The Journal of The Royal Astronomical Society of Canada

Journal

Le Journal de la Société royale d'astronomie du Canada

PROMOTING ASTRONOMY IN CANADA

December/décembre 2017
Volume/volume 111
Number/numéro 6 [787]

Inside this issue:

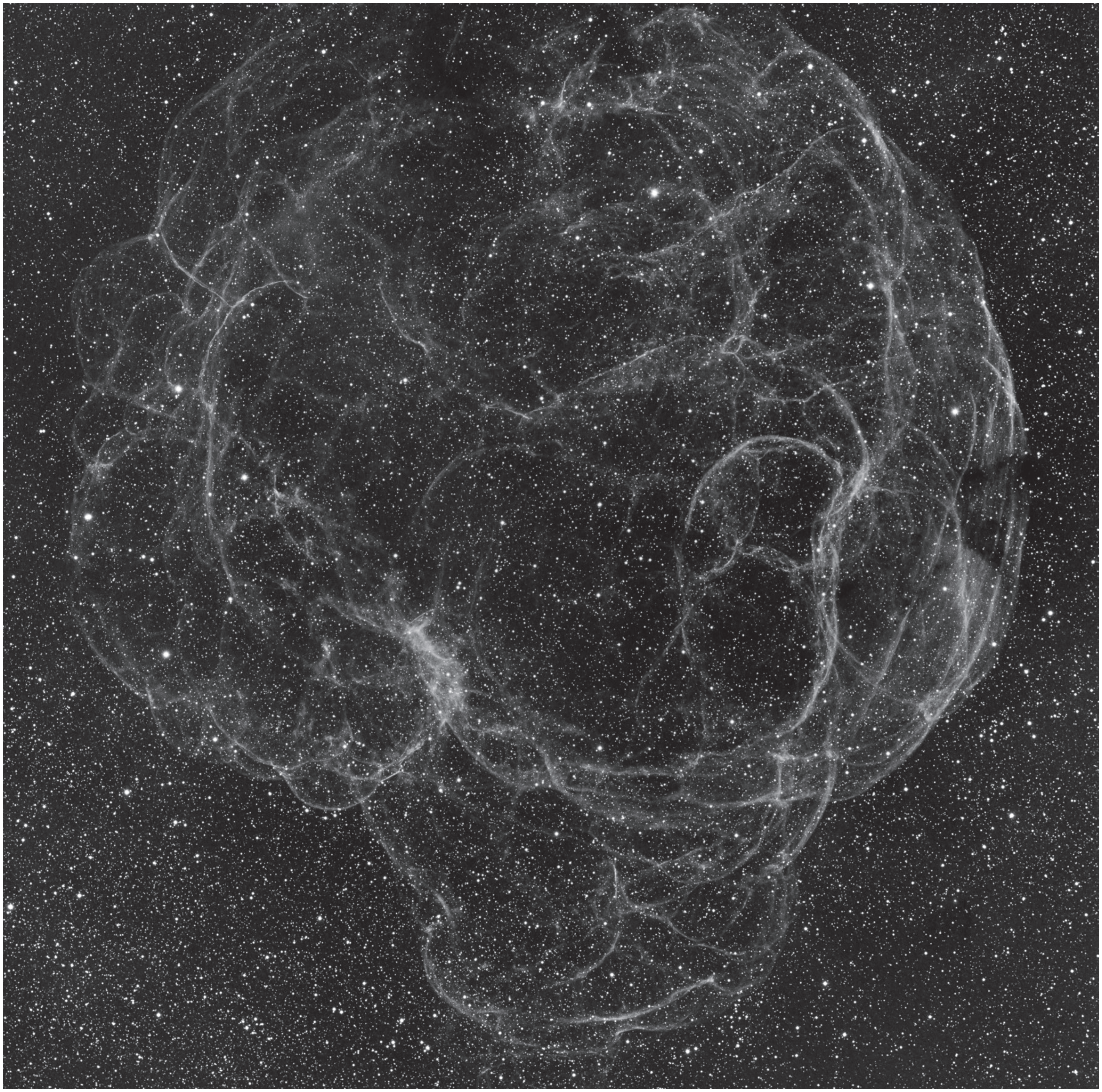
History of Astrophotography: Part 2

An Early Canadian Zodiacal Light Eyewitness Account

The Wall

The Best of Monochrome.

Drawings, images in black and white, or narrow-band photography.



Here, we see the beautiful, faint emission nebula and supernova remnant Sh2-240, also known Simeis 147 taken by Stuart Heggie in Lucknow, Ontario. He says, "It is HUGE. This field of view is 4x4 degrees and it still doesn't totally fit!" Heggie used an Apogee U16M camera with Astrodon Gen II filters, a Takahashi FSQ refractor with Robofocus on a Paramount ME. He took 16 images at 15 minutes each.

Journal

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Royal Astronomical Society of Canada
Société Royale d'Astronomie du Canada

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Compiled by James Edgar

Kerry-Ann Lecky Hepburn imaged "The Wall" of the North America Nebula in Cygnus in full narrowband. It was her first real attempt at tri-colour narrowband processing. She used Hα, OIII, and SII filters, taking 20 10-minute exposures using an SBIG 8300, AT8RC, on an EQ6 mount. Instead of using the Hubble Palette, she mapped red to Hα, Cyan to OIII, and Yellow to SII.

Journal

The *Journal* is a bi-monthly publication of The Royal Astronomical Society of Canada and is devoted to the advancement of astronomy and allied sciences. It contains articles on Canadian astronomers and current activities of the RASC and its Centres, research and review papers by professional and amateur astronomers, and articles of a historical, biographical, or educational nature of general interest to the astronomical community. All contributions are welcome, but the editors reserve the right to edit material prior to publication. Research papers are reviewed prior to publication, and professional astronomers with institutional affiliations are asked to pay publication charges of $100 per page. Such charges are waived for RASC members who do not have access to professional funds as well as for solicited articles. Manuscripts and other submitted material may be in English or French, and should be sent to the Editor-in-Chief.

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The Royal Astronomical Society of Canada
203 – 4920 Dundas St W
Toronto ON M9A 1B7, Canada

Email: nationaloffice@rasc.ca
Web site: www.rasc.ca
Telephone: 416-924-7973
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President's Corner

Colin A. Haig, M.Sc.
(astronome@outlook.com)

Do you catch yourself daydreaming about the stars? I encourage you to "Dream Big." As amateur and professional astronomers, we're empowered to dream big. We ponder the birth and death of stars, galaxies, and the Universe. Through shared adventures under the night sky or the recent solar eclipse, we imagine other worlds, other star systems, and wonder how they are like our own.

Can I ask for your help in building a launchpad for those dreams? As I continue visiting Centres and having exchanges with our members, the public, and our Centre leaders, I'm in awe of the makers, thinkers, teachers, and tinkerers I meet. Modest Centres have taken big ideas and made them come true. Some Centres wonder how to make it happen—maybe we can help each other. Through our Special Projects Program, and the Public Speaker Program, it's possible to generate new ways to launch ideas, inspire the public, and engage our members. I encourage you to learn more about these programs, and encourage your Centre leadership to tackle some bold projects.

Running a Centre is certainly a challenge, and it's where we launch the dreams of many would-be astronomers. It's not easy to stay energized, to create a fun atmosphere, while managing any financial and legal responsibilities a Centre has. I commend you for stepping up to make those things happen. As our Board has come together monthly to work on key issues, we keep drawing on our experiences in prior years at our various Centres, and think of what worked well, and frankly, what we could have done better. To that end, we've created a "Centre Manual" to help guide Centres of all sizes. It's a long way from perfect, but maybe a small step for the RASC. We hope it will help launch some new ideas locally, as well as keep your Centre's obligations and best interests in mind.

Many of us dreamed of going to the Moon or visiting other planets during our school days. Fortunately for us, people like us created the *Cassini-Huygens Mission* to Saturn, that ended its 13-year exploration with a plunge into the ringed planet's atmosphere. Data from *Cassini* will continue to inspire researchers for years to come. New research from both on-the-ground, and space-borne, missions will no doubt bring amazing discoveries in the decades to come.

We recently lost two people that inspired and encouraged many of us. Rosemarie Freeman, our former Executive Secretary, and Paul Boltwood, amateur astronomer par excellence, both passed away recently. Rosemarie touched the lives of many, as she was often the first contact people like me had with the Society. Paul set records for amateur telescopes and invented cloud sensors and other pioneering technologies that are in use today. We'll miss them both.

In my last column, we touched on diversity in our membership, with a focus I hope you will be on board with—improving our culture, to make it a welcoming and healthy environment for all people. Recently, the McKinsey Global Institute, part of consulting the firm McKinsey & Company Canada, issued a report called *The Power of Parity: Advancing Women's Equality in Canada*. They analyzed survey results from 69 Canadian companies totalling 500,000+ employees. The intent was to assess the potential benefits of tackling gender inequality at work. Among STEM-related companies, 3 in 10 roles were filled by women at the senior level. As a country, we can do better. I hope, in our Society, that we can also do better. Make a point of discussing it at your next club meeting, and find ways to encourage more women to become involved.

As promised, we now have a fundraising consultant, helping us work on new ways to generate revenue to support ambitious programs. Lisa DiVeto came on board this fall, and is busy working with staff and the executive on ways to improve our fundraising. In addition to this initiative, we've started rolling out other areas of our Strategic Plan. We hope to connect with each committee, and set forth some inspiring ideas, new challenges, and fresh ideas, as well as encourage the volunteers in their ongoing efforts. These efforts, by so many volunteers like you, will hopefully create a launchpad for all our dreams.

Until next time, I assure you, *at the RASC, our business is looking up!* ✶

News Notes / En Manchette

Compiled by Jay Anderson

Parting the dusty curtains

Deep behind the dust of the central Milky Way lies a region of poorly explored intragalactic space, dimly visible in infrared wavelengths. At visible-light frequencies, only one photon of 10^{12} emitted near the centre of our galaxy (equivalent to 30 magnitudes) is able to reach the Earth's vicinity—enough to reveal the existence of one of the Milky Way's largest young clusters lying only 100 light-years from the galactic centre. The cluster is called the Quintuplet Cluster after five extraordinarily bright stellar members, whose nature has been somewhat mysterious since their discovery in 1989.

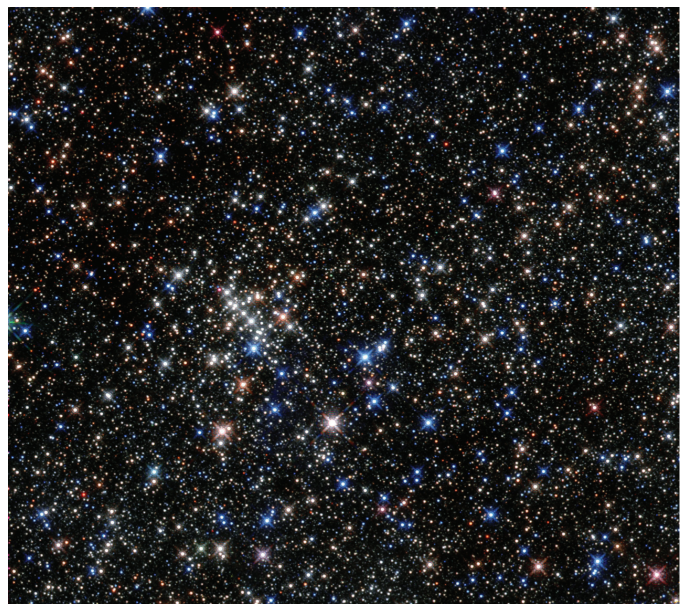


Figure 1 — Although this cluster of stars gained its name due to its five brightest stars, the Quintuplet Cluster, it is home to hundreds more. The huge number of massive young stars in the cluster is clearly captured in this NASA/ESA Hubble Space Telescope *image.*

Recent infrared spectroscopic observations of the quintuplet stars using the Gemini telescope have confirmed that four of the five are evolved, massive stars that have expelled their outer hydrogen layers to reveal their underlying carbon-rich cores. These are Wolf–Rayet (W–R) stars, among the largest and hottest of the stellar menagerie, and are usually accompanied by a diffuse nebula of dust and discarded hydrogen gas. They evolve rapidly—completing their life cycle in a few hundred million years—and then explode into supernovae. This identification has been suspected for some time: in 2006, high-resolution imaging revealed that two of the five stars had pinwheel-like nebulae (a sign of a binary star system) similar to those seen around other W–R stars. Observations of the five are particularly difficult because the stars themselves are embedded in individual dust shells that are warmed by their central stars and so glow in infrared light of their own.

Several years ago, while using the Near-infrared Integral Field Spectrometer (NIFS) at Gemini North for an unrelated research program, Gemini astronomer Tom Geballe serendipitously discovered a very faint and broad emission line due to hot helium gas near 1.7 microns in the infrared spectrum of one of the Quintuplet stars. Prompted by this, a team consisting of Geballe, Paco Najarro (Centro de Astrobiología, Spain), Don Figer (Rochester Institute of Technology), and Diego de la Fuente (Universidad Nacional Autónoma de México), using the NIFS and the Gemini Near Infrared Spectrograph (GNIRS), obtained sensitive spectra of all five members of the infrared Quintuplet, not only near 1.7 microns, but also down to wavelengths as short as 1.0 micron. At those wavelengths, the contaminating emission from the warm dust shells is greatly reduced, increasing the contrast between any spectral features emitted from inside the dust shells and the continuum emission from the shells themselves.

The team's spectra, recently published in *The Astrophysical Journal*, reveal the presence of emission lines of doubly and triply ionized carbon (along with several lines of helium) from four of the five members of the Quintuplet, and have allowed them to definitively identify the four as late-type, carbon-rich Wolf–Rayet stars, as was suspected based on the earlier imaging. These massive stars are only a few million years old, but have completely lost their outer hydrogen-rich layers and probably do not have much longer to exist before exploding violently as supernovae.

With the observations in hand, the team was able to model the characteristics of one of the members of the Quintuplet, determining that it was a binary system consisting of a W–R star with a supergiant OB companion. The team derived a mixture of 20 percent carbon and 70 percent helium on the surface of the W–R star.

Compiled in part with material supplied by Gemini Observatory

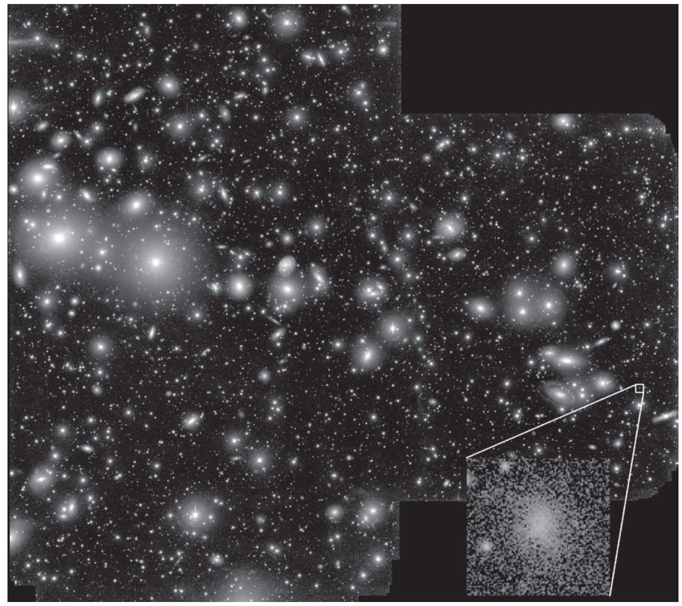


Figure 2 — The central region of the Perseus Cluster. This mosaic image is composed of many individual deep exposures taken with the WHT. Ultra-diffuse galaxies are hard to spot, which is illustrated in the enlarged region containing one of the newly discovered faint objects. Projected on the sky, the entire image has about the diameter of the full Moon. Credit: Carolin Wittmann (ZAH).

Diffuse galaxies continue to puzzle

About 33 years ago, Alan Sandage and Bruno Binggeli unearthed an extremely low-density galaxy in the Virgo Cluster, the first of a class now known as Ultra-Diffuse Galaxies (UDG). Since that initial discovery, UDGs have been found in large numbers in many galaxy clusters and are probably a component of most of them. The largest members of the class may have sizes comparable to our own Milky Way but contain only 1/100 to 1/1000 of the number of stars. In our own galaxy, about 3000 stars can be seen by the naked eye, and the Milky Way itself is prominent in dark rural skies. In an ultra-dense galaxy, only a few dozen stars and a "trace" of a galaxy would be visible to the eye.

Earlier this year, a team of astronomers led by Steven Janssens of the University of Toronto, using *Hubble Space Telescope* observations, identified "a large population of ultra-diffuse galaxies in the massive galaxy cluster Abell 2744.…" Janssens and the team identified 41 new UDGs in the Hubble field and estimated that the whole cluster contained approximately 2100 of the ghostly galaxies. This total is much larger than the number of diffuse galaxies estimated for the similar cluster Abell 1656 and the Coma Cluster (854 UDGs).

