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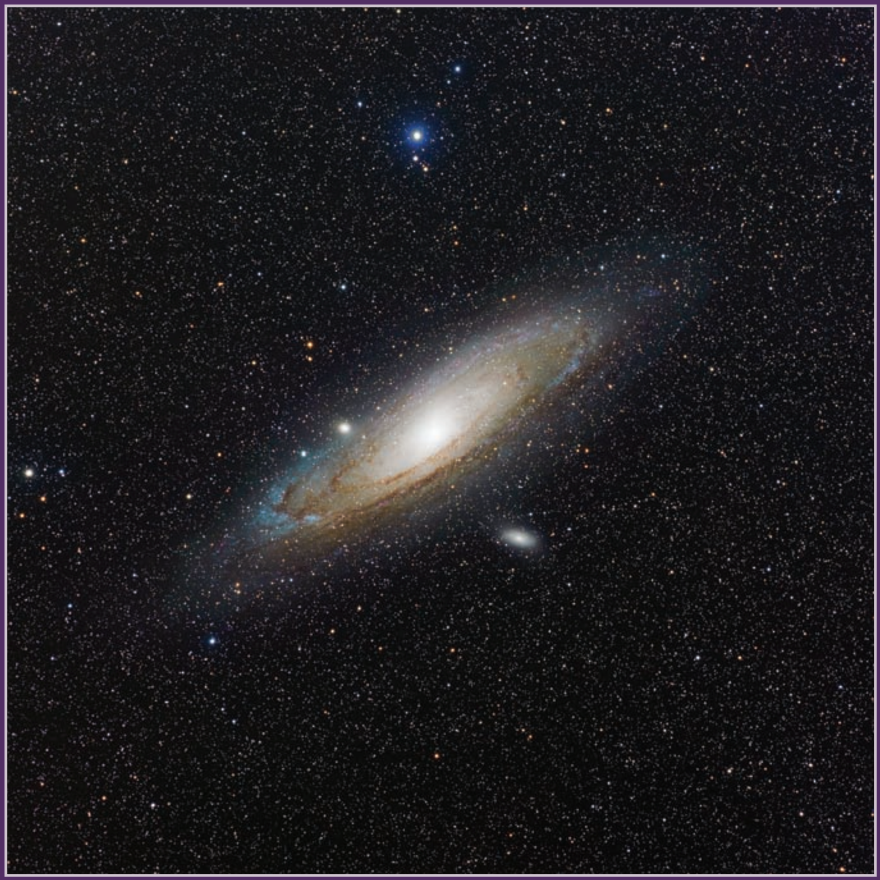

Le Journal de la Société royale d'astronomie du Canada

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PROMOTING ASTRONOMY IN CANADA

October / octobre 2010

Journal

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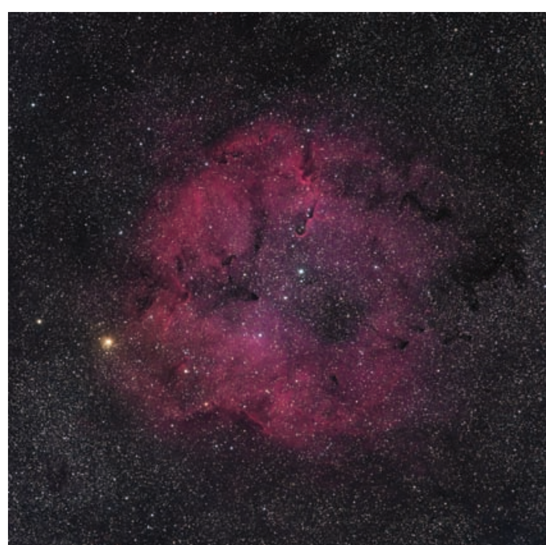

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Royal Astronomical Society of Canada

Société Royale d'Astronomie du Canada

DEPARTMENTS

On the Front Cover:
Stuart Heggie provides us with another superb image for the front cover in the form of this photo of Messier 31, the Andromeda Galaxy. M31 is the closest large galactic companion to the Milky Way galaxy and is one of the farthest objects visible to the naked eye in dark skies. Stuart used an Apogee U16M camera with a Takahashi FSQ f/5 fluorite refractor. Exposure is 10x5 minutes in luminance, 4x5 minutes in R and B, and 3x5 minutes in G.

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President's Corner

by Mary Lou Whitehorne, President, RASC

Twenty-five years ago, when I joined the RASC (and in the years since then), one of the things I most enjoyed reading in every issue of the *Journal* was the *President's Corner*. In the words of that column could be found the thoughts, wisdom, and vision of the lofty individual who knew the Society best, and who shaped and directed its actions and its very being. Naïve, wasn't I? Now here I am, writing that same column for the *Journal*. Who would ever have thought that such a thing was possible? Certainly not me! As for the wisdom and vision, I'm still working on it.

I am the 60th president and the 5th woman to hold the office. Over the Society's 142-year history, there have been only 4 other female presidents. The first was Allie Vibert Douglas (1943-44), and later Helen Sawyer Hogg (1957-59), Ruth Northcott (1962-64), and Mary Grey (1986-88). My female predecessors were all intelligent, strong, capable, and gracious women who earned great respect in Canada. Two of them, Helen Hogg and Ruth Northcott, have achieved almost mythological status in the RASC for the magnitude of their contributions. I am in very intimidating company!

Thus far in the Society's history, eight percent of RASC presidents have been women. It is an interesting parallel that, at present, our general membership is also eight percent female. So the women are holding their own in the RASC leadership department and that's a good thing.

Historically, like the other physical sciences, astronomy has been a male-dominated area of study and hobby. Does this still apply in today's world? Well, yes, it does. But I recently attended the Canadian Astronomical Society's (CASCA) annual conference held in Halifax, Nova Scotia. I was impressed and pleased to see the large number of women graduate students of astronomy who were actively participating in the conference. Their energy, commitment, and passion for the science were sparklingly obvious. I hope they will all become leaders and role models and help attract more women to the fascinating world of the physical sciences. I trust we don't have to wait another 22 years for the next female president!

Although our membership is heavily weighted in favour of a particular demographic, we will soon be taking steps to address our monochromatic membership spectrum. At present, there are a number of "invisible" changes taking place at the National Office. I am delighted to report that under the leadership of Deborah

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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Thompson, our new Executive Director, we are now establishing the needed suite of procedures and practices that will enable us to work more efficiently and without the need to endlessly reinvent the wheel. Next on the to-do list are improving communications, strategic planning, and a membership drive to increase our numbers and broaden our demographic spectrum.

Astronomy has a very wide appeal. The science is interesting, to be sure! But the cultural aspects of the stars and sky are equally engaging. It seems to me that our task is to present the full spectrum of astronomy to our audiences if we are to grow as a vibrant and attractive Society that provides breadth, depth, and value to every person with an interest in the starry night sky. It's a tall order, but we have proven our mettle with the great success of IYA2009. We have what it takes to do it, and I am confident that we will succeed.

Quo Ducit Urania!

News Notes/*En manchettes*

Compiled by Andrew I. Oakes (copernicus1543@gmail.com)

Relatively Recent Comet Strike Suspected on Neptune

The Herschel Space Observatory, a European space telescope, has provided new measurements of Neptune's atmosphere that suggest a comet may have crashed into the gas giant about 200 years ago. Analysis of the composition of Neptune's atmosphere indicates an unusual distribution of carbon monoxide in the gas giant's atmosphere, a possible indication of an earlier comet impact. The collected data has also helped scientists in calculating the approximate time of impact of about two centuries ago.

Herschel's Photodetector Array Camera and Spectrometer (PACS) enables astronomers to analyze Neptune's long-wave infrared radiation, which showed signs that the outermost planet in our Solar System may have experienced a cosmic collision.

Neptune's atmosphere consists mainly of hydrogen and helium with traces of water, carbon dioxide, and carbon monoxide. Astronomers detected an unusual distribution of carbon monoxide with much higher concentrations in Neptune's stratosphere compared to its tropospheric layer beneath. The concentrations of carbon monoxide in the troposphere and stratosphere should be the same or decrease with increasing height. A higher concentration of carbon monoxide in the stratosphere points to a source of external origin.

The collision scenario would have an impacting comet falling apart high in the atmosphere, where the carbon monoxide trapped in the comet's ice would be released and distributed throughout the stratosphere over the years.

The new research, which appeared in the 2010 July 16 online issue of the journal *Astronomy & Astrophysics*, brings into serious question a previous theory about the odd distribution of carbon monoxide. That theory postulated that a constant flux of tiny dust particles from space introduces carbon monoxide into the gas giant's atmosphere.

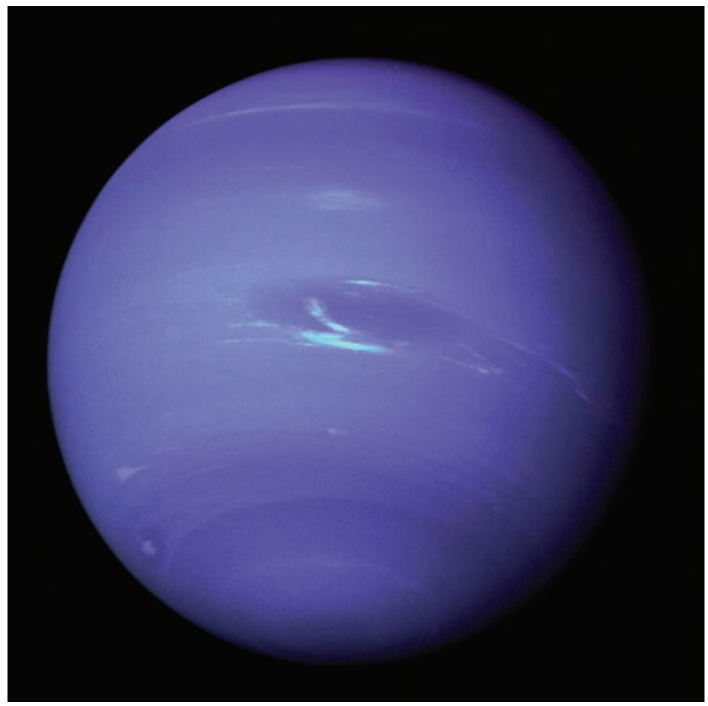

Figure 1 – The European Space Agency's *Herschel Infrared Space Telescope* indicates that a comet may have hit Neptune two centuries ago. Photo: NASA.

The Royal Astronomical Society of Canada is dedicated to the advancement of astronomy and its related sciences; the *Journal* espouses the scientific method, and supports dissemination of information, discoveries, and theories based on that well-tested method.

Lunar Scientist Award for 2010

The recipient of the Shoemaker Distinguished Lunar Scientist Award for 2010 is Dr. Don Edward Wilhelms.

The award, from the NASA Lunar Science Institute, is presented annually to a scientist who has significantly contributed to the field of lunar science.

Wilhelms is the second recipient of the award. The first was Gene Shoemaker, who received it posthumously in 2009 for his many contributions to the lunar geological sciences.

The late Shoemaker hired Wilhelms to work at the United States Geological Survey (USGS), Menlo Park, California, as an astrogeologist where he spent 24 years of his career. Wilhelms retired from the USGS in 1986.

Wilhelms' research covered most categories of lunar science. According to most lunar scientists, no student of the lunar surface, its terrain, and the geologic context of samples can function without the framework Wilhelms developed. Wilhelms is the author of fundamental lunar geology books such as *To a Rocky Moon* and *The Geologic History of the Moon*. Both texts are required reading for students of our Moon.

Shoemaker, of Comet Shoemaker-Levy fame, played a significant role in the *Apollo* lunar program in ensuring the Moon-landing astronauts were well-versed in lunar geology.

Copernicus Reburied and Site Formally Marked

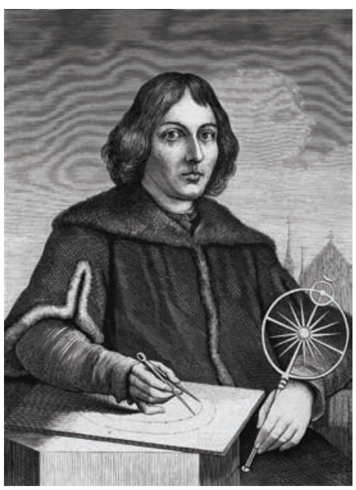

Figure 2 — Engraved portrait of Polish astronomer Nicolas Copernicus (1473 - 1543) drawing the Sun as the centre of the Universe. Photo by Kean Collection/ Getty Images.

After laying for almost a half of a millennium in an unmarked grave beneath the floors of the 700-year-old Frombork Cathedral in Frombork, Poland, the remains of 16th-century astronomer Nicolaus Copernicus were identified in 2005 and reburied with renewed religious ceremony in May 2010 within the same cathedral and in the same spot.

At his death in 1543, Copernicus was a little-known astronomer working in a remote part of northern Poland. His interment 467 years ago below the cathedral's floor in an unmarked grave was the norm for church canons (a clerical ranking below a priest) who served at the cathedral.

Now, a black granite tombstone on the burial site identifies Copernicus as the founder of the heliocentric theory and as a church canon. It is decorated with a model of the Solar System, a golden Sun encircled by six of the planets.

Copernicus died at 70. Forensic facial reconstruction and DNA testing were used to confirm that the skull and bones retrieved from beneath the cathedral floor were indeed his. A computer reconstruction made by forensic police based on the skull showed a broken nose and other features that resemble a self-portrait of Copernicus. Meanwhile, DNA taken from teeth and bones matched the hairs found in one of his books and was compatible with those of his present-day heirs.

Copernicus lived from 1473 February 19 to 1543 May 24. His book, *De revolutionibus orbium cœlestium (On the Revolutions of the Celestial Spheres)* presented the then-revolutionary theory that the Earth revolves around the Sun. The book ushered in a growing theological controversy and led to the birth of the modern scientific age.

Owen Gingerich, a leading and respected world scholar on Copernicus (and an honorary member of The Royal Astronomical Society of Canada), travelled from his home in Cambridge, Massachusetts, to attend the ceremonial reburial.

Yellowstone's Magma Body Bigger than Thought

Scientists who study planetary development and the forces of volcanism on the Earth will be intrigued by the most detailed seismic images yet published of the "plumbing" that feeds the Yellowstone National Park supervolcano in the U.S. The key findings were featured in an issue of the *Journal of Volcanology and Geothermal Research.*

The recently published seismic images show a plume of a mixture of hot and molten rock rising at an angle from the northwest from a depth of at least 650 km. This contradicts earlier claims that there is no deep plume, only shallow hot rock moving like slowly boiling soup.

And, according to a related University of Utah study, the banana-shaped magma chamber of hot and molten rock a few miles beneath Yellowstone is 20 percent larger than previously estimated, suggesting that a future cataclysmic eruption could be much larger than originally thought. It is suspected that the same "hotspot" that feeds Yellowstone volcanism triggered the Columbia River "flood basalts" that buried parts of Oregon, Washington, and Idaho with lava some 17 million years ago. At that time, the Yellowstone hotspot was located beneath the Oregon-Idaho-Nevada border region. It fed a plume of hot and molten rock that produced "caldera" eruptions – the biggest kind of volcanic eruption on Earth.

The massive plume angles downward 240 km to the west-northwest of Yellowstone and reaches a depth of at least 650 km. Researchers estimate that the plume is mostly hot rock, with 1 to 2 percent molten rock in sponge-like voids within the hot rock.

Geologists have calculated that the plume generated more than 140 huge eruptions as North America slid southwest over the hotspot, producing a chain of giant craters – or calderas – extending from the Oregon-Idaho-Nevada border northeast to the current site of Yellowstone National Park. In this area, huge caldera eruptions occurred 2.05 million, 1.3 million, and 642,000 years ago, and

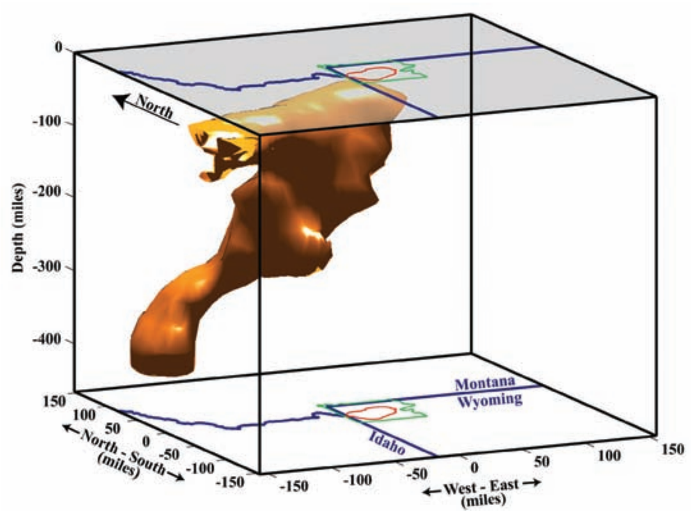

Figure 3 — University of Utah scientists used seismic imaging to construct the Yellowstone hotspot plume of hot and molten rock that feeds the shallower magma chamber (not shown) beneath Yellowstone National Park, outlined in green at the surface, or top of the illustration. The Yellowstone caldera, or giant volcanic crater, is outlined in red. Photo: University of Utah.

were 2500, 280, and 1000 times bigger, respectively, than the 1980 eruption of Mount St. Helens. The eruptions covered as much as half the continental United States with inches to feet of volcanic ash.

New Director for Lunar Science Institute

NASA's Lunar Science Institute (NLSI) headquartered at NASA's Ames Research Center in Moffett Field, California, has a new Director.

Yvonne Pendleton assumed the post recently after serving as the NASA Ames Deputy Associate Center Director, Chief of the Space Science and Astrobiology Division, and as a research astrophysicist for 31 years. She replaced David Morrison, who held the position of Acting Director and who was recently appointed Director for the Carl Sagan Center for Study of Life in the Universe at the SETI Institute. Morrison continues part-time as a senior scientist at the NLSI.

With a Ph.D. in Astrophysics from the University of California at Santa Cruz, a Master's degree in Aeronautics and Astronautics from Stanford University, and a Bachelor's degree in Aerospace Engineering from the Georgia Institute of Technology, Pendleton has asteroid 7165Pendleton named in honour of her work in astrophysics and planetary research. Her scientific interest focuses on how interstellar ices and organics are delivered to bodies in the Solar System via comets and asteroids.

Described as a virtual organization, NLSI supplements and extends existing NASA lunar science programs. NLSI is modelled on the NASA Astrobiology Institute with dispersed teams across the United States working together to help lead the agency's research activities related to NASA's lunar exploration goals.

Mercury's Exosphere, Magnetic Sub-storms, and Volcanism

MESSENGER, a NASA-sponsored scientific investigation of the planet Mercury and the first space mission designed to orbit the planet closest to the Sun, has obtained the first observations of emission from an ionized species in Mercury's exosphere, new information about magnetic substorms, and evidence of younger volcanism on the innermost planet than previously recognized.

The results are reported in three papers published online on 2010 July 15 in *Science Express*, a section of the Web site of *Science* magazine.

