times its aperture in inches, or twice its aperture in millimetres.

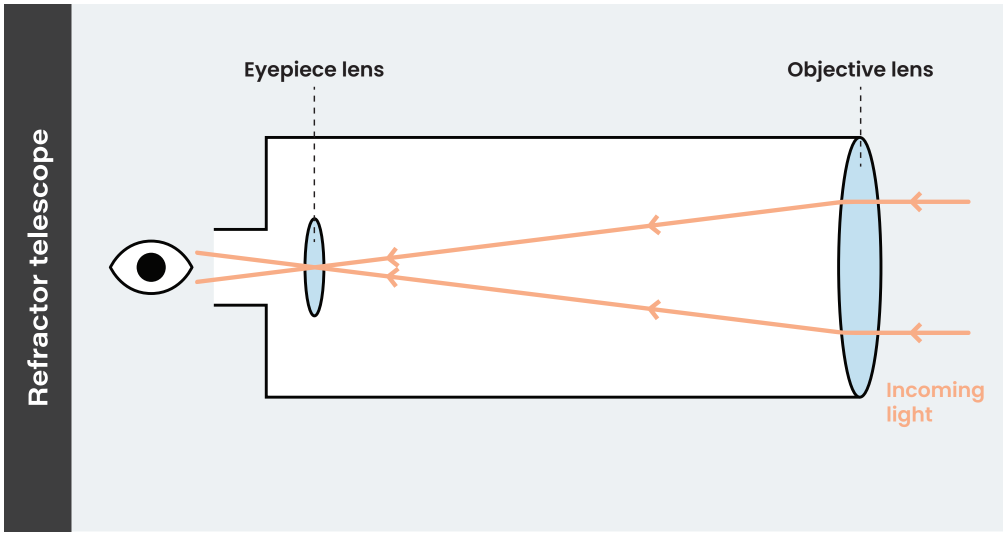
Different types of telescopes

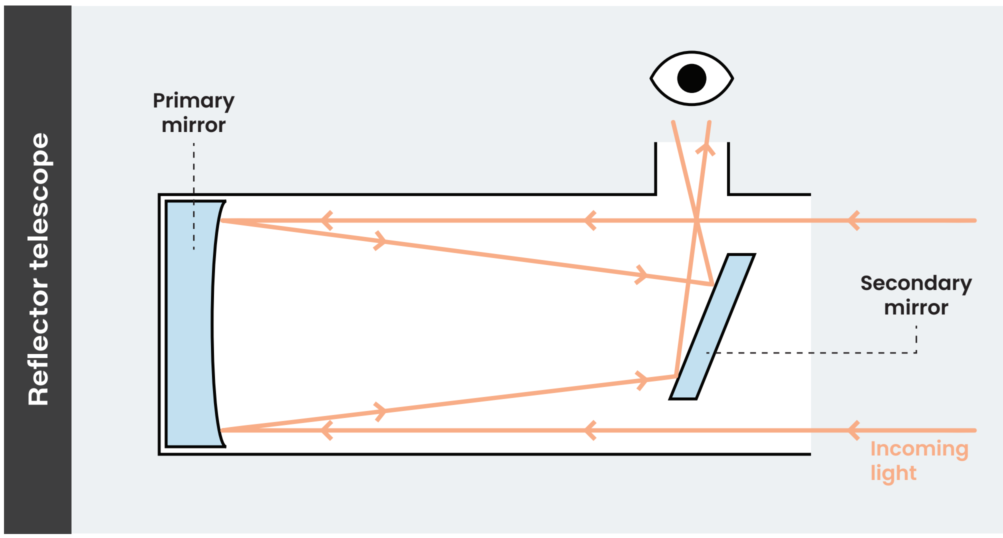
The main types of telescopes each have their advantages.

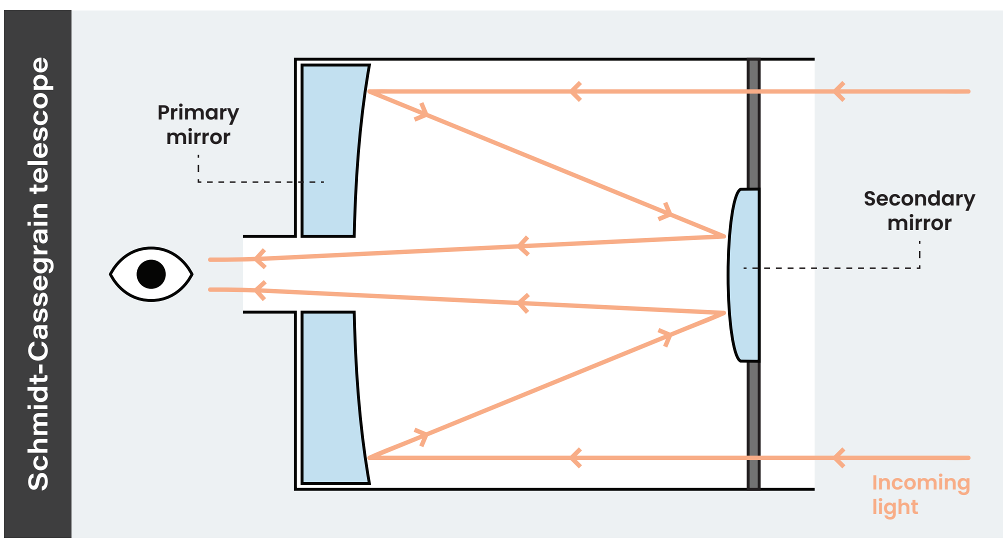
Refractors have a lens at the front that forms an image at the back. These tend to be cheaper owing to their simple design. They are best for planetary and lunar observing because their smaller apertures work best on bright objects, and they are lighter and more portable than other types. The minimum aperture I recommend is 70 to 80 mm.

Reflector telescopes use mirrors to gather and focus the light from incoming objects and direct it out the side of the tube. This type tends to have larger apertures, making them good for viewing dimmer deep-sky objects like star clusters, nebulas and galaxies. The minimum aperture I recommend is six or eight inches. Although larger sizes are quite affordable, those ones can be very large and heavy. Dobsonian telescopes are reflectors that are mounted on a swiveling box instead of a tripod, making them especially sturdy and easy to use.

The **Schmidt-Cassegrain** telescope is the most compact type. Called a Schmidt-Cass or SCT for short, it uses both lenses and mirrors to form an image in a much shorter tube. This makes them easier to transport, but more expensive. Common apertures for SCTs are in the six-inch to eight-inch range, but smaller and larger sizes are available.







Diagrams by Isabelle Santiago

All three telescope types come in manual versions that you point by hand, or as motorized GoTo systems that are computerized, and you can pick targets from a database in the handset. You'll need to supply power to the latter. For either type, the sturdier the tripod the better, so the view doesn't shake too much when you focus the telescope. →

A composite of RASC Calgary Centre members pointing at Polaris at a public star party July 27, 2019, at the Rothney Astrophysical Observatory in Calgary, Alberta. Although many in-person star parties are on hold, there are still online forums and events where you can get some pointers on telescopes. (Alan Dyer)

When you are ready to buy a telescope, consider purchasing from a local astronomy retailer, rather than Amazon or a department store. They'll be able to help you select the best model for your budget and experience level, as well as suitable eyepieces and accessories.

Mounts

My first telescope was a simple refractor, and although it was wonderful (even more so after I upgraded it), the next one I moved to was a six-inch Celestron NexStar Schmidt-Cassegrain telescope. It was compact, easy to set up on my back deck or transport to a dark-sky site.

But then I wanted more. I wanted to take images of the night sky, be it the Moon, planets or deep-sky objects. But this takes a lot more work and a special kind of **mount** — the structure on which the telescope sits.

Rather than a simple **alt-azimuth mount**, which allows you to move the telescope left-right horizontally and up-down in elevation (altitude), imaging needs a sturdy motorized equatorial mount which you align with the North Celestial Pole, near Polaris (the North Star). This allows the telescope to follow the target as Earth rotates, keeping whatever you're observing perfectly still. Alignment can be tricky. Personally, it took me more than a year to learn this, but I'm fairly sure I just didn't grasp the concept. Equatorial mounts are also a lot heavier, and you need weights to balance the telescope and camera for smooth tracking.

Using your telescope

Next step: How do you use your new telescope?

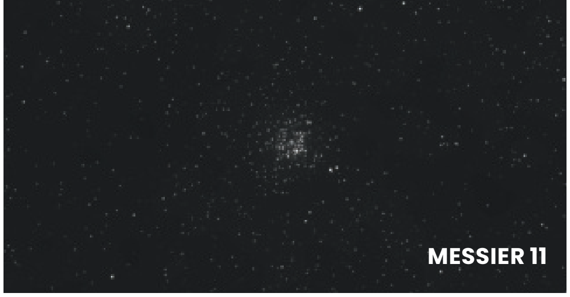
I'm not big on reading manuals, but you should. It will help immensely; I know it helped me.

As well, you can always do a search on YouTube for the type of telescope you own to gain some pointers. I've found this incredibly helpful.

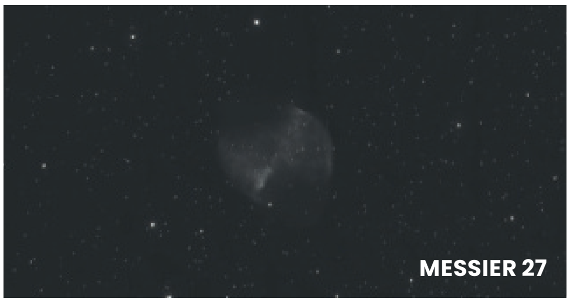
Another quick tip is, after COVID-19 is over and done with, try to attend a star party. Ask people about their telescopes. Most of them will be happy to share their experiences and a glimpse through their telescopes.

Once you have your telescope, master it and improve your knowledge by exploring on clear nights. I learned to navigate the night sky using my GoTo telescope by just slewing it around the sky. The first thing I found on my own was the Ring Nebula (Messier 57) using a good sky chart.

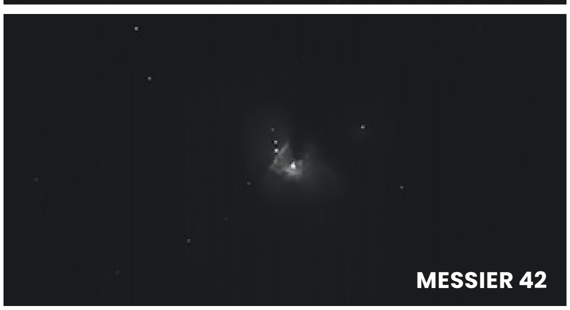
It might seem like a lot, but don't be intimidated when it comes to buying a telescope. Ask telescope owners, join a Facebook group or reach out to a telescope or astronomy community. Most people are happy to help and share their experiences. After all, we're all looking for the same thing: a wonderful view of the night sky and all the universe has to offer. ✷

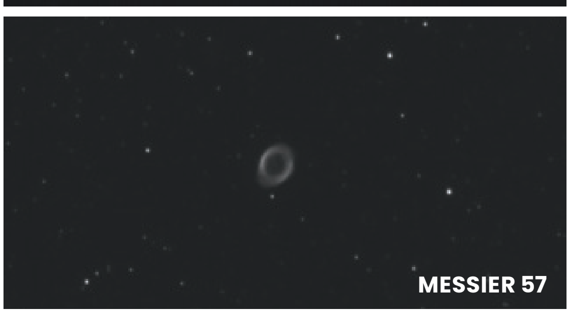

MESSIER 11

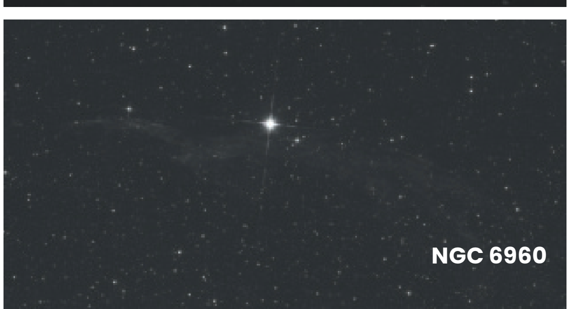

MESSIER 17, MESSIER 18


MESSIER 27


MESSIER 31, MESSIER 32, MESSIER 110


MESSIER 42


MESSIER 57


NGC 6960

In the eye of the beholder

Images by
John Gillies

THE NIGHT SKY IS A BEAUTIFUL THING. But after seeing countless images of glorious, rainbow galaxies and nebulae, the first glimpse of a faint, grey astronomical body through a small telescope can be rather flat. While astronomers and astrophotographers often gather data to portray an object's chemical composition and light emissions, those images do not reflect what one can actually see through binoculars or a telescope.

Gathering the data from his home "Spring Hill School Observatory" near Princeton, Ontario, John Gillies under-processed these final stacked images in monochrome to a degree that matched his visual observations through telescopes, giving us a glimpse of what he actually sees when he puts his eye to the eyepiece.

MESSIER 11: WILD DUCK CLUSTER

With a moniker given for the roughly V-shaped arrangement of its brightest stars, the Wild Duck Cluster is an open cluster located about 6,200 light-years from Earth in the constellation Scutum. Loosely bound by gravity, it is one of the most densely populated open clusters known, containing over 2,900 stars.

MESSIER 17, MESSIER 18: OMEGA NEBULA AND NGC 6613

The Omega Nebula is one of the largest star-forming regions in the Milky Way galaxy. Located about 5,500 light-years from Earth in the constellation Sagittarius, it contains one of our galaxy's youngest star clusters, at only one million years old. Messier 18, also designated NGC 6613, is an open star cluster about 32 million years old, observable between the Omega Nebula and the Small Sagittarius Star Cloud.

MESSIER 27: DUMBBELL NEBULA

The Dumbbell Nebula, located more than 1,200 light-years away in the constellation Vulpecula, is the result of an old star that has shed its outer layers. It was the first planetary nebula ever discovered, spotted by Charles Messier in 1764.

MESSIER 31, MESSIER 32, MESSIER 110: ANDROMEDA GALAXY AND ITS SATELLITE GALAXIES

Located about 2.5 million light-years from Earth, the Andromeda Galaxy is our next-door neighbour and a member of the galactic Local Group. Visible with the naked eye, the 61,000-light-year-long galaxy has two dwarf elliptical satellite galaxies, M32 and M110, that are visible through binoculars and telescopes.

MESSIER 42: ORION NEBULA

The Orion Nebula is a stellar nursery located about 1,500 light-years away, making it the closest large star-forming region to Earth. Its brightness and prominent location just below Orion's belt means the nebula — a huge cloud of dust and gas where new stars are forming — can be spotted with the naked eye.

MESSIER 57: RING NEBULA

The Ring Nebula is a planetary nebula, the glowing remains of a Sun-like star. Sitting about 2,000 light-years away in the constellation Lyra, a white dwarf sits in its centre, lighting up the surrounding helium, hydrogen, oxygen, nitrogen and sulfur.

NGC 6960: VEIL NEBULA

The Veil Nebula is what remains of a massive star that exploded about 8,000 years ago. Once a star 20 times more massive than our Sun, the nebula is now about 110 light-years across, sitting about 2,100 light-years away from Earth in the constellation Cygnus. ✷

Textual sources: NASA and Students for the Exploration and Development of Space

Essential imaging tasks for cloudy nights and sunny days

By Ron Brecher

The Dark Shark, a complex of several objects in Cepheus, is located around 650 light years from us, and about 15 light years from snout to tail. (Images by Ron Brecher)

Astrophotographer Ron Brecher shares how he prepares for imaging the night sky when its treasures can't be seen

I CAN'T BE THE ONLY ONE who has lost a perfect imaging night after an unexpected computer shutdown triggered by an operating system update right in the middle of an imaging run. This is just one example of an obstacle that can defeat our attempts to image the night sky. All of our equipment — computer and software, mount, camera, filter wheel, autoguider and focuser — needs to run reliably and repeatedly.

There can be long gaps between imaging sessions. The Moon impacts deep-sky imaging for half of every month, and there's more weather variance than even the average mail carrier can handle — rain, snow, clouds, wind, extreme cold, extreme heat, fog and forest-fire smoke.

Since clear nights are limited, I perform a lot of essential imaging tasks during the daytime, or on nights that are unsuitable for imaging. This preserves the best nights for sitting back and enjoying the view while the camera gathers photons.

These tasks fall into a few categories: equipment maintenance and optimization, calibration frame collection and planning imaging runs.

Maintain and optimize equipment

Almost all equipment maintenance and optimization can be done on a partly cloudy or hazy night. Some tasks can even be done during daylight hours.

If you have a portable imaging setup, practise setting up the mount on nights when you're not imaging. Practise achieving polar alignment quickly and accurately, and also practise balancing the payload. One important thing to keep in mind is good cable management. During the day, you can work out the best way to prevent your cables from throwing off your mount's balance. Then use that cable management approach every time. Even in a permanent observatory, periodic tweaking of polar alignment is necessary.