More recently, Carolin Wittmann at the Astronomisches Rechen-Institut (ARI) of the Zentrum für Astronomie der Universität Heidelberg (ZAH), using very deep optical images obtained in 2012 with the Prime Focus Camera of the 4.2-metre William Herschel Telescope, identified about 90 such galaxies in the core of the Perseus Cluster. "Surprisingly, most galaxies appear intact—only very few show signs of ongoing disruption," emphasizes Dr. Thorsten Lisker, who initiated the project. "Perhaps the stars in ultra-diffuse galaxies are gravitationally bound due to an especially high dark-matter content" explained Carolin Wittmann.

This explanation adds to two others already postulated for the evolution of UDGs:

- UDGs are small low-luminosity galaxies that were inflated to their current sizes in some manner,
- UDGs are normal galaxies that had their star-forming mechanism interrupted, perhaps by a large number of supernova explosions that stripped the galaxy of star-forming material and expanded a dark-matter halo, or by ram stripping as they passed through the intergalactic medium of the cluster.

Deep images of the Coma Cluster have revealed that two of the UDGs of that system have a large over-abundance of globular clusters—about 6.9 times that expected for similarly sized normal galaxies. These observations suggest that the pair were normal galaxies at the start of their formation, forming a swarm of globular clusters just like other galaxies, but then were stripped of star-forming dust and gas at some later stage in their history.

Compiled using material provided by the Isaac Newton Group of Telescopes (ING) and Heidelberg University.

Optical magic takes ground-based telescopes into space

A new, low-cost attachment to telescopes allows previously unachievable precision in ground-based observations of exoplanets. With the new devices, ground-based telescopes can produce measurements of light intensity that rival the highest-quality photometric observations from space. Penn State astronomers, in collaboration with the nanofabrication labs at RPC Photonics in Rochester, New York, created the custom "beam-shaping" diffusers, which are capable of minimizing distortions from the Earth's turbulent atmosphere that can reduce the precision of ground-based observations.

"This inexpensive technology delivers high photometric precision in observations of exoplanets as they transit…the bright stars that they orbit," said Gudmundur Stefansson, graduate student at Penn State, NASA Earth and Space Science Fellow, and lead author of the paper. "This technology is especially relevant considering the impending launch of NASA's *Transiting Exoplanet Survey Satellite* (TESS) early in 2018. It is up to ground-based facilities to rapidly and reliably follow up on candidate planets that are identified by TESS."

"Beam-shaping diffusers are made using a precise nanofabrication process," said Suvrath Mahadevan, associate professor of astronomy and astrophysics at Penn State, "where a carefully designed surface pattern is precisely written on a plastic polymer on a glass surface or directly etched on the glass itself. The pattern consists of precise micro-scale structures, engineered to mold the varying light input from stars into a predefined broad and stable output shape spread over many pixels on the telescope camera."

The research team tested the new diffuser technology "on-sky" on the Hale Telescope at Palomar Observatory in California, the 0.6-m telescope at Davey Lab Observatory at Penn State, and the ARC 3.5-m telescope at Apache Point Observatory in New Mexico. In all cases, images produced with a diffuser were consistently more stable than those using conventional methods: they maintained a relatively consistent size, shape, and intensity, which is integral in achieving highly precise measurements. Using a focused telescope without a diffuser produced images that fluctuate in size and intensity. A common method of "defocusing" the telescope—deliberately taking the image out of focus to spread out light—yielded higher photometric precision than focused observations, but still created images that fluctuated in size and intensity.

"This technology works over a wide range of wavelengths, from the optical—visible by humans—to the near infrared," said Jason Wright, associate professor of astronomy and astrophysics at Penn State and an author of the paper. "As such, diffusers can be used for a wide range of exoplanet science. We can use them to precisely measure the times exoplanetary worlds transit their stars, which will help us measure their masses and compositions, and even find new

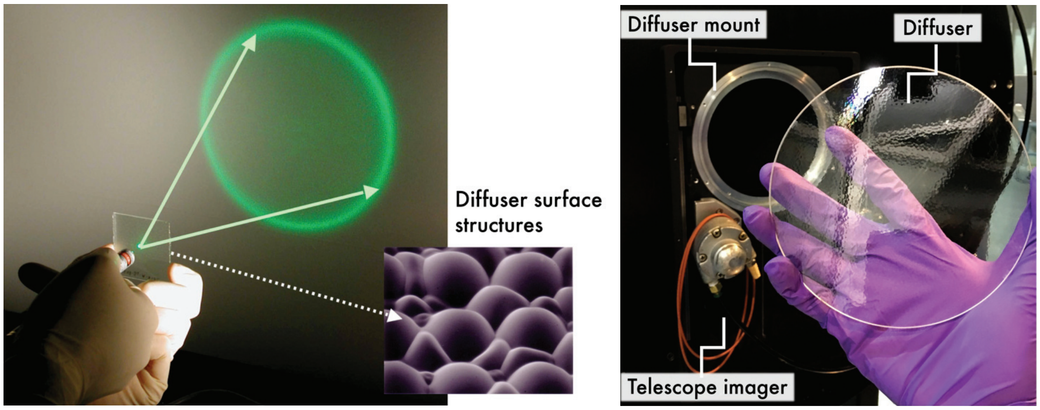


Figure 3 — Left: Light from a laser pointer is shaped into a wide and stable output using a beam-shaping diffuser. A carefully designed pattern is precisely molded into plastic polymers or directly into a glass substrate, creating micro-structures on the surface of the diffuser (credit: RPC Photonics). Right: The diffuser installed at the ARC 3.5-m telescope at Apache Point Observatory. Image Stefansson et al. 2017.

planets in their systems; and we can use them to study the temperature structures of giant planets' atmospheres."

Compiled in part with material from RPC Photonics.

Incoming

The *Hubble Space Telescope* has photographed the farthest active inbound comet ever seen at a whopping distance of 2.4 billion kilometres from the Sun (beyond Saturn's orbit). Slightly warmed by the remote Sun, it has already begun to develop a 130,000-km-wide coma, enveloping a tiny, solid nucleus of frozen gas and dust. These observations represent the earliest signs of activity ever seen from a comet entering the Solar System's planetary zone for the first time.

The comet, called C/2017 K2 (PANSTARRS) or "K2," has been travelling for millions of years from the frigid outer reaches of the Solar System, where the temperature is about -260 °C. The comet's orbit indicates that it came from the Oort Cloud, a spherical region almost a light-year in diameter and thought to contain hundreds of billions of comets.

"K2 is so far from the Sun and so cold, we know for sure that the activity—all the fuzzy stuff making it look like a comet—is not produced, as in other comets, by the evaporation of water ice," said lead researcher David Jewitt of the University of California, Los Angeles. "Instead, we think the activity is due to the sublimation (a solid changing directly into a gas) of super-volatiles as K2 makes its maiden entry into the Solar System's planetary zone. That's why it's special. This comet is so far away and so incredibly cold that water ice there is frozen like a rock."

Based on the Hubble observations of K2's coma, Jewitt suggests that sunlight is heating frozen volatile gases—such as oxygen, nitrogen, carbon dioxide, and carbon monoxide—that coat the comet's frigid surface. These icy volatiles lift off from the comet and release dust, forming the coma. Past studies of the composition of comets near the Sun have revealed the same mixture of volatile ices.

"I think these volatiles are spread all through K2, and in the beginning billions of years ago, they were probably all through every comet presently in the Oort Cloud," Jewitt said. "But the volatiles on the surface are the ones that absorb the heat from the Sun, so, in a sense, the comet is shedding its outer skin. Most comets are discovered much closer to the Sun, near Jupiter's orbit, so by the time we see them, these surface volatiles have already been baked off. That's why I think K2 is the most primitive comet we've seen."

K2 was discovered in May 2017 by the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) in Hawaii, a survey project of NASA's Near-Earth Object Observations Program. Jewitt used Hubble's Wide Field Camera 3 at the end of June to take a closer look at the icy visitor. Digging through archival images, Jewitt's team uncovered views of K2 and its fuzzy coma taken in 2013 by the Canada-France-Hawaii Telescope (CFHT) in Hawaii. At that time, the object was so faint that no one noticed it. "We think the comet has been continuously active for at least four years," Jewitt said. "In the CFHT data, K2 had a coma already at 3 billion kilometres from the Sun, when it was between the orbits of Uranus and Neptune. It was already active, and I think it has been continuously active coming in."

Curiously, the Hubble images do not show a tail flowing from K2, which is a signature of comets. The absence of such a feature indicates that particles lifting off the comet are too large for radiation pressure from the Sun to sweep them back into a tail.

Astronomers will have plenty of time to conduct detailed studies of K2. For the next five years, the comet will continue its journey into the inner Solar System before it reaches its closest approach to the Sun in 2022 just beyond Mars's orbit. "We will be able to monitor for the first time the developing activity of a comet falling in from the Oort Cloud over an extraordinary range of distances," Jewitt said. "It should become more and more active as it nears the Sun and presumably will form a tail." Amateur astronomers are already photographing the 18th-magnitude visitor with expectations that it will become a prominent object as it reaches closest approach in summer 2023. According to *Sky & Telescope*, worbit data suggests that the comet will peak at about the 5th magnitude.

Compiled from material supplied by NASA. ✶

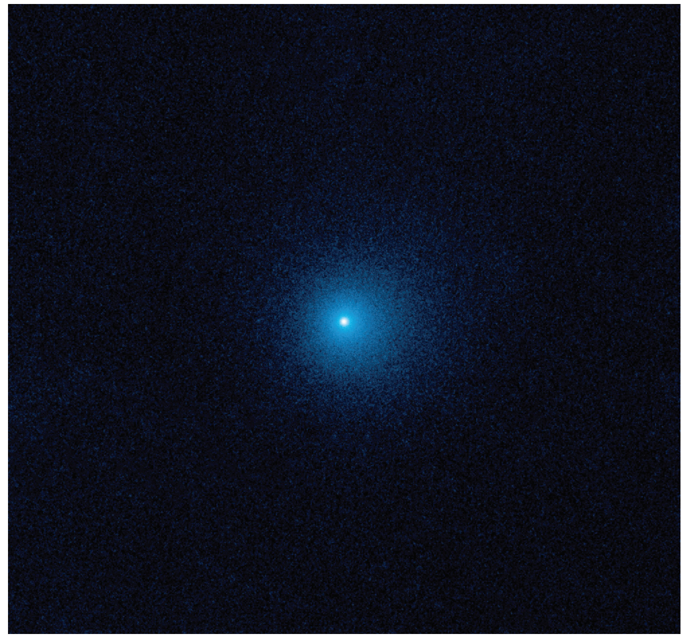


Figure 4 — This Hubble Space Telescope *image shows a fuzzy cloud of dust, called a coma, surrounding the comet C/2017 K2 PANSTARRS (K2), the farthest active comet ever observed entering the Solar System. Hubble snapped images of K2 when the frozen visitor was 2.4 billion km from the Sun, just beyond Saturn's orbit. Even at that remote distance, sunlight is warming the frigid comet, producing an 130,000-km-wide coma that envelops a tiny, solid nucleus. Image: NASA, ESA, and D. Jewitt (UCLA)*

A Short History of Astrophotography: Part 2

by Klaus Brasch

The first part of this concise history spanned the pre-photographic era from the mid-1700s to the mid-1800s, which saw great advances in telescope and supporting technology, including the invention of photography, to the 1960s at the start of the space age (Brasch, 2017). That era too saw major technological advances in astronomical instrumentation, photographic emulsions, electronics, and early computing capabilities (Wrubel, 1960).

In the 1950s and 1960s, Kodak produced several specialized spectroscopic emulsions for astronomical research, including the 103 series. Although designed for selected spectral sensitivity and reduced reciprocity failure, these were available in 35-mm format, but were also very coarse-grained. Because of this and although these films were also commercially available, pretty much all aspects of amateur astrophotography were a compromise. For instance, popular films like Kodak Tri-X Pan, though fast enough for short exposures to minimize the effects of atmospheric turbulence or seeing, were also very grainy, while more fine-grained films like Kodak Microfile or Plus X were rather slow and required relatively long exposures for the necessarily highly magnified planetary images. Much of that changed over time as better films were developed; culminating with the introduction of Kodak's ultra-fine-grained 2415 Technical Pan Film in 1981. The beauty of this film was its suitability for both planetary and deep-sky photography, since it could be developed for maximum dynamic range for planetary work and also hypersensitized for extended exposures of deep-sky objects (Covington, 1999).

Probably the last hurrah of film-based professional planetary research was the Lowell Observatory-led International Planetary Patrol Program (IPPP) (Brasch, 2016). With the launch of Sputnik 1 on 1957 October 4, and the arrival of the space age, interest in Solar System astronomy was rekindled among professional astronomers. Led by William Baum (1924-2012) and funded by the newly established National Aeronautics and Space Agency (NASA), the IPPP mission was to monitor the major planets photographically as continuously as possible using a network of observatories around the world. To those ends, standardized film and cameras were developed and used with specially modified 25–26.5-inch-aperture telescopes. Planets were photographed hourly at each station on Kodak 2498 RAR film, in sets of four 14-exposure sequences through red, green, blue, and ultraviolet (uv) filters, respectively, along with dates, time, observer, location, and colour, imprinted on each frame. By the time this project ended in the late 1970s, it had generated a database of some 1.2 million images of Mercury, Venus, Mars, Jupiter, and Saturn (Brasch, 2016). Among other findings, this work helped to demonstrate the 4-day retrograde motion of the Venusian cloud deck, a 90-day oscillation in Jupiter's Great Red Spot, and the density differential in particulates of Saturn's rings (Baum, 1973).

The IPPP's major scientific contributions, however, were with respect to Mars. This aspect of the program involved not only professionals but also many amateur astronomers, who were recruited thanks to the efforts of a key IPPP observer Charles (Chick) Capen (1926–1986). He made extensive use of colour filters for work with Mars, a tool he encouraged amateur observers in the Association of Lunar and Planetary Observers (ALPO) and elsewhere to also employ both visually and photographically. Collectively such efforts helped IPPP researchers clarify several Martian atmospheric phenomena,

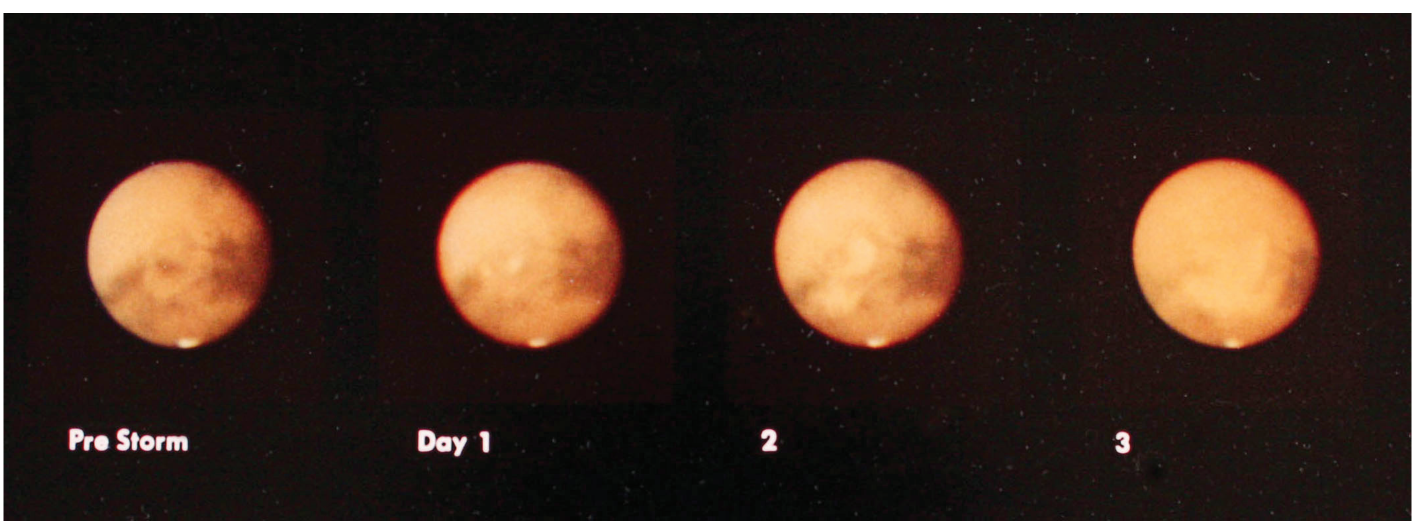


Figure 1 — IPPP colour images of a major dust storm developing over the Solis Lacus region on Mars in October 1973 (Lowell Observatory Archives).

including various colour clouds, dust storm development, polar cap and hood changes, and such seemingly enigmatic phenomena as the "blue or violet" clearing. These findings helped to predict and document a major Martian dust storm in 1971, which coincided with the arrival of Mariner 9 at the planet and blocked the orbiter's view of the surface for several weeks before clearing, and similar storms in subsequent years (Figure 1).

Film-based planetary photography continued among amateur astronomers well into the 1980s and 1990s; again thanks to the availability of increasingly finer-grained and more sensitive emulsions like Kodak Technical Pan film and widespread use of filters and image stacking techniques (see Dobbins et al., 1988). Again, under the leadership of Chick Capen and other professionals, talented amateurs like Don Parker and Jean Dragesco were able to obtain planetary images of such quality that they complemented professional studies (Figure 2). Some amateurs, including the author (Brasch, 1993), combined visual detail with simultaneously taken photographs and then combined them into a single photo/drawing to include fine detail not captured on film (Figure 3). The digital age, however, was on the horizon. The first stage in this evolution was the development of high-resolution digital film scanners. This made it possible to extract far more information from film-based images than regular 35-mm slides or printing permitted; information which could then be processed by computer to enhance contrast, extend the dynamic range and sharpen detail (Covington, 1999; Dickinson and Dyer, 2002; Brasch, 2006). All this, however, was merely the prelude to direct electronic imaging a few years later.