According to scientific data gathered from *MESSENGER*'s third and final flyby of Mercury in September 2009, Mercury's exosphere is a tenuous atmosphere of atoms and ions derived from the planet's surface and from the solar wind. Observations of the exosphere indicate remarkably different spatial distributions among

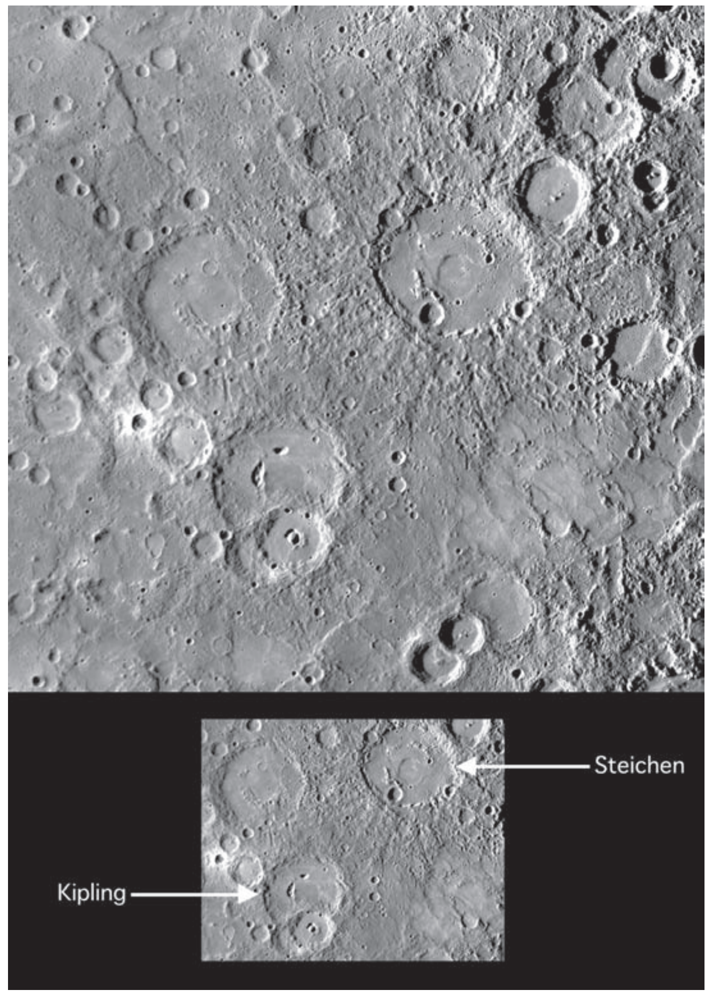

Figure 4 — Neighbouring Mercury craters Kipling (151 kilometres in diameter) and Steichen (159 kilometres in diameter) both feature smooth floors, as do other large craters in this image. Visible on the floor of Steichen are remnants of a "peak-ring" structure seen as low mountains poking up above the smooth floor material. The floor of Kipling shows an oblong "yam-shaped" pit. The Flyby 3 photos were released in August 2010. Photo: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington.

the neutral and ionized elements in the exosphere.

The spacecraft's third flyby produced the first detailed altitude profiles of exospheric species over the north and south poles of the planet. The profiles showed considerable variability among the sodium, calcium, and magnesium distributions, indicating that several processes are at work and that a given process may affect each element quite differently. Also prominent among the discoveries during the third flyby were the first observations of emission from ionized calcium in Mercury's exosphere.

During its first two flybys of Mercury, *MESSENGER* captured images confirming that pervasive volcanism occurred early in the planet's history. The spacecraft's third flyby revealed a 290-kilometre-diameter peak-ring impact basin, among the youngest basins yet seen. The impact basin was recently named Rachmaninoff.

Observations suggest that volcanism on the planet spanned a much greater duration than previously thought, perhaps extending well into the second half of Solar System history.

During *MESSENGER*'s third Mercury flyby, the magnetometer documented for the first time the sub-storm-like build-up, or "loading," of magnetic energy in Mercury's magnetic tail.

The increases in energy that *MESSENGER* measured in the magnetic tail were very large, and occurred very quickly, lasting only two to three minutes from beginning to end. These increases in tail magnetic energy at Mercury are about 10 times greater than at Earth, and the sub-storm-like events run their course about 50 times more rapidly.

The *MESSENGER* (*ME*rcury *S*urface, *S*pace *EN*vironment, *GE*ochemistry, and *R*anging) spacecraft launched on 2004 August 3 and, after flybys of Earth, Venus, and Mercury, will orbit and start a yearlong study of its target planet in March 2011.

Andrew I. Oakes is a long-time Unattached Member of RASC who lives in Courtice, Ontario.

Research papers
Articles de recherche

Paris 1675: The Earliest Known Drawing of the Mare Orientale Complex

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and *Randall Rosenfeld (randall.rosenfeld@utoronto.ca)*[3]

ABSTRACT: In the chronicle of telescopic exploration of the Moon, the discovery of features suggestive of far-side structures has held a special fascination. The Mare Orientale (Eastern Sea) is the best known of such features, and the circumstances of its discovery have been the subject of ongoing confusion and controversy, recently recounted by Baum and Whitaker (2007), who trace its graphic record back to the late 18th century. Evidence is offered here that Mare Orientale was drawn a full century earlier than hitherto attested, due to the collaborative work of Jean Dominique Cassini (Cassini I, 1625-1712) and Jean Patigny (*fl.* 1647-1679). New information is provided on the career of Patigny, one of the most important and hitherto neglected lunar artists.

RÉSUMÉ: Dans l'histoire de l'exploration lunaire, à la lunette ou au télescope, la découverte de structures à l'extrème bord observable du limbe, suggérant l'existence de formations intéressantes sur la face cachée, a toujours fasciné. Mare Orientale (la mer Orientale) est la plus connue de ces formations, et les circonstances de sa découverte ont fait l'objet de continuelles confusions et contestations, comme l'ont récemment rapportées Baum et Whitaker (2007), qui font remonter ses premières représentations graphiques à la fin du dix-huitième siècle. La preuve est ici donnée que des dessins en avaient été faits plus d'un siècle auparavant, grâce à la collaboration entre Jean Dominique Cassini (Cassini I, 1625-1712) et Jean Patigny (*fl.* 1647-1679). De nouvelles informations sont également apportées sur la carrière de Patigny, l'un des plus importants mais aussi l'un des plus oubliés des dessinateurs lunaires.

The Ever-changing Narrative of an Elusive Lunar Feature

Mare Orientale is the youngest, best-preserved multi-ring basin on the Moon, although because of its location – centred at 95° W, it lies just beyond the Moon's western limb – its main rings and mare flows can only be glimpsed under extremely foreshortened conditions during favourable librations. Its very identity as a multi-ring basin was established only in the summer of 1961, when William K. Hartmann, then a graduate student under Gerard P. Kuiper at the Lunar and Planetary Laboratory in Tucson, was working on Kuiper's "rectified" lunar mapping project (Hartmann & Kuiper 1962; Hartmann 1980). Its true splendour was first revealed in the *Lunar Orbiter* photographs of 1967 (*LOPAM* IV-181-M; Wood 2003, 178). To quote Chuck Wood, "Mare Orientale is one of the scientifically most important landforms in the solar system, for it clearly reveals the nature of multi-ring impact basins" (2007).

Because of the difficulty attending its observation, previous records of Mare Orientale's existence have been sketchy, intermittent, and unsystematic; so much so that until recently even the circumstances of its discovery and naming were far from clear.

Sadly, even the present standard history of selenography is quite confused on this point (Sheehan & Dobbins 2001). The name "Mare Orientale" shows clearly enough that it was first adopted prior to 1961, when the International Astronomical Union (IAU) approved the astronautical convention for maps of the Moon and other celestial bodies; previous to 1961, the astronomical convention (corresponding to the view in an inverting telescope) was used, hence Mare Orientale, the Eastern Sea, did indeed lie on the eastern limb of the Moon. After the astronautical (1961) convention was adopted, it came to lie on the western limb, rendering the name Mare Orientale an anachronism – a nomenclatural fly in amber.

Mare Orientale, although it is not shown on most of the standard maps of the visual era of selenography (Cassini I 1679, Mayer 1749/1775, Beer & Mädler 1834-1837, Neison 1876, Schmidt 1878, or Goodacre 1910), was most probably "seen" if not registered by many of the more diligent lunar observers. Hugh Percival Wilkins noted it in 1937, naming it "Mare X" (Wilkins 1938). The sketch he included, as recently revealed by Baum and Whitaker (2007, 133), shows Wilkins to have been "quite probably the first to chart the feature in any detail." Baum and Whitaker also point out, however, that Wilkins' contemporary, T.L. MacDonald (1938), then Director of the British Astronomical Association's Lunar Section, noted Wilkins' "Mare X" had been described at least once before, by the German astronomer who first used the name Mare Orientale, Julius Heinrich Georg Franz (1847-1913).

In his 1906 book, *Der Mond* (90), Franz stated: "On the east side of the Moon I also discovered...new *maria*, among them the large extended Mare Orientale, at -90° longitude, -14° to -22° latitude, and beyond that a southerly disconnected portion that overlaps the limb" (trs. Baum & Whitaker 2007, 132). According to Baum and Whitaker, the printed record of observation of the Mare Orientale Complex (MOC) commences with the late 18th-century Hanoverian planetary impresario Johann H. Schröter (1745-1816) and the British artist and skilled selenographer John Russell, R.A. (1745-1806). Schröter introduced the name Montes Rook, which now designates the two inner chains of mountains encircling Mare Orientale,[4] and his description of "*sehr hohen Mondcordilleren*" ("very high lunar mountain ranges") may be the ultimate origin of the name later applied to the outermost rings of mountains, the Montes Cordillera (Baum & Whitaker 2007, 130). Elements of the Eastern Sea are also present on the gores Russell prepared (*ca.* 1797-1806) for his lunar globe. Can traces of the MOC be found in earlier observational drawings in manuscript?

The MOC, the Lunar Drawings, and the Large Moon Map of Cassini I

Among the numerous treasures of the Library of the Paris Observatory is a book that has been called "the library's greatest treasure" (Cassini 1787, 34 note s; Abbott 2009, 33), a folio-size album of 70 drawings of the lunar surface executed under the direction of Giovanni Domenico Cassini (referred to as Jean Dominque Cassini from 1673, and, as the founder of an astronomical dynasty, Cassini I). These drawings were made during the observatory's ambitious, almost decade-long project to map the surface of the Moon.

The broad outlines of the making of Cassini I's engraved Large Moon Map of 1679 are well known (Wolf 1902; Weimer 1979; Whitaker 1989; Whitaker 2003; Launay 2003; Launay and Sheehan 2010). Cassini I (Figure 1), a native of the dukedom of Savoy was

Figure 1 – Portrait of Cassini I, by Jean-Baptiste Patigny 1678, preserved in the Townhall of Clermont en Beauvaisis. ©Michel Degenne

employed from his mid-twenties as a professor of astronomy at the *Università di Bologna*, from whence he was enticed to come to Paris as a member of the *Académie Royale des sciences* by Jean-Baptiste Colbert, Louis XIV's all powerful *contrôleur général des finances*.

After a delay of several years, he took up occupancy (1671 September 14) in the newly built and architecturally superb Royal Observatory run by the *Académie*. That same night, with refractors set up in the courtyard or on the roof of the observatory (Figure 2), he began work on the lunar map (Cassini 1671).

The chief motivation for founding and funding the observatory was to solve the vexing problem of "finding the longitude at sea." Several different approaches had been proposed for maritime use: observing eclipses of Jupiter's Medicean [now Galilean] satellites, measuring the Moon's position relative to the background stars, or determining the times the lunar terminator swept across specific landforms on the lunar surface. Prior to his becoming the chief ornament of the *Académie*, Cassini I furthered the first method – and ensured his European reputation – with his tables of the motions of Jupiter's satellites. In France, he assiduously embarked on improving the lunar-terminator method through his nearly decade-long lunar cartographic programme (yet he never entirely abandoned use of the Jovian route to longitude determination). The final result was his monumental engraved Large Moon Map of 1679 (van de Vyver 1971, 80, fig. 29).[5] Features of the MOC occur in the Paris Observatory portfolio of preparatory drawings for that map, but,

Figure 2 – Restrike of a foundation coin marking the construction of the Paris Observatory, Æ 1967. Collection of Françoise Launay. Note placement of the telescope.

intriguingly enough, not on the map itself. Before turning to the evidence of the drawing, it would be constructive to ask "who were the artists on Cassini I's team, and how did they make their lunar images?"

The Astronomer and the Artists

Despite his prodigious powers as an observer, Cassini I was a rather indifferent draughtsman. From the beginning of his work on the Moon he was, however, fortunate to have the services of two fully trained art professionals, Sébastien Leclerc (1637-1714) and Jean Patigny (*fl.* 1647-1679).

Few astronomers at the time could call on such expert human capital, and for a comparable example, one has to reach back to a previous generation, when the polymath Nicolas-Claude Fabri de Peiresc (1580-1637) and the astronomer and cleric Pierre Gassendi (1592-1655) worked with both Sir Peter Paul Rubens (1577-1640) and Claude Mellan (1598-1688) on antiquarian and scientific endeavours. Not surprisingly, among those endeavours was a longitude project, which resulted in Mellan producing under Peiresc and Gassendi the other supreme monument of 17th-century artistic selenography, a trio of engravings of the Moon (Whitaker 1989, 126-129; Sheehan & Dobbins 2001, 15-16; Whitaker 2003, 25-35 – Mellan used a refractor by Galileo). To put this in modern perspective, think of Cassini I with his state-of-the-art Campani refractors acquiring the primary data, which Leclerc and Patigny subsequently would rework, as analogous to a present-day principal investigator and her research team remotely obtaining raw data with the MegaPrime/MegaCam CCD on the 3.6-m Canada-France-Hawaii Telescope, to be processed by highly trained and experienced personnel using IRAF. Both are examples of "Big Science," hardly conceivable without institutional sponsorship. Cassini I likely owed his ability to command the services of Leclerc and Patigny to his "favoured savant" position at court.

Leclerc worked on the project for probably a very short period in 1671; from the *Journal des Observations* (Cassini 1671) his participation is only attested for September 14 and 18 (Cassini 1671 – Leclerc does not seem to have been paid for his efforts!). He was, nevertheless, clearly the more famous and esteemed of the two artists, then as now. The abbé Michel de Marolles (1600-1681), whose gargantuan collection of engravings formed the kernel of the Cabinet des Estampes of the Bibliothèque du Roi (1667), in his influential verse account of contemporary artists, states that: "Le Clerc [*sic.*] practices etching with such dexterity –/ His entire production is so good – that one is amazed" (Marolles 1872, LXIV, 26).[6] He was soon replaced by Jean Patigny, who worked for Cassini I for at least nine years (1671-1679),[7] not only on lunar mapping, but on other projects as well. A charming example of the latter is "une planche du cours de la comette" ("a plate of the course of a comet"), for which he was paid on 1672 April 29 (Figure 3; Cassini 1672; Guiffrey 1881, 642).

Figure 3 – Plate of the course of a comet, by Jean Patigny 1672, from the *Journal des sçavans.* Collection of Patrick Fuentes.

Patigny is relegated to a nominal mention in a long list of lesser artists, his name bereft alike of praise or censure (Marolles 1872, LII, 23). Even in the latest multi-volume and multi-author works of authoritative status, such as *Groves* or *Benezit*, Leclerc merits substantial independent entries (Benezit 2006, 8, 601; Préaud 2010), but Patigny is either not mentioned at all, or acknowledged with only a few sentences that do little more than affirm his obscurity (Benezit 2006, 10, 991). Leaving aside the issue of his contemporary estimation, his posthumous reputation was not helped by his frequent practice of *not* signing his work, as with the 1672 comet plate and the Cassini I Large Moon Map.

Leclerc's career path may explain why he was so soon replaced by Patigny. Like other talented men, such as the famous instrument makers – Hubin, Gosselin, Le Bas, Thuret – who were also invited to the Observatory on 1671 September 18 (Cassini 1671), Leclerc was obviously familiar to Cassini I through court circles, having entered royal service by the time the Bâtiment Perrault was erected. His work now most familiar to historians of astronomy depicts that same building as a background to Louis XIV's visit to the Jardin du Roi in 1671, an engraving that serves as the frontispiece of the *Mémoires pour servir à l'histoire naturelle des animaux* by Claude Perrault (Wolf 1902, frontispiece; Boquet 1911; Cohen 1980, fig. 317). Leclerc's star rose so fast that, within a year of the start of Cassini I's lunar programme, he had become a member of the Académie Royale de Peinture et de Sculpture, and shortly thereafter, professor of geometry and perspective, with an ever increasing flood of noble and royal commissions. It is likely that he had simply become too busy and too important to be a technician under a social equal. In after years, he succeeded Claude Mellan as Graveur Ordinaire du Roi, ending his days as a Papal knight. Cassini I had to find a skilled replacement.

Jean Patigny never achieved the success or prominence of Leclerc or Mellan, but his abundant skill is witnessed by the superb work in the lunar folio, and the engraving of Cassini I's Large Moon Map of 1679. It is striking how little information is available on his career, associates, and oeuvre beyond the work done under Cassini I. One can cite a handful of maps, devotional images, and portraits, among which is an engraving of the engineer and astronomer, Blaise-François de Pagan (1604-1665), comte de Merveilles, tipped into some copies of the count's *La Théorie des planètes du comte de Pagan* (1657), and *Les Tables astronomiques du comte de Pagan* (1658). More intriguing is the suggestion that Patigny studied under Mellan himself, yet Mariette (1694-1774), who recorded this tradition, may be relying on no more than anecdote (Mariette 1856, 362).

To judge by the length of Patigny's involvement in Cassini I's lunar programme, and the scientific – and to us, artistic – results, the two men must have had a fruitful working relationship, and one profitable enough to retain Patigny. As official draughtsman of the Observatory, Patigny received 90 livres per month, compared to Leclerc's 150 (Guiffrey 1881; Wolf 1902, 169; Stroup 1990, 43, 257-259; Meynell Database).[8] By comparison, in 1674 Christiaan Huygens (a member of the Académie des sciences), received *appointements* (*i.e.* a salary) from the Crown of 6000 *livres*, while Cassini's remuneration was even more generous, at 9000 *livres* (Guiffrey 1881). Academicians, then as now, outranked their technicians, and it can hardly come as a surprise that Cassini I, the most lavishly supported savant at court, was recompensed nearly nine times as generously as his artist.

The great astronomer's patronage extended to other members of Patigny's household. In that same year of 1674, Cassini I was godfather to one of Patigny's sons (Herluison 1873, 335), and, four years later, another of Patigny's 12 children, Jean-Baptiste, executed portraits of the academician and his wife (Teillet 2001, 61; Launay 2003, 17-18). The importance of Cassini I's patronage is discernible in the locale of the Patigny place of residence. From the 12th century, those engaged in the book trade lived in and around the rue St-Jacques in the Latin Quarter, yet, as is evident from the document of apprenticeship of Patigny's son Gilles, in 1680 Jean Patigny's widow resided in a location facing the observatory (AN 1680).[9] This is a strong indicator that it was more economically and socially advantageous for Patigny to live in proximity to the observatory and Cassini I than to reside among other engravers (this document also provides a *terminus ante quem* for Patigny's life).[10] Cassini I's work may even have provided the inspiration for the career of another of Patigny's sons, François, a "Maître de mathématiques" who died in 1727 (AN 1727). The direct line appears to have gone extinct before the middle of the century.

Graphic Techniques and Paper Artifacts

In default of direct primary evidence of a circumstantial nature, it can be difficult to reconstruct the precise *chaîne opératoire* of an observational programme, particularly after more than three centuries – yet to comprehend a scientific artifact as fully as possible this sort of reconstruction is vital. The effort is made more difficult by the absence since the time of Cassini IV (Cassini 1787, 34 note u) of Cassini I's original observational logbooks covering the period from June 1674 to December 1679.