Well-managed cables are important for consistent tracking. Here, two refractors are mounted on a Paramount MX. The larger scope is a Sky-Watcher Esprit 150. The other scope is a Takahashi FSQ-106. Balance is consistent as the mount moves through the night, and there is no risk of a cable getting caught on another piece of equipment.

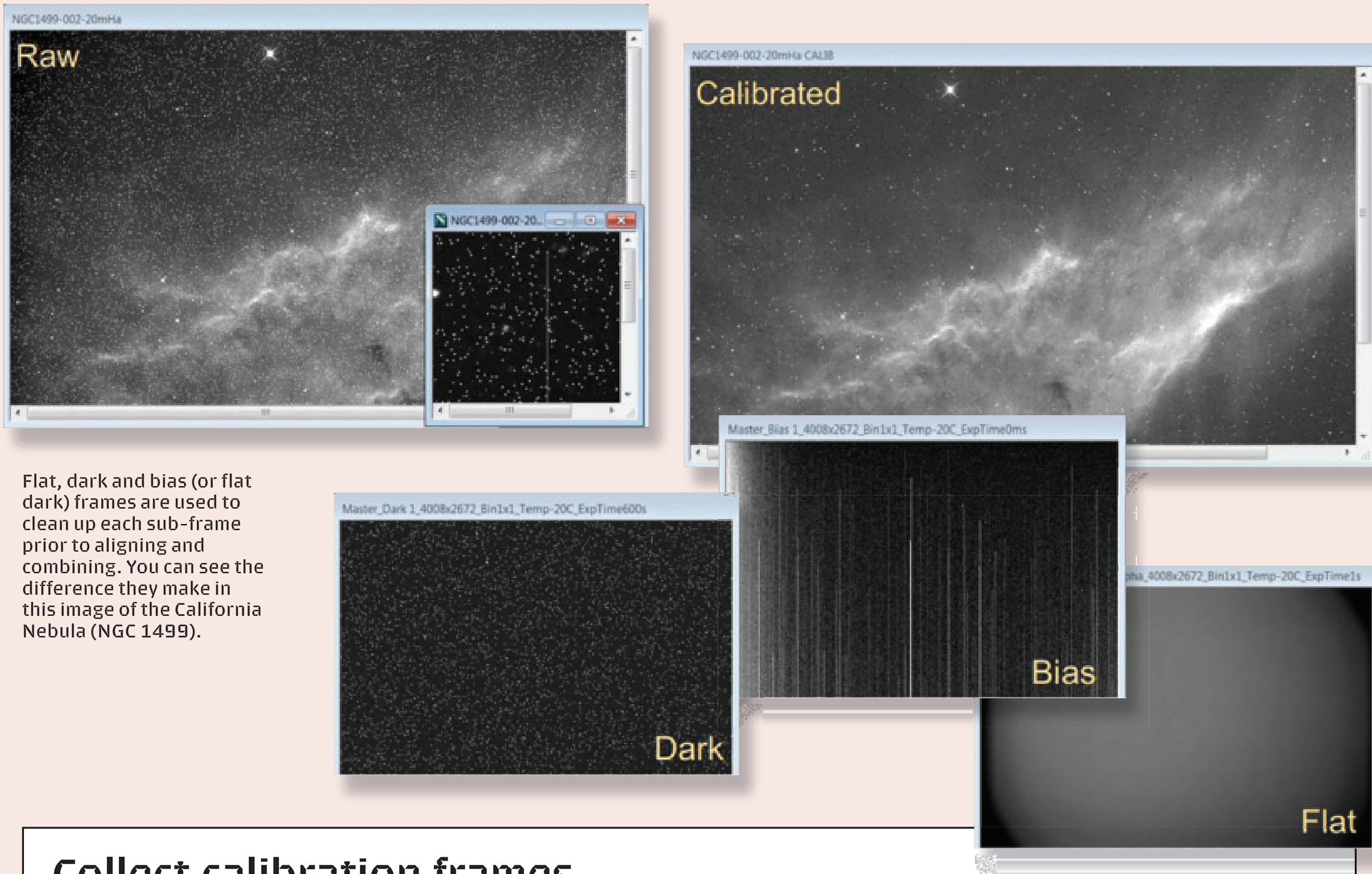
Focusing on the camera for a minute — mediocre nights can be used to optimize autoguider settings. A moonlit, but otherwise clear, night is a good opportunity to train electronic focusers to compensate automatically for changing temperature. Users of monochrome cameras with filters can use these nights to determine filter offsets, small automatic focus adjustments to maintain focus when the filter is changed.

Autoguider woes can stop a night of imaging in its tracks. Use less-than-ideal nights when stars are still visible to work out the kinks. There is no precious data at stake during these nights, so don't worry about the main camera. Instead, try to dial in the best settings for auto guiding — then save them in the guiding software, write them down or take a screen shot.

Many mounts permit you to train them to remove the repeatable, so-called "periodic error" in their tracking. Periodic error is repeated with each cycle of the mount's gears, due to tiny mechanical imperfections. If the periodic error has been recorded by the mount's periodic error control (PEC) software, it can be automatically played back to greatly improve the mount's performance. For many mounts, periodic error correction only needs to be set up once, and this can be done on any night where you can consistently see stars, even if the sky is very hazy or brightly moonlit.

A few occasional hardware tasks can and should be done during the day under good lighting. Optics need to be cleaned once in a while — I clean the objectives of my well-used telescopes about once every year or two. Most mounts that contain gears require periodic cleaning and regreasing; I relubricate my Paramount MX every three years, and I use a grease suited to my locale's very cold winters. If you have a camera that uses a desiccant cartridge to keep the sensor chamber dry, don't forget to recharge or replace it every so often, in keeping with the manufacturer's instructions.

There are a couple of schools of thought on updating and optimizing computers. Some keep the operating system and all software and equipment drivers current, updating every time a new version is released. Others take an "if it ain't broke, don't fix it" approach, leaving things alone when they are running well. If you decide to upgrade regularly, delay a few weeks before updating to the latest software or driver version to see if any problems are reported. Always ensure you have an easy way to undo any changes. This means regular, complete backups. I'll talk about trying new software in a moment. →



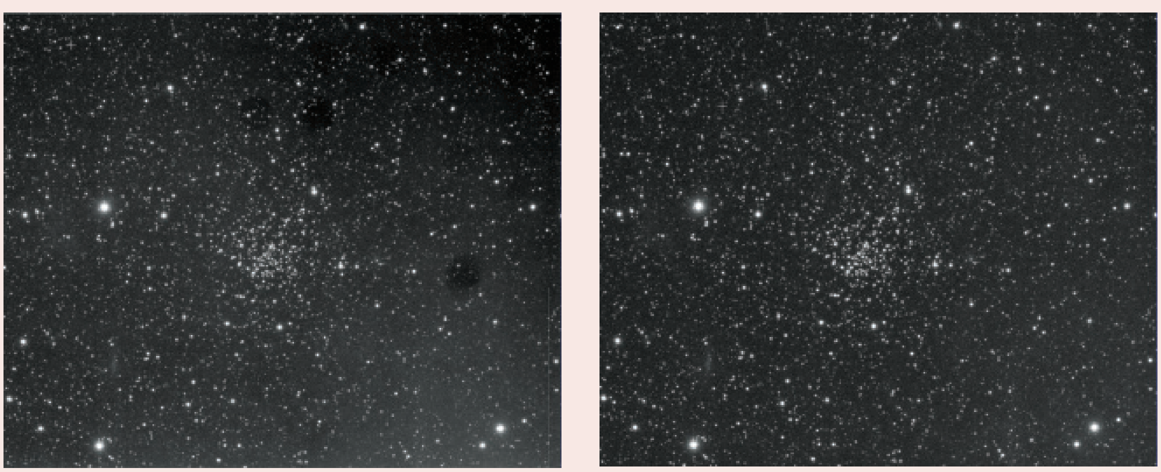
Flat, dark and bias (or flat dark) frames are used to clean up each sub-frame prior to aligning and combining. You can see the difference they make in this image of the California Nebula (NGC 1499).

Collect calibration frames

Image calibration is critical for getting the best possible results from your astrophotographs. This process removes noise generated by the camera's electronics, such as dark current and readout noise. This is done using dark frames and sometimes bias frames. Calibration can also correct uneven field illumination due to dust motes and vignetting from using flat frames. Bias, dark and flat frames can all be acquired during the day, on any cloudy night or at twilight before or after an imaging run.

Since dark and bias frames are acquired with no light reaching the sensor, ensure that the lens cap is on and the whole setup has no light leaks. Since dark noise is relatively stable, these calibration frames can be used over and over again. I update my dark and bias calibration frames about once a year.

Flat frames typically require more frequent updating, as new dust motes can appear at any time. Camera movement relative to the telescope between imaging sessions can change the illumination profile, necessitating acquisition of new flats. The three most common methods for acquiring flats can be done during the daytime (using a T-shirt or electroluminescent panel) or at dusk or dawn (twilight method).



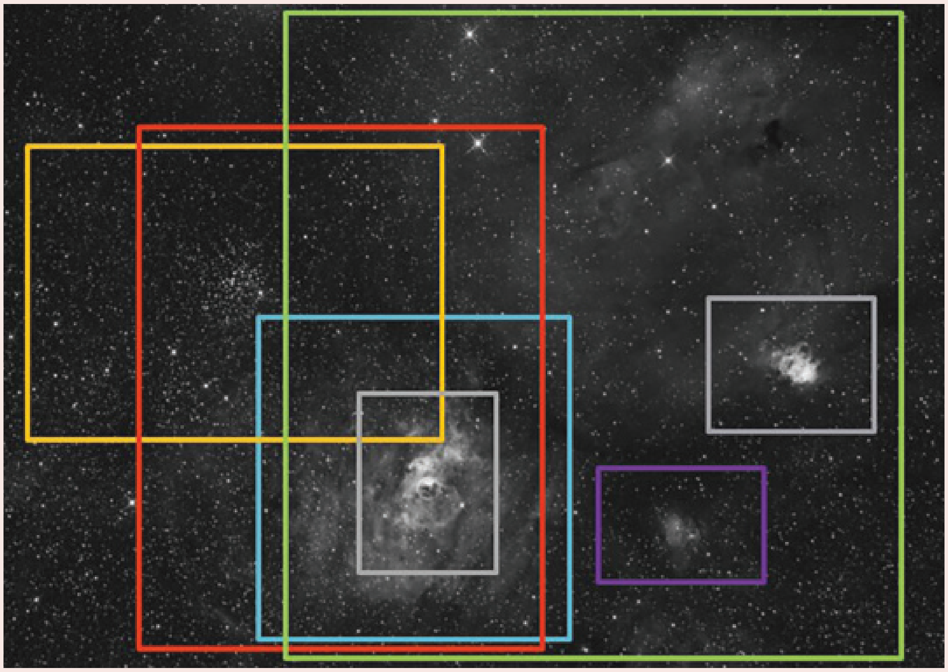
Calibration can make dust shadows vanish like magic, as you can see in these before (left) and after (right) images of NGC 6939.

Plan for the future

So-so nights are a great time for figuring out how you are going to spend the next clear night and for experimenting with new ideas and techniques. Here are a few hazy-night projects you can try.

When the night isn't suitable for imaging, but I can still see stars, I will try short exposures on a few different objects that are candidates for future imaging runs. I might try different framing options, including rotating the camera.

Once you have optimized your setup as described above, see how long you can expose without autoguiding and still get round stars. While autoguiding can be useful, many properly tuned mounts can track accurately enough for unguided imaging. Going autoguider-free has a number of advantages over using an autoguider — including one less thing to go wrong. Autoguiders can lose their guide star and halt an imaging run. Many factors influence how long you can image and still have round stars. Some of the most important are mount mechanical quality, polar alignment accuracy, periodic error correction (PEC), rigidity of the overall system and a correctly balanced payload.



Above right: Consider different ways of cropping your image to best show the features you want to highlight. There are many objects to choose from in this image of the Bubble Nebula region of the sky in Cassiopeia, like Messier 52 and NGC 7538.

Stick to the script

Once all your equipment-control software is running properly, you may feel the urge to experiment with a scripting tool. These tools can automatically direct all your equipment throughout an entire imaging session, allowing you to do other things like observe through the eyepiece, chat with friends or even get some sleep. It's OK to indulge this urge, but not on a good, clear night! You can do these experiments just as effectively during the day and not miss a photon of imaging time. Just make sure you back up your system first, as discussed above. With that precaution, scripting is a worthwhile exploration for serious imagers. Some of the more popular scripting tools are CCD Commander (which I use), CCD Autopilot and Sequence Generator Pro. All have free trials available and are easily found online. They differ in their capabilities and system requirements, so review specifications carefully.

If you have an observatory — or you have ever wanted to get out of the cold or a swarm of mosquitoes — look into a setup to control your imaging computer remotely. Tools like Microsoft Remote Desktop, AnyDesk or TeamViewer allow you to see your imaging computer's screen and control it from any internet-connected device. You can use it on your mobile phone to check on your equipment from your tent at a star party or, as I do, to check on my observatory from inside the house when it is -30 C outside. Of course, this capability can all be set up and practised during the day.

Conclusion

Good imaging nights are few and far between for most of us. When those fine nights come around, we want to be prepared to take full advantage of them, but often end up trying to diagnose problems or fix errant settings. This is unfortunate, because most setup and troubleshooting can be done during the day or on nights that aren't ideal for imaging. By really getting to know your equipment and software, and practising an accurate, repeatable equipment setup, you'll be ready to seize the night. ✴

Shooting from his backyard in Regina, Saskatchewan, in January 2020, Ian Barredo produced this image of the Rosette Nebula using Hα and OIII narrowband filters. He captured the data using a William Optics 71mm telescope with a ZWO ASI1600 monochrome camera on a Sky-Watcher AZEQ6 mount. (Ian Barredo)

By Chris Vaughan

BEYOND MESSIER

Deep-sky observing for advanced beginners

Astronomy educator Chris Vaughan discusses how to take your night sky observing to the next level

AT STAR PARTIES, I frequently overhear telescope owners wondering what to look at after viewing the handful of Messier objects they know about. Dozens of splendid deep-sky objects that are within easy reach of amateur telescopes never made it onto Charles Messier's famous list of 110 deep-sky objects. Let's add to your observing repertoire with some non-Messier deep-sky objects.

The origin of the Messier list

The term "deep-sky object" covers celestial objects outside of our Solar System that aren't merely individual or double stars. The main object classes are open star clusters; globular clusters; emission, reflection and dark nebulae (plus supernova remnants and planetary nebulae); and galaxies.

The Messier list was never meant to showcase the "best of the night sky." In mid-1757, at the Marine Observatory above Hotel de Cluny in Paris, young Charles Messier was attempting to become the first person to see Comet Halley upon its predicted return. Messier was scooped by a German astronomer who glimpsed the object a few weeks beforehand. Nevertheless, he became forever hooked on comets, dedicating his life to sweeping the skies for them on clear, moonless nights using his four-inch-aperture (100mm) telescope under skies that were untouched by today's urban light pollution.

The night sky was still largely uncharted when Messier began his quest. On August 28, 1758, he spotted a possible comet in the constellation of Taurus, but when it didn't move from night to night, he knew it was a permanent feature of the deep sky. He decided to catalogue these uncharted "comet imposters" starting with this first object, which we now know as the Crab Nebula, or Messier 1.

For a quarter of a century, Messier and his fellow comet-seekers took note of imposters until their final list, published in 1784, contained 103 objects. Between 1947 and 1967, Canada's Helen Sawyer Hogg, as well as Owen Gingerich and Kenneth Glyn Jones, added seven more objects that were alluded to in Messier's notes, arguing that Messier either forgot them or had planned to add them later. →

Expanding catalogues

It's not clear why Messier included objects that would never be mistaken for a comet, or why he left out objects that would be. Nonetheless, his list provides a fine starting point for serious beginners. Recognizing the limitations of the Messier list, some astronomy groups have published new lists of objects omitted by Messier, often using the 110-object model.

The foundation for most of them is the 7,840-object New General Catalogue — published by J.L.E. Dreyer in 1888, after earlier work by William, Caroline and John Herschel — and the extended 5,386-object Index Catalogue. The NGC and IC numbers are used on star charts and by astronomy apps and GoTo telescope databases.

The Royal Astronomical Society of Canada publishes its own Finest NGC list of deep-sky objects, containing both easy and more challenging objects. (It appears on page 318 of the *2021 Observer's Handbook*.) RASC members can earn a pin and certificate by observing all 110 objects, either by traditional star-hopping or by using a computerized GoTo system.

Below are my top recommendations for non-Messier deep-sky targets on moonless mid-winter nights. Most of these are best viewed in early evening, when they are highest in the sky. I've provided the common names and the NGC / IC catalogue numbers, plus the Finest NGC numbers (FN) for those interested in earning that RASC observing certificate.