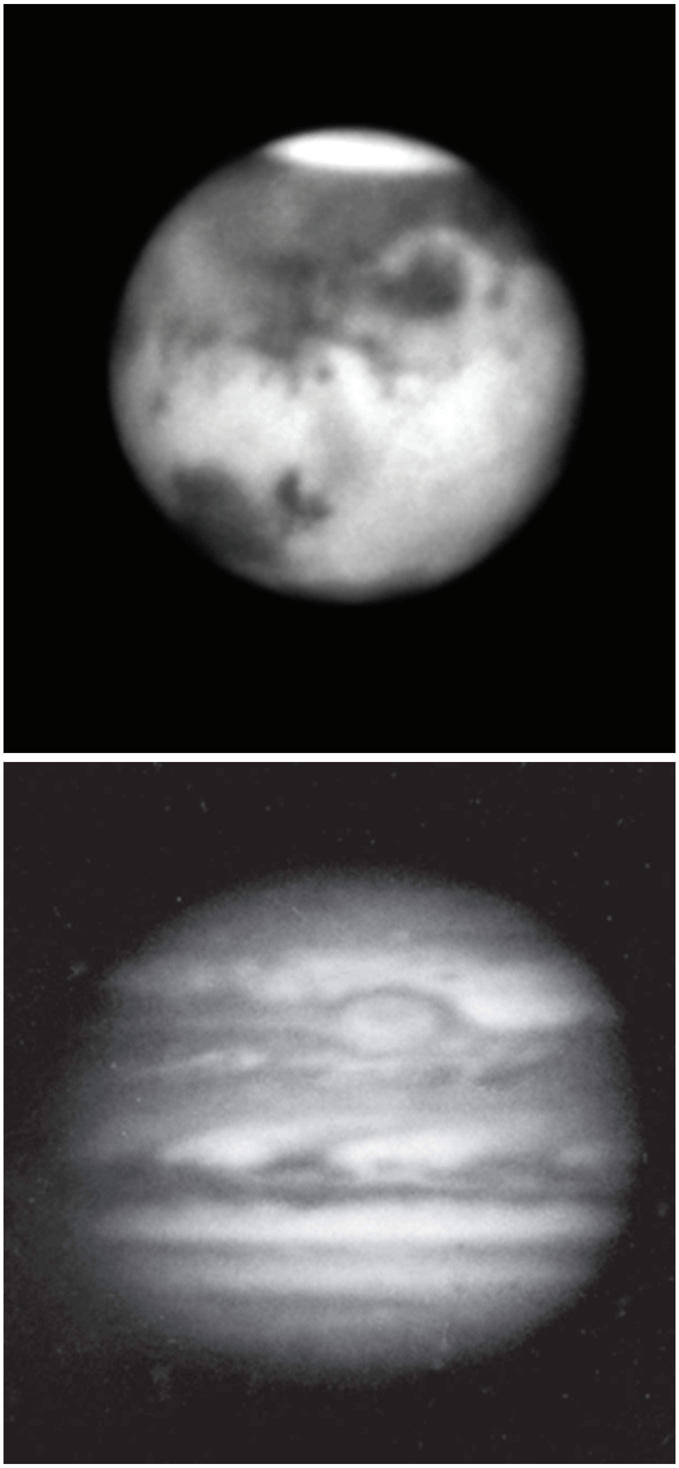


Figure 2 — Examples of some of the finest amateur photographs ever taken of Mars by Jean Dragesco with the 1-m telescope at Pic du Midi in 1988, and Jupiter by renowned planetary imager Don Parker with a 16-inch Newtonian in 1990, with Kodak Technical Pan film (Both Public Domain).

Electronic and Digital Photography

In order to gain greater sensitivity than photographic emulsions could supply, astronomers started experimenting with television cameras in the late 1950s. Capable of amplifying light as much as 50,000 times, these cameras were developed, among other things, to track artificial satellites and other fast-moving object in the sky with great accuracy. One such camera, the Bendix-Friez Lumicon (Figure 4a), was adapted and tested for potential in astronomical research at Yerkes and McDonald Observatories in 1958–59 (Kuiper, 1959). Tests included observations of the Moon, Venus, Mars, Jupiter, and Saturn, as well as star fields and nebulae, using 40- and 82-inch telescopes and a variety of auxiliary lenses. Under the direction of renowned astronomer Gerard Kuiper, then-students Alan Binder and Dale Cruikshank worked with the camera on the Yerkes 40-inch refractor in 1959, and obtained several images of the Moon, Jupiter, and Saturn (Figure 4b). While these results were promising, the consensus was that the technology's usefulness was limited and not quite on par with photography at that time (Kuiper, 1959).

A decade later in 1969, W.S. Boyle and G.E. Smith of the Bell Laboratory invented CCDs (charge-coupled devices) although

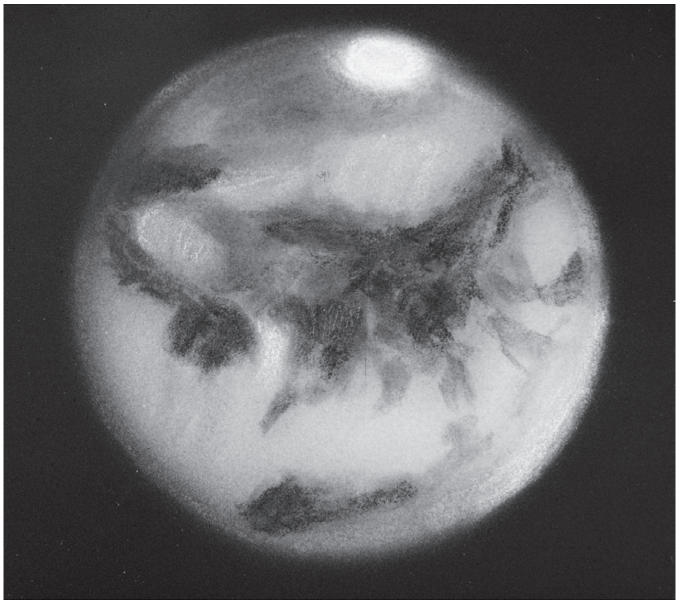
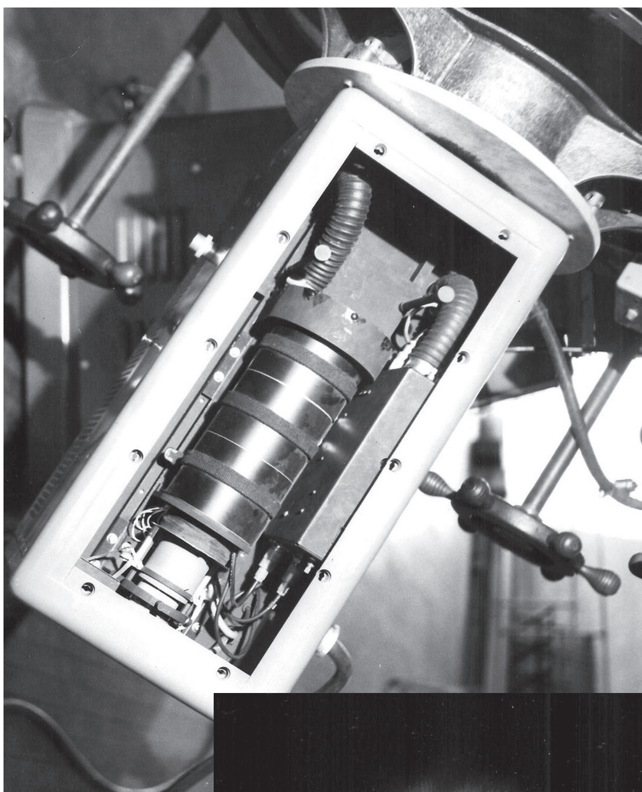
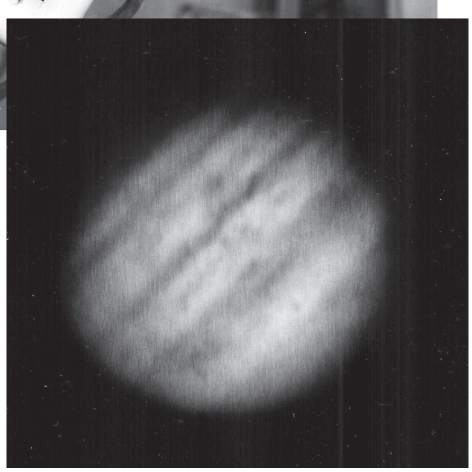


Figure 3 — Triple-stacked photo taken by the author with a Celestron 14 and Technical Pan film in 1988 (left) and a photo-drawing combination of simultaneously sketched visual detail.





Figs 4a, b — Bendix Lumicon TV camera and Jupiter, by A. Binder and D. Cruikshank, Yerkes Observatory (1959)

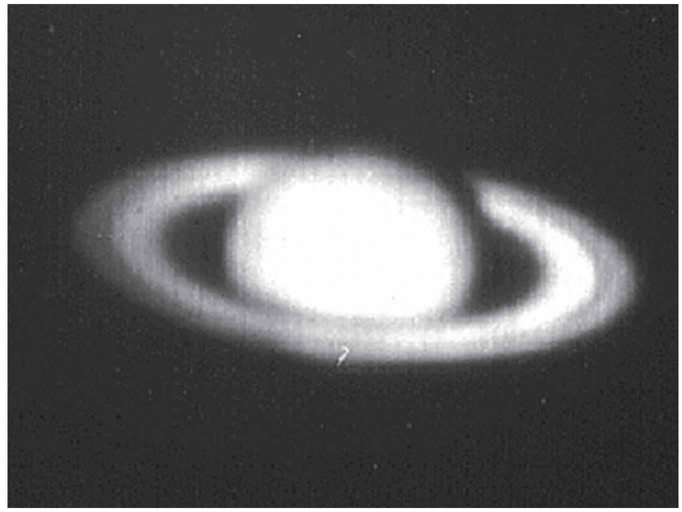


Figure 5 — First CCD image of Saturn by J. Janesick & B. Smith at Mt. Bigelow (1976)

these were not initially intended for astronomical purposes. The first astronomical CCD image of the Moon was taken in 1974 with a 100 x 100-pixel camera developed by the Fairchild Semiconductor Co., and the first images of Jupiter, Saturn, and Uranus were taken in 1976 by J. Janesick and B. Smith with the 61-inch telescope on Mt. Bigelow in Arizona (Janesick and Blouke, 1987) (Figure 5). While these initial results were not on par with photographic images, it was only a matter of time before CCDs were adopted by professional astronomers and became ubiquitous, both for imaging and photometry. CCD devices had several immediate advantages over photographic plates and films, including about 10-fold greater quantum efficiency, wider spectral sensitivity, and effectively no reciprocity failure. Those characteristics made them superior to even the best photographic emulsions for imaging astronomical objects. Moreover, digital images readily lent themselves to combining and stacking, thereby increasing the signal-to-noise ratio and image contrast.

In 1984, an innovative French amateur, Christian Buil, constructed his own rudimentary CCD camera and obtained the first colour digital images of Jupiter using the 1-m telescope at Pic du Midi Observatory (Figure 6). Amateur digital imaging began in earnest, however, in the early 1990s with the introduction of the ST-4 CCD camera by the Santa Barbara Group, and shortly thereafter the far superior ST-6. With it, Canadian amateur Jack Newton secured the first tri-colour image of the Dumbbell Nebula, M-27 (Figure 6) in 1990, as well as some excellent images of Jupiter and Saturn. These images were clearly far superior to any film-based photos, particularly in terms of dynamic range. Accompanying all this were also rapid improvements in the speed and versatility of personal computers and image processing software.

Equally dramatic though for lunar and planetary imaging, inexpensive webcams became available around 2000, which

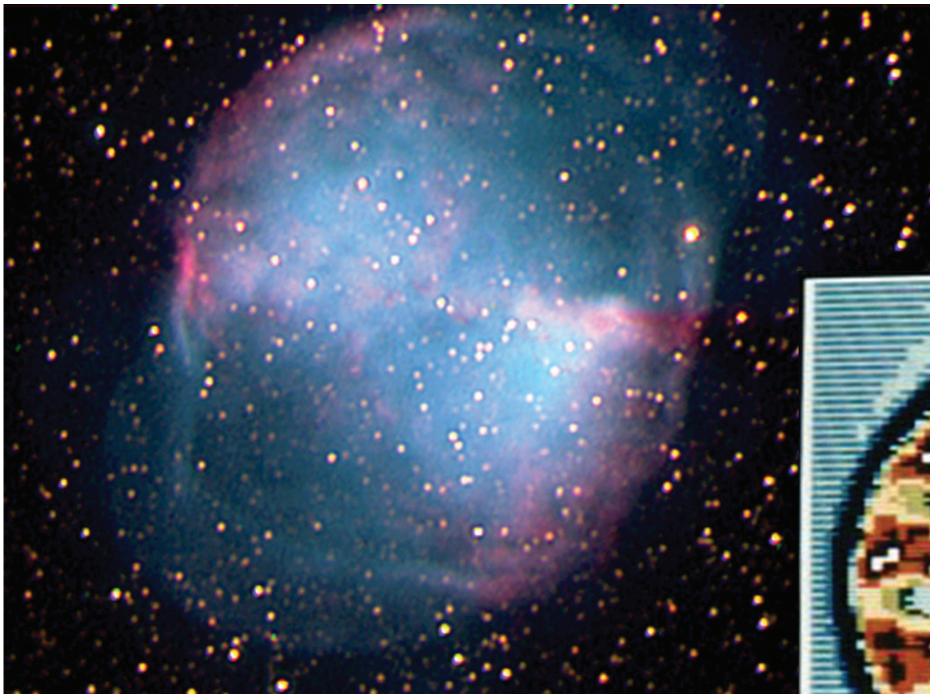
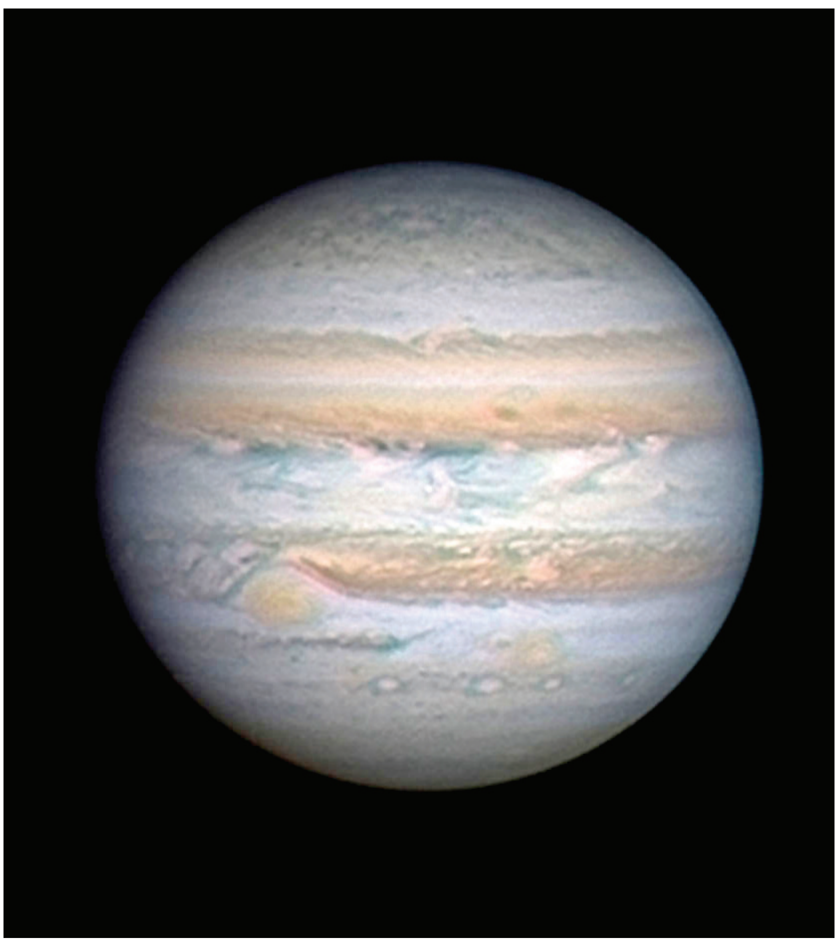



Figure 6 — First amateur colour CCD images of M-27 by J. Newton (1990) and first amateur CCD image of Jupiter by C. Buil (1984)



made it possible to quickly capture extended rapid-exposure videos of the Moon and planets (Figure 7). By subsequently applying software like RegiStax to the best images in a video sequence and stacking them together, it became possible to secure near-diffraction-limited lunar and planetary images, a major technological advance (Dickinson and Dyer, 2008). A decade later, webcam technology had improved to the point where medium-sized amateur telescopes could produce planetary images on par with those obtained by professionals (Figure 8).