The evidence as it stands suggests that Leclerc and Patigny worked under the direct supervision of Cassini I himself; the annotations on the drawings in Cassini I's hand specifying the circumstances of observation imply as much. If this is the case, then what materials did the artists have from which to work?

The overwhelming majority of savants' logbooks that have survived from the Grand Siècle and the "Age of Enlightenment" take the form of bound books in pen-and-ink. Are these indeed the pristine primary records of observation that we usually take them for? Working with pen-and-ink can present special challenges in low-light conditions, out-of-doors, or near open windows, in cold temperatures, and in proximity to sensitive and expensive research equipment. Nor is it always convenient to take notes in a bound book. A variety of more convenient and easily correctible scribal technologies inherited from earlier centuries were available (Rosenfeld 2002; Stallybrass *et al.* 2004). Were they ignored by natural philosophers, or is it that vestiges of their use hardly survive in modern libraries, archives, and museums? Astronomers from Galileo to Messier and beyond could have used *schedulae*, paper or parchment off-cuts, scraps, unbound supports, or tablets, but these, once their data had been transferred onto more permanent media and higher grade supports, are unlikely to have been preserved. Whatever the case, we can easily imagine Patigny being presented with Cassini I's pen-and-ink (?) observations in a booklet or loose-leaf, a melange of text and sketch. The interpretation of Cassini I's material record of observation would almost certainly have been shaped by conversation between the two men, a dynamic part of the transmission from observer's sketch to artist's rendering and one that is now beyond recovery. Every drawing in MS D 6 40 is a composite from observations made when each feature was seen under conditions of optimal contrast. Patigny's work of synthesizing the images required considerable skill. His accomplishment is functionally analogous to planetary-probe technologists and talented amateurs who today "stitch" lunar photos into composites, yet Patigny managed without the aid of computers.

His medium seems a natural choice for lunar images. It involved the use of a limited but effective colour palette of crayons – chalk and charcoal used as mined, or ground and mixed with fillers and binding agents to form into non-oil-based pastels – on a tinted support, in this case paper from coloured rags. Painting in crayon was one of the three standard draft media regularly taught and practised in artists' studios of the day; the other two were pen-and-ink and watercolour.[11] According to Dezallier d'Argenville, FRS, natural philosopher, connoisseur, and engraver, crayon was the most popular of the three (1762, XXXIV – a largely retrospective discussion). Modern commentators have described Patigny's medium in relation to current varieties of crayon, charcoal, pastel, or graphite pencil, all now quite distinct media, and the colours as black and white, or black alone (!), or sanguine and black alone (!).[12] There is much disagreement in the modern accounts. This is hardly surprising given the notorious difficulty in identifying drawing materials by visual inspection alone (*i.e.* sanguine applied subtly among black and white crayon is not always discernible as a separate pigment). Even attempting visual identification by means of known comparison samples and optical microscopy is insufficient to the task. It is necessary to use PIXE (particle-induced X-ray emission spectrometry), Raman spectroscopy, or varieties of chromatography to achieve more positive identifications (Burns 2007, 2-3). In Cassini I's and Patigny's day, the terms crayon, charcoal, and pastel were often used interchangeably (Burns 2007, 2, 7-8).

John Russell, a lunar artist of comparable distinction to Patigny, has left a detailed treatise on working with crayon, which furnishes a good general idea of the stages and techniques Patigny may have used, even if it dates from the following century and chiefly treats of figural painting and portraiture (Russell 1772, 8, 11-12, 15-17, 19, 28, 32 – see Appendix "A" below). According to Russell, the necessary equipment consisted of: white, black, and red "chalk" (aux trois crayons); a port-crayon to hold the pastels; a leather stump (tortillon), one's finger, or a linen rag for blending the pigments when laid down on the support; blue-tinted paper; a pen-knife or razor for levelling the paper's surface (presumably also used for sharpening the pastels); a 60-cm^2 drawing board; a pin to remove small unwanted portions of pastel in a controlled way from the image; and bread for erasing (Philippe de la Hire, Cassini I's colleague and another notable selenographer, mentions bread as well; 1730, 663; Burns 2007, 39; Figure 4a-b).

Figure 4a-b – Drawing by R.A. Rosenfeld of a port-crayon based on Scheiner's *Rosa ursina* (1630), and Villamena's portrait of Clavius (1606), and a photograph of tools for crayon drawings according to Russell (1772). ©Specula astronomica minima.

Russell's treatise does not tell us, however, of techniques Patigny could have used in transferring the relative positional information from Cassini I's observations. Patigny might have employed dead reckoning, dividers, or an overlay or underlay grid, used alone or in combination with a light table. The simplest and quickest technique combines dead reckoning with the use of dividers, which in skilled hands can achieve a high level of accuracy. If enlargement or reduction of Cassini I's sketches were required, Patigny might have used a pantograph (Christoph Scheiner's invention) or a proportional divider such as that refined by Jost Bürgi, or less conveniently, a sector and plain two-legged dividers.

Figure 5 – BOP D 6 40, drawing 56, by Jean Patigny 1675. One of the outstanding monuments of 17th-century selenography. The Mare Orientale Complex is at the top right on the limb, near the Saturn sketch. Reproduced by courtesy of the Bibliothèque de l'Observatoire de Paris.

It was not uncommon in Patigny and Russell's day for professional artists to manufacture their own crayons, although ready-made ones were available for purchase. Patigny was fortunate in being able to source a significant supply of paper with a reasonably consistent tint; artists could occasionally experience difficulty in that regard. It may be possible in the future to localize the mill(s) where his paper was produced using extant watermarks (beta-radiography would be necessary for recording purposes), to reconstruct the appearance of the screen, to gauge the weight and grade of the paper (measurements with an anvil micrometer), and to analyze the constituent fibres (using light microscopy and a comparison atlas).

The final stage in the production of the drawings consisted of Cassini I's textual interventions. These mostly consist of precise observational date-and-time data (time stamp!), in Latin and Italian, executed in a tint as black as the darkest crayon used for the lunar images (the medium of his annotations has yet to be subject to scientific analysis). One can also encounter the occasional very informal sketch of other objects such as Saturn (by Cassini I as well? Figure 7), in the same pigments as used for the main drawings. The annotations partly overlie the drawings, a visual reminder that however alluring the images are to our eyes, to Cassini I and Patigny, they were first and foremost tools of natural philosophy.

A major problem with crayon drawings is the issue of permanence. The pigments form a much weaker mechanical bond with their support than water- or oil-colours, and virtually no chemical bond under normal circumstances. The tendency to shed colour if roughly handled or poorly stored was widely perceived as a problem about mid-point in the reign of Louis XV. Solutions usually involved applying a fix (basically a varnish); Jérôme Lalande published an influential formula for one variant (Lalande 1769, 398-407; Burns 2007, 148). Some varnishes could alter the optical properties of pigments. While it is possible that Patigny's drawings

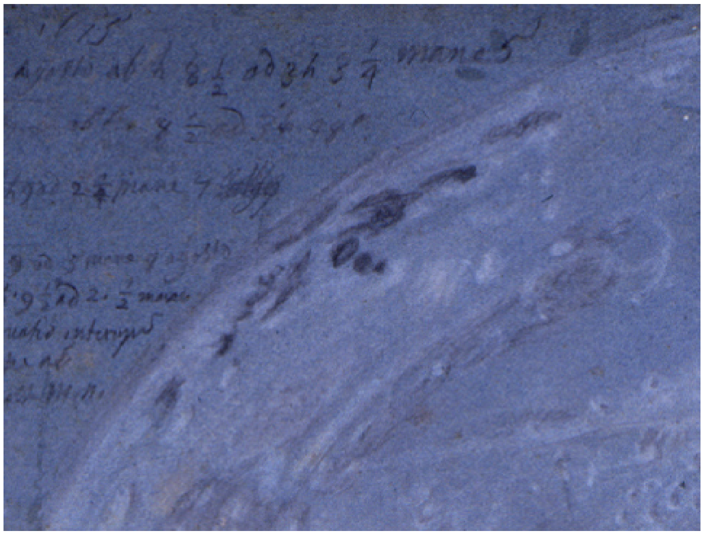

Figure 6 – Detail of drawing 56, showing the Mare Australe. Reproduced by courtesy of the Bibliothèque de l'Observatoire de Paris.

were fixed in the 18th century, it has not proved possible thus far to examine the drawings for the presence of a fix (these can prove quite fugitive).

It was common in this period to store crayon drawings in more-or-less light-fast portfolios, similar to their modern counterparts. Such a storage system would have offered protection together with convenient portability, as well as easy retrieval for consultation when using the drawings as the basis for the engraved Large Moon Map of 1679. Not until 1786, during Cassini IV's directorship, were the drawings bound as we find them today. As a label stuck on the inside first cover shows, this task was undertaken by Gaudreau, the "official bookbinder of the Queen [Marie-Antoinette], Madame [Louis XVI's sister-in-law] and Madame the Countess of Artois" (Launay 2003: 14). The folio volume measures 62 cm × 46 cm, which is comparable in monumentality to the engraved Large Moon Map itself at 55 cm × 56.3 cm, with a lunar image 53 cm in diameter! Cassini IV presented the book to the Bureau des longitudes in 1823.

It would be intriguing to know what led Cassini I and Patigny to choose crayon for this stage of the project. The method may have been adopted solely at Patigny's suggestion. Alternatively, the technique was well known in court circles, and had become so fashionable in the capable hands of Robert Nanteuil (1623-1678), that Cassini I may have independently hit upon adapting crayon technology to his project, and sought artists experienced in the medium. Finished crayon works were mostly portraits, such as Nanteuil's superb image often said to be of Charles Perrault, the brother of the architect of the Observatoire (Goldfarb 1989, 204-205; Burns 2007, 49 – it currently resides at the Fogg Museum, Harvard). When looking at such portraits now, it is hard to conceive how crayon could ever have recommended itself to Cassini I for portraying the Moon, subsequent to engraving her. The general "coolness" of the crayon palette, even in portraiture compared to other media, may have played a role. Inspiration, or at least advice, might have been come from conversations with his colleague Christiaan Huygens, who in 1663 conducted extensive investigations into crayon technology in London and Paris on behalf of his father in Den Haag (Burns 2007, 17-25). Any or all of the above may have played a role in Cassini I's choice.

Cassini I's and Patigny's Representation of the Mare Oriental Complex

Drawing 56 of BOP D 6 40 presents a striking image of the illuminated face of the Moon (Figure 5). A number of features on the limb are clearly visible, such as Mare Australe in the southeast (Figure 6). The relative accuracy of Patigny's depiction of the MOC compared to modern images is striking (*cf.* Figures 7 & 8, *cf.* 9). What, then, can we see?

Parts of the Montes Cordillera are certainly delineated (Figure 8, feature 1; *cf.* Figure 9). Likewise the Lacus Autumni (feature 2), the Outer Montes Rook (feature 3), the Lacus Veris (feature 4), and the Kopff crater (feature 5). The inner Montes Rook (feature 6) are clearly seen in relief on the limb. Traces of a long, thin, discontinuous dark feature contiguous to the Montes Rook on the limb is almost certainly the Orientale basin itself (feature 7). Figure 8, a detail of Patigny's image (Figure 7) redrawn without the obscuring overlay of text, and the superimposition of the image of Saturn, shows this last to best advantage.

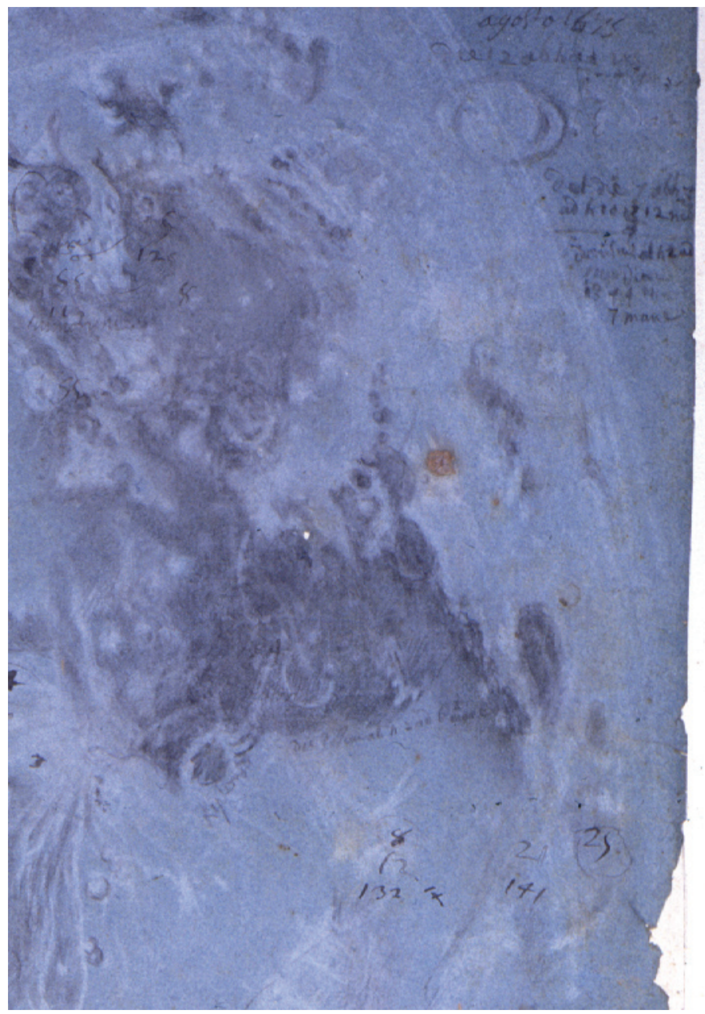

Figure 7 – Detail of drawing 56, showing the Mare Orientale Complex. Reproduced by courtesy of the Bibliothèque de l'Observatoire de Paris.

When was Cassini I most likely to have made his observations?

Various dates are recorded on drawing no. 56, from which it can be determined that the observations were made over a period extending from 1675 August 9 to October 3. Crucially, we assume that for optimum viewing of the MOC, the libration in longitude had to be ***Lb lon.***<-5° (*i.e.* have an absolute value >5°), the ratio of the area of the disc illuminated would stand at ***k***≥15 percent, and the zenith angle of the Moon would be ***z***≤55°. It should be noted that these are conservative values, and, based on the few modern trials with replicas of long-focus non-achromatic refractors (Binder 2010), it is quite possible that Cassini I could have easily bettered these values with his instruments. According to calculations generously supplied to us by Patrick Rocher, these conditions were met during two windows of opportunity, 1675 August 16-17, and September 13-16 (Table 1). The appearance of the MOC in drawing 56 can be seen to agree very closely with the calculated geometry (Figures 5, 7, & 8, and Table 1).

We can refine this further by estimating that the most favourable compromise among ***Lb lon., k, z***, and surficial contrast for Cassini I's observations occurred on 1675 September 13-14. As Cassini I's colleague Jean Picard (1620-1682) did not make any observations on the 13th (Le Monnier 1741, 152), it is possible that atmospheric conditions were not conducive to observing, which at first glance might seem to suggest the 14th as the date Cassini I recorded the MOC. If the factors of atmospheric extinction, the rise, set, and transit times of the Moon for the Paris meridian, and the angular separation of the Moon from the Sun are factored in (Table 2), none of the dates within the windows of opportunity are ideal, but ideal observing conditions rarely occur. On the 14th, the Moon had risen sufficiently above the horizon just past 4:00 a.m. to permit useful observations, and, depending on how contrast was affected by changing light levels, Cassini I would have had between 30 and 40 minutes of useful darkness to sketch the MOC. Unfortunately, the question of when Cassini I observed the MOC cannot be fully settled without recourse to his missing logbooks.

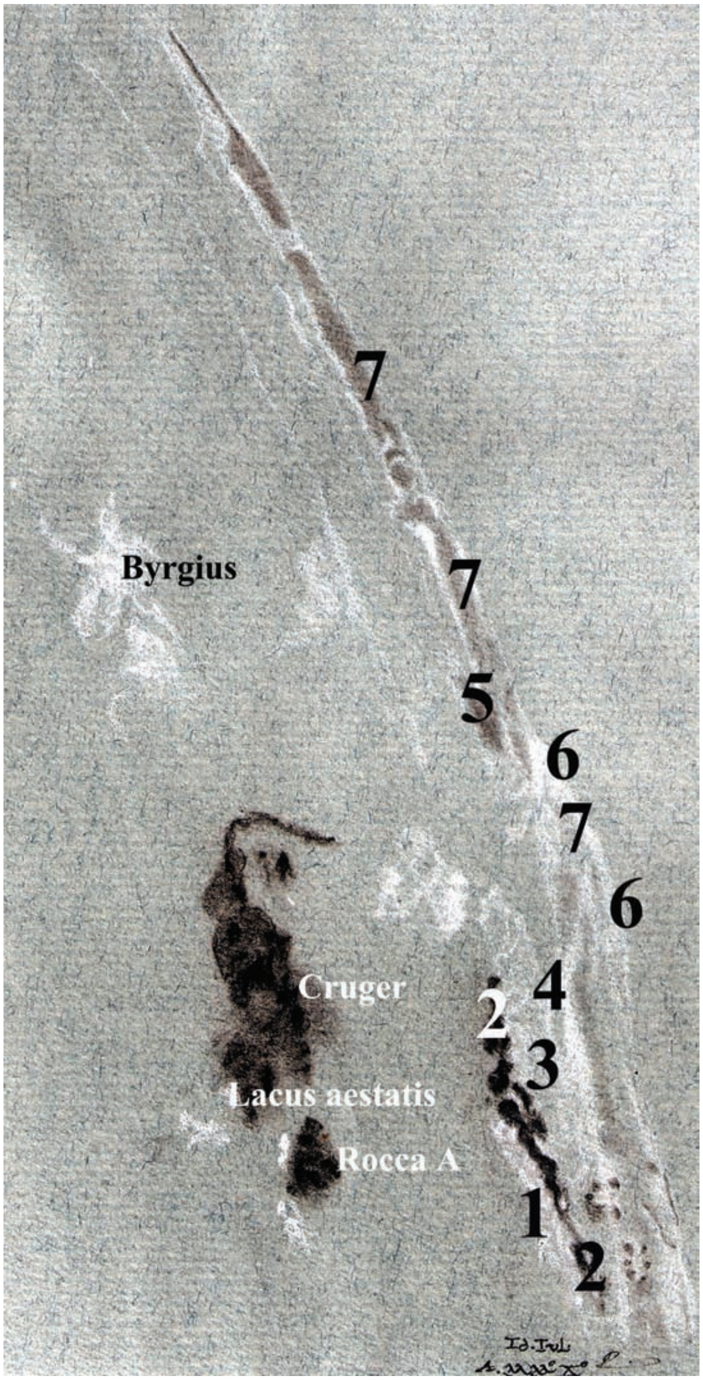

Figure 8 – Redrawing of Mare Orientale Complex based on Figure 7, with modern labelled features, by R.A. Rosenfeld in crayon. ©Specula astronomica minima.