Mid-winter non-Messier targets

The Rosette Nebula (NGC 2238) with its central open star cluster (NGC 2244) is the perfect example of a superb deep-sky object that beginners might overlook. This winter showpiece is located in western Monoceros, about midway between Procyon and Betelgeuse. You'll first notice its bright, circular cluster of young, hot, O-class stars. The magnitude 5.85 star 12 Monocerotis sits toward the southeastern corner of the cluster. The Rosette itself is a one-degree-diameter H II emission nebula that surrounds the cluster. Your best views will be delivered in a very dark transparent sky. Use about 40× to see the entire structure, then magnify and look for dark lanes and other details. An O III or UHC filter will brighten the nebulosity. (FN 032)

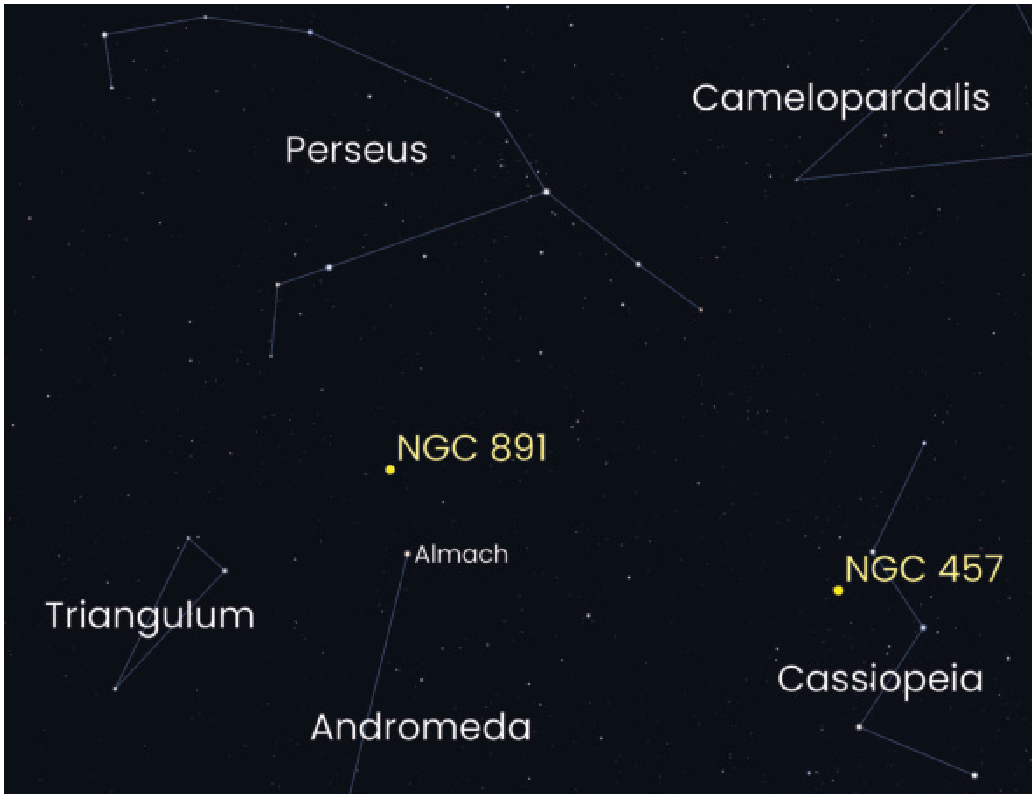
NGC 2261, or Hubble's Variable Nebula, is situated midway between the Rosette Nebula and the medium-bright star Xi Geminorum. This tiny (two-by-four arc minutes) comet-shaped emission and reflection nebula envelops the variable star R Monocerotis. The nebula also varies in brightness over months or years, due to opaque dust orbiting the star. It is bright and easy to see at high magnification — once you locate it. (FN 033)

For another nearby non-Messier treat, shift your view one degree to the northeast for the very large and distinctly shaped Christmas Tree Cluster and Cone Nebula (NGC 2264 and Melotte 49).

NGC 2392 is a magnitude 9.6 planetary nebula in Gemini, located about midway between Kappa and Lambda Geminorum and 2.3 degrees east of Wasat (Delta Geminorum). A ragged outer shell and an irregular inner ring surround a central white dwarf star when viewed at 150× or higher. The disk is about 40 arc seconds across — comparable with the apparent size of Jupiter — and exhibits a slight blinking effect when you alternate between direct and averted vision. A nebula filter will brighten the disk. (FN 031)

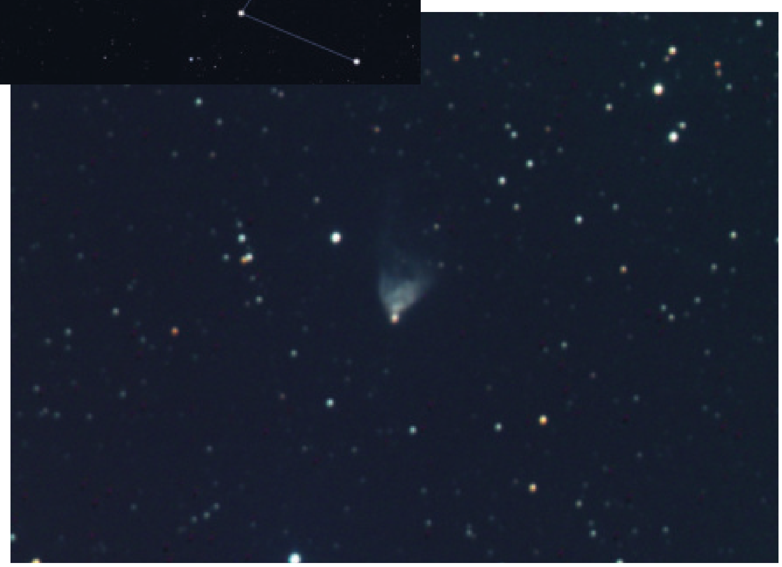
NGC 457 (see sky chart, opposite), the Dragonfly/Owl/ET Cluster in Cassiopeia is a favourite star party object. This gem of an open cluster, 5,200 light-years distant, forms a right-angled triangle with the bright stars Ruchbah and Navi. Observe the critter using 100× magnification. Two brighter golden stars (Phi1 and Phi2 Cas) mark its eyes, while dimmer stars form its toes, body and pair of curved wings or arms. The reddish, pulsating variable star V466 Cas sits where its heart would be. Phi1 and Phi2 Cas are probably not physically related to the cluster. (FN 008)

NGC 891 (see sky chart, opposite), is a magnitude 10.8, edge-on spiral galaxy, 30 million light-years away. It's located 3.5 degrees east of the bright star Almach (Gamma Andromedae). Galaxies oriented edge-on appear brighter because their total light output is concentrated into a smaller area. Use averted vision and look for a slash of light with a thickened core and tapered ends 12 arc minutes in length. Owners of larger-aperture telescopes should try to see its dark dust lane. (FN 012) ✴



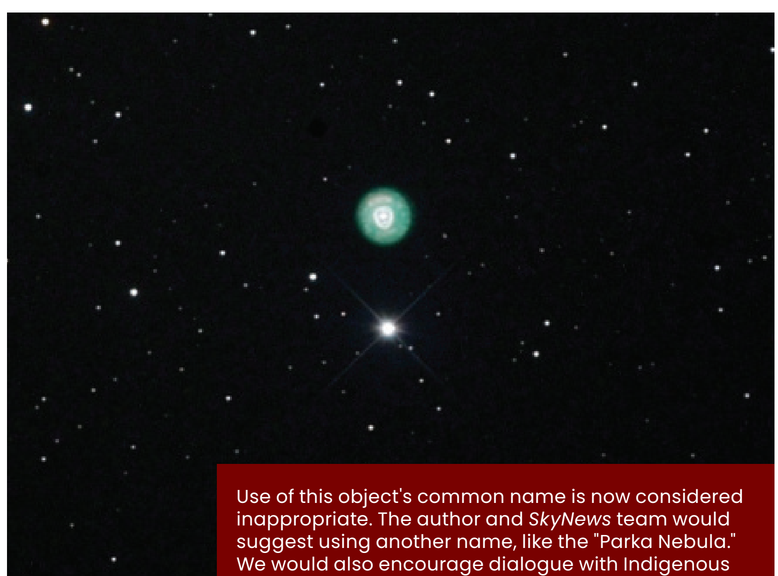
← NGC 891 AND NGC 457

The high surface brightness of edge-on galaxy NGC 891 makes it a relatively easy target for amateur telescopes, while the bright and whimsical ET/Dragon/Owl Cluster (NGC 457) will captivate your viewing companions. Both objects are high in the western sky in early evening during mid-winter. (Allendria Brunjes)



HUBBLE'S VARIABLE NEBULA →

Blake Nancarrow produced this image of Hubble's Variable Nebula using data collected from the Burke-Gaffney Observatory at Saint Mary's University in Halifax, Nova Scotia, on December 7, 2016. The observatory has a 60-centimetre Corrected Dall-Kirkham telescope with a focal ratio of 6.5, and the Apogee CG-16M camera was used to collect the data. Nancarrow also said that over about three or four years, he captured many of RASC's Finest NGC objects.



NGC 2392 →

Rick Wagner composed this picture using two images. On March 30, 2005, he shot an LRGB image from his observatory in suburban Ottawa, using a home-made 20cm f/5.6 Newtonian on a Losmandy Titan, SBIG ST2000XM CCD camera. On March 13, 2019, from his observatory near Elgin, Ontario, he shot eight 100-second unfiltered images with the same camera using a Boltwood 0.4m Newtonian on a Mathis Instruments MI750. These were stacked in Maxim DL and enhanced with the DDP filter. The two resulting images were combined in Photoshop using the more detailed unfiltered image as luminance layer and the earlier LRGB image as the colour layer. The Boltwood telescope was built by the late Paul Boltwood who donated the telescope, mount and pier to Wagner about five years ago.

Use of this object's common name is now considered inappropriate. The author and *SkyNews* team would suggest using another name, like the "Parka Nebula." We would also encourage dialogue with Indigenous groups who could propose a new name for the object.

DOWN TO A SCIENCE

By Chris Gainor

Taking off 50 years ago this January, the Apollo 14 mission pursued scientific study on the Moon

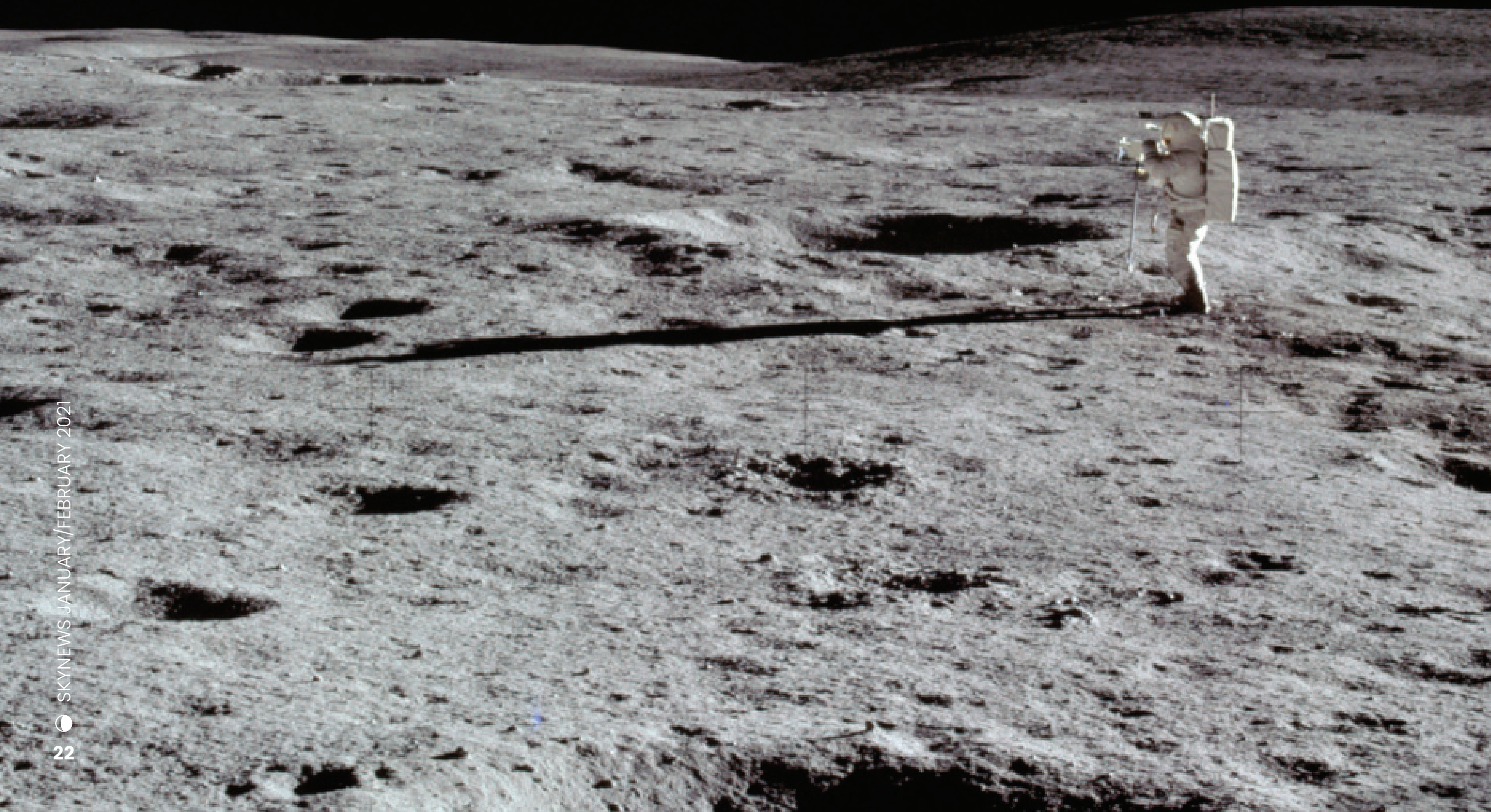
ONCE APOLLO 11 PROVED THAT HUMANS COULD LAND ON THE MOON and Apollo 12 executed a pinpoint landing there, it was time for the program to go to places chosen purely for scientific interest.

Those first two Apollo crews explored the relatively young surfaces of the Sea of Tranquility and the Ocean of Storms. The third Apollo expedition was scheduled to explore a site called Fra Mauro. There, geologists sought samples from the early days of the Moon in the gargantuan impact that created the Imbrium Basin.

After Apollo 13 failed to reach the Moon in April 1970, (read more in *SkyNews*' March-April 2020 edition) and the spacecraft was modified to prevent another accident, NASA decided to try again for Fra Mauro with Apollo 14.

Launching on January 31, 1971 — 50 years ago — Alan Shepard was in command, the only one of America's original seven astronauts to fly to the Moon. His crew was rounded out by two rookies, lunar module pilot Edgar Mitchell and command module pilot Stuart Roosa.

After they reached lunar orbit with Roosa aboard the Command Module Kitty Hawk, Shepard and Mitchell moved to the Lunar Module Antares on February 5 and overcame



Lunar module pilot Edgar Mitchell shoots a panorama of the Apollo 14 landing site on the Moon with a TV camera. Cone Crater is on a portion of this ridge that is off the picture to the right, virtually up-Sun (east) of the landing site. (NASA)

Left: An image of the Apollo 14 Lunar Module Antares at Fra Mauro, looking eastward. (NASA)

Below left: Mitchell took this photo of mission commander Alan Shepard from the lunar module looking northwest on the Moon. Shepard has red stripes on his arms and legs and the top of his helmet, which help distinguish him from Mitchell, who has no stripes. NASA also points out this photo provides good views of Shepard's cuff checklist, his Omega watch, and the strap-on pocket on his left thigh. (NASA)

a software glitch and a radar problem on their way to Fra Mauro. Antares touched down a little more than a kilometre from the 370-metre wide Cone Crater, a relatively fresh crater that acted as a lunar drill hole.

During their first lunar excursion of four hours and 48 minutes, the two astronauts obtained their first lunar samples and photographs, and set up the Apollo Lunar Surface Experiments Package, which included seismology experiments, particle detectors and a laser reflector that is still in use today.

The second lunar traverse was largely taken up with a climb up a ridge that led to Cone Crater. Shepard and Mitchell pulled and sometimes had to push the Modular Equipment Transporter (MET), a two-wheeled cart that carried sampling tools, scientific instruments and lunar samples.

The Moon's unusual lighting conditions and its nearby horizon challenged the astronauts, along with steepening grades as Shepard and Mitchell neared the rim of Cone Crater. As the tired astronauts began to run short of time, Mission Control ordered them to concentrate on gathering precious pieces of lunar bedrock that surrounded the crater. They got a few samples but returned to Antares without ever standing at the rim of Cone Crater.