A second revolutionary development to hit the scene in the early 2000s was the introduction of digital single-lens reflex (DSLR) cameras. Both Canon and Nikon led the way with the 6.3-megapixel CMOS (complementary metal-oxide) sensor 10D and the 6.1-megapixel CCD sensor D70, respectively, providing commercial high-resolution digital cameras that could compete directly with their film-based counterparts in both resolution and sensitivity. Shortly after that, Canon followed with their 8-megapixel 20D and 20Da; with the latter model specifically designed for deep-sky astrophotography through higher red-light sensitivity so important for imaging emission nebulosity. This advantage can be further amplified through aftermarket modifications that extended sensor sensitivity into the far-red portion of the spectrum to record the all-important hydrogen-alpha emissions. Today, spectrally modified DSLRs, with highly effective internal noise-reduction software and coupled narrow-bandpass filters, have become extremely popular with amateur astrophotographers (Dickinson and Dyer, 2015).

As the price of high-end CCD cameras has declined, while their capabilities in terms of ease of use, resolution, low noise levels, and high signal-to-noise ratios continue to improve steadily, many amateur astroimagers have reached a level of sophistication on par with professional efforts. Indeed, today more than

Figure 7 (top) — Saturn imaged in 2003 by R. Hess with a simple Philips ToUcam and a 10-inch Newtonian.

Figure 8 (bottom) — Jupiter, imaged in 2013 by Leo Aerts with a Celestron 14 and DMK camera, showing superb detail and diffraction-limited resolution.

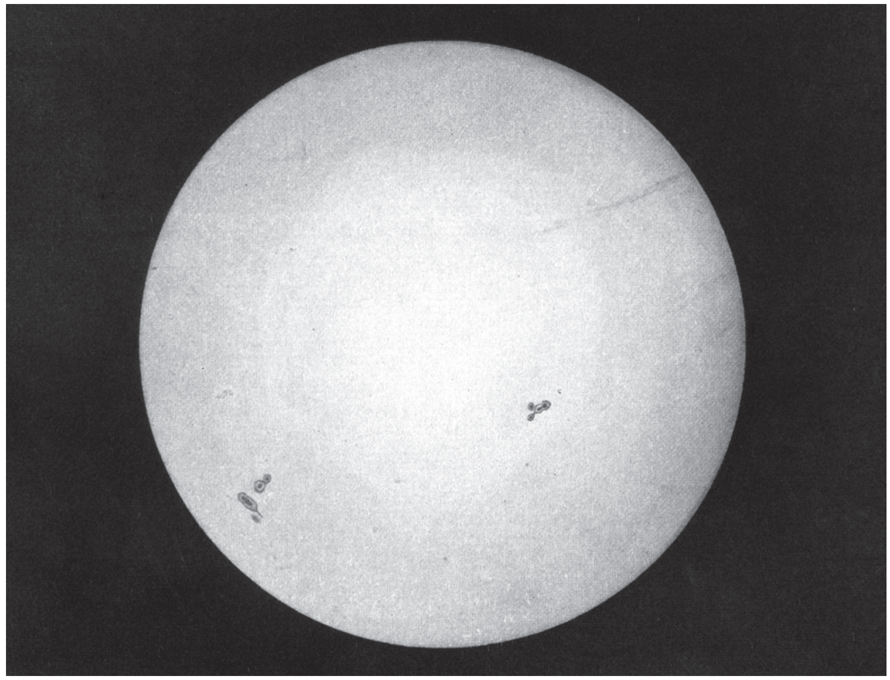


Figure 9 — First Daguerreotype image of the Sun by A. Fizeau and J.B. Foucault in 1845

ever, some amateurs are teaming with professional astronomers in such cutting-edge research as dwarf galaxy surveys, hunting for Kuiper Belt objects, spotting impact events on Jupiter, supernova searches and, most recently, exoplanet transit monitoring (Gary, 2010; NASA, 2015). In these regards, talented amateurs with quality optical and imaging equipment can devote extended periods of observing time, time that professionals often cannot obtain due to intense competition for instrument use at major observatories. In many ways, therefore, astronomy has come full circle, from a largely amateur undertaking in the 18th and 19th centuries, to renewed amateur engagement today thanks to unprecedented advances in optical equipment, imaging technology, and processing.

Photographing the Moon and Sun

Because of their brightness and large apparent size as seen from Earth, the Sun and Moon were natural targets for the first attempts at astrophotography. As early as 1839, Louis Daguerre endeavoured to photograph the Moon, but the image was blurred, and a year later J.W. Draper succeeded. As outlined previously (Brasch, 2016b), lunar photography advanced rapidly in the second half of the 19th century, culminating with the publication in 1903 of two major works.

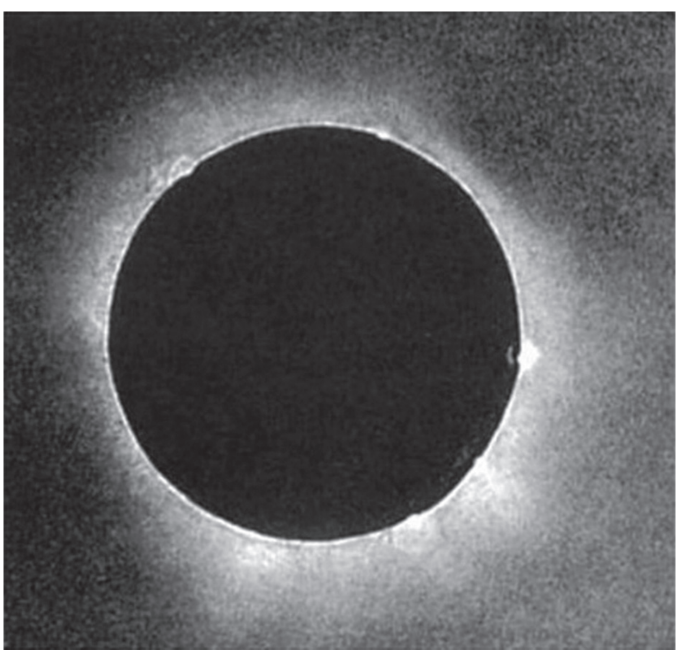


Figure 10 — First daguerreotype image of the solar corona by Berkowski during the 1851 eclipse

First was Edward Holden's *Lick Observatory Atlas of the Moon*, and second, the *Atlas Photographique de la Lune* by Maurice Loewy and Pierre Puiseux of Paris Observatory (Loewy and Puiseux, 1903). The latter would remain a major reference for lunar studies for the next 60 years, until publication by Kuiper et al. of the *Photographic Lunar Atlas* (Kuiper et al., 1960; Sheehan and Dobbins, 2001; Hughes, 2013).

In 1844 and 1845, Armand Fizeau and J.B. Foucault at Paris observatory obtained several successful daguerreotypes of the Sun (Figure 9). The first successful photograph of the solar corona was obtained during the total eclipse of 1851 July 28 by daguerreotypist Berkowski (Figure 10). He used a 6.1-cm (2.4-inch) telescope of about 80-cm focal length attached to a heliometer at Königsberg Observatory (now Kaliningrad, Russia) (en.wikipedia, 2016). A few years later, Warren de la Rue (1815–1889) in Britain devised the photoheliograph or solar telescope and applied stereoscopic methods showing that sunspots are depressions in the Sun's atmosphere (en.wikipedia, 2016b) (Figure 11), thereby verifying a theory advanced by Alexander Wilson of Glasgow in the 18th century (encyclopedia.com, 2008).

Advances in solar photography and spectroscopy progressed rapidly thereafter (Hughes, 2013), and took a giant leap forward in the 1930s with development of the coronagraph by French astronomer Bernard Lyot (1897-1952). This revolutionary instrument made possible not only direct photography of the solar corona (other than during a total eclipse) (Figure 12), but also spectral analysis and select visualization of solar features by means of narrow-bandpass filtration (Lyot, 1933). Today, of course, similar instruments are in wide use at professional observatories and also available to amateur astronomers (Hufbauer, 2007).

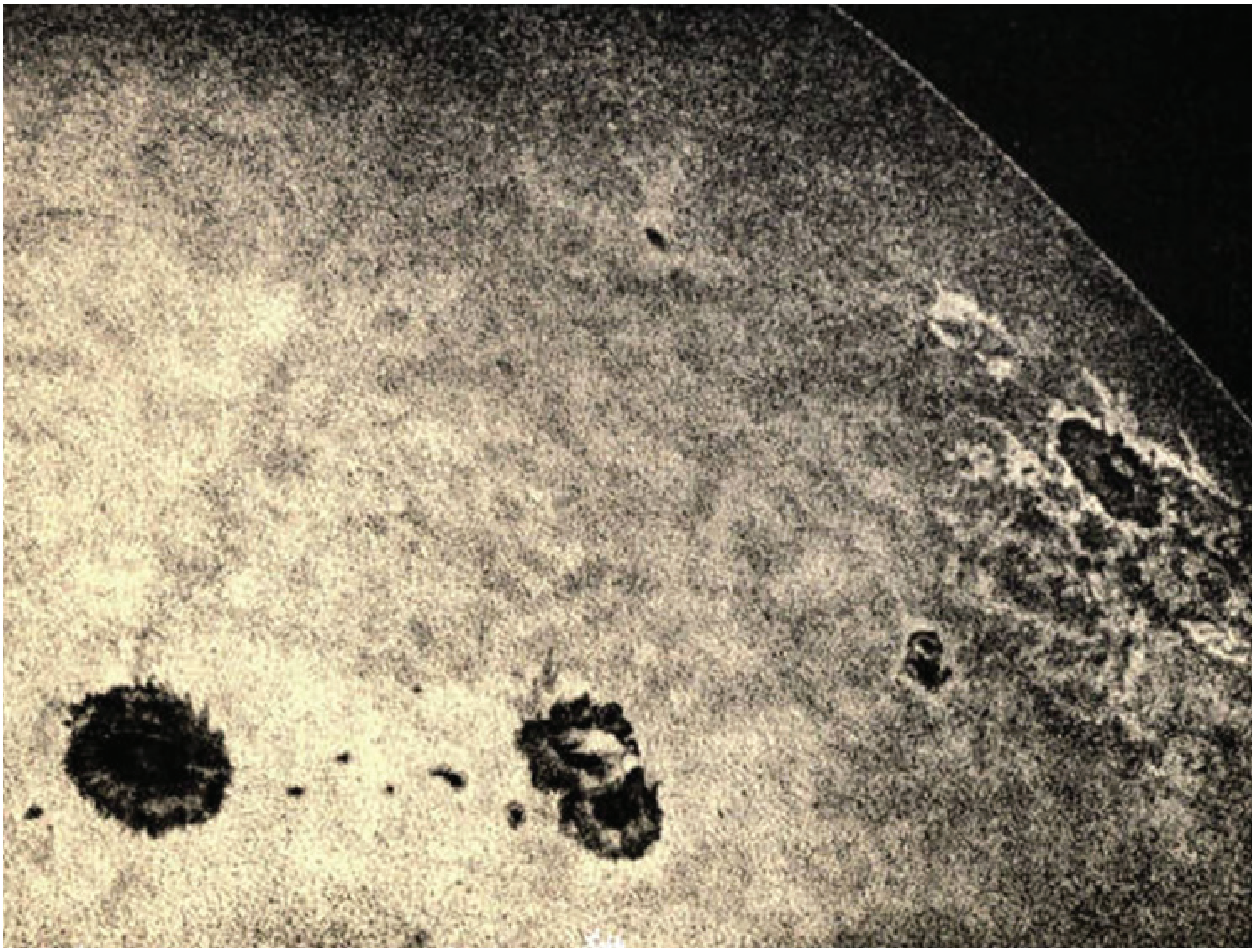


Figure 11 — Stereoscopic photo showing detail of sunspots and granulation by W. de la Rue in 1861

Figure 12 — Image of the solar corona by Bernard Lyot, inventor of the coronagraph (Wikimedia)

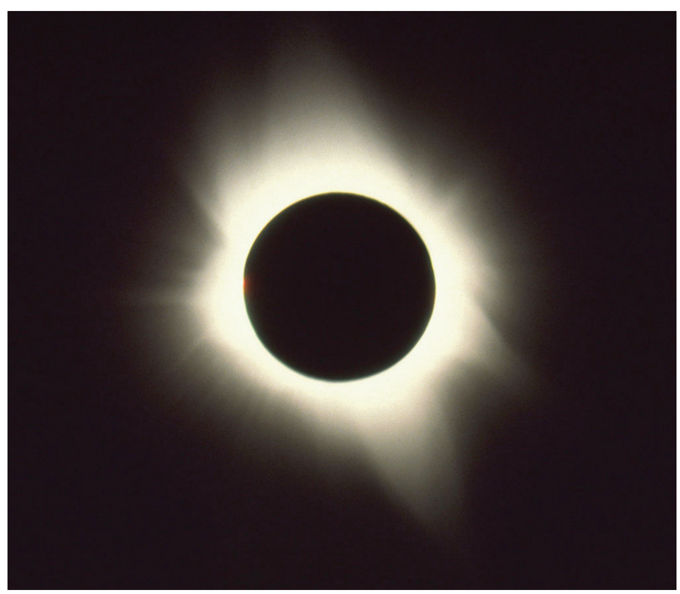


Figure 13 — The extensive solar corona of the 1991 total eclipse captured by the author with Fuji Velvia 50 film and a 300-mm lens. The slide was later digitized and processed in Adobe Photoshop to bring out subtle detail not evident on the original slide.

As with all aspects of photography in general, image quality of Solar System objects improved dramatically with each advance in photographic plate and emulsion technology. Notable in this regard were the development of dry plates and gelatin emulsions toward the end of the 19th century. These led to greater light sensitivity, image stability, resolution, and of course versatility, including celluloid-based films, inexpensive box cameras, and ultimately motion pictures. Photography subsequently became a popular profession and pastime, leading to mass production of cameras, which reduced equipment costs.

From the 1970s through the 1990s, 35-mm films saw major improvements in resolution, colour rendition, and saturation, as well as reduced reciprocity failure, a particular bane in astrophotography. That, coupled with film scanning and conversion to digital images, provided an extended lease on the use of film in amateur astrophotography. Solar-eclipse photography, in particular, became popular as literally thousands of "eclipse chasers" travelled to remote corners of the planet to hopefully catch those few precious minutes of totality and secure that once-in-a-lifetime photograph (Figure 13). Since then, advances in optics and imaging techniques have provided amateurs with dedicated solar telescopes and narrow-bandpass filters previously available only to professionals. Consequently, even modest aperture refractors, such as the Lunt 60 or 90-mm telescopes, coupled with 0.5–7-angstrom hydrogen-alpha filters, reveal solar-flare and prominence details unimaginable just a few years ago (Figure 14).

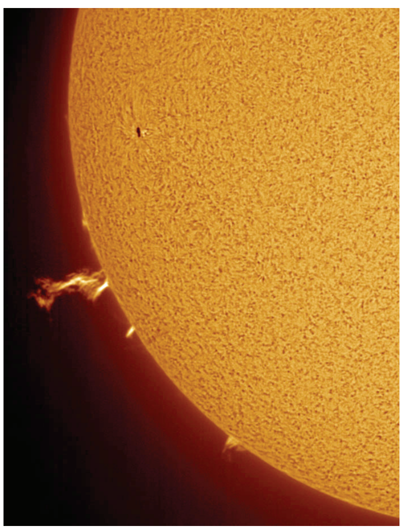
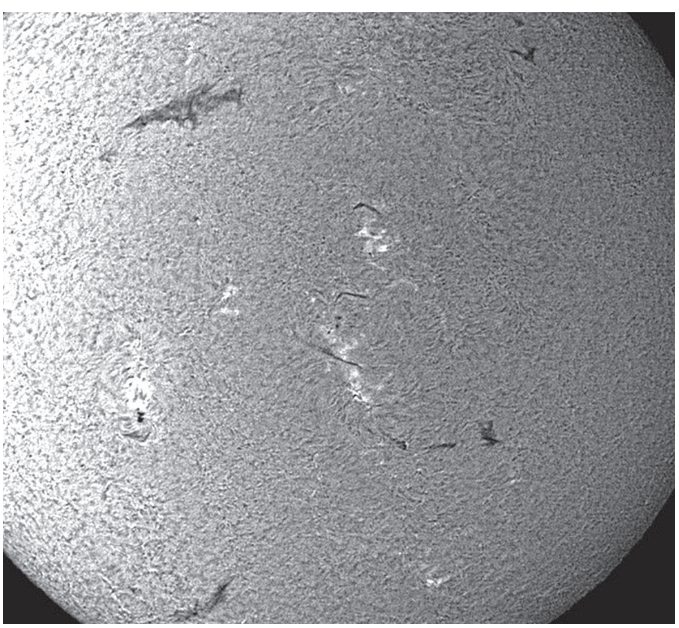


Figure 14 — Examples of amateur images taken with Lunt solar telescopes equipped with 0.7 angstrom h-alpha passing filters and high-resolution video cameras. The colourized image at left (E. Marlatt) shows limb prominences and the monochrome image below (F. Tretta) shows abundant photosphere filaments, sunspots, and granularity.