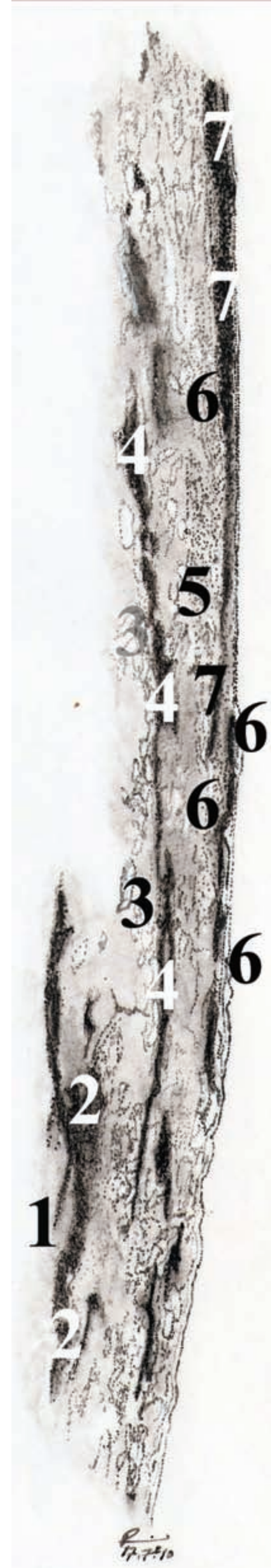

Figure 9 – Composite drawing of Mare Orientale Complex, based on modern images, by R.A. Rosenfeld. ©Specula astronomica minima.

Conclusion

Several intriguing questions remain.

Why did Cassini I and his artists think that the medium of crayon drawings was the logical intermediary between his primary record of observations, and the engraved Large Moon Map of 1679? Was the engraved Large Moon Map of 1679 envisioned from the start of his lunar programme as the final mode of presentation of the data in BOP MS D 6 40? Are there many comparable astronomical projects employing precisely this technological sequence?

In Patigny's hands, the medium used seems tailor-made for portraying the Moon. Why was it used so little for that purpose before the advent of photography? His greatest successor, John Russell, a master of the use of crayon in lunar portraiture, followed a similar path. The basis for his *Selenographia Moon Globe* (1797), lunar gores, and worked-up crayon paintings of the Moon are hundreds of sketches executed in a style evocative of pen-ink techniques (Russell 2008). Cassini I's lost observational sketches, which guided Patigny's hand, were probably functionally similar, although much less accomplished in appearance. Other masters of crayon in lunar portraiture were Maria Clara Eimmart (1676-1707; Gualandi 2009) and É. Léopold Trouvelot (1827-1895; Launay 2003b; Sheehan & Rosenfeld 2010). Why isn't the list longer?

At what point were Patigny's drawings seen as worthy objects of cultural importance on equal grounds of scientific *and* artistic merit? Was it during the planning stages of Cassini I's lunar programme, or when some of the drawings were completed, or did it happen immediately or substantially after the programme had ended?

To Cassini IV, the lunar drawings produced under his great-grandfather were clearly worthy of preservation, for he is the one who had them bound in 1786.[13] Does this imply that he viewed the drawings as important works of observational art, or as a valuable and useful record of scientific observations? Probably both.

There is contextual evidence that he may have considered them also as integral to the family patrimony, especially after the Revolution.[14] This does not rule out an appreciation of the qualities of the drawings – and what holds for him would hold for his contemporaries. John Russell was acutely aware of the aesthetic qualities of accurate observational art (Ryan 1966, 28-30).

It is most fortunate the book survived the political upheavals of the late 18th and early 19th centuries, for it is arguably unequalled among the extant selenographical monuments of its age. In sheer physical bulk, it impresses, but that is as nothing to the number of quality observations that went into its making, which in turn are as chaff to the wheat of their graphic embodiment. And for now we can say that Cassini I's observations rendered by Patigny's dexterous hand initiates the observational history of the "one of the scientifically most important landforms in the solar system" (Wood 2007). Cassini I and Patigny could not have known of the significance of the MOC, but their observational art was of a high calibre. It enabled them to accurately render a geology whose nature they could scarce conceive.

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Appendix "A"

This is advice from Russell 1772, which could have guided an artist of the period in making a crayon drawing of the Moon (the original orthography is maintained):

> "[p. 8]...The materials necessary for Drawing are a Port-Crayon, a Leather Stump, some stained Paper, Charcoal, black, white, and Red Chalk, with a Drawing-Board of about two foot square... [p. 11] having the Drawing-Board partly resting in the lap, and partly on the table, (the most convenient method)... with the Charcoal, let him lightly draw the general shapes...[p. 12]...but, let the Student sketch the Out-line very light, that any mistake may the more easily be altered. His greatest attention must be paid to the producing his Drawing correct, and the lines of the Features parallel to one another, and each at a proper distance, If the Student fails here, all his labour in the finishing will be to no purpose; but when the lines are properly drawn, the broad Shadows may be laid in with soft Chalk, disregarding the lesser parts till afterwards; sweetening with the Leather Stump: Then the demy Shades, and the heightening with white are added, with which the whole is to be compleated, preserving an intermediate space of the stained Paper, which, as a middle teint, must be left between white and black, otherwise the use of drawing on teinted paper is effectually destroyed...[p. 15]... the knowledge of Light and Shadow, as this, in particular, will instruct him how to preserve harmony in his pictures, and a proper expression of the different projections...[p. 16]...the whole care should be to preserve the masses of light and shade, broad and masterly. Care should be observed where the principal mass of light falls...this method of comparing one degree of light and shadow with another will be the only certain rule of preserving the tone and consistency of the whole together, as the comparing of [p.17] lengths and breadths with each other is the only rule to produce the just forms of Figures...the eye will more easily discover how much he has erred from the rule, which he may soften with a linen rag, or rub out with bread at pleasure... [p. 19] The Student must provide himself with some strong blue paper, the thicker the better, if the grain is not too course and knotty, though it is almost impossible to get any intirely free from knots. The knots should be levelled with a penknife or razor, otherwise they will prove exceedingly troublesome [Russell then describes a method used by his master to paste the paper to a linen backing to provide additional strength, and to enable it to hold heavier amounts of pigment]...[p. 28]...When he wants a point to touch a small part with, he may break off a little of his *Crayon* against the box, which will produce a corner fit to work with in the minutest parts...but as it is possible they may be defective in neatness, they should be corrected with a pin, taking off the redundant parts, by which means they may be formed as neat as can be required...[p. 32]...With the light and

dark Teints, the smaller parts are next to be made with freedom, executing, as much with the *Crayon* and as little with the Finger as possible...In the case of reflections, the simple touch of the *Crayon* will be too harsh, therefore, fingering will be necessary afterwards [*i.e.* using one's finger as a stump], as reflected lights are always more gentle than those which are direct. With respect to reflections in general, they must always partake of the same colour as the object reflecting...."

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Abbreviations

BOP=Bibliothèque de l'Observatoire de Paris

JBAA=Journal of the British Astronomical Association

LOPAM=Bowker, D.E. & Hughes, J.K. (1971). *Lunar Orbiter Photographic Atlas of the Moon*, NASA SP-206. Washington, D.C.: NASA

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Françoise Launay's scientific career was as a research engineer operating the 10-metre high-resolution vacuum ultraviolet spectrograph at Meudon Observatory. She is the author of the well received *Un globe-trotter de la physique céleste: L'astronome Jules Janssen* (Vuibert and l' Observatoire de Paris 2008), the co-author with Jean-Yves Roncin of the *Atlas of the Vacuum Ultraviolet Emission Spectrum of Molecular Hydrogen* (American Chemical Society and American Institute of Physics 1994), and a host of papers on spectroscopy, and the history of astronomy, particularly its instrumentation. Now a Research Associate at Paris Observatory, SYRTE department, she is a member of IAU Commission 14, Atomic & Molecular Data, and Commission 41, History of Astronomy, and of the History Commission of the Société astronomique de France (SAF).

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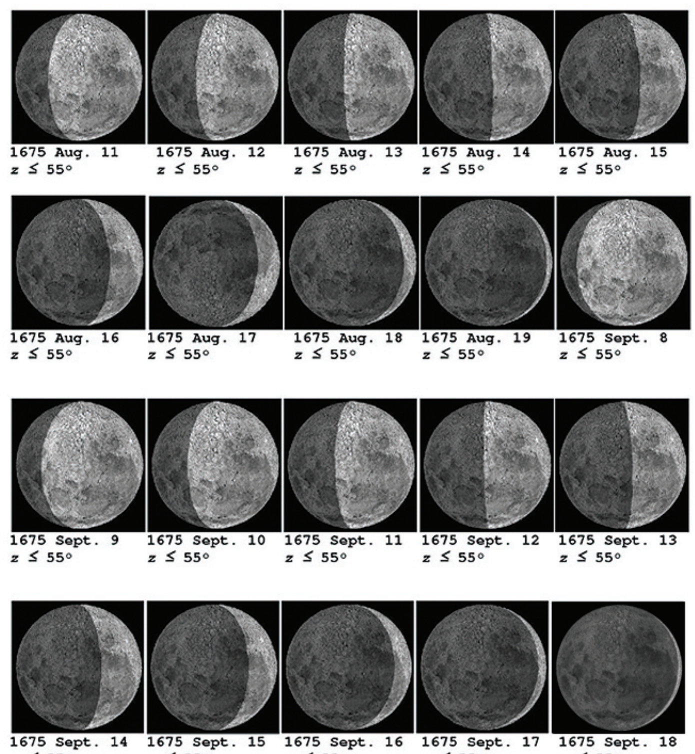


Table 1a – Moon with z≤55° (z = zenith distance) at longitude 2° 20′ E, latitude 48° 50′ N, IAU code 007 Paris Observatory. Graphics courtesy of the Virtual Moon Atlas © C. Legrand and P. Chevalley (www.ap-i.net/avl/en/start).
Table © R. Rosenfeld.

Table 1:

Date (UTC)	α	Δ	Lb Lon.	Lb Lat.	PMP	k	PN.	E.S.
1675 Aug.								
11 0h 0m 0s	1h 3m 5.142s	12° 16' 10.72"	0.39°	-5.91°	65.0°	0.74	337.16°	118.66°
12 0h 0m 0s	1h 48m 52.123s	16° 24' 49.36"	-0.80°	-5.54°	68.0°	0.65	338.71°	107.71°
13 0h 0m 0s	2h 36m 32.243s	19° 55' 2.83"	-2.02°	-4.90°	71.7°	0.56	341.25°	96.76°
14 0h 0m 0s	3h 26m 30.408s	22° 36' 52.16"	-3.18°	-4.01°	76.1°	0.46	344.75°	85.73°
15 0h 0m 0s	4h 18m 52.651s	24° 19' 53.91"	-4.20°	-2.89°	81.0°	0.37	349.12°	74.53°
16 0h 0m 0s	5h 13m 20.955s	24° 54' 19.22"	-5.01°	-1.59°	86.2°	0.28	354.16°	63.09°
17 0h 0m 0s	6h 9m 13.890s	24° 12' 36.63"	-5.53°	-0.14°	91.1°	0.19	359.61°	51.36°
18 0h 0m 0s	7h 5m 36.401s	22° 11' 30.90"	-5.70°	1.39°	95.2°	0.11	5.10°	39.30°
19 0h 0m 0s	8h 1m 36.608s	18° 53' 31.89"	-5.48°	2.93°	97.0°	0.06	10.31°	26.92°
1675 Sept.								
8 0h 0m 0s	1h 35m 2.858s	15° 3' 7.00"	-0.35°	-5.61°	64.1°	0.87	338.08°	137.49°
9 0h 0m 0s	2h 21m 59.462s	18° 44' 14.35"	-1.55°	-5.03°	68.4°	0.80	340.31°	126.58°
10 0h 0m 0s	3h 10m 52.769s	21° 39' 54.52"	-2.77°	-4.20°	73.1°	0.72	343.51°	115.65°
11 0h 0m 0s	4h 1m 50.779s	23° 40' 40.02"	-3.93°	-3.15°	78.3°	0.63	347.59°	104.64°
12 0h 0m 0s	4h 54m 42.702s	24° 37' 44.58"	-4.98°	-1.91°	83.7°	0.53	352.38°	93.47°
13 0h 0m 0s	5h 48m 59.190s	24° 24' 5.31"	-5.81°	-0.54°	89.2°	0.43	357.64°	82.07°
14 0h 0m 0s	6h 43m 58.871s	22° 55' 38.13"	-6.35°	0.92°	94.3°	0.33	3.07°	70.38°

15 0h 0m 0s	7h 39m 0.374s	20° 12' 23.31"	-6.51°	2.41°	98.6°	0.24	8.34°	58.32°
16 0h 0m 0s	8h 33m 35.160s	16° 19' 3.52"	-6.23°	3.84°	101.5°	0.15	13.17°	45.88°
17 0h 0m 0s	9h 27m 35.755s	11° 25' 14.76"	-5.49°	5.13°	102.2°	0.08	17.31°	33.08°
18 0h 0m 0s	10h 21m 17.108s	5° 45' 21.41"	-4.30°	6.17°	97.9°	0.03	20.54°	20.06°

Lunar ephemeris courtesy of Patrick Rocher (IMCCE); graphics courtesy of the Virtual Moon Atlas© C. Legrand & P. Chevalley (`www.ap-i.net/avl/fr/start`).
α=right ascension, δ=declension, Lb Lat.=libration in latitude, Lb Lon.=libration in longitude, k=portion of the disc illuminated, PN.=polar angle measured from the north pole of the lunar axis, reckoned positively towards the east from celestial north, PMP=polar angle measured from the centre of the lunar phase, reckoned positively towards the east from celestial north. The ephemeris INPOP06 has been used in the generation of this table. The base of the ephemeris has been reduced to the FK5 system. The precession used is Capitaine *et al*. PO3 (2003), and for nutation 2000A, and for sidereal time IAU (2000). Table© Françoise Launay and R.A. Rosenfeld.

Table 2

Date	period when $z \leq 55°$	angular separation of moon from Sun at time of local meridian transit
1675 Aug.		
11	1:19-8:09	na
12	1:41-9:13	na
13	2:09-10:15	94.84° at 6:11
14	2:45-11:15	83.34° at 6:59
15	3:29-12:10	71.75° at 7:50
16	4:20-13:05	59.92° at 8:43
17	5:18-13:55	47.86° at 9:36
18	6:20-14:34	35.11° at 10:31
19	7:32-15:07	21.98° at 11:25
1675 Sept.		
8	[7 23:46]-7:02	na
9	0:12-8:04	na
10	0:45-9:02	na
11	1:24-10:00	na
12	2:10-10:54	91.27° at 6:33
13	3:04-11:44	79.59° at 7:25
14	4:05-12:27	67.53° at 8:18
15	5:11-13:04	55.05° at 9:10
16	6:25-13:33	41.83° at 10:03
17	7:46-13:54	28.24° at 10:54
18	9:20-14:03	14.62° at 11:46

Table compiled using *StarCalc*© Alexander E. Zavalishin. All values should be taken as approximate. *z*=zenith distance.

End Notes

[1] 2105 Sixth Avenue SE, Willmar MN 56201, USA.
[2] Observatoire de Paris, SYRTE, 61, avenue de l'Observatoire, 75014 Paris, France.
[3] The Royal Astronomical Society of Canada, 203-4920 Dundas St W, Toronto ON M9A 1B7, Canada.
[4] It is important to note that Schröter's "Montes Rook" were two isolated peaks, the precise identity of which remains to be established; the referent of his toponym, therefore, is not strictly identical to ours.
[5] The quality of Van de Vyver's reproductions is commendable, but the text must be used with caution.
[6] "Le Clerc fait à l'eau-forte avecque tant d'adresse/ Tout ce qu'il fait si bien, qu'on en est étonné."
[7] Records of his employment at the Paris Observatory are extant for 1673 (7 months), 1674 (12 months), 1675 (12 months), 1676 (12 months), 1677 (9 months), 1678 (12 months), and 1679 (9 months); Guiffrey 1881, 712, 780-1, 874, 928, 990, 994, 1089, 1211.
[8] We are following Guiffrey's figures as the most reliable (1881; 1887). It should be noted that the artists were not paid annual salaries or honoria, but were basically paid on a piece-work basis.
[9] Jean Patigny and Marie Philippe were married in 1657 (AN 1657).
[10] The "*dessignateur*" Patigny mentioned in 1681 and 1683 in the *Comptes des Bâtiments du roi* (Guiffrey 1887, 99, 354) for his drawings made for the *Gobelins* factory was definitely not the father Jean, but Gilles who had already been paid for similar work in 1680 (Guiffrey 1881, 1339).
[11] "Drawing" and "painting" were used interchangeably to describe work in crayon.
[12] In fact, 2 of the 70 drawings are in sanguine alone on white paper, while the rest are in black and white (aux deux crayons) on blue-tinted paper.
[13] Did all the drawings survive between 1679 and 1786? A full codicological and comparative contextual study of MS D 6 40 and the Large Moon Map of 1679 and associated documents might provide the answer.
[14] Cassini IV appears to have considered the copper plate of the Large Moon Map as his own, not the Observatory's, for he received 4000 francs in 1801 upon agreeing to leave it to that institution (the plate was then kept at the Imprimerie Nationale, where it was tragically destroyed). He displayed the same proprietary attitude in regard to the bound volume of the drawings he eventually gave back in 1823 to the Bureau des longitudes (which then directed the Observatory).

Feature Articles/ Articles de Fond

The Contribution of Street Lighting to Light Pollution

Peter D. Hiscocks (RASC Toronto Centre)
Sverrir Guðmundsson, (Amateur Astronomical Society of Seltjarnarnes, Iceland)

1. Introduction

Urban centres create a bubble of light overhead, known as *sky glow*. Sky glow is a form of wasted energy and light pollution that impedes our view of the night sky, contributes to the destruction of wildlife habitat, and affects human health. There are many sources that contribute to sky glow: light from residential and business windows, illuminated signs, uplight on buildings and billboard advertising, and street lighting. An aerial view of a city at night suggests that street lighting is a major contributor to sky glow. In this note, we estimate the contribution of street lighting to sky glow over the city of Reykjavik, Iceland.

2. Photographs of Reykjavik

One method of estimating the contribution of street lighting to sky glow is to switch it OFF and then ON, and to measure the change in the sky brightness. Unfortunately, that is generally not practical. In Toronto, for example, streetlights are activated by light-sensitive switches, one for each lamp or small group of lamps. There is no *master switch* for street lighting. A power outage, while welcomed by astronomers, is not useful for this measurement because it affects *all* light sources.

To prepare for the opening ceremony of the Reykjavik International Film Festival, 2006 September 28, at 10:00-10:30 p.m., all inhabitants of Reykjavik and the surrounding area, together with private companies and institutions in the public sector, were asked to shut off their lights. The idea was to create total darkness in the city.

The streetlights were turned off. However, most private companies and the public sector (schools, sports grounds, *etc.*) did not shut off their lights. The reduction in sky glow from 10:20 to 10:40 was therefore almost entirely due to the absence of street lighting.

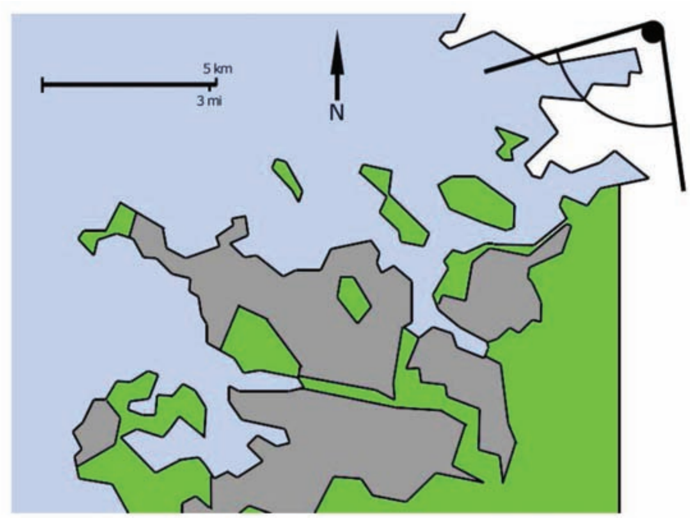


Figure 1 – Map of Reykjavik. The filled circle and lines indicate the location of the photographers and the camera viewing angle.