Science was the focus, but not the only thing astronauts did. Before wrapping up the four-hour, 20-minute traverse, Shepard stepped before a television camera and hit two golf balls with a jury-rigged club. And on the way back from the Moon to Apollo 14's February 9 splashdown in the Pacific Ocean aboard Kitty Hawk, Mitchell attempted the first extrasensory perception (ESP) experiment in space.

That said, Shepard and Mitchell had walked 3.4 kilometres over the lunar surface and brought home 43 kilograms of lunar samples, and the studies augmented by the mission's samples continue. Just last year, an Apollo 14 lunar rock was found to contain material that may have come from the Earth early in its history, possibly one of the oldest geological samples from our home planet. ✴

Canada's night sky for January/February

Compiled by James Edgar • Cartography by Glenn LeDrew

CELESTIAL CALENDAR

** Impressive or relatively rare astronomical event*

JANUARY 3
Quadrantid meteors peak 10 a.m. EST (see Page 27)

JANUARY 6
Last quarter Moon

JANUARY 9
*Mercury 1.7° south of Saturn

JANUARY 10
*Jupiter, Saturn, & Mercury in 2.3° circle (see Page 31)

JANUARY 11
*Venus 3° north of Moon;
*Mercury 1.5° south of Jupiter

JANUARY 13
New Moon at 0:01 a.m. EST;
Jupiter, Mercury and Saturn within 6° of new Moon

JANUARY 15
*Jupiter, Saturn, Mercury and Moon in 15° arc (see Page 28)

JANUARY 20
First quarter Moon

JANUARY 21
*Mars, Uranus and first quarter Moon within 5°;
Mars 1.7° north of Uranus

JANUARY 22
*Mars 1.7° north of Uranus (see Page 28)

JANUARY 23
*Mercury at greatest elongation east (see Page 29);
Jupiter in conjunction with the Sun

JANUARY 28
Full Moon at 2:16 p.m. EST;
Jupiter in conjunction with the Sun

FEBRUARY 4
Last quarter Moon

FEBRUARY 6
Venus 0.4° south of Saturn

FEBRUARY 8
Mercury at greatest heliocentric latitude north

FEBRUARY 10
Saturn 3°, Venus 5° north of thin crescent Moon

FEBRUARY 11
Venus 0.4° south of Jupiter;
New Moon 2:05 p.m. EST

FEBRUARY 17
Uranus 3° north of Moon

FEBRUARY 18
Mars 4° north of first quarter Moon

FEBRUARY 19
First quarter Moon

FEBRUARY 27
Full Moon at 3:17 a.m. EST

PLANETS AT A GLANCE

	DATE	MAGNITUDE	DIAMETER (")	CONSTELLATION	VISIBILITY
Mercury	Jan. 1 Feb. 1	— 1.5	4.7 5.6	Sagittarius Capricornus	— Dusk
Venus	Jan. 1 Feb. 1	−3.9 −3.9	11.0 10.1	Ophiuchus Capricornus	Dawn Dawn
Mars	Jan. 1 Feb. 1	0.2 0.5	10.3 7.7	Pisces Aries	Evening Evening
Jupiter	Jan. 1 Feb. 1	-2.0 —	33.0 32.5	Capricornus Capricornus	Dusk —
Saturn	Jan. 1 Feb. 1	0.6 —	15.1 15.0	Capricornus Capricornus	Dusk —
Uranus	Jan. 1 Feb. 1	5.7 5.8	3.6 3.5	Aries Aries	Evening Evening
Neptune	Jan. 1 Feb. 1	7.9 7.9	2.3 2.2	Aquarius Aquarius	Evening Evening

Our chart shows the major stars, planets, and constellations visible from Canada and the northern United States within one hour of these times:

Early January:	11:00 p.m.
Late January:	10:00 p.m.
Early February:	9:00 p.m.
Late February:	8:00 p.m.

USING THE STAR CHART:

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.)

The star groups linked by lines are the constellations approved by the International Astronomical Union as a way of mapping the night sky.

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 your night-vision sensitivity.

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.

For additional details or late-breaking information, visit our website at **skynews.ca**.

Also consult the *Observer's Handbook*, published by The Royal Astronomical Society of Canada, available at **rasc.ca** or by calling 1-888-924-7272.

A composite of the Quadrantid Meteor Shower, on January 3, 2016. The images were shot in a sequence over two hours from southern Alberta. (Alan Dyer)

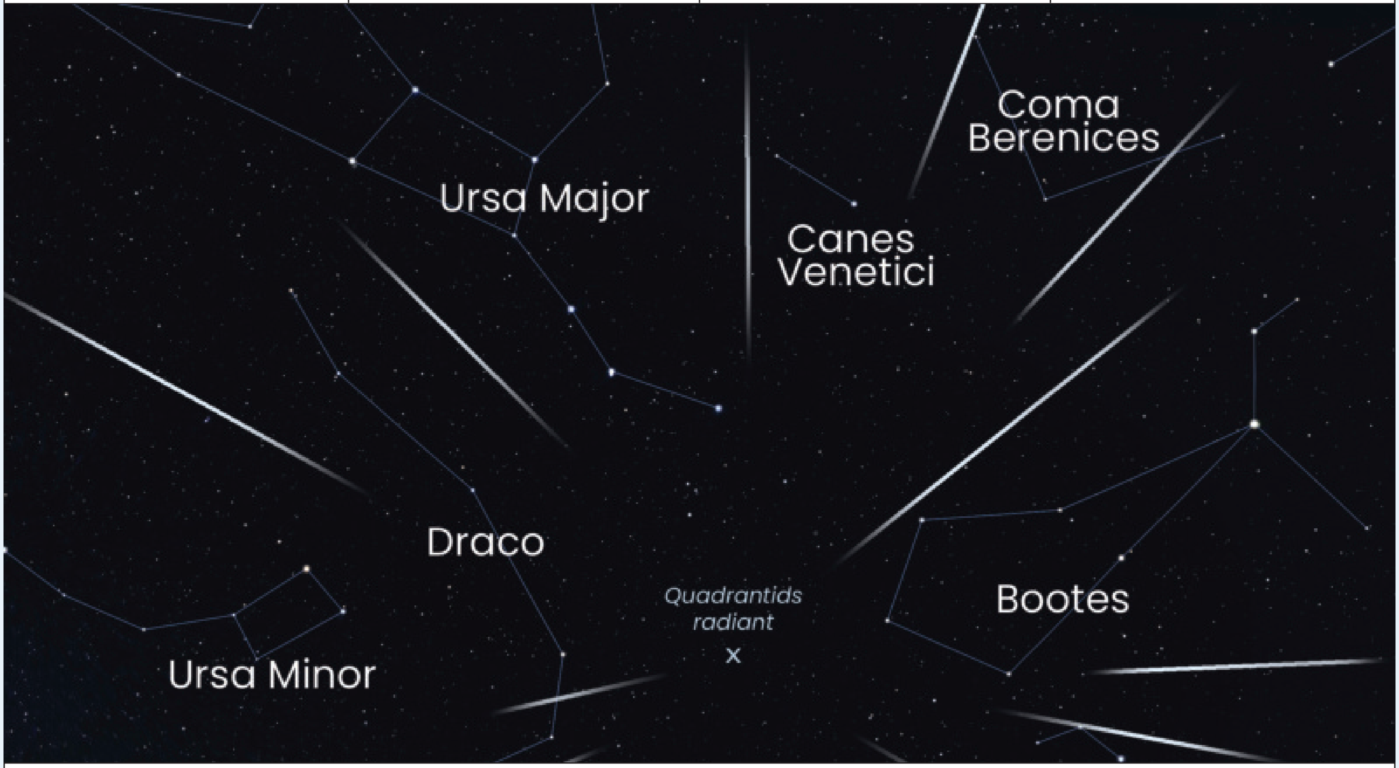
Planets and a meteor shower lead the year

By Brian Ventrudo

Mercury, Jupiter and Saturn make brief appearances before heading toward the Sun, while Mars slowly saunters through the winter constellations

The Quadrantid meteor shower leads the year, and while not ideally timed for Canadian observers, it offers the chance to see a short burst of meteors in the pre-dawn sky. After a spectacular close encounter in December 2020, Jupiter and Saturn are on their way to conjunction with the Sun but before that, they will join Mercury and the crescent Moon in the southwestern sky after sunset.

DATE:	TYPE:	TIME:	VIEW:
January 3, 2021	Meteor shower	Before dawn	Naked eye



Quadrantid meteor shower peaks

Named after the defunct northern constellation Quadrans Muralis, the brief but sometimes spectacular Quadrantid meteor shower can feature more than 100 meteors per hour. Conditions are less than ideal this year, as a waning gibbous Moon obscures the faintest meteors. But if you're up before dawn on January 3, then take a look. You never know. Quadrantids can appear anywhere in the sky and their paths trace back to a point just north of Arcturus, which is visible in the northeastern sky pre-dawn.

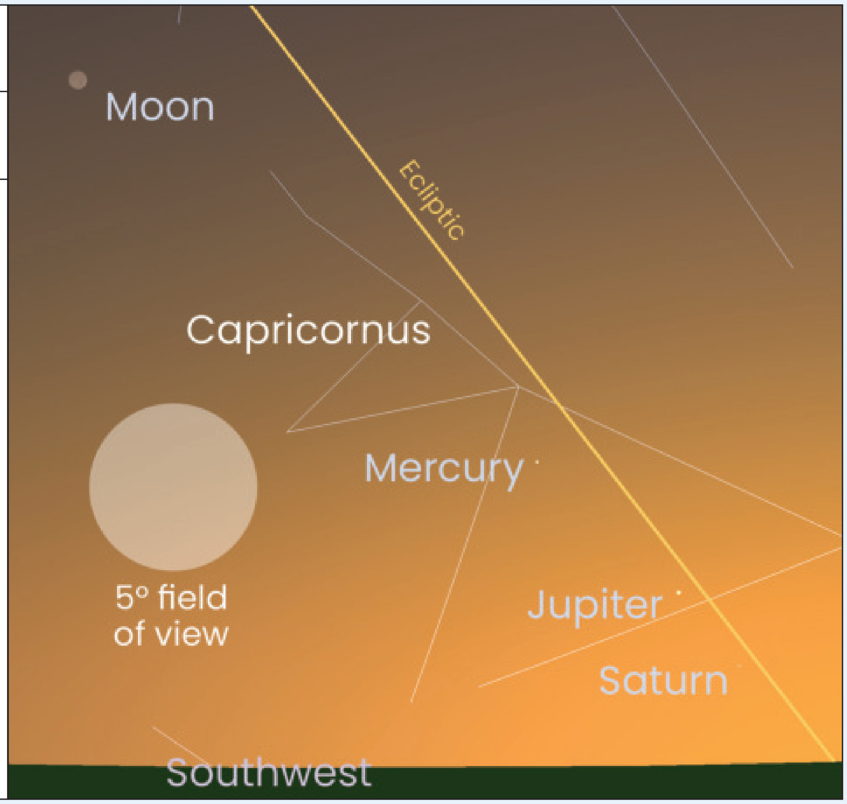
The predicted time of the meteor shower's peak favours western Canadian observers just before dawn. →

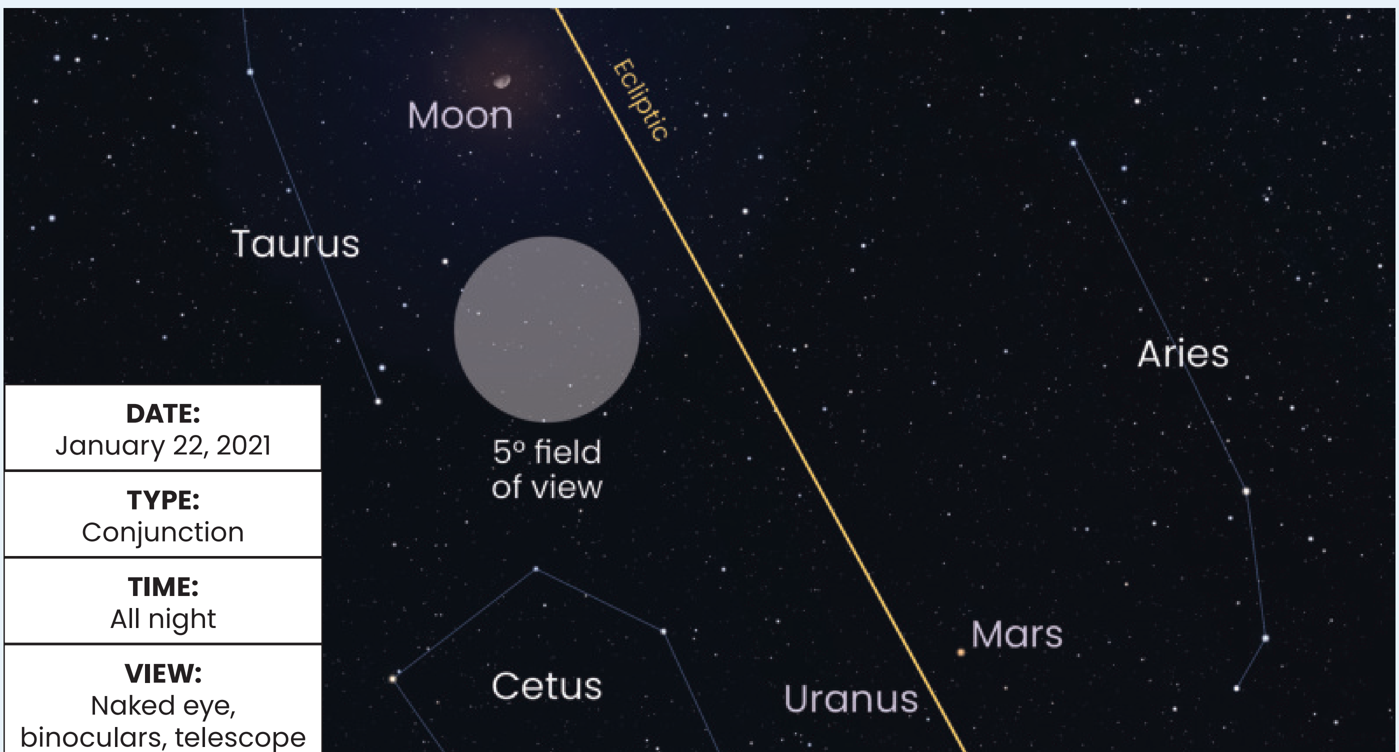
Charts by Allendria Brunjes (Stellarium)

DATE: January 15, 2021	TYPE: Conjunction
TIME: Evening	VIEW: Binoculars

Moon and planets meet after sunset

Just after sunset, grab a pair of binoculars and look low over the southwestern horizon to see a very slender crescent Moon along with Mercury, Jupiter and Saturn in a shallow arc about 15 degrees long. In darker sky, this would be a spectacular display, but all four objects are low and somewhat obscured by bright twilight. At magnitude -1.9, Jupiter is the brightest of the three planets, while Mercury shines at magnitude -0.9. Saturn, the rightmost and lowest of the planets, shines at magnitude +0.6 and presents the greatest challenge, even with binoculars.





DATE: January 22, 2021
TYPE: Conjunction
TIME: All night
VIEW: Naked eye, binoculars, telescope

Mars and Uranus conjunction

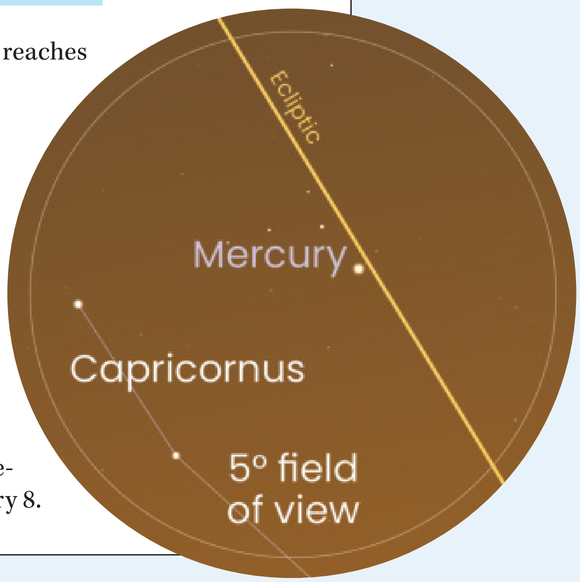
Mars passes about 1.7 degrees north of the planet Uranus tonight. The Red Planet spans less than half the apparent diameter of last October's opposition so it yields little detail through a telescope. Still relatively bright at magnitude +0.3, Mars far outshines sixth-magnitude Uranus.

Both planets easily fit in the same field of view with binoculars. A telescope with a suitably wide field of view offers a study in planetary colours with ochre-coloured Mars contrasting the pale grey-green of Uranus. The disk of Mars spans 8.5 arc-seconds while Uranus appears 3.6 arc-seconds across.