Epilogue

Perhaps the best way to summarize how far lunar, as indeed all types of astronomical imaging has evolved over the last half century or so, is illustrated in Figures 15a and b, featuring the magnificent craters Theophilus and Cyrillus. Thetop image is an enlargement of the 1963 Lunar Aeronautical Chart (LAC-78), prepared by the United States Air Force and NASA in planning for the Apollo Moon missions and early spacecraft exploration. The LAC series was based entirely on the best Earth-based photographs available at the time from Lick, Mt. Wilson, Yerkes, McDonald, and Pic du Midi Observatories, and augmented with visual detail obtained with the 24-inch Clark refractor at Lowell Observatory. These charts, therefore, marked the culmination of what was possible with the technology at the beginning of the space age.

The bottom image exemplifies what is possible with cutting-edge technology today. Using a Celestron 14, a DMK webcam, RegiStax, and AutoStakkert! software and skilled processing magic, Belgian amateur Leo Aerts routinely captures lunar images that far exceed what was done with much larger professional telescopes during the film-based era. It is now possible, in effect, to circumvent atmospheric turbulence by capturing thousands of video images in rapid sequence, and combining only the very best frames to generate diffraction-limited images with modest-aperture telescopes, that rival not only the best professional results but approach those obtained by spacecraft. ✶

Note: The author is greatly indebted to Lowell Observatory archivist Lauren Amundson, and amateur and professional astronomers Leo Aerts, Christian Buil, Dale Cruikshank, R. Hess, J. Janesick, Eric Marlatt, Jack Newton, and Fred Tretta, for use of their modern and/or historic images.

Klaus Brasch is a retired bio-scientist and public program volunteer at Lowell Observatory. He first joined the RASC in 1957 and has been an avid amateur astronomer ever since. A frequent contributor to JRASC, SkyNews, Astronomy *magazine and* Sky & Telescope, *he enjoys astrophotography from his observatory in Flagstaff, Arizona.*

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Figure 15 a,b — (top) 1963 Lunar Aeronautical Chart prepared by the United States Air Force and NASA, (bottom) amateur image captured by Leo Aerts.

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An Early Canadian Zodiacal Light Eyewitness Account

Clark Muir (Kitchener-Waterloo Centre RASC)
cmuir10@rogers.com

Included among the significant works of literature in early Canadiana are the personal diaries and notes of Catharine Parr Traill (1802–1899).

Traill, a writer, settled to Upper Canada (Ontario) from England in 1832 with her husband Thomas.

In modern times, Traill's works are revered not only because they highlight the difficult day-to-day living experiences in the new wilderness, but they also preserve them from the female perspective.

Her brother Samuel Strickland (1806–1867) made the journey to Upper Canada a few years earlier. The two siblings and their families would eventually reunite and farm on adjoining acreages along the Otonabee[1] River (north of Lakefield, Ontario).

A previous JRASC[2] article includes their personal eyewitness reports of the remarkable Leonid meteor storm of 1833 November 13.

Although Traill's work has been well documented there is an interesting passage that has escaped the attention it deserves. The episode is to be found in perhaps her most popular work "The Backwoods of Canada." Published in 1836, it contains a series of her letters detailing her experiences and thoughts about life in Upper Canada.

Near the end of letter 18[3] dated 1835 May 1, Traill writes with fascination about a peculiar light in the evening sky from the previous early winter (around Christmas time). She describes it in intricate detail, allows her imagination to wander and speculates to its cause.

The passage is presented in its entirety:

> *Coming home one night last Christmas from the house of a friend, I was struck by a splendid pillar of pale greenish light in the west: it rose to some height above the dark line of pines that crowned the opposite shores of the Otanabee, and illumined the heavens on either side with a chaste pure light, such as the moon gives in her rise and setting; it was not quite pyramidical, though much broader at the base than at its highest point; it gradually faded, till a faint white glimmering light alone marked where its place had been, and even that disappeared after some half-hour's time. It was so fair and lovely a vision I was grieved when it vanished into thin air, and could have cheated fancy into the belief that it was the robe of some bright visitor from another and a better world;--imagination apart, could it be a phosphoric*

Continued on page 264

(top) Nigel Ball of the United Kingdom writes "I was fortunate to be on Ynys Mon recently for a course. The ruined chapel at Lligwy near Moelfre [Anglesey] must be one of the most peaceful locations I've visited in a long time." He imaged the star trails here using a Nikon D810A with a Nikkor 14–24-mm lens. Sky exposure for 20 seconds, ISO 6400, ƒ/2.8; foreground was 600 seconds, ISO 1250, ƒ/6.3.

(left) Kersti Meema imaged this wintery scene of Orion in Haliburton Lake, Ontario, on 2017 January 6. She used a Canon EOS REBEL T5i at ƒ/4, 8.3-sec exposure, at ISO 1600 with a focal length of 17 mm.

Pen & Pixel

(right) IC 1396 is seen here in this image taken by Michael Watson. He photographed the nebula at Algonquin Provincial Park in Ontario using a Nikon D810a camera body on Teleview 101is apochromatic refracting telescope, mounted on Astrophysics 1100GTO equatorial mount. The final is a collection of 15 stacked frames, each with a 540-mm focal length at ISO 6400, 1-minute exposure at ƒ/5.4, unguided.

(below) Dan Meek imaged our beautiful Andromeda Galaxy (M31) from Calgary. He took this 9-hour LRGB image with a Tele Vue NP127is telescope and a QSI583wsg camera.

Continued from page 261

> *exhalation from some of our many swamps or inland lakes, or was it at all connected with the aurora that is so frequently seen in our skies?*

If brought to the attention of an astronomer, this narrative must sound like an eyewitness account of the zodiacal light. Traill's use of the word "pyramidical" is particularly insightful. Even today the expression is used to describe the light's somewhat triangular appearance with the base at the horizon and its point upwards in the sky.

The date of her account can only be approximated. "One night last Christmas" would clearly suggest a few days either side of 1834 December 25. This is consistent with a favourable Moon phase starting approximately at 1834 December 20 to 1835 January 1.[4]

It can be interpreted that Traill was alone when she witnessed the phenomenon. There is no indication that she directed another person to her observation, which she certainly would have done. Nor is there a suggestion of an explanation of the strange light from a fellow traveller.

Traill marks the passage of time indicating that her solitary walk was a lengthy one. She had observed the light change in appearance in over a "half-hour's time" and probably longer. At some point she noticed the light purely by accident and from then on examined its appearance.

It should be further noted that Traill, as far as can be determined, did not have a particular interest in astronomy or even sky-watching in general. Her books and letters reveal that she was an astute observer of her environments. However, any of her scientific interests appear more centred around the earth sciences, especially botany.

Traill would likely not have had any means in which to research her observations. It would be improbable that she had any chance of obtaining an authoritative scientific explanation of the phenomenon she was observing. She can only speculate that it is related to the aurora or caused by a "phosphoric exhalation."[5]

The reader is given a brief glimpse into her imagination with her passage "…cheated fancy into the belief that it was the robe of some bright visitor from another and a better world…" Perhaps this is not much different from what would be supposed today when people romanticize about an unknown or unfamiliar sky phenomenon.

In modern times beyond the astronomical community, most people have not seen the zodiacal light and, in many cases, have not even heard of it. With light pollution pervasive, it is increasingly unlikely that most people today will ever chance to see it. For residence of Canada, the higher latitude makes it even more elusive.

Figure 1 — Portrait of Catharine Parr Traill

Almost every account of the visual appearance of the zodiacal light is sourced from experienced amateur or professional astronomers. Most descriptions are given by veteran observers who have witnessed a striking view of the phenomenon and occasionally, it is even for the first time in their life.

In common literature the zodiacal light is a subject rarely broached. Traill's report is an exception. A detailed description of the zodiacal light from someone who was not looking for it, was not a keen sky observer nor even knew it existed is perhaps without precedence. In addition, Traill being a proficient writer and witnessing it from Canadian soil makes her unbiased testimony even more satisfying. ✶

Endnotes

1 The Otonabee or Otonobee refers to the river near Lakefield, Ontario

2 JRASC; Canada and the 1833 Leonids, 2014 April. Muir C.

3 Some sources incorrectly date the letter 1833 May 1

4 The Moon above the horizon at any phase can dramatically influence the visibility of the zodiacal light.

5 Could be referring to ignis fatuus or "Will-o'-the-wisp"

Second Light

"A bang in the night"

by Leslie J. Sage
(l.sage@us.nature.com)

On 2017 August 17, at about 12:41:04 UT, the Laser Interferometer Gravitational-wave Observatory detected the gravitational wave "chirp" of two neutron stars merging. About two seconds later, the gamma-ray burst monitors on the *Fermi* and INTEGRAL satellites detected a short, hard gamma-ray burst. The European counterpart, Virgo, did not detect it, but should have, helping to locate the source in one of its blind spots. Notification of these events went to astronomers around the world, who scrambled to find an optical counterpart. The very first team to do so was the Swope Supernova Survey, who named it SSS17a. Soon, other groups either found it independently, or modified their search strategy in the light of the information that was going out on a private distribution network. Part of that story appeared online in *Nature* on 2016 October 16, with printed papers scheduled to appear in the November 2 issue. Another part of the story appeared in Science, and part in the *Astrophysical Journal Letters*. The paper announcing the gravitational wave chirp itself appeared in the *Physical Review Letters*. These involve large teams of physicists and astronomers from around the world. One paper reportedly has about 3500 authors, but I have not personally counted them all. This is a historic event in astronomy—the combination of the chirp, the burst, and the optical counterpart.

The broad story is as follows: An optical transient was located in the galaxy NGC 4993, which is about 40 Mpc from the Solar System. It is an S0 galaxy in the group ESO 508-G018. The formal IAU designation of the transient is AT2017gfo.

The transient was fainter than a supernova, and faded much more rapidly. It sort of matched the predictions for a "kilonova"—a kind of failed supernova associated with the merger of binary neutron stars, and which has become over the last five years the preferred explanation for short gamma-ray bursts. The kilonova started out very blue, and over the course of several days became quite red. When it was discovered, it was about 17th magnitude. No one knows if that was at/near the peak or whether it was already fading.

Spectroscopy revealed early on that the ejecta had a velocity of about 20 percent of the speed of light. As it faded, lines consistent with the so-called "r-process" appeared. R-process is where atomic nuclei are bombarded with neutrons (which decay rapidly when not in nuclei), generating heavy elements such as gold. The mass of the ejecta was a few hundredths of a solar mass.

The general consensus is that we saw a short gamma-ray burst, off the main axis of the jet of material that gives rise to the gamma-ray burst. This cements the association of neutron star mergers with short gamma-ray bursts. Curiously, this is by far the closest short gamma-ray burst ever seen.

The luminosity distance of the merger event is easily recoverable from the chirp data, and based upon that, coupled with knowledge of the recession velocity, yields a Hubble constant of 70 km s^{-1} Mpc^{-1}. The uncertainties are quite large, because NGC 4993 is barely in the "Hubble flow," but the number is comfortingly close to what has been determined by other means, and is entirely independent of the distance ladder. On the other hand, this demonstrates that the distance ladder, for all its flaws, is in fact quite accurate.

Where do we go from here? The next step is to get chirp notifications to astronomers within minutes, so that they can "get glass" on the counterparts as soon as possible, to see the kilonova as it is brightening. As the sensitivity of LIGO and Virgo increases over the next few years, we will detect more chirps and see more counterparts. Who knows what that will tell us? ✶

Leslie J. Sage is Senior Editor, Physical Sciences, for Nature Magazine *and a Research Associate in the Astronomy Department at the University of Maryland. He grew up in Burlington, Ontario, where even the bright lights of Toronto did not dim his enthusiasm for astronomy. Currently he studies molecular gas and star formation in galaxies, particularly interacting ones, but is not above looking at a humble planetary object.*

Skyward

Eclipses and Fond Memories

by David Levy, Montreal and Kingston Centres

A wonderful eclipse

A total eclipse of the Sun is possibly nature's grandest show. And to be somewhere in the path of totality, looking at a darkened sky and seeing the jewelled crown around what was once the Sun, is truly an experience like no other.

Throughout most of 2017, the world has appeared to be fractured, disingenuous, and unfriendly. But for a few hours on Monday morning, August 21, all that changed as hundreds of thousands of people looked up at the sky and witnessed a solar eclipse.

Almost everyone in the United States and Canada was treated to at least a partial eclipse. But those lucky enough to find their way to a 70-mile-wide swath of utter darkness saw the rare and wonderful phenomenon of a total eclipse of the Sun.

Wendee and I were in that path. Actually, we were in Madras, Oregon, not far from the base of Mt. Jefferson in the Cascade Mountain range. From the front entrance of our hotel in Madras, we enjoyed the entire two-and-a-half-hour event uninterrupted by any clouds. Smoke from nearby wildfires did not seriously interfere with our enjoyment of the eclipse.

Because eclipses occur in repeating series called Saros (Greek for cycle), this is not the first time I have seen this eclipse. I saw it first on the afternoon of 1963 July 20 with my parents and a friend. But despite the wonder of totality, the thing that impressed my dad with that eclipse was that it started on time. Punctuality meant a lot to him, and he was impressed that a schedule formed a billion years ago was still accurate to the second.

Figure 1 — This is Wendee's picture of the 1999 eclipse. The darkness below the eclipsed Sun is the shadow of the Moon hanging just to our south.

I saw the eclipse for a second time on 1999 August 11. This time we were aboard a ship just southeast of the coast of Nova Scotia. Because the Moon's shadow was just beginning its journey across the face of the Earth that morning, the totality was very brief, only about 50 seconds long. It allowed Wendee to take my favourite picture of any eclipse, a simple shot through her "point and shoot" camera that captured the shadow of the Moon as it tore across the face of the Earth.

And so, on 2017 August 21, the Moon's shadow reappeared in yet another iteration. Since this was the third repetition, it is called an *exeligmos*. This means that the eclipse was almost identical to what some of us recall seeing in 1963. This eclipse was just a bit south of the original path from 1963. In any case, it was a welcome event.

Even though some astronomers try to conduct science experiments during solar eclipses, I've never been much for doing science during these events, mostly because the emotional feel of a total eclipse is so captivating that it leaves little extra room for logic or scientific thinking. True, helium was discovered during the solar eclipse of 1868 August 18, and Sir Arthur Eddington gathered evidence supporting Einstein's general theory of relativity during the eclipse of 1919 May 29. My overriding goal for any eclipse is just to enjoy the spectacle.

My 91st eclipse will hopefully be an eclipse of the Moon coming early in 2018. I expect to be amazed by that one too.

Figure 2 — My picture of totality during this eclipse, 2017 August 21, showing multiple streamers in the corona close to the Sun. It was taken using Cupid, a Questar, with Nikon camera attached.

Alouette

As a youngster growing up in Montréal, Canada, I always enjoyed the children's song "Alouette." It was a little ditty about a small lark whose loud chirp woke little children early every morning, and each stanza referred to a different part of the bird.

In 1966, I prepared to graduate from Westmount High School. By this time, I was passionate about astronomy and active in almost every branch of observing, including a daily check on the Sun to count the number of sunspots from day to day. In order to make this particular project a bit more convenient, I used a very small pocket-sized telescope that I named Alouette. During recess or lunchtime, I would take the telescope outside the school, set it up on the steps and project its image of the Sun onto a piece of paper. I even still have a record of two of those observing sessions from so long ago:

1296S: Wednesday, March 2, 1966/1230-1235/Partly cloudy/ Westmount High School/Alouette/ Sunspot II: 0 spots.

1297S2/1515-1520/Clear/Westmount High School/Alouette/ Sunspot-II.

After I graduated Westmount in the spring of 1966, I put Alouette away someplace safe, and it has since been lost. However, around the same time I stored the original Alouette,

Figure 3 — One of the Alouettes as it appears after it was painted green in 2016. It provides beautiful, wide-field views of the Milky Way.

I purchased a small finder telescope, which did service for many years before I decided to use it as an independent telescope; I named this second telescope Alouette in honour of my earlier interest.

It turned out that this was the third Alouette. Last summer I was reminded of yet another Alouette I bought in 1978 and which I named Alouette II. I lent that telescope to Angelika Hackett, a friend from Queen's University where I was studying for my MA at the time. Ika held onto the telescope for many years and returned it to me after this summer's eclipse of the Sun. I use the two remaining Alouettes on many clear nights. They are both too small to be my major instruments but they make great travel and quick-look telescopes.

Why am I writing about tiny, almost useless telescopes that I had when I was very young? Because they are far from useless. They provide great views of the Moon and of wide fields of the Milky Way.

Figure 4 — Both Alouettes mounted in a wooden frame. The black one is better for the Moon. Photographs by David Levy.

It doesn't matter what you use to enjoy the sky. Going out for a few minutes on a hazy, moonlit night may not be the best way to enjoy the night sky, but a small telescope like Alouette will give you a very good view of the Moon.

The slightly larger one, Alouette III, has a wide field that gives unsurpassed views of wide areas of the Milky Way.