Members of the Amateur Astronomical Society of Seltjarnarnes, Grétar Örn Ómarsson and Þórir Már Jónsson, photographed the city and the sky from the location shown in Figure 1. Around 170,000 people live in the gray area where the streetlights were switched off.

The photographers were around 300 metres above sea level on the slope of the mountain Esjan. The weather on that evening is documented as *temperature 12 °C, no precipitation, around 75 percent cloud cover, height of lowest clouds around 100-200 metres.*

The photographs [1] are shown in Figure 2.

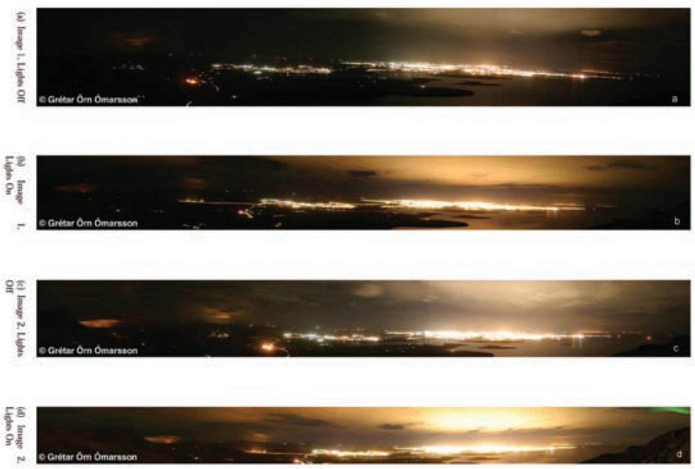


Figure 2 – Composite images of Reykjavik with night sky: a and b: 5-second exposures at ISO 800; c and d: 15-second exposures at ISO 800.

Each photograph is a panorama, with the city location denoted by the bright area at the right of the photograph. It is evident that the city and the cloud cover above the city are brighter when the streetlights are on. Clouds are usually not welcome in astronomical observations, but in this case they serve fortuitously as a projection screen for the city lighting. The photographic information is as follows:

Camera Type: Canon EOS 10D
Lens: Canon 36-mm focal length, f/1.4
Image 1 Exposure: 5 seconds
Image 2 Exposure: 15 seconds
Film Speed: ISO 800
Aperture: f/2.8

3. Average Brightness

Measurements were made of the brightness of the cloud cover, using the image analysis program *ImageJ* [2]. *ImageJ* allows one to select an area of the image and determine the average grey level within that area[1]. The level is reported in 8-bit pixel brightness units, between 0 and 255. The area selected was entirely cloud covered, centred over the city, roughly in line with the island in the foreground. Results for the average brightness of the cloud area and the average brightness of the complete image are shown in Table 1.

Measured in brightness units, the clouds are substantially brighter when streetlights are on. However, is this what a human observer would perceive? To answer that, we need to convert brightness units into luminance values. The relationship between brightness units and luminance is non-linear and varies between cameras. Conversion values for the Canon EOS 10D characteristic [3] are shown in Figure 3.

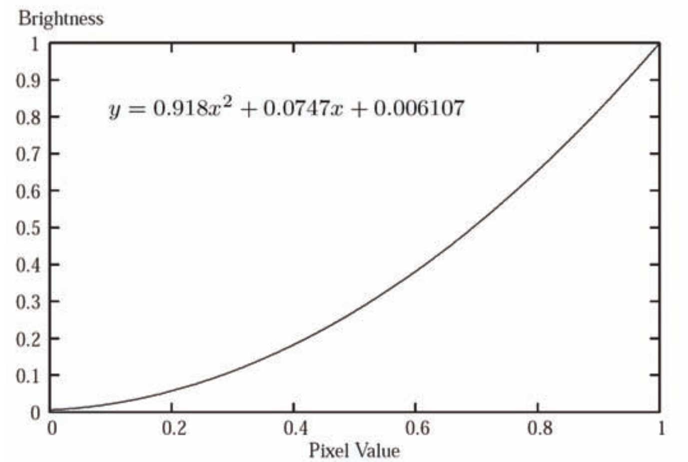


Figure 3 – Canon EOS 10D pixel value vs. brightness

Each 8-pixel brightness reading N is converted into its corresponding X value using:

$$X = N/255.$$

Then the corresponding luminance Y value is found from the Canon EOS 10D conversion:

$$Y = 0.918X^2 + 0.0747X + 0.006107.$$

This relationship is applied to the Cloud and Image Grey Level data of Table 1 to obtain the corresponding luminance values.

Finally, we need to correct for the response of the human eye to changes in brightness. According to Ngai [4], the approximate perception of luminance increases monotonically with the cube root of luminance ratio. Consequently, the Luminance Ratio is converted into Perceived Luminance Ratio by taking the cube root. These entries are shown in the last column of Table 2.

Table 1: Cloud and Total Image Brightness Levels and Ratios

Image	Cloud Grey-Level Brightness Units	Ratio (lights on/off)	Image Grey-Level Brightness Units	Ratio (lights on/off)
Image 1, lights off	99.3		35.1	
Image 1, lights on	160.9	1.62	53.6	1.53
Image 2, lights off	161.4		69.8	
Image 2, lights on	227.6	1.41	91.3	1.31

Table 2: Cloud Brightness, Luminance, Ratio of Luminance, and Perceived Luminance					
Image	Grey-Level Brightness Units	Brightness X	Luminance Y	Luminance Ratio (lights on/off)	Perceived Luminance Ratio
Image 1, lights off	99.3	0.388	0.173		
Image 1, lights on	160.9	0.627	0.413	2.39	1.33
Image 2, lights off	161.4	0.630	0.418		
Image 2, lights on	227.6	0.890	0.800	1.92	1.24

From the last column in the table, the perceived increase in Perceived Luminance Ratio is 33 percent for Image 1 and 24 percent for Image 2, for an average of 28.5 percent. Consequently, a rule of thumb that street lighting increases perceived sky-glow light pollution by approximately 30 percent is indicated in this case.

4. Image Histograms

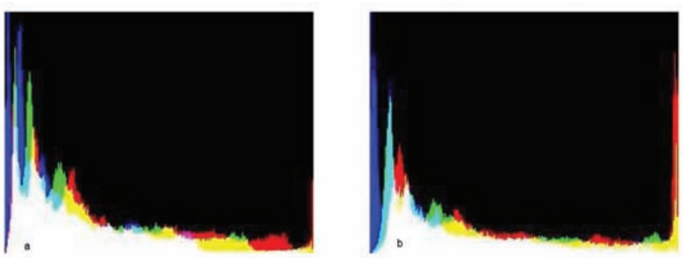


Figure 4 – Histograms of pixel brightness

An image histogram shows the relative distribution of pixel brightness values. In Figure 4, pixel brightness values run from 0 to 255 (dark to light) on the horizontal axis. The vertical axis is a count of the number of pixels at that pixel brightness value. This figure shows the histograms for Image 2, with streetlights on and off. In Figure 4a (lights off), the large peak at the left indicates most of the pixels are dark-valued. In Figure 4b (lights on), there are fewer dark-valued pixels and there is a large spike of bright-valued pixels at the right boundary of the histogram.

5. Perceived Luminance Ratio, Linear Sample

Section 3 discussed the difference between areal brightness and luminance, lights on and off, for an area of the cloud cover above the city. Figure 5 shows a plot of Perceived Luminance Ratio along a vertical line through the same clouds. The horizontal axis of Figure 5 is the position in pixels along this vertical line. The vertical axis is a measure of the Perceived Luminance Ratio with lights on and lights off, calculated using the same method as Section 3.

Figure 5 shows up *hot spots* in the illumination where there is a substantial increase in Perceived Luminance Ratio with street lighting present.

For the first image pair, the Perceived Luminance Ratio approaches 1.6, that is, 60 percent increased perceived luminance with streetlights on. For the second image pair, the peak Perceived Luminance Ratio is a little less at about 1.45, or 45 percent brighter with streetlights on.

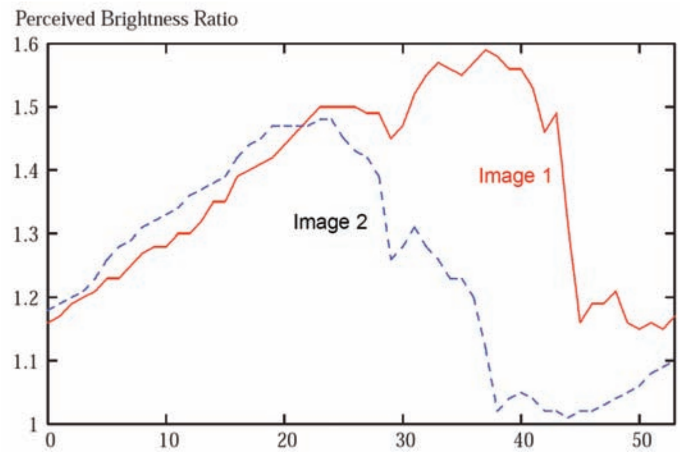


Figure 5 – Perceived Luminance Ratio along vertical cloud sample line

6. Conclusion

All three measures of light pollution – average over an area, histogram, and linear plot – show a substantial, detectable increase in brightness and perceived luminance when streetlights are on. This indicates that street lighting is a significant contributor to sky-glow light pollution. Even for a relatively small city such as Reykjavik, that lighting is substantial (Table 3).

Table 3: Streetlight Power Consumption in Reykjavik (2006)	
Type	Power (Megawatts)
Sodium	2.44
Sodium-Potassium	1.75
Metal-Halide	0.09
Other	0.15

7. Acknowledgements

The authors thank photographers Grétar Örn Ómarsson and Þßórir Már Jónsson of the Amateur Astronomical Society of Seltjarnarnes for taking the photographs of Reykjavik. We also thank Sherrilyn Jahrig of the RASC's Edmonton Centre, for making the photographs known in Canada. Hilmar Jónsson kindly provided the statistics on lighting in Reykjavik.

[1] Icelandic Web of Astronomy and Stargazing: `www.stjornuskodun.is/light-pollution`

[2] *ImageJ*: http://rsbweb.nih.gov/ij/
[3] WebHDR, Camera Calibration for Canon EOS 10D: https://luminance.londonmet.ac.uk/webhdr/cameras/Canon_Canon_EOS_10D
[4] Ngai, Peter Y. (2000). The Relationship Between Luminance Uniformity and Brightness Perception. *Journal of the Illuminating Engineering Society, Winter 2000*, page 41 ff.

[1] These are colour images, so the RGB values must be converted to an equivalent grey level. *ImageJ* allows for a straightforward average or weighted average (based on human vision). Both settings yielded similar results, probably because the image is grey to begin with.

A Most Comfortable Eclipse

by Jay and Judy Anderson, Winnipeg Centre (jander@cc.umanitoba.ca)

In 1768, Captain Cook slipped away from his moorage at Plymouth and set sail in the Endeavour on an expedition to observe the transit of Venus. Eight months later, after sailing the length of the Atlantic, rounding the Horn, and crossing most of the Pacific, he arrived at Tahiti, "the truest picture of an arcadia (idyllic and peaceful)...that the imagination can form." His was a trip with multiple goals, among them, testing a variety of experimental foods for their ability to prevent scurvy. There was no choice in the diet – sailors who refused to eat the mealtime concoctions, sauerkraut mostly, were whipped – a fate that was judged acceptable by one-fifth of the crew.

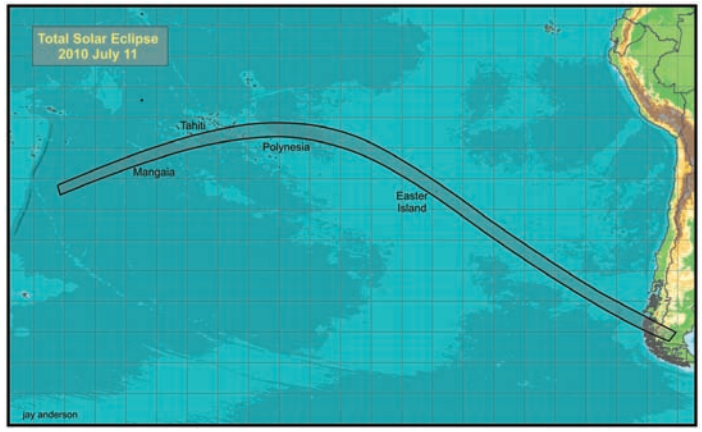


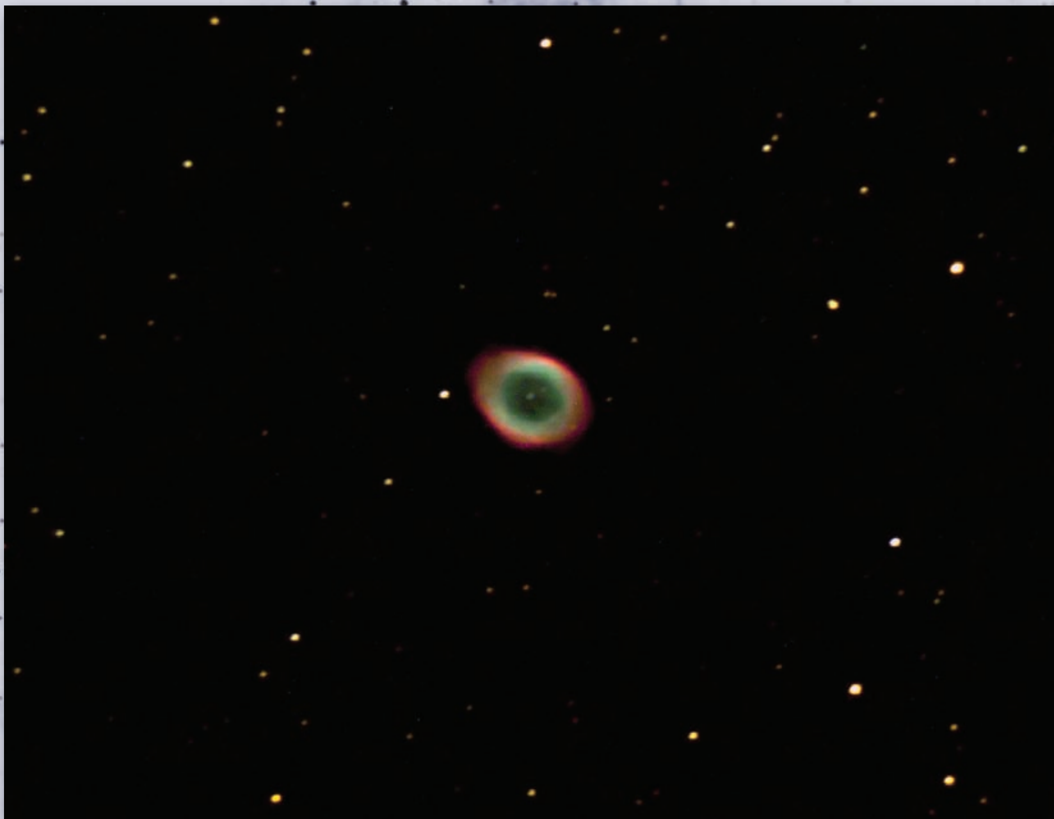
Figure 1 – The path of the eclipse across the Pacific.

continued on page 197

Pen & Pixel

Good weather (finally!) and a new camera allowed Stuart Heggie to sample his favourite objects in the night sky this past summer. One of them is IC 1396 in Cepheus, composed of the Elephant Trunk Nebula (the nebula) and vdB142 (the trunk). Stuart used an Apogee U16M camera on a Takahashi FSQ Refractor. Exposure was 25x10 minutes through a 5-nm Hα filter and 5x5 minutes in each of R, G, and B on July 3 and 17.

Blair McDonald of the Halifax Centre photographed the Bubble Nebula and Messier 52 together using his Canon EOS 350D and a Meade 8-inch f/4 Schmidt-Newtonian telescope. Exposure was 5x5 minutes, guided manually. Blair notes that the image was heavily processed because of the too-short exposure.

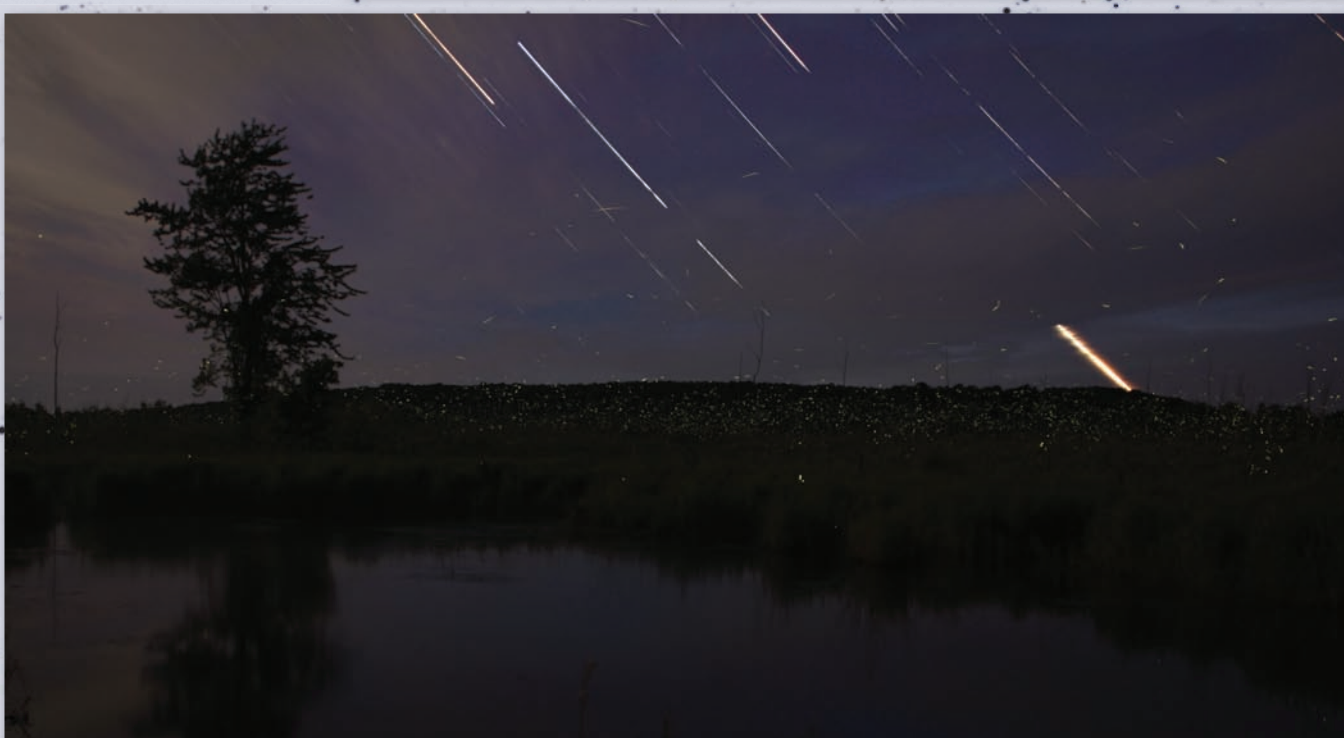


Dan Robertson of Winnipeg used his Centre's 12-inch Meade to collect photons for this image of one of summer's favourite objects, M57, the Ring Nebula in Lyra. Exposure was five minutes at ISO 200 on August 11. "The seeing was not great that night." Dan notes.