DATE:	TYPE:
January 23, 2021	Apparition
TIME:	**VIEW:**
After sunset	Naked eye, binoculars, telescope

Mercury at greatest eastern elongation

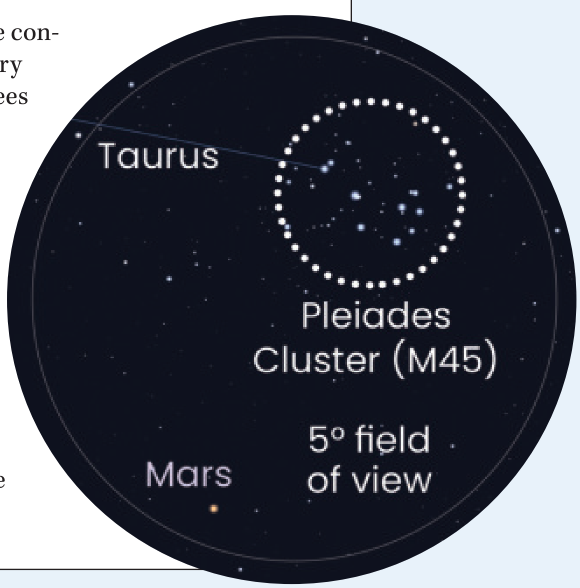
The speedy planet Mercury reaches greatest eastern elongation about 19 degrees from the Sun. The planet shines in the southwestern sky after sunset at magnitude -0.7, unattended by any other bright celestial body in the twilight glare. A pair of binoculars enhances the view. After today, the planet appears to move quickly toward the Sun each night on its way to inferior conjunction on February 8.



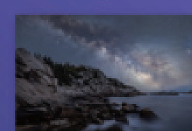
DATE:	TYPE:
February 28, 2021	Conjunction
TIME:	**VIEW:**
All night	Naked eye, binoculars

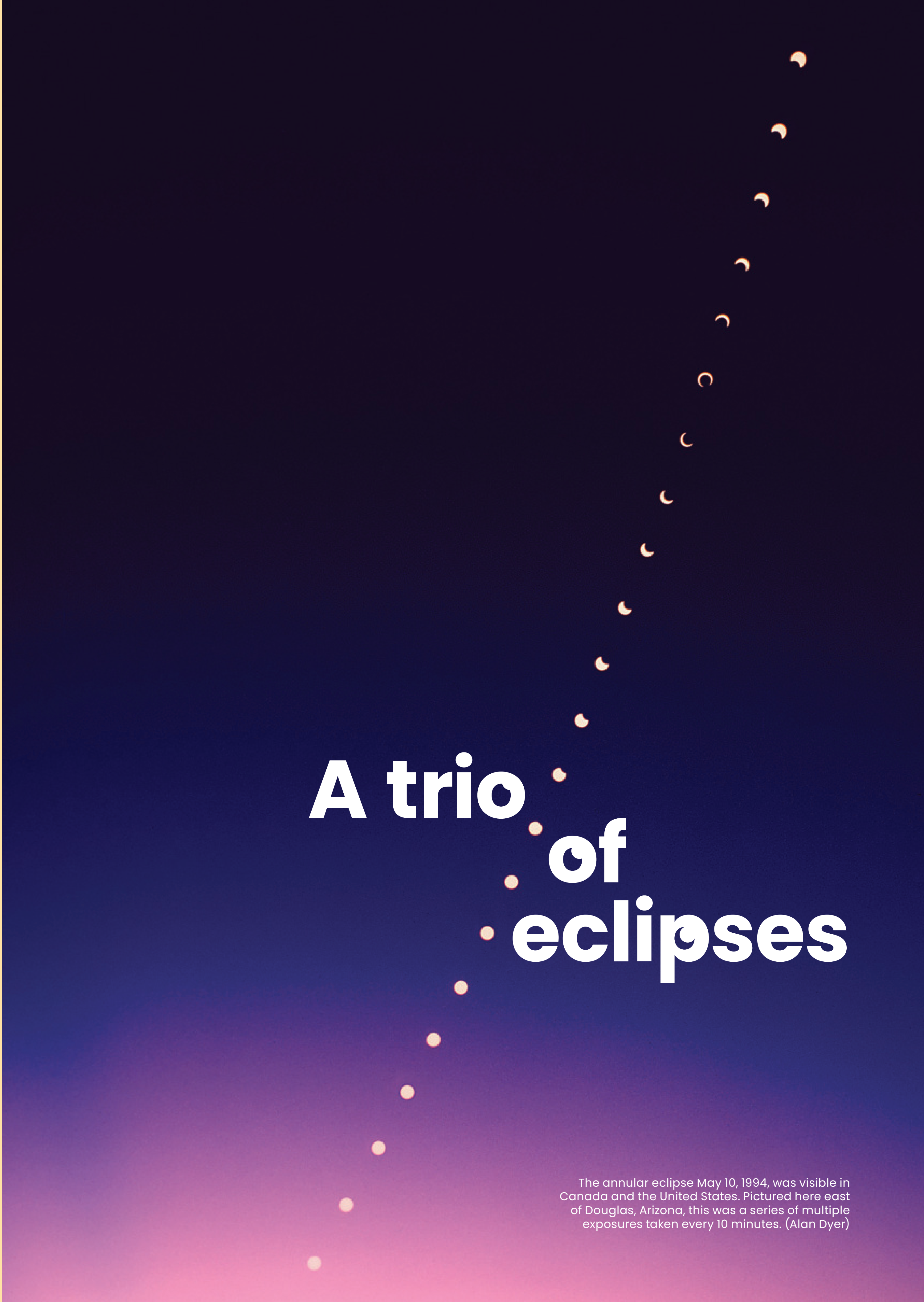
Mars south of the Pleiades

Mars makes its way into the constellation Taurus as February ends and lies just four degrees south of the Pleiades star cluster tonight. The planet spends the next month passing through the constellation. Though faded to magnitude +0.9, Mars makes a fine colour contrast to the blue-white stars of the Pleiades and closely matches colour and brightness of the bright star Aldebaran in the "eye" of the celestial bull. ✴



Charts by Allendria Brunjes (Stellarium)



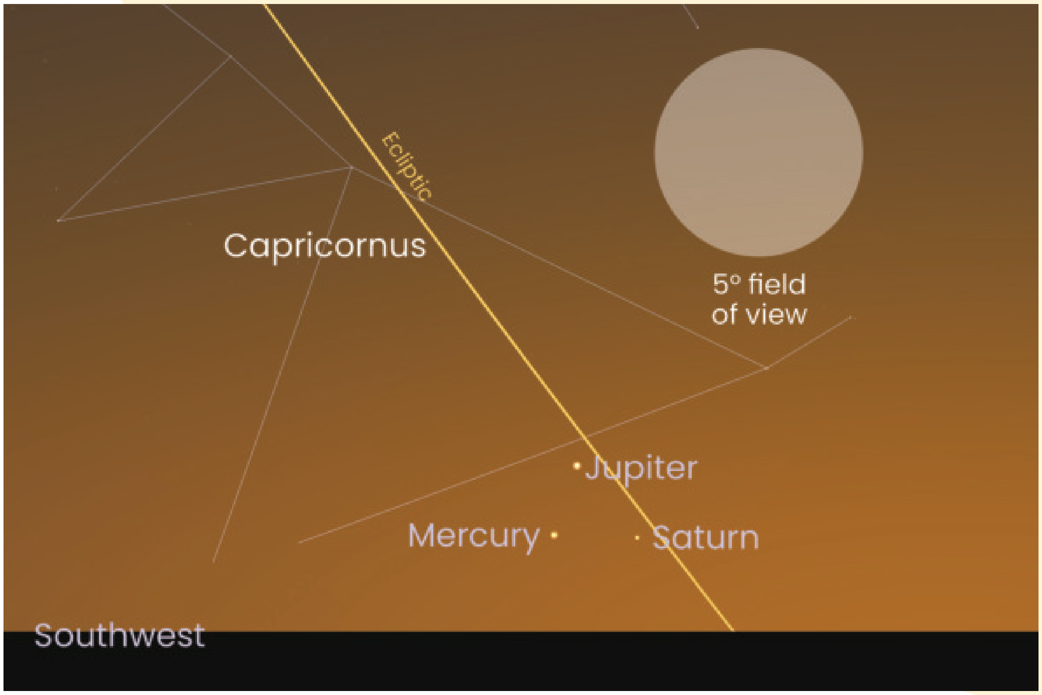


A trio of eclipses

The annular eclipse May 10, 1994, was visible in Canada and the United States. Pictured here east of Douglas, Arizona, this was a series of multiple exposures taken every 10 minutes. (Alan Dyer)

WHILE WE CAN'T KNOW FOR CERTAIN WHAT'S IN STORE FOR US ON Earth in 2021, the skies feature many excellent events to enjoy as they operate with their customary clockwork regularity. The Moon and bright planets bob and weave along the ecliptic and align for some lovely conjunctions throughout the year. The August Perseid meteor shower promises its usually reliable display as the Moon stays out of the way. Perhaps more uncertainly, sunspot cycle 25 slowly gets underway with the promise of more activity in the solar chromosphere. And there are four eclipses on tap for 2021, three of which — two lunar and one solar — are at least partly visible from Canada. While it's always hard to narrow down a year's worth of celestial events to a short list, here's our selection of ten of the best celestial events for 2021.

By Brian Ventrudo



DATE:
January 10, 2021
TYPE:
Conjunction
TIME:
Evening
VIEW:
Naked eye, binoculars

Charts by Allendria Brunjes (Stellarium)

EVENT #1:

Jupiter, Saturn and Mercury gather after sunset

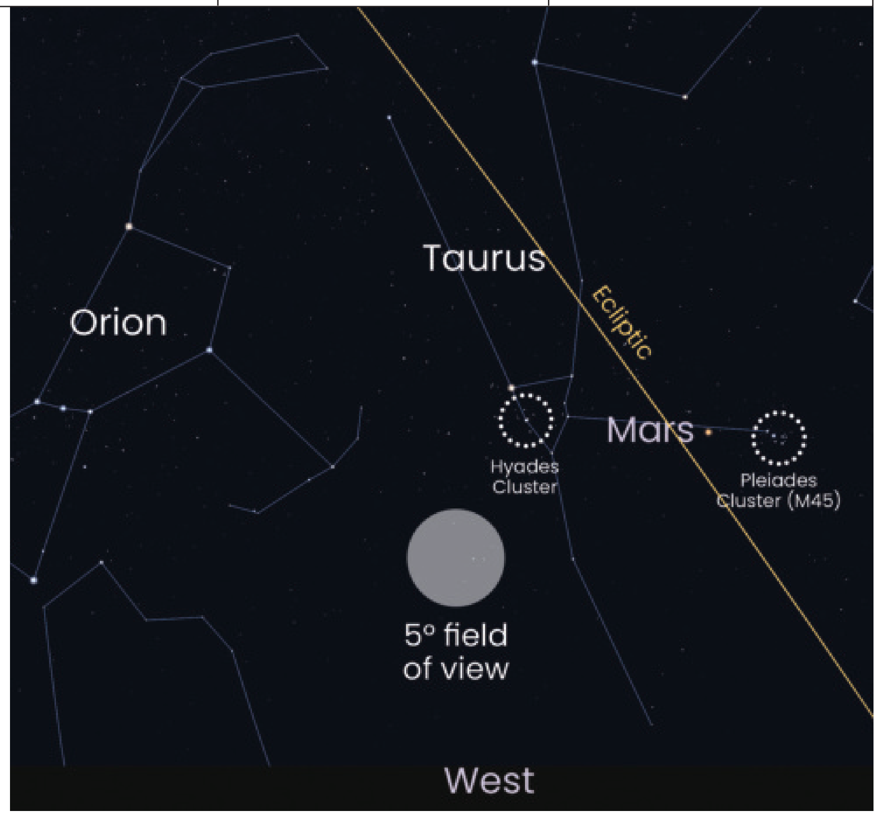
Begin 2021 with a worthy observational challenge: try to spot Mercury, Jupiter and Saturn gathered in a tight triangle less than three degrees wide. The three planets are plenty bright, but they're all low in the sky after sunset and just 13 degrees from the Sun. You'll need binoculars and a clear view of the southwestern horizon. Jupiter and Saturn, just past a spectacular close conjunction in December 2020, are on their way to conjunction with the Sun later this month, but still shine at magnitude -1.9 and +0.6, respectively. Mercury shines at magnitude -0.9 today and continues to move slightly higher above the horizon on its way to greatest eastern elongation on January 24. The wafer-thin Moon sits to the left of the three planets on January 14. →

DATE: March 7-8, 2021	TYPE: Conjunction	TIME: All night	VIEW: Naked eye, binoculars

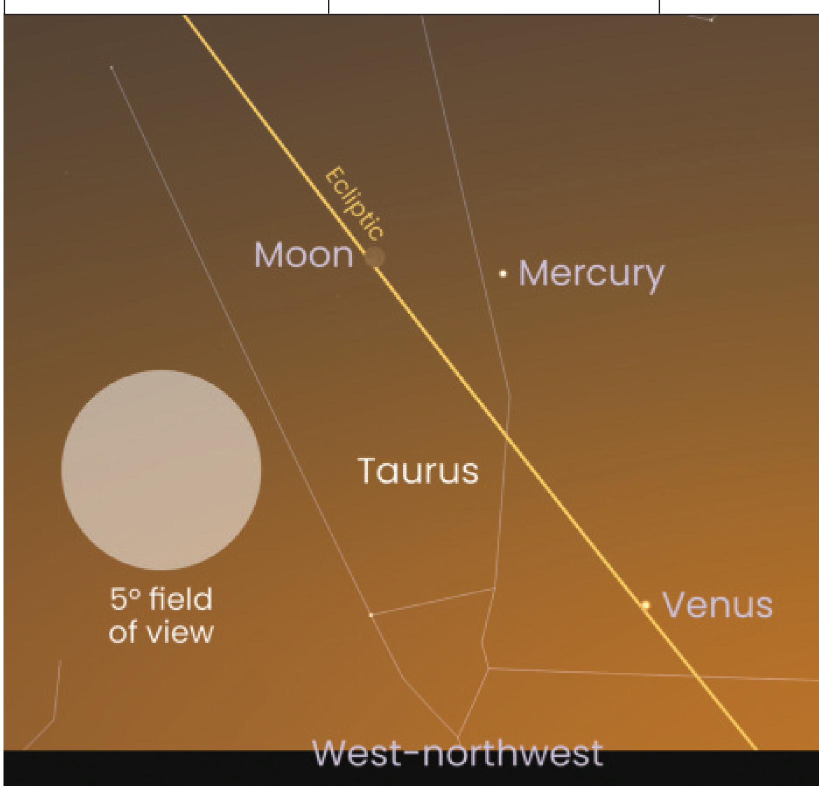
EVENT #2:

Mars adorns Taurus

During its namesake month of March, Mars makes a leisurely trip through the prominent constellation Taurus, well above the western horizon. On the nights of March 7 and March 8, the Red Planet lies between the Hyades and Pleiades star clusters, a little closer to the latter. Long past its 2020 opposition, Mars has faded to a still respectable first magnitude, roughly the same brightness and of similar colour to Aldebaran, the brightest star in Taurus. The waxing crescent Moon joins the show on March 18. As March comes to a close, Mars moves up the "horns" of the celestial bull and lies halfway between the stars Aldebaran and Elnath (beta Tauri).