The Alouettes remind me of what I had to work with when I was young and just starting out. The two Alouettes bring me back to my youthful days in Montréal, when my life stretched endlessly ahead of me, I could sing about a lark, and I had plenty of time to reach for the stars. ✶

David H. Levy is arguably one of the most enthusiastic and famous amateur astronomers of our time. Although he has never taken a class in astronomy, he has written over three dozen books, has written for three astronomy magazines, and has appeared on television programs featured on the Discovery and the Science Channels. Among David's accomplishments are 23 comet discoveries, the most famous being Shoemaker-Levy 9 that collided with Jupiter in 1994, a few hundred shared asteroid discoveries, an Emmy for the documentary Three Minutes to Impact, five honorary doctorates in science, and a Ph.D. that combines astronomy and English Literature. Currently, he is the editor of the web magazine Sky's Up!, *has a monthly column, Skyward, in the local* Vail Voice *paper and in other publications. David continues to hunt for comets and asteroids, and he lectures worldwide. David is also President of the National Sharing the Sky Foundation, which tries to inspire people young and old to enjoy the night sky.*

Imager's Corner

Eclipse Review

by Blair MacDonald, Halifax Centre
(b.macdonald@ns.sympatico.ca)

Having just had an incredible total solar eclipse across much of the Unites States, there have been a series of fantastic images documenting every aspect of the "Great Canadian Eclipse" from the partial phases through Baily's Beads, diamond rings, and of course totality. In this edition I thought we would take a short break from masking techniques to take a look at eclipse shots from imagers across this country. After contacting RASC Centres across the country looking for images, several people stepped up to volunteer in time for inclusion in this edition, so without any further delay let's take a look at the "Great Canadian Eclipse" experience.

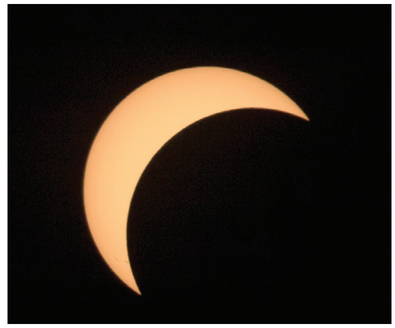
As the Moon's shadow first touched down on the west coast, we'll start there. Alicja Borowski from Edmonton decided to trek to Vancouver Island to view the event. Alicja took a "low-tech" approach using a Canon PowerShot SX40 on a tripod with a Celestron Eclipsmart filter. Alicja's image is a 1/20-second exposure at *f*/5.8 with an ISO setting of 1600 using the camera's digital zoom function.

Moving eastward to Alberta, John Mirtle snapped this shot of an 81 percent eclipse from Calgary.

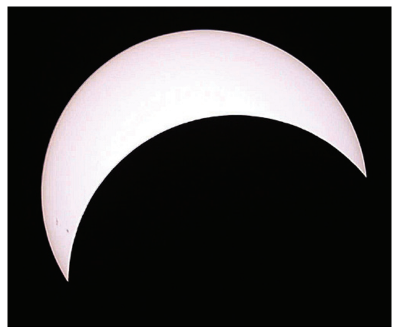
With less of the Sun covered than in B.C., you can begin to see some of the lovely sunspots that covered the face of the Sun on eclipse day.

As the shadow moved further east, Colin Chatfield of the Saskatoon Centre captured it as it passed overhead. Colin's image was taken using a Canon 7D MKII andCanonEF 70-200mm *f*/2.8L IS II with a homemade sun filter made from Celestron solar viewing glasses.

Colin's image shows more of the sunspot group at the lower limb; this group and others become more apparent as we move eastward across the country. My apologies to Colin as I have cropped his photo to fit the landscape presentation of the other images in this column.



Grant Ursaki of the Saskatoon Centre was shooting the eclipse from his backyard in Prince Albert. Grant used a Celestron 9.25″ CPC with a 0.63 focal reducer and a Canon T4i (650D) through a Baader white-light Mylar filter to capture the image below.



In Manitoba, Brian Renaud of the Winnipeg Centre awoke to cloud. He drove to the International Peace Gardens in the southwest end of the province to set up his gear, a Takahashi TSA102 on a Losmandy G8 mount with a JMB full-aperture solar filter. After attaching his Nikon D7000, he turned his computer loose and was rewarded with the following great image.

It's interesting to see that by travelling south, approaching the path of totality, more of the Sun is covered than in Colin's image and the sunspots are not visible.

It's a good thing that Brian was willing to drive for some clear skies. Adrian Graca grabbed a few quick cell phone shots from Winnipeg showing the eclipse and the cloud cover that chased Brian out of town.

Continuing our eastward journey, we arrive in Ontario, where Roman Kulesza captured the eclipse using his modified Canon Xsi DSLR camera and a 10″ Newtonian telescope with ASA ReducerCorrector. He used a 1/500-second exposure at ISO 400 and protected his vision and camera with a Thousand Oaks Optical Silver-Black Polymer solar filter.

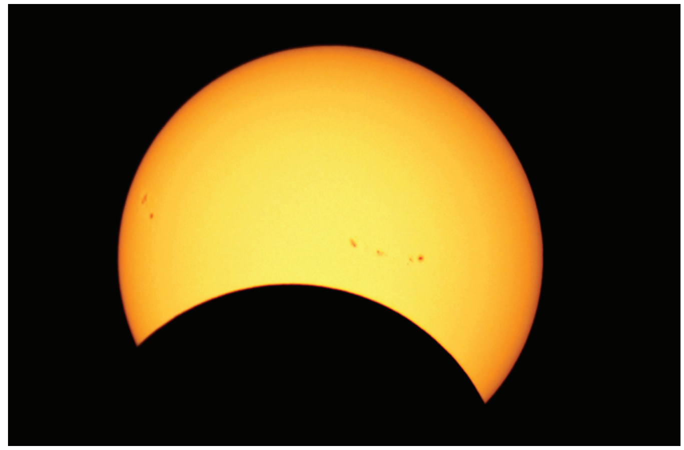
Roman captured the sunspots on the lower limb and has great contrast with the lunar disk.

Unfortunately, none of the imagers in Quebec or New Brunswick got back to me with images in time for this edition, so we have to jump to Nova Scotia. The Halifax Centre held several public events, and Art Cole and I took scopes to the office to give our co-workers a look. Art used his Canon 7D II attached to an 8″ *f*/10 Celestron SCT on a Celestron Advanced VX mount with a Baader AstroSolar filter. His shot is a 1/500 second, ISO 100 exposure.

At the same time Art was taking his shot, I managed to grab a sequence of images using my Esprit 120 refractor with a Mylar white-light filter. The shot is a 1/1000-second exposure at ISO 100. The camera used was my Canon 60Da.

Being further east and north of the track than the other imagers so far, we were treated to a great view of the eclipsed Sun with most of the sunspots across the disk visible. Even with some high, thin cirrus cloud, Art and I were able to grab some nice images.

With no RASC Centre on PEI, we head to Newfoundland & Labrador, where Fred Smith captured this last look at the eclipse from Canadian soil.



With a little work in a layer-capable image processor we can stitch the images together, rotating and resizing them as necessary to get a view of just how the eclipse changed from coast to coast.

There you have it, the "Great Canadian Eclipse" experience as imaged from coast to coast. I want to take a moment to thank all the imagers who sent pictures for inclusion in this issue. And next time we will return to your regularly scheduled Imager's Corner.

Remember, this column will be based on your questions so keep them coming. You can send them to the list at hfxrasc@lists.rasc.ca or you can send them directly to me at b.macdonald@ns.sympatico.ca. Please put "IC" as the first two letters in the topic so my email filters will sort the questions. ✶

Blair MacDonald is an electrical technologist running a research group at an Atlantic Canadian company specializing in digital signal processing and electrical design. He's been an RASC member for 20 years and has been interested in astrophotography and image processing for about 15 years.

The February *Journal* deadline for submissions is 2018 December 1.

See the published schedule at www.rasc.ca/sites/default/files/jrascschedule2017.pdf

Dish on the Cosmos

Seeing ALL the Things

by Erik Rosolowsky, University of Alberta (rosolowsky@ualberta.ca)

The Jansky Very Large Array (VLA) is currently the best radio interferometer on the planet. It observes the hidden universe of radio waves from 0.4 to 50 GHz where the Earth's atmosphere is transparent (for reference, your car radio listens to radio waves that are transmitted at about 0.1 GHz). The VLA was built in the late 1970s and has been delivering world-class science since that time. About a decade ago, the VLA completed a major upgrade process that improved its performance by almost a factor of 10 in nearly everything the VLA did. Suddenly, the VLA leapt to the forefront of the field, thanks to a key Canadian contribution that allowed it to see far deeper than it had ever done before. In particular, our contribution was the correlator that combines the different signals from the radio telescopes. By using new technologies, the scientists and engineers at the National Research Council Canada improved the range of frequencies the VLA could capture simultaneously by a factor of 100. This innovation changed the game for the study of a class of radiation called continuum radiation.

Continuum radiation indicates that a wide range of energies is involved in creating this kind of radio light. In contrast, spectral "line" emission arises from the narrow range of energies allowed by the quantum mechanical transitions of atoms and molecules. Instead of a fixed energy range producing a lot of energy at a given frequency (called a line), continuum emission refers to light being seen at a range of frequencies. White light is the most common form of continuum radiation that we see in the optical.

The upgrades to the VLA allowed it to see a far wider range of "colours" of radio waves at once. To extend the analogy with optical light, compare the light received by observing the Sun in the narrow range of light around H-alpha to the full range of light seen from red to blue across the optical. This wider range of frequencies studied led to a huge jump in the sensitivity of the VLA. Given this generational improvement, astronomers argued that the time had come to conduct an ambitious survey of the entire radio sky. After two years of planning, the VLA Sky Survey (VLASS) is now underway.

The survey covers a frequency range of 2 to 4 GHz, which usually contains two main sources of continuum radiation. The first type of radiation is called synchrotron radiation, caused by electrons accelerated to nearly the speed of light. Since the electrons are charged, they twirl around the magnetic field within and between galaxies. Electromagnetic radiation comes from accelerating charges, and electrons arcing around the magnetic field are accelerating, giving rise to synchrotron radiation. The other type of radiation is called thermal radiation or bremsstrahlung. This German word means braking radiation and has a similar origin to synchrotron light. In this case, warm plasmas of protons and electrons are moving around each other. Because of the attraction between the protons and electrons, the electrons are deflected from their straight-line paths giving off radiation. This thermal continuum radiation is usually associated with recent star formation, because the young high-mass O- and B-type stars give off the ionizing radiation required to maintain a warm plasma in interstellar gas.

It can be difficult to distinguish bremsstrahlung from synchrotron radiation: they are both continuous spectra. Thermal radiation tends to be stronger at higher frequencies (or relatively "bluer," though colour isn't really seen for radio light). Synchrotron radiation tends to be relatively redder. The other distinguishing feature is polarization: the electricity in the electromagnetic radiation from most sources, including bremsstrahlung, is oriented randomly. However, synchrotron light that is generated through interactions with a magnetic field comes out oriented perpendicular to that field. We can measure whether there is a preferential orientation of the electric field and learn whether the emission comes from relativistic electrons (synchrotron) or merely warm gas (bremsstrahlung). We can also use this polarization to study the magnetic field.

VLASS offers new discoveries in four major ways: resolution, area, polarization, and dust penetration. VLASS is the highest-resolution radio survey yet conducted. Normally, radio observations have very poor resolution because of the long wavelength of radio light. The VLA operating at relatively high frequency can overcome this limitation. The reason such high resolution is important is that the sky is being surveyed at other wavelengths: most notably optical wavelengths having a typical resolution of one arcsecond in ground-based observations. Matching resolution between the two data sets allows astronomers to match up stars and galaxies seen in the optical radiation with those same targets seen in radio wavelengths. This is not an easy task, because some radio emitters do not have any counterpart in the optical radiation and vice versa. Based on targeted observations, we have some sense of what we will see: most of the sources in the radio range will be galaxies driving huge jets of relativistic particles out from their nuclei, powered by the ejected by-products of material falling onto the supermassive black hole at the centre of that galaxy. These relativistic electrons shake around in the magnetic field of the jets giving off synchrotron radiation (see Figure 1). While the jets are impressive, even more galaxies light up in thermal radiation driven by recent star formation.

Since we already know the sources of this type of radiation, why then are we surveying the entire radio sky? The entire

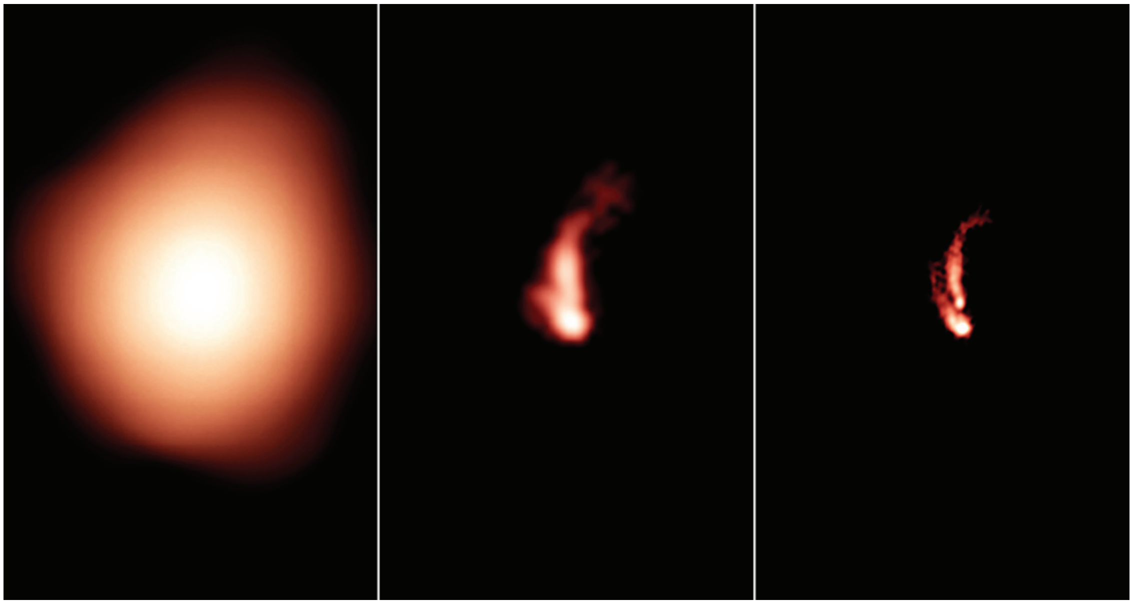


Figure 1 — Jets from a radio galaxy seen in different radio surveys over the years. Data from the VLA Sky Survey are seen on the right, revealing a complex jet structure, where previous studies only found an indistinct blob. The VLASS data concretely show that the emission comes from synchrotron-emitting jets billowing out of the centre of the galaxy. Credit: Bill Saxton, NRAO/AUI/NSF.

survey will last seven years, which is a huge effort, even though only a minority share of the overall time is being used. The major driver here is covering all the sky, finding every one of the hundreds of millions of objects available. Our basic problem in understanding the Universe is that we only see it for a single moment, effectively frozen in time, compared to the billion-year evolutionary timescales for many of the objects we study. We simply will not see our galaxy rotate, or the jets of particles blow out from galaxies, or even watch a single star form. Instead, we undertake surveys and we invoke the idea that we are not observing any particularly special time in the evolution of all the objects. We then use the rarity of different objects to understand what portion of a galaxy's life is spent in that condition. My favourite analogy is to describe what would happen if an alien came to Earth and tried to, from just a nanosecond of observations, understand how human beings live and evolve. If the alien could find 1000 humans, randomly selected from all different types, they could learn a lot about how human beings grow and develop. For example, a small fraction of them would be crawling around, but many of them would be larger and be upright on both legs. Thus, the alien scientist would infer that the humans don't spend much time in the crawling state. Deducing that the crawling state precedes the standing/walking state would require more work. Using similar kinds of reasoning we leverage the huge number galaxies in surveys to infer how they evolve.

The polarization studies of VLASS allow a new study of magnetism through the properties of synchrotron radiation. Cosmic magnetism is one of the major unknowns in astrophysics. Magnetic fields are difficult to measure but every time we can reveal them, they are found to be a significant influence. However, sensitive polarized synchrotron measurements, especially paired with the population studies, will reveal how the magnetic field develops in galaxies.

Finally, one of the reasons why radio waves are so useful at seeing the hidden universe is that they propagate freely through most of the sources of obscuration. Optical light, such as what we observe from stars, is readily obscured by the dust grains that sit inside galaxies. VLASS will be able to see through these dust screens, across our galaxy and even into the dark hearts of the most richly star-forming galaxies. There we hope to reveal catastrophic supernova explosions that are invisible underneath a blanket of dust and gas, but revealed in the radio light. We may even see supernovae in our own galaxy, happening far across the disk. We expect about two supernovae per century in our galaxy, yet the last supernova we have good optical evidence for is from the Kepler supernova explosion in the 1600s. We are likely missing these nearby events.

The final reason to study the entire sky broadly and uniformly is simple serendipity. By gathering this data in making them freely available to the entire community, we share everything that is happening in the radio sky. There may be some mysterious new physics that is illuminated by trying to understand all these observations. From Kepler wondering about 8 minutes of arc, to the discovery of dark energy, many of our key insights come from failing to make excellent data fit our preconceived notions. More scientific discoveries begin with "hmmmm, that's funny..." as opposed to the classic "Eureka."