Vancouver Centre's James Black used an f/2 Hyperstar-equipped C14 CGE Pro from Pitt Meadows last January to capture this wide-field view of the Pinwheel Galaxy, M101. Exposure was 24x8 minutes with a Starlight Xpress SXVF-M25C one-shot color camera. There are over 100 galaxies within the frame, including NGC 5204, NGC 5474 (large distorted galaxy at bottom middle), NGC 5477, NGC 5585, and Holmberg IV.

Pen & Pixel

Daniel Fischer elected to watch the July total solar eclipse from Argentina, in spite of the poor weather prospects. After the passage of a strong cold front, crystal-clear skies afforded him the opportunity to capture this image of the eclipsed Sun over the Andes Mountains. The strong "cone-shape" of the lunar shadow is only visible when the eclipse is near the horizon. See the article by Anderson in this issue for more details.



Steve Irving likes a foreground in his star trails, and what better foreground than Ontario fireflies? Steve took this composite photo overlooking a pond near his home. The greenish-yellow dots and streaks are the random flashes of the perching and flying fireflies. The bright streak in the lower right is Venus; Mars caused the orangey streak in the upper left. Total exposure was one hour. He used a Canon 50D with a Canon EF 20mm lens set to f/3.2 and ISO 800.

continued from page 193

Figure 2 – Alson Wong used his processing skills to construct this composite image of the July 11 corona. Alson caught the Sun "between the waves" from the MV Paul Gauguin southeast of Tahiti.

By contrast, there was no punishment for astronomers who travelled to Tahiti in July to watch the solar eclipse aboard the MV Paul Gauguin. Tahiti was only an eight-hour flight from Los Angeles, and the menu on the Gauguin was two centuries and many calories away from a "scurvy" choice. Just as with Cook's crew, though, the islands of Polynesia were enchanted forest oases floating on an aquamarine sea that teemed with fish and corals. It was a delicious voyage, with stops at Bora-Bora, Raiatea, Taha'a, and Moorea, sunset searches for the "green flash," crescent-moonrise vistas over volcanic hills, and nightly star parties on a darkened deck.

Figure 3 – Magical Easter Island provided an unmatched opportunity to photograph the eclipse against the mysterious moai on Anakena Beach, on the north side of the island. Image courtesy Beau and Pearl Pinkerton.

The 2010 eclipse track was not a crowded one, as the shadow of the Moon barely touched land – only four "places" in its entire sweep across the globe (Figure 1). One landfall was at Easter Island, adding historical mystery to the darkness of the lunar shadow. On the west side of the track, tiny Mangaia in the Cook Islands provided one foothold; on the east, southern Argentina anchored the sunset, where the eclipse could be seen but barely above the Andes Mountains. At Tahiti, the Sun was more than 99 percent covered, but eclipse chasers had to travel at least 15 km offshore to get into totality. Farther east, in the outer reaches of French Polynesia, a number of eclipse teams found a hard surface on various atolls from which to await a touch of the Moon. Tahiti is where my wife Judy and I went, to be treated royally by the crew of the Gauguin as we sailed along the centre line.

Eclipse morning on the Gauguin began in dark, 4 a.m. skies. Orion was rising upside-down off the port bow, while sparkling stars overhead promised a successful eclipse. It was not to last, as sunrise an hour later found us under a gloomy sky, especially near the horizon, that threatened to meddle with our Transit of the Moon. Nevertheless, a few early risers took encouragement in the omen of a morning green flash to predict that the eclipse would be a successful one. And indeed, as the Sun climbed higher, clouds began to burn away. The upper decks started to fill with a jumble of people, tripods, and deck chairs as the available real estate was claimed by the variety of eclipse chasers, some 320 in all. There was plenty of room. Winds were brisk out of the east, enhanced by the 7-knot speed of the Gauguin, but the motion of the ship was surprisingly smooth in spite of a 2½-metre swell that challenged only photographers using tripods.

First contact ignited the excitement on the observing decks, and cameras everywhere began the inaudible digital record of the start of the eclipse. Occasional cloudy patches gave us natural solar filters, allowing us to view the Sun by eye alone through the sporadic cumulus clouds. Time passed slowly in the hour to totality, interrupted by forays for breakfast and observations of projected crescents, sharpening shadows, and the appearance of strange colour casts on the scenery. The crescent grew narrower and narrower as the Sun shrank to a thin Cheshire-cat grin, but attention began to focus on an ominous patch of cloud that appeared ahead. "Would we make it in time? Should we change direction? Which way?"

The hair-thin crescent shrank further into a short arc, and then a series of a dozen beads appeared, just as the Sun slipped behind the opaque turret of a building cumulus cloud. A few shouts of "shadow bands" gave way to a weak cheer that spread across the decks as the last of Baily's beads faded into a cloud-filtered second contact and the beginning of totality. The coronal halo around the Moon and a few prominences were dimly visible through the clouds, especially in binoculars, but early on, it was a sombre group of observers who awaited the passage of the cloud.

A quick turn to starboard brought the Sun out of the clouds within the first minute, and then a longer and lustier cheer erupted across the decks. It faded quickly as eclipse-chaser efforts turned to observation and photography. Two marvellous tapered streamers of corona pointed down toward the horizon, while a tangle of superimposed coronal filaments marked the opposite side of the lunar backside. Magnetic field lines were outlined by narrow steamers flowing outward from the north and south poles. Impossibly red prominences dotted the circumference of the Moon, disappearing on one side while shyly emerging from the opposite, as the lunar

Figure 4 – An Easter Island moai, unmoved by the eclipse spectacle. Image courtesy Nicholas Branson.

disk slipped across the Sun. In the next few minutes, a few patchy clouds filtered the light and made for some beautiful iridescent colours in the sky. One cloud was more substantial than the others at the 3-minute mark, but the last minute of our appointed four was mostly free of cloudy tendrils. The corona began to brighten on the emersion side and, after a final flurry of photos while compensating for the wave motions, an impossibly long diamond ring emerged from an unknown lunar valley as darkness turned back into day. Cheers, hugs, kisses, whoopin' and hollerin', and a Corona beer celebrated our success.

Probably Cook and his astronomers felt the same way after Venus was done, 242 years earlier.

Alas, observers on Mangaia Island were clouded out for the most part as a large patch of cloud moved onto the island on the morning of the eclipse. There were a few holes that allowed some lucky souls to be rewarded with a view of the corona and diamond ring, but the main group, gathered at the airport, was left with only a thin crescent to tease them when the darkness had passed. Missing an eclipse, especially for beginners, is a tragic event, but one is usually overcome by the experience of being in an out-of-the-way and beautiful corner of the world, watching it get amazingly dark when the Sun should be shining. Mangaia's church was full after the eclipse, as visitors attended the morning service they'd expected.

In Polynesia, the weather was generally good; most descriptions talked of patchy cloudiness that interrupted, but did not lessen, the entire eclipse experience. A few unlucky chasers found themselves under an unforgiving cumulus build-up that released its grip on the sky only after the magic moment had ended. At Hao and other places in the Tuamotu Islands, cumulus clouds kept some watchers guessing, while others in a different nearby location were completely clear in the moments between second and third contact. The thin cloudiness had an unexpected benefit as some photographers captured images and video of shadow bands projected onto the overhead clouds – a totally unexpected phenomenon that brought the normally ephemeral flickers into plain view. Check out *YouTube* to see them.

Farther east, Mother Nature rolled the dice; both Easter Island and Argentina came up winners. Both experienced a sudden clearing on eclipse day and viewers there were able to see the Sun largely unencumbered. Easter Island chasers clustered around the moai to get the "once in a lifetime shot." In Argentina, veteran chaser Joe Rao ran out of words: "...the skies were unimaginably clear and the eclipsed Sun 1.5 degrees above the Andes with dramatic light and color patterns above was incredibly beautiful... and the chromosphere before 3rd contact was even redder than usual, due to some extinction, and absolutely stunning to the naked eye." Daniel Fischer's photo on page 196 will show you the spectacle that captured Joe's mind.

Eclipse 2010 will go down as one of the most beautiful in recent years, with gorgeous streamers, numerous prominences, challenging weather, and that spectacular sequence of shadow bands. Now begins the long wait until the next shadow passage in 2012 in Australia.

Jay Anderson is an eclipse chaser who has been under the shadow more than 20 times. Judy usually travels with him.

The *Hubble Space Telescope* and Astrophotography

by Chris Gainor, Victoria Centre (cgainor@shaw.ca)

This year's celebrations of the 20th anniversary of the launch of the *Hubble Space Telescope* have rightly focussed on *Hubble*'s stunning images of the cosmos and its many important contributions to the body of knowledge about our Universe.

Almost forgotten in these commemorations is the fact that *Hubble* helped popularize and revolutionize amateur astronomy, because it helped move astrophotography from film to digital detectors. This was driven home to me by a recent article on *Hubble* by art historian Elizabeth Kessler (2010) in the spaceflight history journal *Quest*.

Historians such as Kessler look at how society affects art, and vice versa. In this case, she was writing about the cultural impact of the *Hubble* images that have so captivated the public in the 20 years since the satellite was launched in 1990.

In the 1970s, astronomers and engineers at NASA had to decide what kind of electronic detector would be used for imaging in the proposed orbiting space telescope that became *Hubble*. Photographic film had already been ruled out since, among other reasons, it would be difficult to retrieve from space. The choice of electronic detector came down to a specialized type of vidicon tube, as was used in television cameras at the time, or the charge coupled device (CCD). CCDs had been invented in 1969, but the ones available in the 1970s had many limitations, though new and better CCDs were being developed for military and commercial purposes.

In spite of the many disadvantages that early CCDs had for astronomy, the first astronomical images acquired with them were taken in 1976, and so, the next year, NASA decided to use CCDs for one of the main cameras on *Hubble*. While most major telescopes began using CCD cameras in the 1980s, their limitations and expense kept them out of the hands of amateur astronomers until much later.

Computers and software were needed to process CCD images, and in 1990, the same year *Hubble* was launched with its digital camera, Adobe launched its new image-processing program, *Photoshop*. In the media and among the public, a debate began about the newfound ability to manipulate images.

In common with those attached to most major telescopes, *Hubble*'s camera shoots only monochrome (grayscale) images. Colour images are produced by combining monochrome images shot through various colour filters. Kessler noted that, while colour astronomical images had been difficult to produce on photographic film, digital images brought a much easier process and many new options for assembling colour astronomical images.

Hubble's first deep-sky images were seriously flawed due to an error in the telescope's mirror curvature. In 1994, after a *Shuttle* repair mission, the first clear deep-sky images from *Hubble* became available, and scientists and technicians at the Space Telescope Science Institute had to decide how to process them for colour, contrast,

Figure 1 – The latest in space cameras: *Hubble*'s Wide Field Camera 3 in the clean room prior to launch and installation. Image: NASA

and composition before releasing them to the public. There was a minor controversy on how "realistic" the first images were; since 1998, when the release of colour images from *Hubble* became more systematic with the beginning of the Hubble Heritage Program, the Space Telescope Science Institute has included descriptions of how those images were processed, along with the image itself.

Indeed, those involved with processing and releasing the images have provided a great deal of detailed information about their work, including academic papers, a 2002 article in *Sky & Telescope*, presentations to astronomy meetings, a television story on *60 Minutes*, and, of course, information postings on the Hubble Heritage Web site.

Kessler noted those descriptions answered questions about the trustworthiness of *Hubble* images, suggesting that the *Hubble* images "could stand on their own, as an invitation for further research rather than as a reflection on past achievement."

Since *Hubble* data, including raw images, are available to the public after principal investigators have had exclusive access to the data for a time, members of the public can process their own *Hubble* images, and many have done so. Kessler concluded that *Hubble* has contributed to the public's cultural acceptance of digital images, which have gone from a being novelty at the time of *Hubble*'s launch to becoming omnipresent today.

As a historian of technology and someone who has been an amateur astronomer since the days when the *Hubble Space Telescope* was just an idea, I have been led by Kessler's article to ponder the role that *Hubble* played in the transformation of amateur astrophotography. There is no doubt that the availability of CCD cameras, powerful personal computers, image-processing programs, and, of course, the Internet, drove the digital revolution in astrophotography. While I have only dabbled in astrophotography, I certainly remember that the changeover from film to CCDs was not a painless one for my friends who had spent long hours learning how to hyper and process photographic film and prints. With the arrival of digital cameras, they then had to master the new "dark arts" of digital processing.

I use the word "arts" deliberately, because of the processing options made available by computers and digital images. Images of distant stars, galaxies, and nebulae do not, and so far cannot, replicate what the eyeball sees through the eyepiece, either on film or CCD. Each image involves several judgment calls by the person processing the final image, which is often produced from multiple originals.

I wonder how often the well-known images taken by *Hubble* or by astronomers working at facilities such as the Canada-France-Hawaii Telescope influence – consciously or unconsciously – the choices made by amateur astronomers at their computer terminals in deciding the "right" colour or orientation?

Ultimately, this question is one for further study by astronomers and historians, but it is certainly worth consideration today as new cameras, telescopes, processing programs, and computers give amateur astronomers new means to better view distant objects.

Further Reading

Kessler, Elizabeth (2010). The Hubble's Anniversary. *Quest: The History of Spaceflight Quarterly, Vol.17, (No. 2)*, 34-43.

Smith, Robert W. (1993). *The Space Telescope: A Study of NASA, Science, Technology, and Politics.* Cambridge: Cambridge University Press.

Villard, R. & Levay, Z. (2002). Creating Hubble's Technicolor Universe. *Sky & Telescope*, September 2002, 28-34.

The Hubble Heritage Web site: `http://heritage.stsci.edu`

Papers, Posters, and Panel Discussions at the Fredericton GA

The Helen Sawyer Hogg Lecture
The First Images of Exoplanets
René Doyon, Université de Montréal

Detecting exoplanets, ultimately rocky ones like the Earth, is an inescapable step towards detecting life outside our Solar System. One step was taken in 1995 with the first "indirect" detection of a Jovian planet orbiting the nearby star 51 Pegasi. Since then, more than 400 exoplanets have been identified, the vast majority through indirect techniques. Only recently has it been possible to "see" planets, that is, detect light from the planets themselves. One such discovery was made by Canadians, of a system comprising three planets. How does one take pictures of exoplanets that are millions to billions of times fainter than their parent stars? What have we learned from these recent imaging discoveries? What is the next step in exoplanet science? These are the questions that I will briefly address in my presentation.

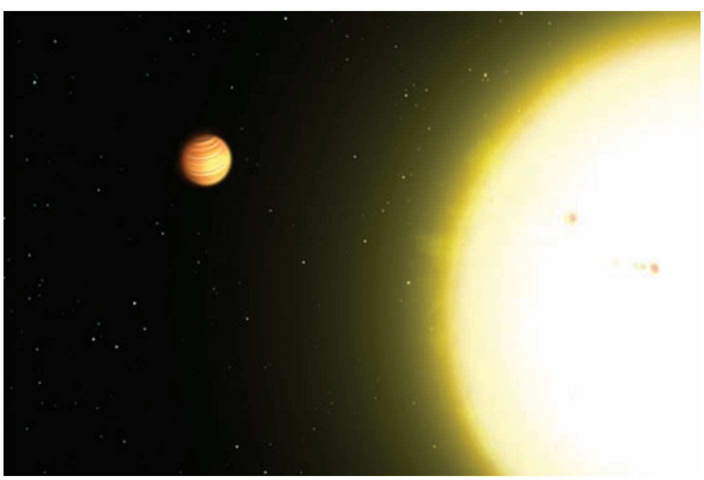


Figure 1 – An artist's concept of the planet orbiting 51 Pegasi. Image Wikipedia.

Papers

Imaging Arp Galaxies
Rémi Lacasse

Within ten years of beginning astrophotography, I went from imaging different objects with short exposures to taking long exposures of single objects. Then, looking for a long-term challenge, the *Arp Atlas of Peculiar Galaxies* provided a project for me. Starting in the early 1950s, Halton Arp conducted a photographic investigation of those galaxies that did not fit into Edwin Hubble's "tuning fork" diagram. In November 1966, his *Atlas* was published.

His observations had led him to believe that the spectral red shifts of many quasars, whose locations on the sky were close to certain kinds of peculiar galaxies, were not due to cosmological recession but instead to certain inherent properties. This controversial hypothesis led him into a number of career difficulties.

In April 2007, I decided to image the 338 Arp galaxies in colour over a period of five years. Although some are spectacular, many are extremely small and challenging. Three years into the project, 327 are completed and can be seen on my Web site at `www.astrorl.ca.`

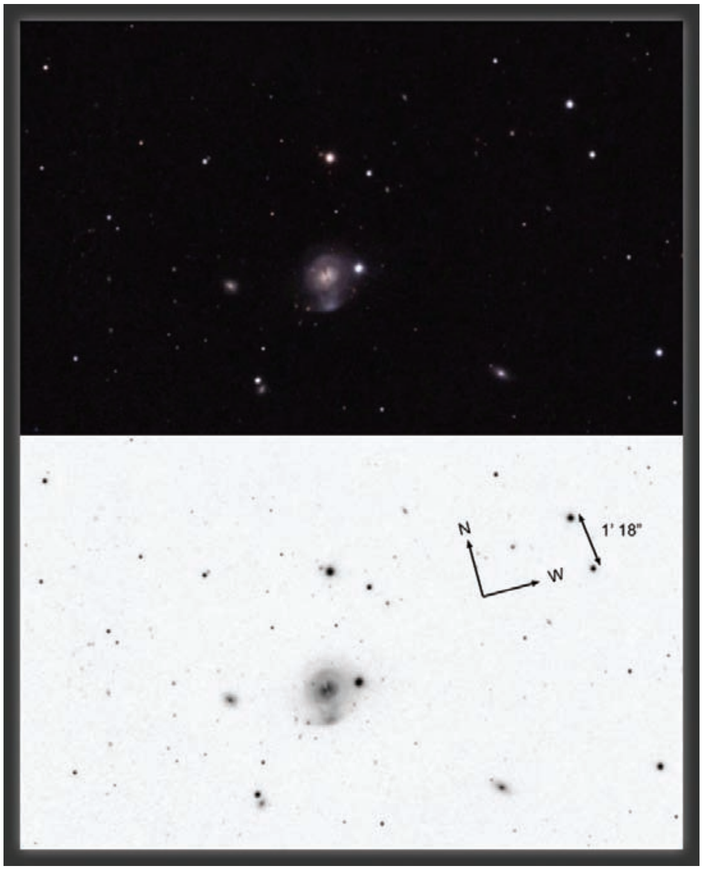


Figure 2 – Arp 155 (NGC 3656) photographed by Rémi Lacasse as a part of his Arp imaging project.