DATE: May 13, 2021	TYPE: Conjunction	TIME: Evening	VIEW: Naked eye, binoculars

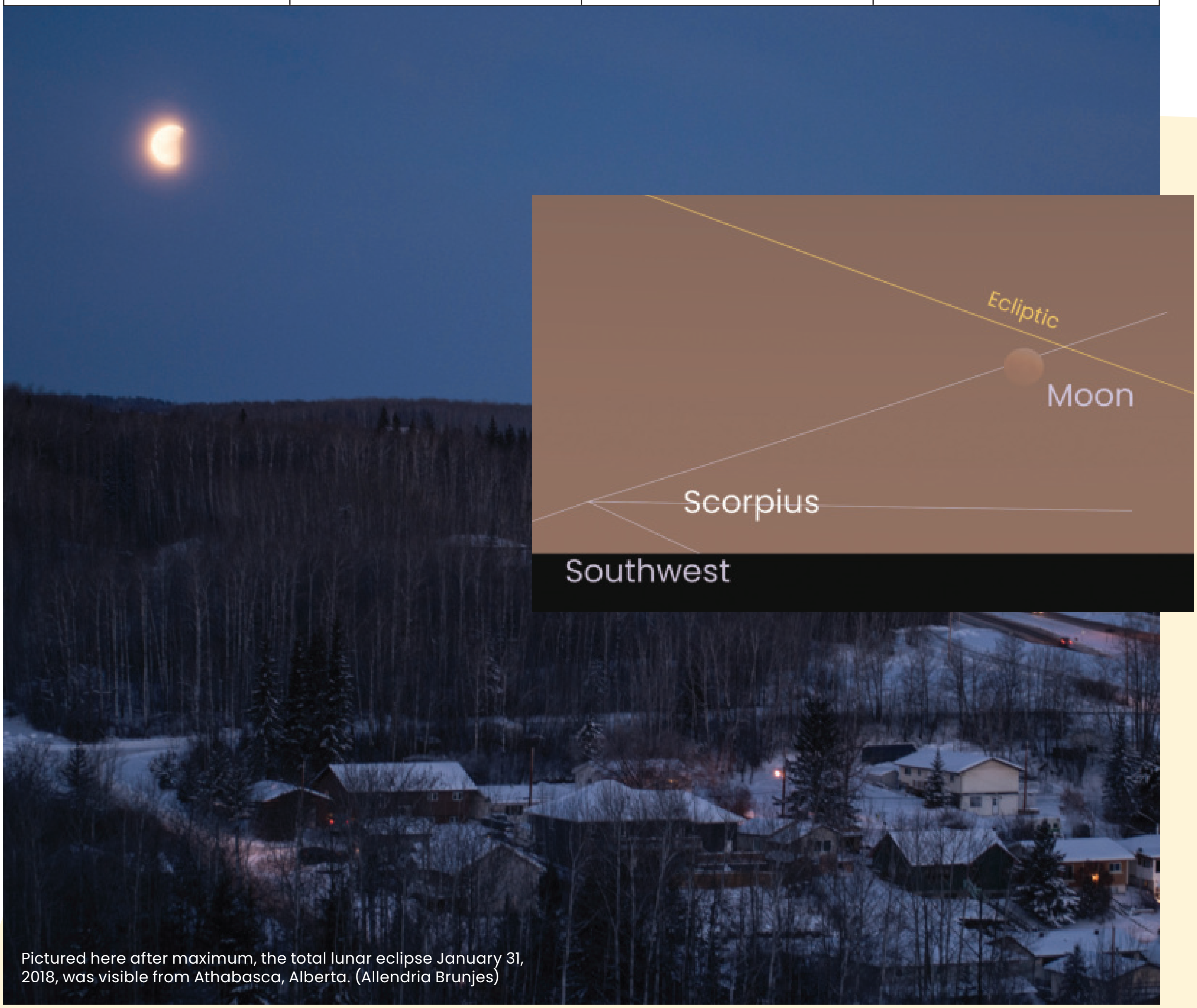


EVENT #3:

Moon and Mercury meet

The speedy planet Mercury emerges from the Sun's glare into the evening sky in May for its best apparition this year for Canadian observers. A slender crescent Moon helps mark the position of zero-magnitude Mercury on May 13 when it lies about three degrees to the left of the planet in the northwestern sky. The pair lie tangled in the long horns of the constellation Taurus and well below the bright stars Castor, Pollux and Capella. Venus lies less than 10 degrees below and to the right of Mercury, but it's a challenging sight in the bright twilight. Mercury rises a little more until May 17 when it reaches greatest eastern elongation, and then it heads back toward the horizon during the rest of the month.

DATE:	TYPE:	TIME:	VIEW:
May 26, 2021	Total lunar eclipse	Early morning	Naked eye, binoculars



Pictured here after maximum, the total lunar eclipse January 31, 2018, was visible from Athabasca, Alberta. (Allendria Brunjes)

Charts by Allendria Brunjes (Stellarium)

EVENT #4:

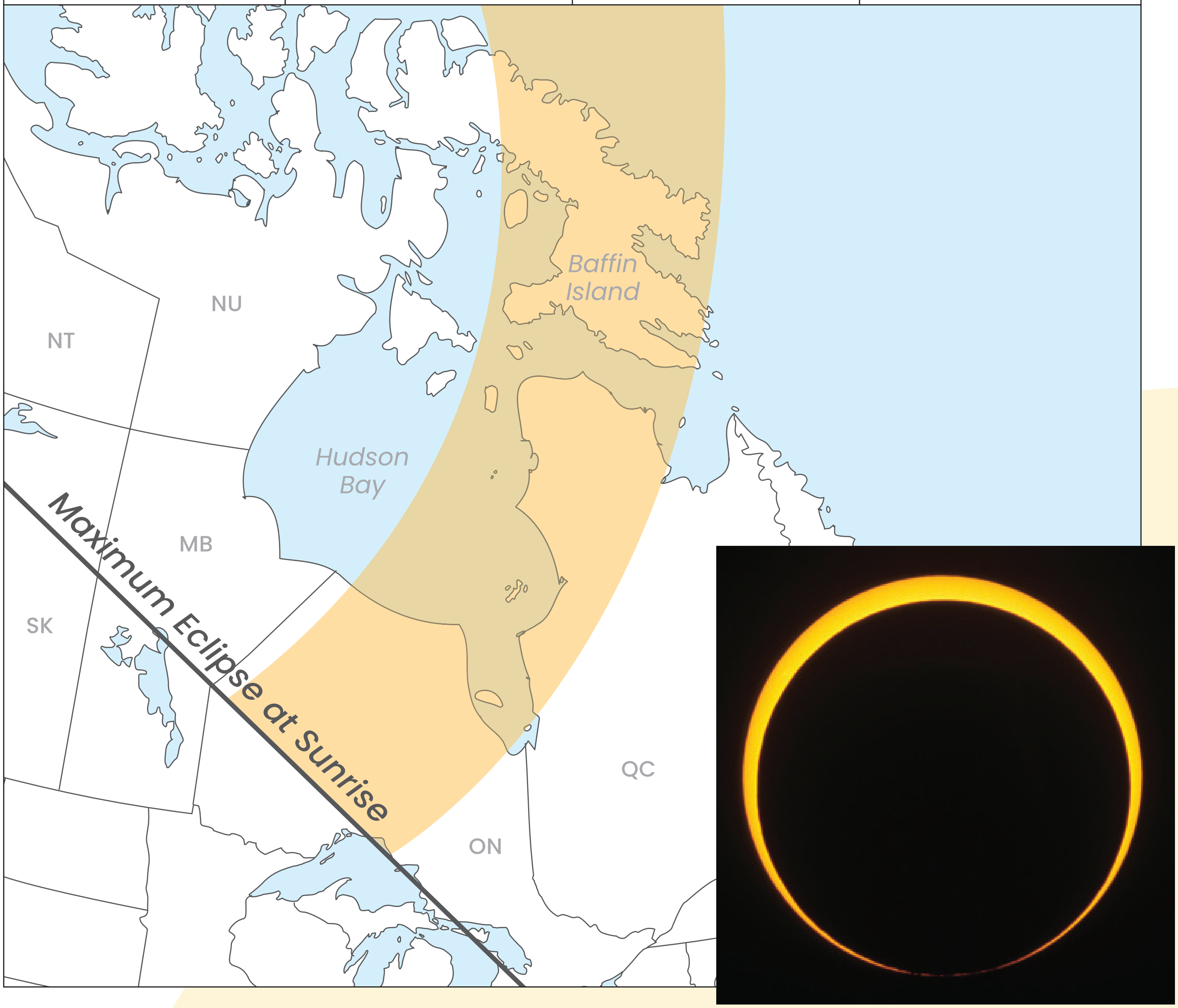
A Western lunar eclipse

The last week of May brings a total lunar eclipse to observers in western Canada, the first total lunar eclipse since January 2019. The eclipse arrives as the Moon reaches perigee, its closest point to Earth in its orbit, making this also the largest full Moon of the year (get ready for media reports of the Super Blood Moon).

Observers in British Columbia, much of southwestern Alberta and the extreme southwestern tip of Saskatchewan are lucky enough to see the eclipse begin and reach totality before moonset. Observers at points eastward see the Moon enter the Earth's penumbra at the start of the eclipse, but the Moon sets before the full eclipse gets underway. No part of the eclipse is visible from Newfoundland, northern Quebec or most of the Maritimes, but observers there can still enjoy the oversized Full Flower Moon as spring weather (hopefully) makes for pleasant stargazing.

This is an early-morning event, one that promises superb opportunities for photographers. From Calgary, the eclipse gets underway at 2:47 a.m. Mountain Daylight Time, with the total eclipse running from 5:11 a.m. to 5:25 a.m. The Moon will lie low over the southwestern horizon at totality, ideal for capturing dramatic images before moonset at 5:42 a.m. From Vancouver, totality runs from 4:11 a.m. through 4:25 a.m. Pacific Daylight Time, while moonset occurs at 5:26 a.m. →

DATE: June 10, 2021	TYPE: Annular solar eclipse	TIME: Morning	VIEW: Naked eye, binoculars (with solar filter)



An image of the annular eclipse May 10, 1994, showing "reverse" Bailey's Beads — lunar mountains just touching Sun's limb — taken from east of Douglas, Arizona (Alan Dyer)

EVENT #5:

A 'ring of fire' eclipse

Two weeks after the lunar eclipse of May 26, the Moon — just 2.3 days past apogee — passes in front of the face of the Sun, yielding a spectacular annular solar eclipse. The event is visible from northwestern Ontario and much of James Bay and from parts of Hudson Bay, Baffin Island (including Iqaluit), the Canadian high arctic, northwestern Greenland and northeastern Siberia. It's also the only such eclipse during the 21st century to pass over the North Pole. Observers in Ontario, Quebec and the eastern provinces, as well as much of Europe, will see a partial solar eclipse during this event.

The annular solar eclipse begins at 9:55 Universal Time (5:55 a.m. Eastern Daylight Time) along the north shore of Lake Superior and Lake Nipigon when the Sun rises as the annular eclipse is in progress. Here, along the central line of the eclipse, annularity lasts about 3 minutes and 37 seconds. A view of the northeastern horizon is essential. The eclipse races over northwestern Ontario and the towns of Armstrong, Pickle Lake and Attawapiskat before moving northeast across northwestern Quebec. In Iqaluit, peak eclipse occurs at 6:06:27 a.m. Eastern Daylight Time and lasts 3 minutes and 5 seconds, with the Sun 18 degrees above the horizon.

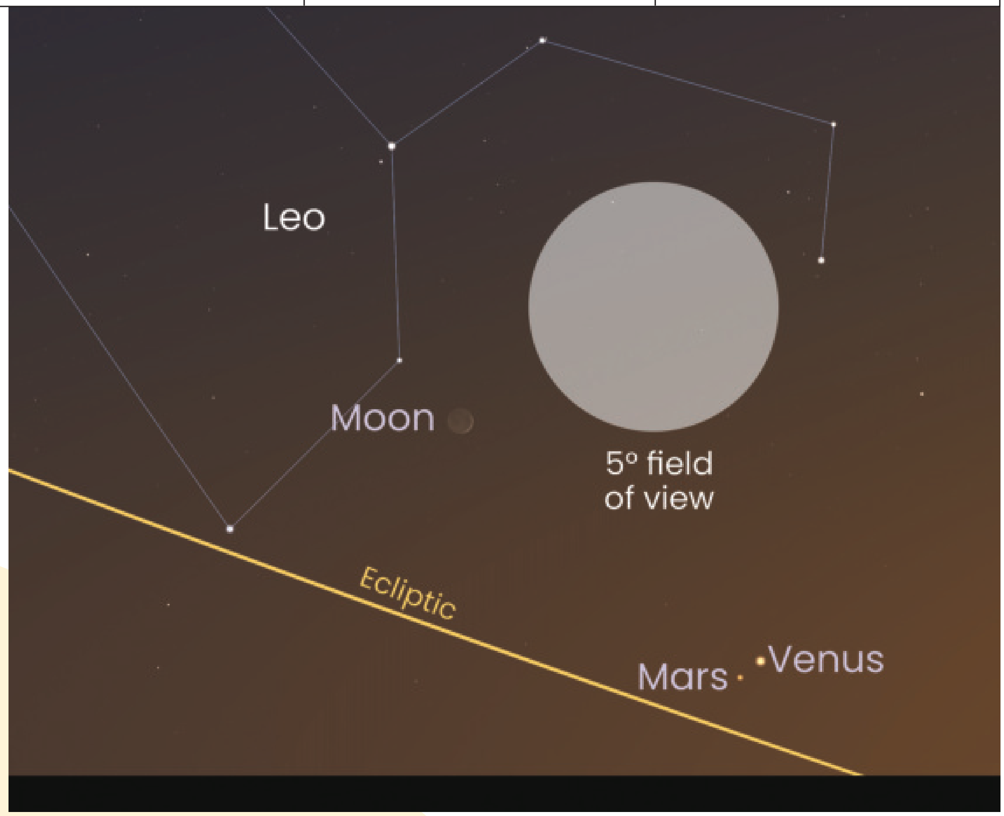
With the Sun low over the northeastern horizon during this eclipse, imaging opportunities abound. Don't forget: a safe solar filter is a must for both visual observers and astrophotographers during all phases of this annular eclipse.

DATE:	TYPE:	TIME:	VIEW:
July 11–13, 2021	Conjunction	Dusk	Naked eye, binoculars

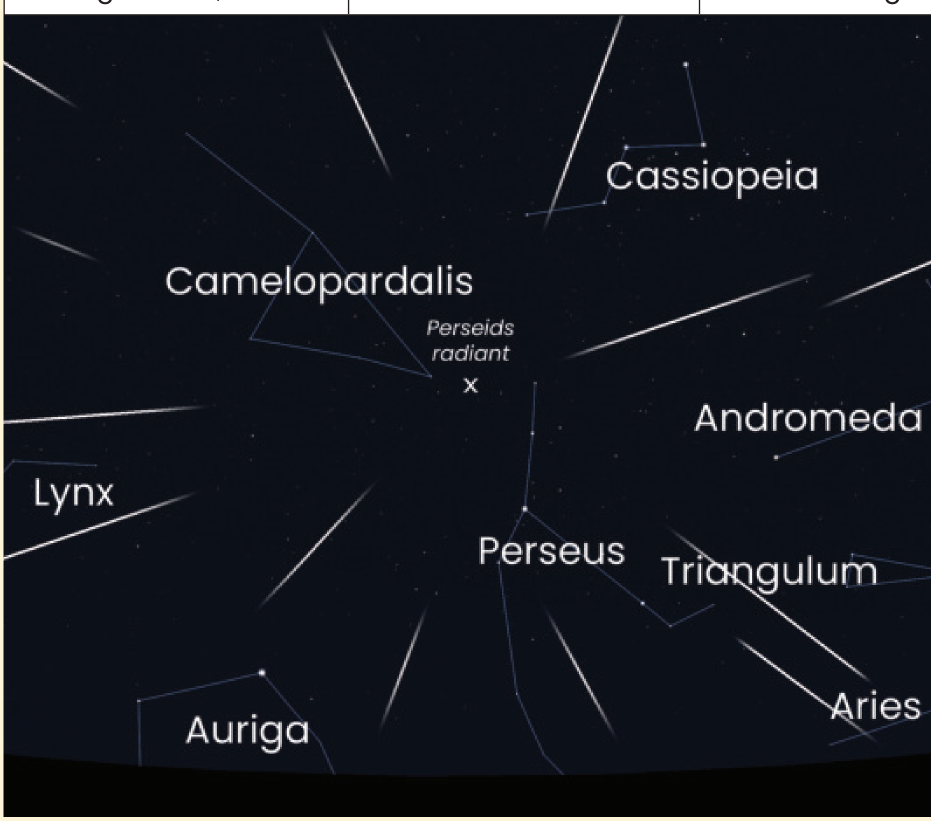
EVENT #6:

The Moon meets Mars and Venus

It's a perfect celestial meetup for a summer evening as the slender crescent Moon, Mars and Venus lie along a line about 7 degrees long in the northwestern sky after sunset on July 11. A pair of binoculars helps pull them out of the bright evening twilight. The Moon moves westward over the next two nights away from the planets and toward Regulus. On July 13, Venus moves closer to Mars and lies just half a degree to its north. Venus should be an easy sight in clear twilit sky, but much fainter Mars may be more challenging.