With the VLA beginning its new seven-year mission, you can follow along the progress at the survey website https://science.nrao.edu/science/surveys/vlass. ✶

Erik Rosolowsky is a professor of physics at the University of Alberta where he researches how star formation influences nearby galaxies. He completes this work using radio and millimetre-wave telescopes, computer simulations, and dangerous amounts of coffee.

Binary Universe

Polar Aligning Quickly

by Blake Nancarrow, Toronto Centre
(blaken@computer-ease.com)

In the late '80s, I decided I wanted a telescope. My research led me to a medium-sized Schmidt-Cassegrain for light grasp and portability and I sought a tracking mount for long-exposure photography. With a bit of luck, I obtained an SP-C8, Celestron's combination package of an 8″ Schmidt-Cassegrain atop a Vixen Super Polaris equatorial mount.

My outings for the next year or so were filled with lots of learning. Aligning the finder, powering the mount in the field, dealing with dew, and polar aligning the EQ mount. I learned the broad strokes of aligning to the pole. I had to ensure one of the axes of the mount (then I wasn't even sure which was which, but memorized later, Right Ascension) was parallel or co-linear to the Earth's spin axis. I read it had to be done fairly accurately for better telescope performance, particularly if one was planning through-the-telescope imaging.

But, as I reviewed my Celestron instruction manual, I discovered the Polaris Guiding Plate was missing. After another visit to Efston Science in Toronto, I had the Meade Polaris Reference Circle, which compared well with the image in my instructions.

It feels like I read the section on *Using the Polar Guiding Plate* dozens of times. Back then I found it all very confusing. I tried hard to follow the instructions by Celestron but they made no sense. The North Celestial Pole (NCP) position shown was not correct. Now I know there are errors in the steps and missing critical pieces of information. The Polar Guiding Plate is sensitive to longitude and time zones. There is no mention in the notes about field rotation or inversion depending on the type of telescope or use of a mirror- or star-diagonal. No wonder I struggled.

I also tried learning the polar-axis scope itself. Oddly, the Celestron manual did not refer to this piece of equipment. Years later, when I understood the mount was made by Vixen, I found the relevant documentation. It addressed one's offset (east or west) from the standard meridian, explained how to rotate the entire RA axis (ideally before installing the OTA) for the observing session using the built-in graduation scales for the date (on the polar scope itself) and time (on the mount housing). Then, using the polar-axis reticle, compensating for precession, of course, one would place Polaris in the designated spot. Unfortunately, my previously owned mount was missing the hour graduation scale metal plate so it didn't make sense to me, once again, at the time.

In those early days, I was getting stymied at every turn. I know that others entering the hobby find polar alignment something of a Black Art. Poor and misleading documentation continue to hamper efforts of the novice. Now, it's a lot easier.

When I started using astronomy software, I simply asked the application to show me where the NCP was in relation to Polaris. In early 2000s, I was using RedShift on my PC and Mac computers. I briefly tried the Windows shareware tool *Polar Finder* by Dr. Jason Dale, which allowed custom reticles and rotated views. *Stellarium* (JRASC Feb. 2015) works well and allows the view to be rotated and flipped as needed. I continue to use software to help me get to the NCP. If I have my netbook at hand, I can use SkyTools (JRASC Apr. 2015).

During a recent summer weekend, without a computer nearby, I wanted to get close to the NCP as I used a friend's equatorial mount. I fired up the handy dandy app on my Android smartphone, also called *Polar Finder*, by the developer TechHead. Immediately, it shows Polaris and the NCP (Figure 1).

The current version of *Polar Finder* available from the Google Play Store is 1.34.

https://play.google.com/store/apps/details?id=com.techhead.polarfinder

I bought this inexpensive app a couple of years ago and I like how it quickly takes care of everything. Of course, it uses your longitude (from GPS or manually entered) and system date and time automatically. Then it accurately calculates the position of the NCP in relation to alpha Ursa Minoris.

The main screen in *Polar Finder* shows the preferred reticle, hour angle, position angle, local sidereal time, current longitude and latitude, and other details.

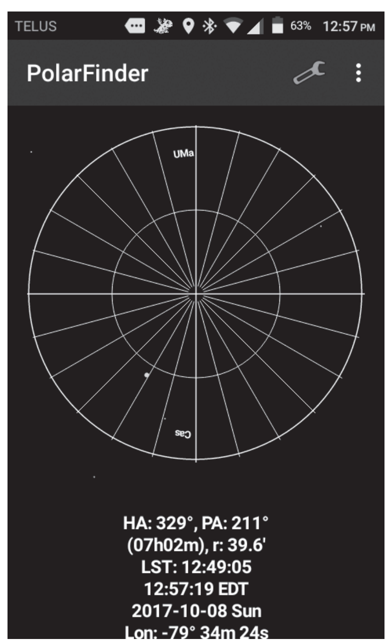


Figure 1 — The main screen in Polar Finder *with general purpose reticle.*

And, the app can be used in the Northern or Southern Hemisphere.

It supports an astronomer-friendly red-light mode (Figure 2) with Polaris (and other field stars) rendered in green. If you're using red film over your screen, watch out. The verdant stars will disappear.

The best feature of *Polar Finder*, I believe, is that it can show on the display a reticle pattern that matches that of

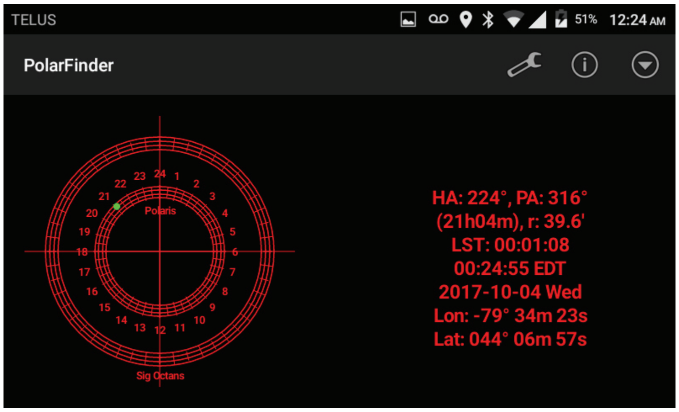


Figure 2 — Running in night mode using the Astro-Physics *dual-use reticle.*

your mount's or tracker's polar-axis scope. It currently supports Astro-Physics, iOptron, Losmandy, Sky-Watcher, Takahashi, and Vixen reticles. Conspicuously absent are Celestron, Meade, and Orion, but I'm not entirely surprised—it is likely a copyright issue.

The app also includes a couple of tracking-mount reticles. Supported systems are AstroTrac and Star Adventurer.

For the loaner CGEM, I used the Sky-Watcher pattern (Figure 3), which shows Cassiopeia and the Big Dipper; for my old Vixen SP, I use the Star Adventurer ring.

Polar Finder has a general-purpose reticle that works well if nothing suits, and this "built-in" view can be fully configured. In the Preferences screen (Figure 4) the display can be set to show the stars as we would see them with our "naked eye" or through binoculars, that is, not rotated and not flipped. The "telescopic" mode rotates the view 180 degrees like a refractor telescope (straight-through) or reflector would present the sky. Finally, the "diagonal mirror" horizontally flips the display like when we use a mirror or star-diagonal in a refractor or SCT. You may also set the gridlines, and whether they show every 15 or 22.5 degrees.

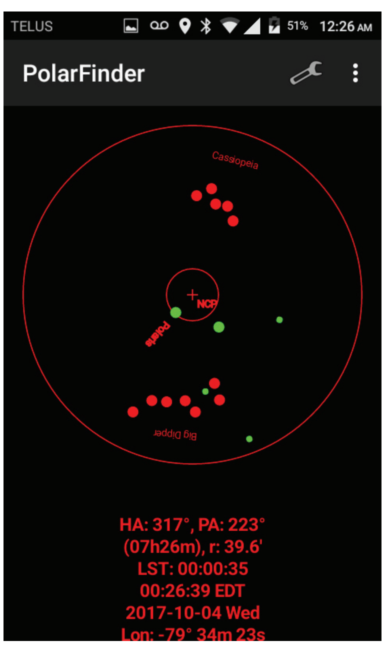


Figure 3 — Sky-Watcher reticle (similar to Celestron) with larger stars.

If you're like me and you have or use different telescopes and trackers, you will likely find *Polar Finder* indispensable. It's in your pocket, is quick and easy to use without having to worry about your meridian offset, it's inexpensive, and it lets you get your gear aimed at the celestial sweet spot.

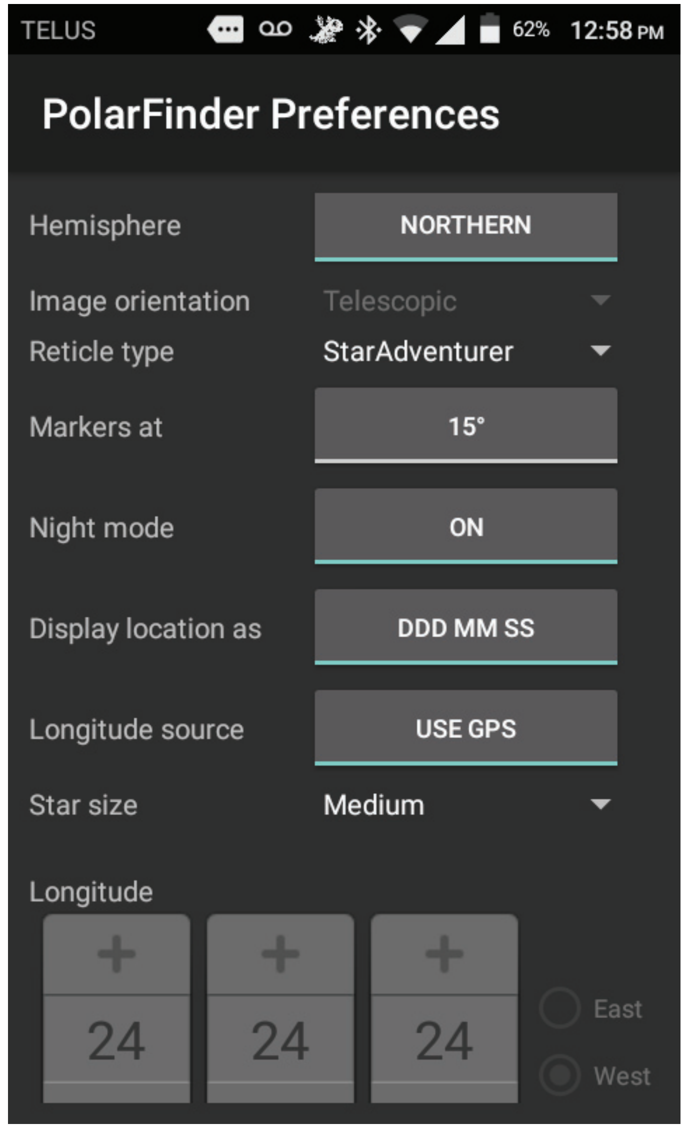


Figure 4 — Polar Finder *Preferences screen.*

For iPhone users, there are similar apps. I've not used it, but *Polar Align* by George Varros comes highly recommended. www.gvarros.com/polaralign_iphone.htm

Update Bits

Backyard EOS has been updated. The latest version is 3.1.16. And the Nikon edition was updated as well, to 2.0.9. ✶

Blake's interest in astronomy waxed and waned for a number of years, but joining the RASC in 2007 changed all that. He volunteers in education and public outreach, supervises at the Carr Astronomical Observatory, and is a councillor for the Toronto Centre. In daylight, Blake works in the IT industry.

Observing Tips:

My Astronomical Journey: How I Became an Observer

by Judy Black, Halifax Centre
(jblackns@icloud.com)

[Note from RASC Observing Committee Chair, Dave Chapman: Judy's article is the second in a regular column I inaugurated last issue (for which Halley Davies supplied photos). My plan is to invite active observers to contribute in upcoming issues. Please send ideas to me at observing@rasc.ca]

Figure 1 — The author at one of her backyard telescopes. [Photo: Jerry Black]

My astronomical journey began five years ago. I attended a star party when I had absolutely no interest in astronomy: my husband did. An afternoon "Walk the Solar System" with children and an evening laser-pointer sky tour, combined with sneak peeks of our Universe through the eye of a telescope, changed my life—all within a 12-hour period. The wonder of the night sky excited me (much to my husband's surprise), and made me want to learn more about what I could observe from my backyard or at a backcountry campsite.

My initial knowledge and understanding of astronomy was zero. I was starting from scratch. My perception of astronomy was that of math, astrophysics, and physics, none of which were ever my strong suits. So, where does one start? Joining the RASC was the obvious and logical thing to do, a starting point for learning from the experts in the field. Being lost at first was to be expected. I knew enough to read and to ask questions when I didn't understand, and fellow observers were always willing to talk about what they were seeing, be it through binoculars, telescopes, or astrophotography. Becoming an expert in the field was never my intention. I just wanted to know what I was looking at and how it related spatially to what I was discovering in the night sky. My curiosity led me to doggedly seek answers or a source to get the answer.

And then there's the terminology! After all, astronomy is literally a world away from my previous career in emergency cardiovascular-care education. As with any field of study, there are jargon and terms one needs to know. There's a difference between a comet and an asteroid? Emission and reflection nebulae? Messier objects? An ecliptic? Seeing and visibility are different things? Right ascension and declination? Binary versus optical double stars? So much to learn, and at my age!

Consequently, I sought education about observing for my edification and enjoyment. I attended the RASC New Observers to Visual Astronomy (NOVA) course. Light bulbs were turned on (or should I say stars began to twinkle). I began the Explore the Universe (EtU) observing program and set the personal goal of finding all 110 items—91 found so far—even though only half are required. The Explore the Moon (EtM) program, binocular version, was completed this past spring, while I was working on the EtU program, and the EtM telescope version is now in progress. I use these programs as learning tools. As I find objects, be it a deep-sky object or a lunar crater, I take the opportunity to learn a bit more about it, take a really good look at it, and maybe even ask someone about it. It's also the opportunity to become more familiar with my search-and-find skills using my binoculars or one of our telescopes. For me personally, the success is in the finding of the objects and in recognizing how things relate to one another in our skies.

Then there was the task of finding reliable print sources, i.e. what to use when a wise RASC mentor was not with me. The RASC *Observer's Handbook* is always in my binocular bag for quick reference, and the B*eginner's Observing Guide* (out of print) is on my bookshelf. What type of star atlas should I purchase and what size? A large version wouldn't fit into my pocket unless that pocket was my backpack. Solution? Go ask fellow RASC members, of course! I was told that "none of us are getting any younger, so consider a larger print format." Given my age, I wasn't offended by the suggestion. My larger "pocket" version is now used constantly:

- planning the observing session (where to find this object, how to star-hop to it),
- while observing (confirm the correct location and identify the "what have I found?" object), and
- post-session (sketch the item's location and, as is the case for me with constellations, determine which stars were seen and which were not).

I have found these resources to be invaluable. And then there are the mobile apps to which my husband and RASC members have introduced me…

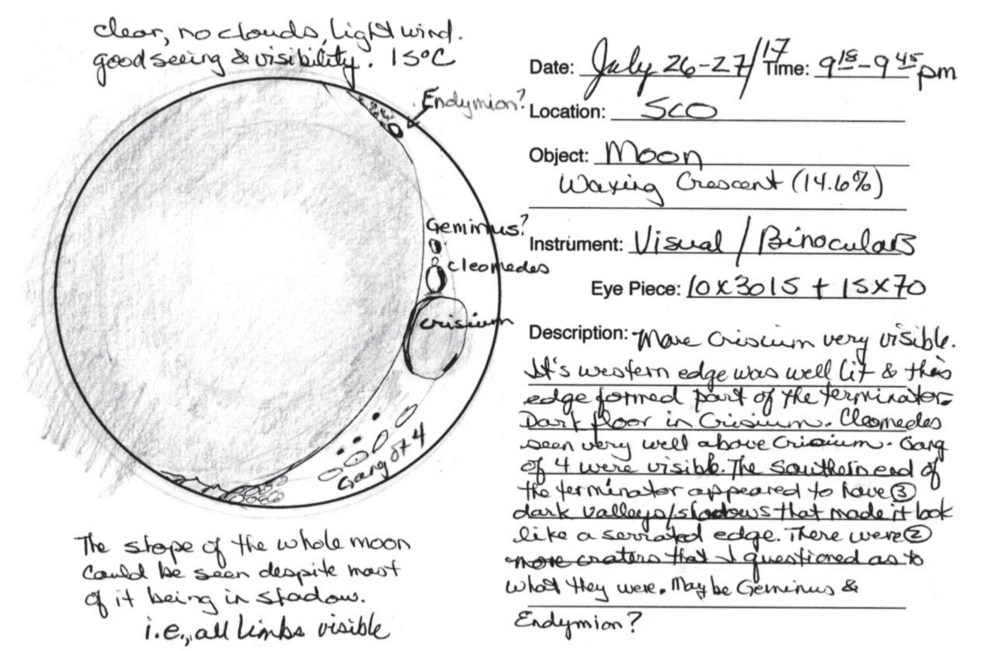


Figure 2 — A sample of the author's observing logbook. [Image: Judy Black]

causing me the greatest grief, but let me tell you of my greatest success despite this challenge. The triple star Omicron[1] Cygni (an EtU object) had escaped me for several months. I found and identified Omicron[2] and two of the three stars of Omicron[1] in binoculars, but the third star associated with Omicron[1] was a frustration. I tried observing from home to no avail, then at a backcountry campsite where I couldn't see it through binoculars but did see it through a small telescope. I had a very patient mentor who provided explanations and sketches to explain the triple star. Then finally, at the Sky Circle at Kejimkujik National Park & National Historic Site, I saw it! Perseverance and long stares at Omicron meant eventual success. "Observing" is not always simple and I have come to realize the search-and-find process is part of what makes it all enjoyable, especially when it's a challenging target. I think I can safely say my mentor and my husband were as equally excited and pleased about my success.