Beyond The International Year of Astronomy: Opportunities in Canada
Jim Hesser, Victoria Centre, University of Victoria

A historic partnership between members of amateur and professional astronomy organizations (RASC, FAAQ, and CASCA) helped almost 2 million Canadians enjoy a "Galileo Moment" of astronomical discovery during the International Year of Astronomy (IYA2009). Collaborations with the arts, library systems, parks, First Nations and others, brought astronomy to non-traditional audiences. In the Beyond IYA era, the partnership remains strongly committed to continuing efforts to share our passion for astronomy with the public through fun and informative activities that also serve to raise science literacy. An NSERC PromoScience grant was awarded to the partnership for FYs 2009-12 with the particular goal of seeking mutually beneficial collaborations with groups who already have effective education and public outreach efforts that target youth in such underserved communities as inner cities, rural and remote areas, and Aboriginal/Metis/Inuit groups. Led by Dr. John Percy (U. Toronto) and administered by CASCA, we have an improved understanding of the impact of IYA in Canada and globally.

Terrestrial Impact Craters: Past, Present, and Future Threats
John Spray

The collision of asteroids and comets with each other and with planetary surfaces has been fundamental to both the formation and the evolution of our Solar System. The collision of planetesimals (small solid bodies) during the early stages of Solar System evolution (4.6 to 4.5 billion years ago) resulted in their accretion and agglomeration to form planets. As the impact frequency decreased over geologic time and impacts became sporadic, life was able to form and evolve on Earth. Evolution has subsequently been punctuated by impact events that caused mass extinctions, setting back or otherwise altering the evolutionary path. Our last major impact was 65 million years ago (the Chicxulub event), an event that set back the reptiles and allowed mammals and, eventually, humans to flourish. This presentation will assess past, present, and future risks from large extraterrestrial projectiles. What are the current threats to our society and how should we mitigate them?

David Dunlap Observatory: Back in Business
B. Ralph Chou and Paul Mortfield, Toronto Centre

The RASC Toronto Centre assumed management and operation of the 74-inch telescope of the David Dunlap Observatory in May 2009. In addition to supporting provincial science education and presenting astronomy public outreach programmes, the Toronto Centre has participated in consultations of the development proposals for the parcel of land surrounding the DDO. In this paper, we report on the Toronto Centre's first year of operation of the largest optical telescope in Canada. Our management plan is a model for other Canadian observatories facing closure, and how they can best be re-used to serve their local and national communities.

The Brightness and Colour of the Saturn System
Richard Schmude, Kingston Centre

I will review my brightness and colour measurements of Saturn made between 1995 and 2010. I will also describe how the opposition surge, solar-phase angle, ring-tilt angle, and the positions of both the Earth and Sun affect the brightness and colour of the Saturn system. In all cases, the brightness measurements were made with filters in the Johnson B, V, R, and I system. These filters transmit light in the visible and near infrared portion of the electromagnetic spectrum.

Saturn's brightness changes as a result of several processes and we now have equations that can predict both the brightness and colour of the Saturn system. These equations yield brightness values that are accurate to a few percent. We can now predict Saturn's colour and brightness even at low phase angles, when there is a sharp increase in brightness.

Street Lighting and Crime Reduction: A Reassessment
Roland Dechesne, Calgary Centre

Although active monitoring studies are promoted in the literature as the better methodology, I will demonstrate that this methodology creates large biases in the data that invalidate this type of study as a test of the lighting/crime relationship.

25 Years in the Telescope Industry
Ray Khan, Toronto Centre

A light-hearted look at how amateurs and equipment have progressed over the past quarter century, and where the hobby is heading in the future.

Posters

Green Laser Pointers: SMART Use
Randall Rosenfeld, Unattached Member

Green laser pointers (GLPs), upon their wide dissemination, quickly became essential tools for education and public outreach (EPO) in astronomy; they have proven signally effective. As with many other useful devices, GLPs can be potentially harmful if used incautiously. The last five years have seen a rise in reports of the flashing of aircraft with GLPs, a matter of legitimate concern to the aviation industry and Canadians at large. On the one hand, these reports and some criminal cases have led some in the media, regulatory, and law-enforcement agencies to imply that the amateur astronomical community is at fault, and to call for restrictions and bans on GLP use. On the other hand, not all in the amateur astronomical community realize the real risks inherent in GLP technology. This poster sets out the potential physical harm of improper GLP use, and the wider consequences of such actions, including possible GLP restriction or complete banning. (See `www.rasc.ca/education/other/glpuse.shtml`)

Towards a Lighting Protocol for Oil and Gas Facilities in Alberta
Roland Dechesne, Calgary Centre

While objections to new oil and gas facilities on the basis of adverse effects of outdoor nighttime lighting are not raised for each new project, such objections occur frequently in Alberta. We believe they occur frequently enough that, together with overwhelming evidence for the negative biological effects of nighttime light, the relative low costs to implement proper lighting protocols, and the potential for great benefits, these objections merit the regulation of nighttime lighting in all future development. Based on such, we propose that the Alberta Energy Resources Conservation Board consider the creation of a nighttime lighting protocol, similar to the ERCB Noise Control Directive 38, in collaboration with conservation groups, industry participants, and private citizens.

Panel Discussion

Boldly Navigating Where No One Has Gone Before: The Future of the RASC in the 21st century

Panellists

Roland Dechesne, President, Calgary Centre
Jim Hesser, Director of the DAO, Single Point of Contact for the Canada Node of Beyond IYA (BIYA), and member of the Victoria Centre
Lauri Roche, 1st Vice-President, Victoria Centre
Mary Lou Whitehorne, National President of the RASC, and member of the Halifax Centre
with moderator
Randall Rosenfeld, RASC Archivist, and Unattached Member

IYA2009 was an unparalleled success, and while RASC membership did not grow appreciably, it did not shrink – a remarkable feat given the economic climate. We are still faced with a volunteer deficit, a membership that is too homogeneous (50+, white, and male), seemingly with too little energy for long-range planning, an impending shortage of skilled hands comfortably to ensure the longevity of our core programmes (such as the Society's oldest and most respected serial publications), and a weak capacity for innovation. Are we making the most of social networking and other rapidly developing modes of electronic communication? Can we successfully remake the RASC better to reflect the demographics of Canadian society without alienating segments of our current membership? The practice of science at all levels is not as well funded in Canada as many think (a condition shared with the arts); are there innovative funding sources and opportunities in the public and private spheres that remain underutilized? Conversely, is lack of funding a sufficient excuse to stop developing and delivering programmes? What can we learn from other Canadian and international examples? Partial solutions may lie in modelling diversity and depth into our programmes:

DIVERSITY – offer a rich and richly sustainable variety of astronomical activities – attract a wide cross-section of people

DEPTH – present flexible, multi-staged programmes allowing beginners as well as experts to participate – programmes with depth should enable participants to grow in astronomy over a lifetime

The IAU's conferences on *Communicating Astronomy with the Public* report that providing the general public with genuine opportunities to contribute to the scientific enterprise through ***doing real science*** is a sure way to attract and retain significant numbers of people. Successful projects such as the AAVSO's *Citizen Sky*, NASA's

Figure 3 – Detail of the Argo Navis by Hevelius. To boldly go...

Stardust@home, Galaxy Zoo and Galaxy Zoo 2, and Moon Zoo are examples of effective citizen science that deal with large amounts of data through crowdsourcing. These are pro-am collaborations in the best sense of the term. Integral to the success of these projects is the provision of on-line interactive training and different forms of mentoring, the acquisition and honing of research skills, and the chance to make discoveries and share in their scientific recognition. Many of these projects are ambitious and well funded; if the RASC cannot develop such projects on its own, it could certainly partner with others in furthering them.

Science as culture has proven remarkably attractive to many people who do not think of themselves as scientifically adept. The exhibition across Canada of graphic art from the Canadian Astronomical Images Gallery was very popular, in airports and in pubs. Many found the production of the Mi'kmaq legend of *Muin and the Seven Bird Hunters* compelling. One of the most impressive of such projects is Stonehenge Aotearoa in New Zealand, created with significant participation across all age groups. Could something similar work in Canada? The RASC has only begun to explore opportunities for partnerships with arts organizations.

The most exciting EPO ventures worldwide are those that bring astronomy to youth at risk, and to underserved or impoverished communities at home and abroad. The IYA Universe Awareness (UNAWE) is one such international project, and Julie Bolduc-Duval, the BIYA Education and Outreach Coordinator, is developing and coordinating a Canadian programme involving professional astronomers. Related projects are those that provide astronomy clubs and basic educational institutions in the developing world with first-world expertise and quality second-hand astronomical equipment in good condition (*e.g.* project STAR of Astronomers Without Borders). How many of us would be willing to donate equipment for a good cause rather than trade-in to trade-up? The RASC would have much to gain in bringing astronomy to people who are not clones of us. The risks of doing so should not be underestimated, but the advantages for astronomy, for the communities partnering with the astronomers in the education process, and for the astronomers, are hard to overestimate. The RASC could gain a lot of "street cred" and favourable press notice it could not otherwise buy, and probably much increased youth participation – but these should never be the motivation for EPO. No project could be successful without partnerships with organizations already working with the target communities. Could the RASC realistically contemplate such commitments?

Partnerships – IYA has shown how important these can be. They are now essential for professional astronomy. What of the amateur scene? A RASC that can function harmoniously as a national organization is stronger than a RASC marred by infighting, and a RASC that can forge mutually beneficial working partnerships with other national and international organizations can reach for the stars.

2010 General Assembly Report

by Denis Grey, Toronto Centre (denisjgrey@gmail.com)

The 2010 General Assembly was held at the University of New Brunswick (UNB) in Fredericton from June 30-July 4. The New Brunswick Centre (celebrating its 10th anniversary as a Centre of the RASC) put on a great show including excellent social events and hospitality suites. About 150 RASCals and their guests attended this year's event, which brings members of the Society together from across Canada.

Paper Sessions – Saturday, 2010 July 3

A highlight of the GA is the opportunity to hear presentations from RASC members from across the country. The quality was generally excellent – here are the ones I was able to attend:

Astro-imaging and Food – Debra Ceravolo (Ottawa Centre) spoke about the aesthetics of imaging and how to use more natural techniques when rendering images. It was an excellent introduction to the use of better techniques.

DDO Update – Ralph Chou (Toronto Centre) informed the GA about the Toronto Centre's work with the David Dunlap Observatory since its sale in 2007. He spoke about the challenges involved in bringing the observatory back into service and operating it for the benefit of the public.

Imaging the Arp Peculiar Galaxies – Rémi Lacasse (FAAQ) talked about his project to photograph all 338 of the Arp peculiar galaxies in colour (for the first time). This was a personal project for him that would combine better imaging techniques with a historic list.

Education and Public Outreach (EPO) – Mary Lou Whitehorne, incoming President and author of *SkyWays*, talked about how EPO makes an important impact in our society as a whole.

Invited Papers

In the afternoon, the program featured a number of invited speakers.

Terrestrial Impact Craters: Past, Present, and Future Threats was presented by John Spray of UNB. He started close to home with objects in low Earth orbits. He reviewed the effects of impacts at different scales, the current tracking and early warning systems, and options for avoiding or preventing impacts.

Diffusion of Elements in Stars was presented by Dr. Francis LeBlanc, founding President of the RASC-NB (in French with simultaneous translation). He spoke about how chemically unusual stars come about through a process of selective diffusion of elements in the star that gives rise to their unique outer layers, which can be measured spectroscopically. Rapid stellar rotation tends to smear these lines out and creates what appear to be different spectra but which really are more or less the same. Atomic diffusion can explain anomalies in HR diagrams of globular clusters. New computer techniques allow for very precise modeling of these atmospheres at the specific temperatures where this effect becomes strongest. By better understanding this effect, astronomers can probe the deeper layers in stellar atmospheres.

2010 Helen Sawyer Hogg Lecture

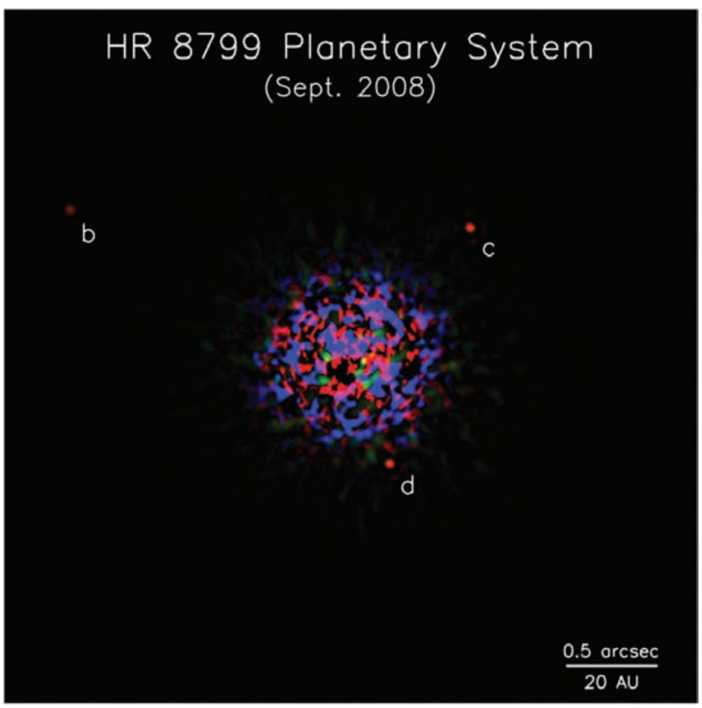


Figure 1 – Three Jupiter-like planets imaged using the Keck and Gemini North telescopes. Image NRC Canada.

A great GA tradition is the annual public lecture. This year's edition was entitled **First Images of Exoplanets** by Dr. René Doyon (Université de Montréal and Mont Mégantic Observatory). The presentation told more of the story behind the discovery of three planets in orbit around HR 8799. The use of angular differential imaging allowed the investigators to tease out the signal of planets that were 10^{-5} times fainter than the star. Because young stars were targeted, the planets were relatively bright since they had a lot of residual heat from their formation about 60 million years ago (850-1100K). The planetary system is about twice as large as our own in spatial extent.

Dr. Doyon compared this with similar discoveries at Fomalhaut and Beta Pictoris. The exciting news is that Canadian and U.S. astronomers are working on a new advanced-imaging system called the Gemini Planet Imager that may provide even more images and data. He also discussed the *Kepler* mission's work to identify terrestrial planets via the transit technique. Already 300 candidates have been identified. Finally, the *James Webb Space Telescope* has tremendous potential for exoplanet discovery – exciting times ahead!

2010 Annual Meeting

On Sunday, the annual business meeting kicked off the morning. Twenty-two of the 29 RASC Centres were represented at the meeting. Much time was spent reviewing our legacy from the International Year of Astronomy including 1.9 million "Galileo Moments" across Canada. **Deborah Thompson** was introduced as the Society's new Executive Director. She was hired in late June and was able to attend the General Assembly after spending a very short time (only two days) at the National Office.

A motion to increase the Society's membership fees by $3.00 was approved. This increase will bring the membership fee to $70.00 for new members and members whose expiry date is later than August 31, 2010.

At the Annual Meeting the new National Executive was confirmed as follows:

President – Mary Lou Whitehorne (Halifax)
1st Vice-President – Glenn Hawley (Calgary)
2nd Vice-President – Colin Haig (Hamilton)
Treasurer – Mayer Tchelebon (Toronto)
National Secretary – James Edgar (Regina).

Congratulations to Dave Lane (Halifax) who completed 2.5 years in the Presidency, caused by the early resignation of Scott Young in 2008. During the International Year of Astronomy, the National Society made significant progress in reorganizing itself to better serve its members and deliver its mandate.

Lunch Presentation – (Dr.) David Levy

Well-known author and Kingston Centre member David Levy provided a 40-year history of his fascination with the night sky and his continuing comet search. He highlighted some of his discoveries as well as how he became interested in astronomy in his early teens. Folksy and warm, David's presentations always highlight his deep appreciation for and affection for the Society. David is now the recipient of a Ph.D. in English Literature. For his thesis, he focused on links between astronomy and Shakespeare, a subject that he shared in his presentation to the General Assembly.

Figure 2 – Parting gift for David Lane, outgoing president, by the incoming president Mary Lou Whitehorne – a totally useless boat anchor. Is it indicative of his term as our guiding light for those 2.5 years? Not at all! Image: Debra Ceravolo

Figure 3 – The IYA2009 Executive Committee: Dr. James Hesser (Canadian IYA Chair); Rémi Lacasse (FAAQ); Kim Hay (RASC Education Chair); Damien Lemay (FAAQ); and Dave Lane (RASC President). Missing: Kim Breland and Doug Welch (CASCA). Image: James Edgar

Miramichi Rural Star Troopers

A group of Grade 6 students from a Miramachi, NB, elementary school presented its story of how the students built their own observatory at their school. Using a grant for innovation in teaching, they succeeded in funding an observatory and a whole suite of equipment. The ***Galileo Observatory*** has been open since April 2010 and has already hosted 500 visitors. The observatory's equipment includes a Coronado PST, seven Celestron Skyscouts, ten sets of 15x70 binoculars, several 10-inch Dobsonians, some Galileoscopes, and other observing aids. An 11-inch Celestron CPC is the observatory's main instrument.

In addition to helping the school's club activities, the observatory is a resource for the whole school district. Believe it or not, these highly motivated students actually deliver school programs to their peers at other schools! Their video presentation on the story of the Star Troopers was a highlight of the whole General Assembly. Visit the Miramachi Rural Observatory Web site (`http://miramachirural.nbed.nb.ca`) for more information and look for an article in an upcoming issue of the *Journal* on this wonderful story.

Beyond the International Year of Astronomy in Canada

Dr. Jim Hesser, Honorary RASC President and Chair of the IYA program, presented the results of the IYA in Canada based on the final report (available from the RASC Web site). Some of the interesting projects include the International Observe the Moon Night on September 18th that will be coordinated by the Canadian Lunar Research Network (`http://clrn.uwo.ca`) and enhancing the astronomy component of National Science and Technology week (2010 October 15-24).

Panel Discussion: The RASC in the 21st Century

Prior to the closing banquet, a special panel discussion was held on the subject of the RASC in the 21st century. Panellists included Dr. James Hesser (National Honorary President), Mary Lou Whitehorne (RASC National President), Laurie Roach (1st Vice-President of the Victoria Centre), and Roland Deschene (President of the Calgary Centre). The moderator was Randall Rosenfeld.

Opening remarks focused on youth programs, the value of membership, and the need to retain and support our volunteer resources. Jim Hesser reflected on the need to make our *Journal* more visible to the professional community and the need to try new ways to engage younger audiences (*e.g. YouTube*). The panel discussion involved a lot of lively dialogue with the audience and many members of the audience took up the microphone to participate. To hear a recording of the panel discussion, visit David Levy's Web site at `http://www.letstalkstars.com`.

Closing Banquet - Awards and the Tides of Fundy

The final item on the GA program was the closing banquet. This year's banquet featured a presentation on the remarkable tides of the Bay of Fundy by RASC Past President Roy Bishop. To see just how big these tides are you can see pictures on Debra Ceravolo's Web site `www.ceravolo.com/ga2010.html`. Dr. Bishop explained how the unique resonance effects of the Bay of Fundy lead to these extraordinary tides in this part of Canada.

As part of the Awards ceremony, the following National awards were presented:

> Ken Chilton Prize – To the members of the team from across Canada who helped to create the outstanding set of educational aids that were distributed by the Society during IYA2009.
>
> Service Awards – Service Awards were given to Bryan Kelso, Guy Mackie, and Jim Tisdale (Okanagan), Barry Matthews (Ottawa), and Curt Nason (New Brunswick).

The first ever President's Award was presented to Sid Sidhu of the Victoria Centre for his contributions to the International Year of Astronomy (Victoria Centre member Chris Gainor accepted on Sid's behalf).