DATE:	TYPE:	TIME:	VIEW:
August 11–13, 2021	Meteor shower	All night	Naked eye



EVENT #7:

A good year for the Perseids

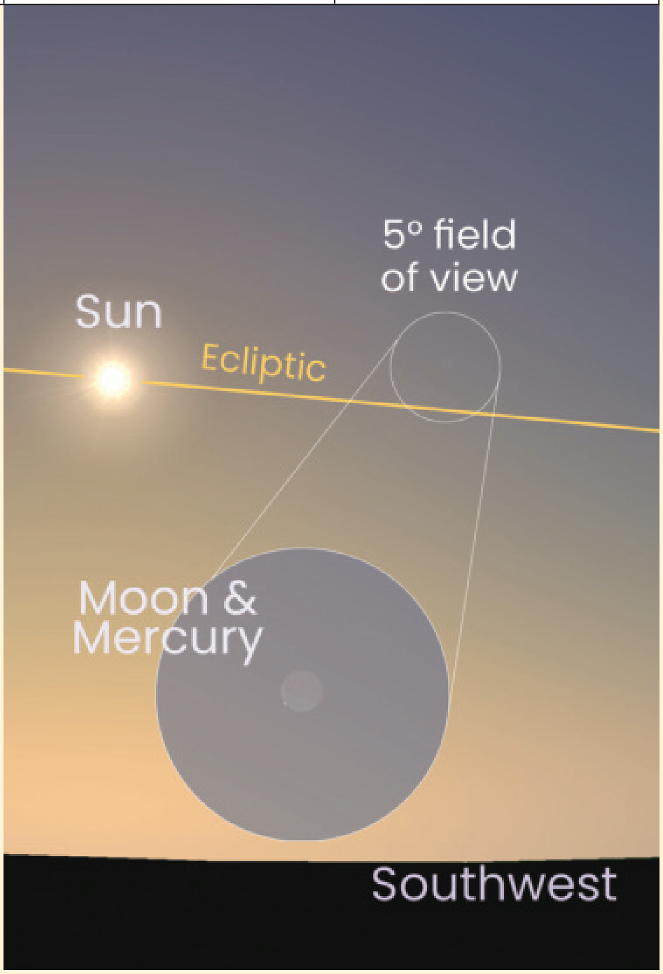
The reliable and usually dazzling Perseid meteor shower arrives to promising skies this year. With a new Moon on August 8, the shower coincides with a slender waxing crescent Moon that gets out of the way well before midnight. Predictions put the peak at 19:00 Universal Time (3 p.m. Eastern Daylight Time) on August 12, so that night and the early morning of August 13 likely offer the times to look for meteors. However, it's also well worth looking the night before. The best show usually happens after midnight as the Earth turns into the source of the meteors, a stream of debris left by Comet 109P/Swift–Tuttle. In dark sky, some 40-60 meteors per hour are common during the Perseids. →

Map by Rosie Sobczuk; Charts by Allendria Brunjes (Stellarium)

DATE: November 3, 2021	TYPE: Occultation	TIME: Daytime	VIEW: Telescope

EVENT #8:

Moon occults Mercury by daylight

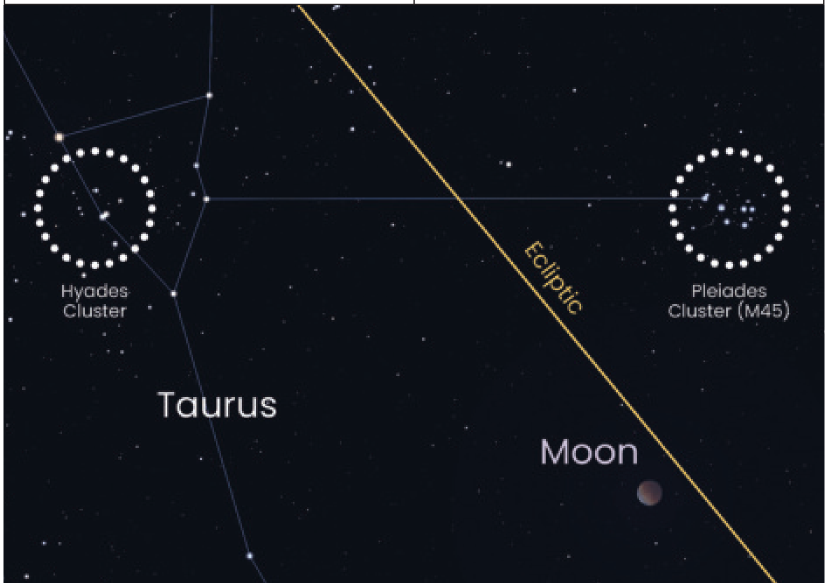


At magnitude -1 today, Mercury appears bright but low in the east-southeastern sky before sunrise, just to the left of the bright star Spica. About three degrees above the pair lies an extremely slender crescent Moon, just one day from new. With less than three per cent of its face illuminated, the Moon will be a very difficult object to see even with optical aid.

But the real action happens later today as the Moon occults Mercury at approximately 19:00 Universal Time (3 p.m. Eastern Daylight Time) for observers in central and eastern Canada. The Moon itself will be out of reach visually, even with a telescope, but Mercury will appear to "wink out" behind the unseen eastern limb of the Moon when observed by telescope, then reappear approximately an hour later from the western limb. The precise time and duration of the occultation depends on location. Careful attention to telescope safety is a must: the planet and Moon lie just 15 degrees west of the Sun during this daytime event.

Just four days later, on the evening of November 7, the waxing crescent Moon lies about 4 degrees from brilliant Venus in the southwestern sky as the Sun sets.

DATE: November 18–19, 2021	TYPE: Lunar eclipse
TIME: Night to early morning	VIEW: Naked eye, binoculars



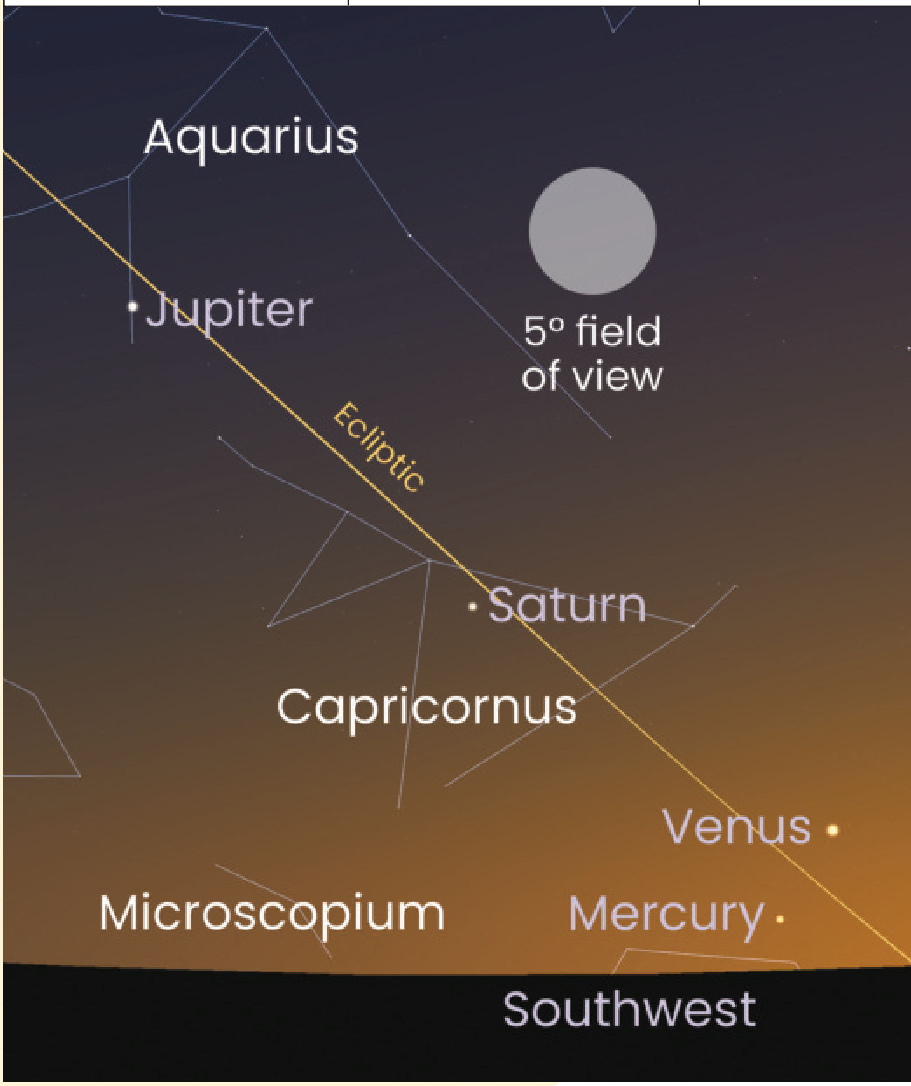
EVENT #9:

A nearly total lunar eclipse

All of Canada enjoys a partial lunar eclipse during the night and morning of November 18-19. Don't let the term "partial" discourage you: at mid-eclipse, about 97 per cent of the Moon lies in the Earth's shadow. This promises to be excellent viewing, especially since the Moon lies in a photogenic part of the sky near the Pleiades and Hyades star clusters.

The eclipse runs from 6:02 to 12:03 Universal Time on November 19 (11:02 p.m. to 5:03 a.m. Mountain Standard Time on November 18-19). Maximum eclipse occurs at 2:03 a.m. MST. Most of the country can see the entire eclipse, except for the far eastern regions where the Moon sets after maximum eclipse but before it fully exits the Earth's shadow.

DATE:	TYPE:	TIME:	VIEW:
December 28–29, 2021	Conjunction	Evening	Naked eye, binoculars



EVENT #10:

Close encounter of Mercury and Venus

The year ends with a relatively close conjunction of the two inner planets, Mercury and Venus, low in the southwestern sky after sunset. Observers with a clear view down to the horizon will see these two blazing-hot worlds fit nicely in a binocular field of view. Jupiter and Saturn, both well past opposition for 2021, appear to the upper left. Mercury shines at magnitude -0.7 in the twilight glow, while Venus shines some thirty times brighter at magnitude -4.4. Over the next ten days, Mercury gets a little higher as Venus drops quickly toward the horizon on its way to inferior conjunction on January 9, 2022. ✴

Charts by Allendria Brunjes (Stellarium)

The in-betweeners

A new discovery is shaking up astronomers' understanding of black holes and how they form

By Ivan Semeniuk

AFTER FIVE YEARS OF LISTENING FOR VIBRATIONS FROM ACROSS THE UNIVERSE, scientists who work with the Laser Interferometer Gravitational-Wave Observatory (LIGO) have learned a lot about things that go bump in the cosmic night. But even by the standards of a brand new science, the signal that rattled the Nobel Prize-winning experiment on the night of May 20, 2019, was in a class by itself.

LIGO, which consists of two sprawling detector facilities in the United States, works jointly with a third detector in Europe, called Virgo. All three are built to measure waves that travel through the fabric of space-time like ripples on the surface of a pond. The waves are generated when massive bodies collide with great violence and speed. From the frequency and strength of the waves, researchers can extract information such as the size and distance of the objects that collided.

The 2019 event, designated GW190521, was the most powerful and most distant ever recorded by LIGO-Virgo. The collision involved two black holes, estimated to be 65 and 84 times the mass of our Sun, located about halfway to the edge of the visible universe. Caught in a death spiral, it took a mere one tenth of a second for the pair to merge and form an even larger black hole with 142 times the Sun's mass. Once team members analyzed their data, they knew that their detectors had captured something unexpected.

"It's one of the biggest discoveries we've made," said Jess McIver, an assistant professor at the University of British Columbia and a member of the LIGO-Virgo collaboration, when the observation was announced in September 2020. "We have never observed a black hole in this mass range before."

Black holes happen when the gravitational field around an object is so strong that not even light can escape its pull. They are the mathematical byproducts of general relativity, Albert Einstein's 1915 theory of gravity. But it wasn't until the 1960s that physicists began to take seriously the idea that such bizarre entities might exist somewhere out in space.

In the decades since then, overwhelming evidence has accumulated for two different kinds of black holes. One kind is formed when the core of a giant star undergoes a sudden and unstoppable collapse. The result, called a stellar black hole, can range from a few times to a few dozen times the mass of our Sun. The other kind is a supermassive black hole — a gravitational behemoth that lurks at the centre of a large galaxy and has a mass equal to millions or billions of our Suns.

Cygnus X-1, the first black hole candidate to be identified by astronomers in the 1970s, is shown in this artist's representation. The system consists of a black hole 14.8 times the mass of the Sun peeling hot gas from an orbiting stellar companion. New evidence based on gravitational wave observations confirm the existence of a new class of black holes with masses 10 times greater. (NASA/ESA/Martin Kornmesser (ESA/Hubble))

"Until now, we've never had anything in between," McIver said. What makes GW190521 so interesting is that it confirms the existence of a third class of objects known as intermediate-mass black holes. It may be a link between the other two types or it could indicate an entirely separate phenomenon. Either option raises intriguing new questions about the formation of black holes — questions that LIGO-Virgo team members and astrophysicists at large are eagerly beginning to explore.

Mind the gap

Intermediate-mass black holes are typically defined as having a mass that ranges between 100 and 100,000 times the mass of the Sun. First described by theorists in the 1970s, they were once considered a possible explanation for dark matter — an idea that has since been ruled out by observations. More recently, astronomers have looked for evidence of intermediate-mass black holes inside globular clusters, which are ancient and dense concentrations of up to ten million stars each that orbit around galaxies, including the Milky Way.

One of the best-studied examples of this scenario is a powerful X-ray source that was first spotted by Europe's XMM-Newton orbiting telescope. In 2018, a team led by Dacheng Lin of the University of New Hampshire suggested that the X-rays could be produced by an intermediate-mass black hole ripping apart a star that ventured too close. Last year, the team reported that they used the Hubble Space →

Telescope to show that the X-rays are indeed coming from a globular star cluster located well away from the galaxy's centre. "The new observations confirm the source as one of the best intermediate-mass black hole candidates," the team wrote.

While promising, such observations remain circumstantial. X-rays can only provide an indirect estimate for what the true mass of a suspected black hole might be. Gravitational waves, on the other hand, yield a measurement that is directly tied to the mass of the black holes that generate them. This has allowed the LIGO-Virgo team to claim the first definitive evidence for intermediate-mass black holes based on the outcome of the GW190521 collision. But the discovery has also left astronomers with a puzzle that has to do with the two black holes that collided.

Stellar physics puts a limit on how massive a star can be and still collapse to form a stellar black hole. Beyond a certain threshold, instabilities arise that cause a massive star to blow apart without allowing a black hole to form. At a much higher mass, the instability is overcome and black hole formation is again possible. But the theory predicts there should be a "mass gap" — an absence of stellar black holes between 65 and 120 solar masses. At 84 solar masses, the larger of the two black holes that collided to trigger the GW190521 event sits squarely in that mass gap.

Snowball!

Maya Fishbach, a postdoctoral researcher at Northwestern University in Illinois and a LIGO-Virgo team member, came up with one explanation based on the possibility that the mass of the smaller of the two black holes was overestimated.

"If you assume it's a conventional stellar black hole that is below the gap, then you push it to a lower mass, which means pushing the other one up to a higher mass. In that case, there's a possibility that the heavier black hole is actually above the gap," she said.

In other words, the pair might straddle the mass gap rather than sit inside it. This is also consistent with data released by the experiment in October, including the first half of its 2019-2020 observing run. Of the 50 events it has detected, most were caused by colliding black holes, but none besides GW190521 began with a black hole that was in the mass gap. However, if black holes really do exist in the mass gap, there must be a way for them to form. Perhaps the 84-solar-mass black hole was itself the product of an earlier black hole collision. If such interactions are frequent enough, they could lead to a succession of mergers that start with ordinary stellar black holes and cross the mass gap on their way to building intermediate-mass black holes.

Researchers at the University of Melbourne in Australia have explored this possibility by using a computer simulation to reproduce chains of black hole collisions within a globular cluster. In one case, the simulation generated a black hole of nearly 100 times the Sun's mass through a chain of seven collisions over a six-billion-year period. The team dubbed the simulation "Snowball."

Yet there are hurdles to building black holes through hierarchical mergers. First, it requires a series of encounters between black holes that did not originally form together, something that is far less likely than the collision of a pair that started out as a double star system. In addition, black holes that are born from mergers often receive a high velocity kick that could push them away from the denser regions of a star cluster, lowering the chances of further collisions.

One clue that may help LIGO-Virgo distinguish between theories is how the black holes spin. Black holes that share an origin in one star system should have axes of rotation that point in roughly the same direction while those that meet later on should be randomly oriented.

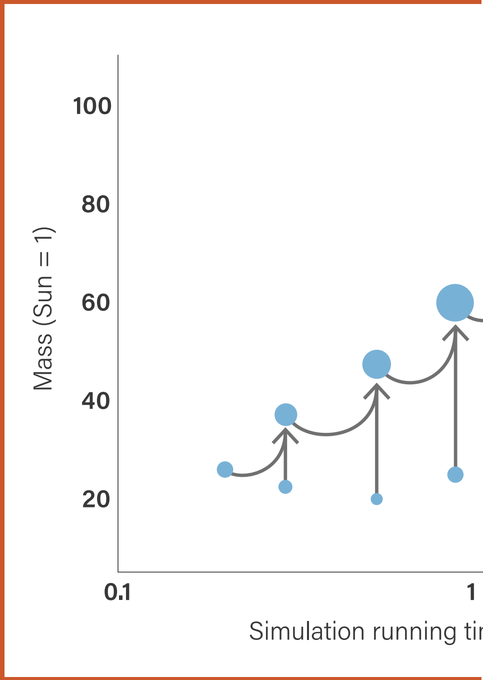
Either way, "the first true detection of an intermediate-mass black hole... has led to a significant increase in interest surrounding the formation of these massive bodies," said Oliver Anagnostou, who led the snowball study.