One question that had to be answered was "what tool would I prefer to view the wonders of the night sky—binoculars or telescope?" Telescopes initially held little interest for me, primarily due to lack of access but also due to lack of knowledge on how to use them. A RASC member introduced me to the simplicity of using binoculars—and two pair fit into my backpack! Have binos, will travel.

Then my husband and I were given Meade telescopes: an 8″ Meade Schmidt-Cassegrain with a GoTo mount, and what we affectionately refer to as the 10″ Meade "Push To." Practice makes perfect, they say. I am still practicing with both, and learning how to use them more effectively is half the fun and challenge of finding things. My comfort and enjoyment still primarily lies with binoculars, but I have learned that telescopes do serve a purpose in exploring the Universe and in helping me see what I want to see as clearly as possible, i.e. if I can't see or identify it initially in binoculars then perhaps a telescope can help, or maybe it can only be seen in a telescope.

Finding one or more mentors was never a hurdle and it was certainly key to having my first "aha," "cool!" and "WOW!" moments. Our Centre has been blessed with a cadre of amateur and professional astronomers who are always willing to show newbies like me something new and wondrous, to explain what we're seeing in the telescope or binoculars, or to help us find an object that eluded us in other observing sessions.

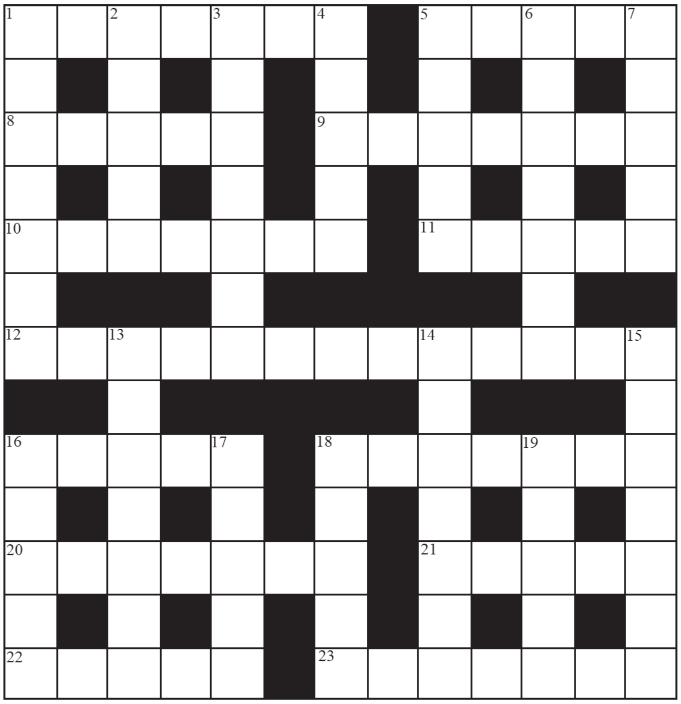
And that leads me to my greatest challenge: my vision. I know that cataracts are beginning to develop in both eyes. This is

Another joy of observing is the camaraderie among RASC observers. The gathered friends acknowledge what you are seeing and there's always someone who can provide some insight to or humour about your find. The inclusiveness of experienced and inexperienced observers, male and female, the young and not so young, adds to the exhilaration of watching the heavens. Thank goodness, too, for hot chocolate and an observatory warm room on those cold winter nights! I follow the recommendation of another observer: I log all my observations and occasionally sketch them (I am no artist, trust me). By doing so, I track what I've seen, what portions of a constellation still need to be explored, how and where I found the object, and suggestions for next time. The recommendations for "next time" made in a previous session also help in the planning of a new observing session.

Where I go from here is probably less well known than the outer reaches of our universe. I continue to learn through the various facets of knowledge enhancement offered by the RASC and a local university. I still marvel at our Universe every time I'm under the stars or looking through a filtered eyepiece at the Sun. My expanded cadre of friends who share the enjoyment of observing have added to my enjoyment of life. I am delighted when sharing my knowledge with others and they have their first "aha" or "WOW!" moments. These all bring a twinkle to my eyes. ✶

Astrocryptic

by Curt Nason



ACROSS

1. Red dwarf within approximately a parsec (7)
5. Scatter rug is from a crane (5)
8. Balance 0.4 L with two cups (5)
9. I am sick about not turning a comet feature (3,4)
10. Takes in orbiting data from a double star catalogue (7)
11. Navigational star observed from the keel (5)
12. Crooked smile is in one's spectral features (8,5)
16. Italian X-ray mission's namesake was almost a Marx Brother (6)
18. Surreptitiously gaze o'er when a star begins fusion (4,3)
20. Supergiant insect will be back in France (7)
21. A ship wrecked in Orion (5)
22. Interstellar matter perplexed sages (5)
23. Canadian, with no end and at sea, flagged a star (7)

DOWN

1. Intrinsic variable's action to emit hydrogen from sulphate excitation (7)
2. It follows a sphere around another one (5)
3. One appliance company invested in Mars, inspired by astrophotographers (7)
4. A sign one is eaten by a war god (5)
5. X-ray satellite aging ungracefully (5)
6. Muse over north of a planet (7)
7. Soar around Luxembourg's capital in the ionizing wind (5)
13. About Saturn, it is the IAU's pet disorder (7)
14. Orbiting Neptune, Allan Rahill sails around recklessly (7)
15. Solo step taken before he observed five galaxies (7)
16. Boast about first generation crystal X-ray spectrometer (5)
17. Toro's rotation akin to galactic rotation constants (5)
18. Where the lion's tail begins to cross Bonzo's mane (5)
19. After morning, here in Mont-Mégantic they use the spectrometer prism (5)

Answers to October's puzzle

ACROSS

1 GALLE (anag); **4** KAPTEYN (k(apt)ey+n); **8** LAPLACE (L+anag); **9** ONDES (anag); **10** LYDIA (anag); **12** ELTANIN (E(anag)n); **13** OLBERS (hom: paradox); **15** CRATER (2 def); **18** PROLATE (anag); **19** AGNES (an(n)ag); **20** FAINT (2 def); **21** TEKTITE (te(KT+it)e); **23** SONORAN (2 def); **24** ABELL (anag)

DOWN

1 GALILEO (gal+I(le)o); **2** LIP (hid); **3** ELARA (el+Ara); **4** KEELER (keel+er); **5** PROCTOR (2 def); **6** EDDINGTON (anag+n); **7** NISAN (anag); **11** DOBSONIAN (Dobson+Ian); **14** REACTOR (anag); **16** RUSSELL (ru(S)se+LL); **17** NEWTON (NE+anag); **18** PUFFS (2 def); **19** ANKAA (A(nk)AA); **22** ICE (hid)

It's Not All Sirius

by Ted Dunphy

A "26-0754-BO-PD" form.
A notice of proposal to conduct outdoor laser operations.

John Percy's Universe

Up in Lights: Canadians' Names in the Cosmos

by John R. Percy FRASC
(john.percy@utoronto.ca)

As this sesquicentennial year draws to a close, let us celebrate the Canadians whose names are immortalized in the cosmos!

These names remind us that astronomy is a human endeavour and a cultural endeavour. Each civilization had its own names for visible objects—Sun, Moon, planets, bright stars, and constellations—and it's fitting that these have been recognized and archived. For early civilizations, they were a "storybook in the sky." As modern astronomy developed, there was a wide variety of more "logical" naming systems, often based on catalogues such as the star catalogues of Johann Bayer, John Flamsteed, and Henry Draper, and the "fuzzies" catalogue of Charles Messier.

The International Astronomical Union (iau.org) now has the official responsibility for naming celestial objects[1]. The IAU recently released a new list of "official" star names, mostly Arabic[2]. Almost all celestial objects also have numerical designations, which are appreciated by computers, but names derived from people and their cultures definitely add to the interest of astronomy.

The Moon

Most lunar features are craters. They are named after (dead) scientists and explorers; many smaller ones are named after "satellites" of these. As noted by Millman (1970), University of Toronto professor Clarence Chant (1865–1956) and government astronomer John Plaskett (1865–1941), the "co-fathers of Canadian astronomy" are there, as are Carlyle Beals (1899–1979), John S. Foster (1890–1964), Frank Hogg (1904–1951), Andrew McKellar (1910–1960), and Robert Petrie (1906–1966), but not Hogg's wife Helen Sawyer Hogg (1905–1993), Canada's best-known and most beloved astronomer. There is a crater named after insulin discoverer and Nobel Laureate Fred Banting (1891–1941), but not after his colleagues Charles Best or John Macleod. Astronomers Simon Newcomb (1835–1909) and James Craig Watson (1838–1880), geologist Reginald Daly (1871–1957), and medical researcher Oswald Avery (1877–1955) were Canadian-born, but found their fame in the USA; they are also on the Moon.

*Figure 1 — The lunar impact crater **Chant**, named after Professor Clarence A. Chant, guiding light of the RASC for over 50 years. It is located on the far side of the moon (so unfortunately not visible from Canada!), and has a diameter of 33 km.*

The Planets

Planetary exploration has revealed thousands of new features, and has enabled astronomers to be more inclusive and diverse in attaching names to the cosmos. The number and diversity of these are mind boggling! Features on Venus are given women's names, with the exception of (James Clerk) Maxwell Montes. Most are names of goddesses or generic women's first names in various cultures, including some Canadian Aboriginal cultures. Several dozen are named after eminent women, but the only Canadians are artist Emily Carr (1871–1945), novelist Frances Brooke (1724–1789), and Queen's University professor Allie Vibert Douglas (1894–1988), considered to be Canada's first woman astrophysicist. I had not heard of Brooke; she was born and died in England, but spent some years in Canada. I learn something new every day!

Some features on Mercury are named after artists. You can find photographer Yousef Karsh (1908–2002) there, and Arthur Lismer (1885–1969), but not Tom Thomson or any other member of the Group of Seven. On Mars, you will find a crater appropriately named after Peter Millman (1906–1990), a world expert on meteors and related topics.

By the way: you can search the Gazetteer of (Lunar and) Planetary Nomenclature[3], maintained by the US Geological Survey, by the ethnicity or national origin of the names—e.g. Canadian.

Comets and Asteroids

Comets are named after the person, or team, or increasingly the ground-based or spacecraft survey instrument (such as Pan-STARRS) that discovered them. One exception is Comet Halley; Edmond Halley (1656–1742) didn't discover it, but he determined that it reappeared periodically, and he correctly predicted its reappearance in 1758. On the RASC website, you can find a list of comets discovered by Canadian amateur or professional astronomers[4]. The current leaders are David Levy, with 22 discoveries or co-discoveries, and the late Rolf Meier (1953–2016), with four.

Asteroids are named *by* the discoverer. They are being discovered at a large and accelerating rate, so there is a backlog of objects waiting to be named. Again, the RASC website contains a long and comprehensive list of Canadians who have been honoured in this way[5].

Exoplanets and their Host Stars

In 2015, the IAU organized a competition to name 31 exoplanets and their host stars[6]. More than half a million votes were cast, from 182 countries and territories. These names were vetted by the IAU, with only minor modifications necessary. The RASC Thunder Bay Centre named 14 and its exoplanet *Veritate* and *Spe*.

Stars

There are very few stars bearing a person's name; *Wikipedia* lists 21. One is Plaskett's Star, named after John Plaskett, who discovered that it was a 14.4-day binary system. Until recently, it was considered to be the most massive binary system known, but it has recently been surpassed by Eta Carinae. Watch for *Northern Star*, Peter Broughton's forthcoming biography of Plaskett.

Not to be outdone, Plaskett's DAO colleague Joseph A. Pearce (1893–1988) also has a massive binary named after him, also known as the variable star AO Cas. By the way: the "Barr effect" which occurs in binary stars, is named after the enigmatic amateur astronomer, J. Miller Barr (1856–1911), from St. Catharines (Percy 2015).

A post to the American Association of Variable Star Observers (AAVSO) forum produced an assortment of non-Canadian names for variable stars. Some were casual, such as "Hertzsprung's Enigmatic Object," or of local interest only, but two made it to *wikipedia*: Cor Caroli (named after Charles II, or possibly Charles I), and Romano's star—a luminous blue variable in M33. But it didn't say who Romano was; he was the Italian astronomer and archaeoastronomer Giuliano Romano (1923–2013).

There's a standard process for naming novae and supernovae, no matter who discovers them, but Tycho's Supernova (1572) and Kepler's Supernova (1604) generally go by those names. It is therefore not unreasonable to refer to SN 1987A as Supernova Shelton, after Ian Shelton, the young University of Toronto astronomer who discovered it—the brightest supernova since Kepler's, 400 years ago.

Many star clusters or asterisms are named after the astronomer who catalogued them, such as Charles Messier. Canada is represented by the asterism Kemble's Cascade, named after amateur astronomer Father Lucian Kemble (1922–1999), who also has two lesser-known asterisms named after him.

Warning: There are companies claiming to name a star after you or your loved one—for a price. These names are not official, and there is nothing to prevent any other company from naming "your" star after someone else—again, for a price. Only the IAU assigns official names, and does so on a non-commercial basis.

Nebulae

These tend to be named for their appearance (e.g. the Ring Nebula), but there is Edwin Hubble's (1889–1953) Variable Nebula—variable because it is illuminated by R Mon, a nearby variable star. Herbig-Haro Objects, named after George Herbig (1920–2013) and Guillermo Haro (1913–1988), are patches of nebulosity, energized by jets from nearby, newly formed stars. There are dark nebulae with the names of U.S. astronomers Edward Barnard (1857–1923) and Robert Burnham (1931–1993) attached. Barnard has an unusually long list of different kinds of celestial objects with his name on them. I'm not aware of any "nebulous" Canadians.

Galaxies

The RASC *Observers Handbook* contains three pages of "Galaxies with Proper Names," compiled by Barry Madore. Many are named after the astronomer who discovered and/or catalogued and/or studied them, but I don't see any Canadian names. Sidney van den Bergh (1929–), a former colleague of mine, discovered Andromeda II, so it could well be named after him. He already has his name on a comet and an asteroid. But it's fun to look through the lists of galaxies and other deep-sky objects in the *Handbook*, and see the variety and creativeness of their names.

Citizen Astronomy

Amateur astronomers have long discovered and studied comets, asteroids, and variable stars. Now, "citizen astronomy" has been greatly expanded, through projects such as *Galaxy Zoo*[7]. Over 150,000 people have contributed to this project. One was Dutch schoolteacher Hanny van Arkel. She discovered a new and remarkable object, now known as "Hanny's Voorwerp" (or blob), of a type not previously known. The best guess is that it is a small galaxy, close to an active galactic nucleus, which flared in the past, and energized the gas in this galaxy. As a citizen astronomer, you too might discover something equally interesting and bizarre, and get your name on it!

What Next?

This article is only a cursory census of Canadians' names in the cosmos. If you know of others, or have any corrections to make, please let me know.

To increase the number, you could go out and discover a comet, or some exotic object like Hanny's Voorwerp. If you know of any unnamed asteroids, you could suggest to the discoverer the names of some deserving Canadians, of which there are many. Nobel Laureates such as Gerhard Herzberg, Arthur McDonald, and Alice Munro come to mind. There are established procedures, given on the IAU website, for proposing names for newly discovered objects or surface features. Find out these procedures, and submit the names of deserving Canadians. We are a young country, and thousands of celestial objects and surface features have been named after eminent people from much older societies. After 150 years, it's time for us to catch up! ✶

John Percy FRASC is Professor Emeritus, Astronomy & Astrophysics and Science Education, University of Toronto. The asteroid johnpercy is named in his honour.

Notes

1. www.iau.org/public/themes/naming
2. www.iau.org/news/pressreleases/detail/iau1603
3. planetarynames.wr.usgs.gov
4. www.rasc.ca/canadian-comets
5. www.rasc.ca/asteroids-canadian-connection
6. nameexoworlds.iau.org
7. www.galaxyzoo.org

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Great Images

by Chris Turner

Chris Turner of Halifax imaged the Horsehead Nebula on 2017 October 13 from his roll-off roof observatory in Upper Tantallon, Nova Scotia. This image is comprised of 45 minutes of hydrogen-alpha data. He used a Maksutov Newtonian with 190-mm aperture on an EQ6Pro piered mount and a QSI 683 WSG camera cooled to −25 °C, equipped with an $H\alpha$ filter. Pixinsight was used for post processing.

Journal

Great Images

NGC 891 was taken by Blair MacDonald at his St. Croix Observatory in Nova Scotia.

He used a Canon 60Da at ISO 800 on an Optics Sky-Watcher Esprit 120 ƒ/7 APO refractor with a focal length of 840 mm.