In future, gravitational wave detectors that can probe even deeper into the universe may be able to determine whether hierarchical mergers once enabled intermediate-mass black holes to become the seeds of the supermassive black holes we see at the centre of galaxies today.

Until then, McIver said she and her colleagues are working on how to improve the sensitivity of LIGO and extract more examples like GW190521 that may still be hiding in the noise just beyond the limit of the experiment's capability.

"We are expecting that as our detectors get more sensitive, we're going to be seeing things farther and farther out," she said. "We're definitely driving the theory, which I think is really cool." ✷

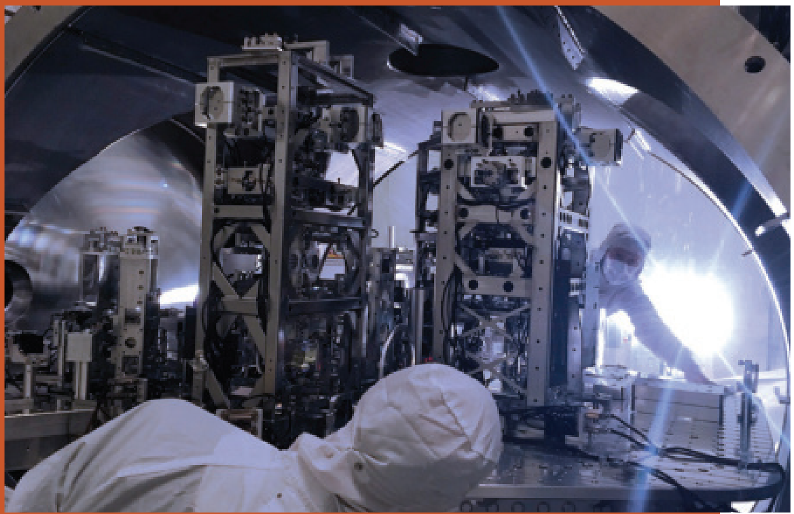
Graph by Rosie Sobczuk



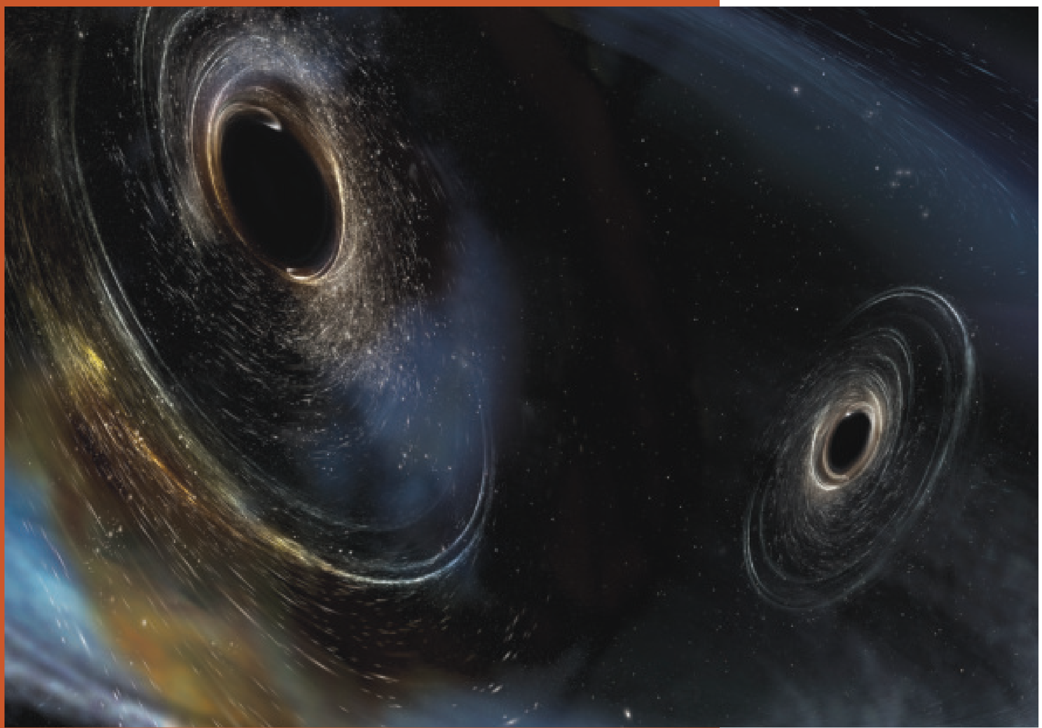
Above:
A dense cluster of stars (circled) in the vicinity of a much larger galaxy (centre) may be home to a black hole 50,000 times the mass of our Sun. Astronomers suspect a powerful burst of X-rays from this location was produced by the black hole tearing apart a star that came too close. Theories suggest that star clusters are the birthplaces of intermediate-mass black holes that are built up by collisions. (NASA, ESA and D. Lin (University of New Hampshire))

Above right:
Engineers complete hardware upgrades at one of the LIGO detectors based in Hannaford, Washington, ahead of the experiment's third observing run, which began in the spring of 2019. Data released from the first half of that run show that the LIGO-Virgo collaboration has now detected 50 gravitational wave events, primarily from colliding black holes. (LIGO/Caltech/MIT/Jeff Kissel)

Bottom right:
An artist's representation of two black holes shortly before they collide. Gravitational waves generated by the collision can be picked up by the LIGO-Virgo experiment to reveal the masses of the black holes and, in some cases, the orientation of their axes of rotation. These details can help illuminate the formation history of the black hole pair. (LIGO/Caltech/MIT/Sonoma State (Aurore Simonnet))



Above:
Computer simulations can reveal how an intermediate mass black holes may form from the successive collisions of smaller black holes that are formed through the collapse of individual stars. In the case illustrated, a chain of seven collisions over a 10 billion year period ends with the creation of a black hole that is nearly 100 times the Sun's mass. (Oliver Anagnostou (University of Melbourne))



Dear *SkyNews* readers

From the desk of Robyn Foret, president of The Royal Astronomical Society of Canada

I DON'T THINK I'M ALONE in happily saying goodbye to 2020. We learned a lot. We perfected new ways to connect and do business with one another. We introduced new ways of offering education and outreach. We spent a lot of time evaluating what is truly important in our lives, and hopefully, we finished the year better and stronger after facing the challenges and obstacles 2020 presented.

In the hopes of getting you all thinking about astronomy and your role in it, I'll share with you my New Year's resolutions for 2021. Using some December downtime to build a realistic plan, here's my list in no particular order:

- Continue to advance RASC's Strategic Plan
- Continue to advocate for inclusivity and diversity
- Facilitate and enable the goals and objectives of our committees
- Attend two to three RASC Centre meetings per month
- Volunteer at a minimum of one public outreach event per month
- Do two nights of personal astronomy per month with specific objectives for each session encompassing RASC certificate programs:
  - Complete Explore the Universe program in 2021
  - Start the Explore the Moon — Telescope program
  - Work on my Messier Certificate
  - Work on the new Double Stars Observing program
- Develop basic astro-imaging skills
- Break ground on a new public observatory in Calgary

While compiling this list, I came across some other interesting things to watch for:

- Conjunctions:
  - January 7-12, Mercury, Saturn and Jupiter – SW horizon
  - January 10 and 11, Moon and Venus – SE horizon
  - January 19-22, Moon, Mars and Uranus (These characters continue their dance later into the year with multiple upcoming conjunctions.)
- Meteor showers
  - August 12, Perseids peak (with the new Moon on August 8!)
  - August 31, Aurigids predicted to be similar to 2007's exceptional event

And finally, some things to wish for:

- A vaccine for COVID-19
- A return to a normal economy
- Safe public gatherings and public outreach
- The ability to safely gather with friends and family

Take good care, everyone, and all the best to you and yours for a healthy and prosperous 2021. ✷

(Morgan Foret)

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Seeing the stars for the first time

IT'S EASY TO TAKE THE STARS ABOVE US FOR GRANTED, especially with what little urban Canadians can see of them from cities.

But for eight-year-old Sam Banon, twinkling Montreal skies were the most wonderful sight to behold after he received a life-changing treatment for a type of genetic blindness. The treatment allowed him to see stars for the first time.

"Part of the disease is that you can't see anything at night. For Sam it would be pitch black… So to be able to see a teeny, teeny star, it was incredible," said Sarah Banon, Sam's mother. "It still gives me goosebumps."

Now that he can see in the dark, eight-year-old Sam Banon says he is excited to gaze at not just stars, but planets, too, with the telescope gifted to him by RASC.

His story and awed reaction to the stars was featured by CTV News, moving members of The Royal Astronomical Society of Canada so deeply that RASC decided to gift Sam a membership, some books and a telescope to encourage an interest in astronomy. Seeds for the gift idea were planted in RASC's Facebook group, which has about 7,300 members. RASC member Glenn Colin de Kavanagh-Norman posted a link to the CTV article about Sam, describing the boy's reaction to seeing stars for the first time.

De Kavanagh-Norman wrote, "I LOVE what impressed this child most about the 'miraculous' improvement in his loss of sight. Perhaps gifting him with student membership in the RASC might be in order???"

Other members shared his enthusiasm in the comments, catching the attention of RASC outreach co-ordinator Jenna Hinds.

"Many astronomers have that sort of 'Galileo moment,' usually when they see the rings of Saturn for the first time and go, 'Oh my goodness — space is amazing,'" Hinds said. "Sam hadn't seen any of the stars before, so to see them at all for the first time — and that be his Galileo moment — was so inspiring."

Hinds said Sam would receive classic astronomy books such as *Nightwatch: A Practical Guide to Viewing the Universe* (Terence Dickinson, Firefly Books, 2006) and RASC member John Read's *50 Things to See with a Telescope – Kids* (John A. Read, 2017). But the most elaborate gift is the smartphone-enabled Celestron StarSense Explorer DX 102AZ refractor telescope that Hinds and other RASC members planned to help Sam set up over video call.

"I cannot wait for the moment when he sees the rings of Saturn," Hinds said. "It's such a unique situation, to never have seen the stars and then all of a sudden the sky opens up for you.

"He's just an astronomer waiting to be."

Sam was the first Canadian to be treated with gene replacement therapy for retinitis pigmentosa, the name for a group of genetic disorders that damage light-sensitive cells in the retina. He was diagnosed with the disorder when he was 10 months old. The condition — affecting between 1 in 3,500 and 1 in 4,000 Canadians, according to Fighting Blindness Canada — meant he could not see anything in the dark.

When Sam was six, his family took him to the United States to receive eye injections using a gene therapy called Luxturna, developed by Spark Therapeutics.

Within weeks, he was able to see in the dark, his mother said. Health Canada approved the treatment this October.

Until then, Sam had only ever heard about stars from books and from his family, his mother said.

"What it looks like in a drawing is not what it actually looks like when you see it in the sky," Banon said. "It was exciting because it was something he was discovering on his own."

When she heard RASC wanted to gift Sam a telescope, Banon said she was "genuinely surprised" but also "extremely grateful."

"We know that he'll make good use of it, and hopefully this will inspire a love of astronomy that will continue on," Banon said. She added that her son is excited to see the planets. "He keeps asking me, 'A real telescope, Mommy? A real one?'" Banon said. "It's so generous and kind of [RASC]."

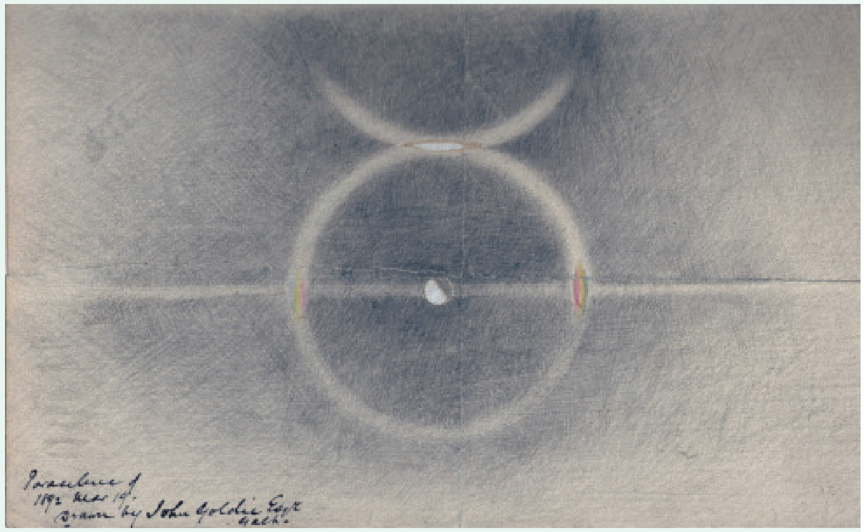
Hinds said she was thrilled to see how many RASC members wanted to do something special for Sam.

"I hope this fuels his curiosity and makes him excited to learn more about space," she said. "I just hope he finds joy in looking at the sky."

— *Sahar Fatima*

THROUGH TIME'S LENS

Memory and the art of observation



ONE OF THE ATTRACTIONS OF ASTRONOMY is the promise of seemingly unlimited scope to become more adept in its pursuit. The challenge to see more detail and with greater understanding is integral to the art of observation, visual or photographic. The faculty of memory can play an almost miraculous role in the art of science, nowhere more than when a remarkable phenomenon leaves its impression.

In 1892, John Goldie — a member of the Astronomical and Physical Society of Toronto, which became RASC — sent an account of a remarkable observation of paraselenae or "Moon dogs" to his colleague A.F. Miller, who gave a report of it at the next meeting. With another member "being anxious to see diagrams of the phenomenon, Mr. Miller said he would ask Mr. Goldie for a sketch."

Goldie met the request several days after his observation with the striking drawing reproduced here. For more on Goldie and this image, visit **articles.adsabs.harvard.edu/full/seri/JRASC/0102//0000246.000.html.**

ABOVE: John Goldie, Paraselene, pencil and crayon on paper. Galt, Ontario. March 19, 1892. Reproduced courtesy of the RASC Archives. **RIGHT:** John Goldie's observatory. Galt, Ontario. Reproduced courtesy of the RASC Archives.

A 'ripple effect'

AS A YOUNG GIRL, growing up in the light-polluted skies of Brooklyn, New York, I had a curiosity for the natural world. I dreamed that one day, I would be able to see many of the things I only read about in books.

Fast forward to 2018 — a bout of Lyme and a medication-induced Sun sensitivity sidelined me from my usual activities volunteering for various conservation organizations in New Jersey. One night, my husband, Rob, suggested we use our birding scopes to explore the night sky. When he showed me Saturn's rings, Jupiter and four of its moons and our own Moon, something sparked. I needed to learn more! A visit to Amazon procured books from John Read's "50 Things to See" series.

In 2020, COVID-19 kept many of us confined to our yards, and I found myself turning to astronomy once more. I reached out to a few folks asking for guidance. I received an enthusiastic response from John saying he was co-leading a program through RASC called Explore the Universe. I enrolled.

COVID-19 eased in the summer, but others' lack of caution kept us close to home. Car rides at 3 a.m. to the Jersey Shore to see Comet NEOWISE or watch Mercury rise felt like "treats." Our local cemetery provided dark enough skies to explore deep-sky objects.

I started planning my schedule around bi-weekly "classes" with John and RASC outreach co-ordinator Jenna Hinds. Everyone at RASC has made me feel welcomed and encouraged. I've earned my Explore the Universe certificate, and now I'm starting the Explore the Moon program.

As for that young girl who used to sneak up to the roof of her Brooklyn apartment to look at the Moon — I wish I could tell her that one day the author of some books she would buy and some folks she had never met in Canada would help make her dream come true during a global pandemic. Thank you, RASC! ✷

— *Lisa Ann Fanning*

Image data from RASC Robotic Telescope • Edited by Ian Barredo

Eye on the prize

THE HELIX NEBULA, or NGC 7293, is located about 650 light-years away in the constellation of Aquarius. A typical planetary nebula, it developed as a star shed its gaseous layers and left behind a tiny, hot, dense white dwarf core that lights up those same gases.

The nebula was the target of the *SkyNews* and RASC Robotic Telescope image editing contest in September. Using the "Level 3" RASC RTscope files for the deep-sky object, Ian Barredo's composition won the competition and a year's free access to RASC RTscope files.

Barredo processed the image using the Ha-OIII bicolor technique for narrowband. He stretched it in Astro Pixel Processor and created a synthetic green channel using Ha and OIII. He worked on curves, selective colour and saturation adjustments in Photoshop.

Located near Auberry, California, the RASC Robotic Telescope is a 16-inch, f/8.9 RCOS with a SBIG STX-16803 camera on a Paramount ME mount. It has seven filters: LRGB, Ha, OIII and SII. A Canon 6D — used to capture larger targets — is piggy-backed on the scope, sporting a 200mm f/2.8 lens. ✴