Fun and Games at the GA

As always, the General Assembly featured local flair and fun. Two tours were available: a whale-watching expedition, and a tour to the Hopewell Rocks on the Bay of Fundy. The Hopewell Rocks provide an outstanding demonstration of the powerful tides that wash into and out of the Bay twice each day. In addition to the nightly hospitality suite, we were treated to "Who wants to be an astronomer" with quizmaster (and *Observer's Handbook* Editor) Patrick Kelly (Halifax). This event was an absolute hoot!

Winnipeg in 2011

Finally, if this article has intrigued you, then make a note in your calendar for 2011 June 30 - July 3, when the Winnipeg Centre will be hosting the GA as part of their 100th anniversary celebrations. Based on the presentation from the organizing committee, this also looks like another great opportunity for fun and learning from another part of the RASC family.

Figure 4 - Peter Ceravolo trades optical insights with a lobster; Dr. René Doyen looks on in delight. Image: Debra Ceravolo.

This report was adapted from one previously published in the Toronto Centre's *Scope*.

On Another Wavelength

by David Garner, Kitchener-Waterloo Centre (jusloe1@wightman.ca)

Messier 101 - the Pinwheel Galaxy

Messier 101 (also known as NGC 5457) is a face-on spiral galaxy (type Sc) about 25 million light-years away in the constellation Ursa Major. It can be found easily using the handle of the Big Dipper asterism (Figure 1).

Pierre Méchain discovered M101 in March 1781 and described it as a "*nebula without star, very obscure and pretty large, 6' to 7' in diameter, between the left hand of Bootes and the tail of the great Bear.*" He then notified Charles Messier who added it to his not-a-comet list.

M101 was also observed by Sir William Herschel and again later by William Parsons, the 3rd Earl of Rosse, who sketched the spiral structure using his 72-inch reflector (the Leviathan of Parsonstown). Lord Rosse described the galaxy as being "*Large, spiral, faintish; several arms and knots.*"

The outer regions of M101 appear to have several separate arms, but these can be traced back as branches from two principal arms stretching out from the central core (Figure 2). With a linear

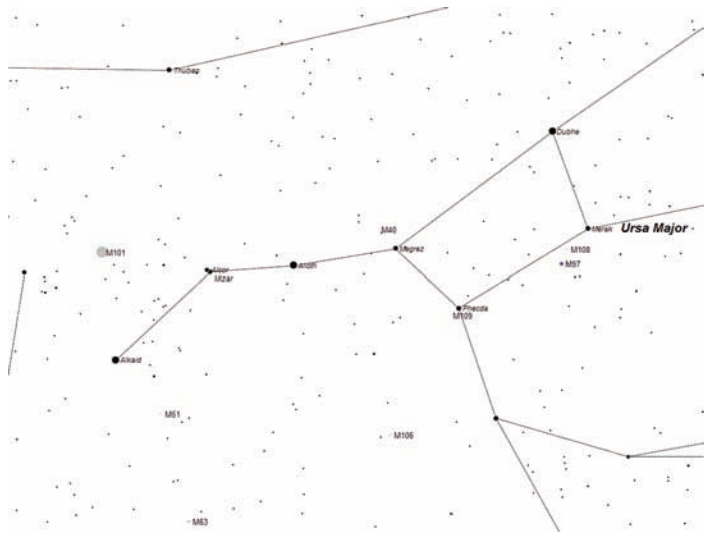


Figure 1 – The location of Messier 101 in Ursa Major.

diameter of 170,000 light-years, it is twice the size of our Milky Way. In addition, with a mass of 100 billion suns, M101 is one of the larger disk galaxies. But for all this, its combined light is spread out over an area nearly equal to that of the full Moon, and accordingly its apparent visual magnitude of +7.9 makes it impossible for naked-eye viewing. It is however, a fine object in a telescope, although only the bright central core is visible in smaller instruments.

When viewed through optical or infrared telescopes, M101 appears much like our own Milky Way with dark dust lanes, multiple spiral arms, and a yellowish central bulge. Images taken with the

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Society News

by James Edgar, Regina Centre (jamesedgar@sasktel.net)

The annual General Assembly has come and gone, and life is back to normal for most of us, with one main exception – our new Executive Director, Deborah Thompson, is now hard at work at National Office. She has already started to make

Figure 1 – Deborah Thompson and a newfound friend.

Figure 2 – Paul "The Lobster" Gray in his fancy cap – replete with claws!

Figure 3 – Dave Lane (Past President) presents the first President's Award; Chris Gainor (Victoria) accepts for Sid Sidhu.

Figure 4 – The RASC Executive Committee 2010-2011: Deborah Thompson, Executive Director; Colin Haig, 2nd Vice-President; Glenn Hawley (1st Vice-President); Mary Lou Whitehorne (President); Mayer Tchelebon (Treasurer); and James Edgar (National Secretary) Photo: Denis Grey

changes, and we see the results in "behind-the-scenes" activities, such as drafting a sorely needed Human Resources Manual for the Society, establishing a series of forms for claiming travel expenses, taking charge of the Society's Privacy Policy, and establishing a list of task and project priorities for the short term.

These activities aren't of the Earth-shattering kind, but necessary, just the same. Some of these practices and policy changes are long overdue and needed to bring the Society operating procedures up to current standards.

Past President, Dave Lane, nudged me while were dining at the home of Ted Dunphy on the evening of June 30. Dave said, "I think you're missing a photo opportunity." Here is the result – see Figure 1 (as background, Deborah Thompson was most recently Interim Executive Director of the Ontario Equestrian Federation).

While still on the subject of the GA, a big "Thank you" goes to the New Brunswick Centre organizing committee for putting on a splendid event. This year was their tenth anniversary, and for a young, small Centre, they put on quite a show - well done (Figure 2)!

Dave Lane presented the very first President's Award (Figure 3), shown here being accepted by Victoria Centre member, Chris Gainor. The award was given to Sid Sidhu (Victoria) "in recognition of outstanding leadership in the Victoria area during International Year of Astronomy."

General Assemblies always bring together people from across the country and across the globe, giving more photo opportunities. Here is one to wrap up this Society News update: the RASC Executive Committee 2010-2011 (Figure 4).

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Ultraviolet Imaging Telescope aboard the *Space Shuttle* have shown that the spiral arms of M101 are filled with hot, young, and very luminous blue stars. The galaxy is peppered with numerous bright HII regions – hydrogen gas clouds that are ionized by the young stars. As the hydrogen gas clouds slowly contract, under their own gravitational attraction and the pressure from surrounding stars, they eventually heat up enough for fusion to begin in their cores, and new stars will be born.

In Figure 2, M101 appears to be slightly asymmetrical. It is believed that sometime in the past, it may have had a near collision with one or more of its companion galaxies (NGC 5204, NGC 5474, NGC 5477, or NGC 5585), with the resultant gravitational tides distorting the star distribution and triggering new bursts of star generation.

The next time you are out galaxy gazing, take a few moments to find this one. Although you can see faint nebulosity with a smaller telescope, you will want something a bit bigger to see the spiral arms in all their glory.

Messier 101 resides in the constellation of Ursa Major, and can be found using the pointer stars Alioth and Mizar in the handle of the Big Dipper. Project a line from Alioth to Mizar an equal distance away from the bowl of the Dipper; M101 lies just above the projected point. Otherwise, use the following coordinates: Right Ascension: 14h 03m 12.6s, Declination: +54° 20′ 57"

Figure 2 – Messier 101, the Pinwheel Galaxy, courtesy of Ron Brecher, Kitchener-Waterloo Centre. Image is composed of 22x10-minute light frames, acquired using *Nebulosity 2* software, a QHY8 camera (Gain=0; Offset=125) with UV/IR filter and an 8-inch f/8 Ritchey-Chrétien telescope on an MI-250 mount. The mount was guided using *PHD* software and the KWiqGuide system. Light frames were calibrated with 16 darks (bad pixel mapping only), 50 flats, and 50 bias frames. The calibration, grading, normalization, alignment, and stacking were done in *Images Plus 3.0*. The stacked image was processed almost completely in *PixInsight* – final adjustments were made in *Photoshop* and saved as a jpeg image at full scale (about 1 arcsec/pixel). The observing site was my SkyShed POD, just north of Guelph, Ontario.

Dave Garner teaches astronomy at Conestoga College in Kitchener, Ontario, and is a Past President of the K-W Centre of the RASC. He enjoys observing both deep-sky and Solar System objects, and especially trying to understand their inner workings.

Through My Eyepiece

By Geoff Gaherty, Toronto Centre (geoff@foxmead.ca)

Essential Accessories

In past columns I've talked about telescopes and eyepieces, the glamourous parts of astronomy hardware. This time I thought I'd talk about some of the less glamourous but essential tools of our trade.

Finder

There are two quite different types of telescope finder. The traditional finder is a small telescope mounted parallel to the main telescope's optical axis. It always has adjustment screws to align its axis with the main telescope. The best of these mounts use two bolts operating against a spring to make alignment easy. The worst have six bolts in two rings requiring simultaneous adjustments of all six.

Any finder with an aperture less than 50 mm is useless. It helps if your finder has approximately the same magnification and field of view as your binoculars. I once made a careful comparison of the many different finders I've acquired over the years, and found that the Antares 8×50 was the best one I owned. I particularly value its long eye relief, which makes getting my eye behind it, while in awkward positions, much easier than with other finders.

Many manufacturers have recently started offering finders containing right-angle prisms. The idea is that these help avoid awkward head angles when viewing through the finder. In practice, I find that these don't work well because there is no intuitive way to get one of these right-angle finders pointing in the right direction.

A better solution is to learn how to use your straight-through finder properly, and to thereby minimize the length of time you have to assume an uncomfortable position. Use your binoculars first to establish your starhop. Then use the "two eye" approach: look through the finder with one eye while keeping the other eye open and looking at the sky beyond. Use the crosshairs, seen in the finder eye, on the sky, to get in the right vicinity, and then switch to the finder telescope for the actual starhop. This requires an ability to superimpose the view through your naked eye with the magnified view through the finder; it can be done with surprisingly little fuss, and is a very useful way to get the telescope pointed at the right starting point.

In recent years, a new type of finder has become popular. It is known by various names, such as "red dot finder" or "unit power finder," or by brand names such as Telrad and QuikFinder. These are "heads up" displays that superimpose a red dot, circle, or other pattern on the sky. You move the telescope until the target overlays the object you're looking for. These are very popular among many observers, but I've never taken to them myself, though I've tried. I have a lot of trouble locating my head back of the finder to pick up the target. The brand names mentioned above are by far the best. The little ones adapted from BB-gun sights are the worst. The red dot is often too bright and the window often coated, making it very hard to see any stars.

Binoculars

Aside from their enormous value as an observing tool, binoculars are also an essential tool for observing with a telescope. Because of their erect images and ease of pointing, they are essential for working out the details of a starhop *before* attempting it with the telescope. It is for this reason, as I've noted above, that it helps if the binocular field of view and magnification match the telescope finder.

I've owned and used many different sizes of binoculars but have found that the 10×50 size is by far the best for general astronomy, and especially so when used in conjunction with a typical 8×50 or 9×50 finder.

Star Atlas

When I started in astronomy 50 years ago, the *Norton Star Atlas* was the standard. It showed wide areas of sky on a reasonable scale. Recent versions have not been as well designed as the older editions because they don't open flat, causing you to lose a strip of stars along the celestial equator. But never mind, a much better atlas has come along recently: *Sky & Telescope's Pocket Sky Atlas* by Roger W. Sinnott (Sky Publishing). This atlas shows the result of careful rethinking by a group of seasoned observers. They seem to have been aware of every atlas problem that has ever bothered me, and in every case they've put it right. The size and scale is perfect, page breaks are well handled, the text is more readable than in any other atlas, and the maps from page to page follow the directions in the real sky instead of following hour angle and going the opposite way. It's simply a delight to use.

For more difficult starhops to faint Herschel objects, I use the *Millennium Atlas*. I do my starhopping with a low-power, wide-angle eyepiece in my 280-mm Newtonian, and I find that the large scale and the 11th-magnitude star designations in the *Millennium Atlas* make excellent guides, better than the 9th-magnitude star limit and smaller scale in *Uranometria*. Since the *Millennium Atlas* is large and heavy, I use slightly reduced photocopies at the eyepiece.

True confession time: Nowadays I find myself not using any of the above tools, as I've become addicted to digital setting circles and GoTo telescopes. After initial alignment (and not even that if the telescope is in Hibernate mode), I just use the hand controller to move between objects. It may be that many of you also skip starhopping entirely, though the penalty is a less comprehensive familiarity with the night sky.

Flashlight

After trying many different flashlights over the years I've settled on Rigel's nice little Skylite. This has both red and white LEDs, and comes on a handy lanyard to hang around your neck. The white LEDs are great for lunar observing and for when you drop that eyepiece holder screw in the grass. When stumbling around the observing field in the dark, I leave the Skylite hanging around my neck, switched to red. This way I can see where I'm going hands free, and I don't bother anyone else, since the light is shining straight down at waist level.

Beware of some cheap imitations that have a hot spot in the light and require a miniature Phillips screwdriver to change the battery.

Observing Chair

An observing chair that enables the observer to be seated comfortably at the eyepiece probably adds a few centimetres to the effective aperture of the telescope. It's so much easier to keep your eye located at the eyepiece's "sweet spot." Currently I use an adjustable desk chair with arm rests and a back because my telescope is permanently mounted in a SkyShed POD. This is the ultimate in comfort! When out on the lawn with other telescopes, I generally alternate between a standard plastic lawn chair and an inexpensive but sturdy folding stool, depending on the eyepiece height. I tried a "Denver chair" but found that it kept dumping me on the ground!

Planetarium software

I've used *Starry Night* since it first came out, and liked it so much that I went to work for the company. There are other fine programs out there, but I've never felt a need to try any of them.

Guidebooks

There's so much to say about these that I'll defer my discussion to the next issue.

Geoff Gaherty recently received the Toronto Centre's Ostrander-Ramsay Award for excellence in writing, specifically for his JRASC *column, Through My Eyepiece. Despite cold in the winter and mosquitoes in the summer, he still manages to pursue a variety of observations, particularly of Jupiter and variable stars. Besides this column, he writes regularly for the* Starry Night Times. *He recently started writing a weekly column on the Space.com Web site.*

A Moment With…

by Phil Mozel,
Toronto and Mississauga Centres (dunnfore@gmail.com)

Dr. David Charbonneau

"*Home Fusion-Reactor Repair.*" "*Cloning Dinosaurs in Your Spare Time.*" "*Exoplanet Observing For Amateurs.*"

All are book titles we might like to see but are never likely to. Or are we? That last tome is already out there, and amateurs are now contributing to the study of planets orbiting distant suns. This is due in no small part to the work of Dr. David Charbonneau, who demonstrated that almost no matter what your aperture, you too can contribute to the study of far-off worlds.

Dr. Charbonneau was interested in astronomy from a young age, watching the sky from Ottawa as a Boy Scout. Around the age of twelve, he bought a planisphere and used it to find the Andromeda galaxy. He was blown away by being able to spot it with the unaided eye, and this experience, along with the fact that both his parents were scientists, propelled him into his own career.

But why exosolar planets in particular? The discovery of the first such planet was just a few months old when Dr. Charbonneau graduated from the University of Toronto in 1996. At that time, he was considering going into cosmology but while attending Harvard for his graduate studies, he found that a lot of people there were talking about exosolar planets. He decided that searching for planets would be a good idea, because they seemed practical, concrete, and important.

His method of choice is the transit technique: observe a star's brightness and, if it dims periodically, a planet may be moving across its face as seen from Earth. The Venus transit of the Sun in 2004 was a recent local example. It is this technique that is being used by the *Kepler Space Telescope* team, of which Dr. Charbonneau is a Participating Scientist, to ferret out planets in the direction of the constellations Cygnus and Lyra. He was an early proponent of using space-based observatories to study the chemical makeup of exoplanet atmospheres. In 2001, he used the *Hubble Space Telescope* for just this purpose and is currently a Principal Investigator for *HST* studies of exoplanets.

Figure 1 – Dr. David Charbonneau. Image courtesy Julia Cort/NOVA scienceNOW

Dr. Charbonneau is also a Deputy Principal Investigator for the EPOCh (Extrasolar Planet Observation and Characterization) investigations of the re-purposed *Deep Impact* spacecraft that is scheduled to arrive at Comet Hartley 2 this November. On its way to the comet, the spacecraft is being used to investigate exosolar planets. In 2008, eight such planets were studied, and their vicinity searched for others. Evidence for rings and moons was also sought, although none were detected. While the imaging equipment being used is not large by any stretch of the imagination, Dr. Charbonneau points out that *any* telescope in space, situated above the atmosphere, is powerful. He cites the small but mighty Canadian satellite *MOST* that is doing amazing work with an optical system that is small even by amateur standards. As any realtor will tell you, it's a matter of location, location, location.

The *Deep Impact* spacecraft has also observed a type of planet so seemingly rare that only one example is known: Earth. The reason for doing so is so that our "ground truth" data can be compared to the spacecraft's observations to help us understand what it might see when looking at terrestrial exosolar planets. We can watch the Earth's albedo change as it rotates, with successive passages of forests, deserts, and oceans, and compare those to some future changes that might be seen in a distant planet.

On a scale perhaps more familiar to amateur astronomers, is Dr. Charbonneau's team's observatory containing eight 16-inch telescopes used for the MEarth Project, of which he is the Principal Investigator. Each night, the automated telescopes scan about 200 nearby M-type dwarf stars for transiting planets from a list of 2000, looking for worlds within their star's habitable zone (the region where liquid water would be expected to exist). Why M dwarfs and not Sun-like stars? For one thing, there's a lot more of them. And, to be in a dwarf's habitable zone, the planet must be close to the star. This means that the chances of a transit alignment visible from Earth are greater, and, since the planet orbits the star more closely, that the transits occur more frequently, on the order of every two weeks. Furthermore, a smaller star means that smaller planets (*i.e.* about the size of Earth) may be detected.

Habitable zone...liquid water...life?

We're getting ahead of ourselves here, but Dr. Charbonneau says that the composition of any detectable atmosphere can be determined using transmission spectroscopy, as was done with the *Spitzer Space Telescope* (before the cryogen ran out), where he is a Principal Investigator. (In 2005, Dr. Charbonneau led the team that used *Spitzer* to make the first direct detection of light from an exoplanet). This would be a good first step in seeing if life might be present on a planet of suitable temperature and atmospheric composition. Hopes are also running high for the work that can be done in a few years with the *James Webb Space Telescope*.

MEarth is closing in on its quarry: it has discovered the first nearby transiting "super Earth," this one being 2.7 times the Earth's diameter and just over 6.5 times its mass. It orbits its star in 1.6 days and has a predicted temperature of 200 degrees; hot, but still cooler than most other transiting planets. Given the temperature and the presence of water, it has been dubbed a steam world. Plans are in place to observe its atmosphere spectroscopically with the *HST*.

One unusual problem faced by the MEarth team is animals, specifically ring-tailed cats that like to walk across the telescope mirrors, leaving paw prints on otherwise pristine reflective surfaces! While Dr. Charbonneau says this does not really hinder observing, and suggests the cats may simply want to look at themselves, nonetheless, seeing footprints on your mirror is enough to make any observer cringe!

Using 16-inch telescopes to observe planets around distant stars would have been unheard of a few short years ago, but that's nothing compared to what Dr. Charbonneau has accomplished with even smaller instruments. He became the first to detect such a planet transiting its star – while a graduate student – using a 4-inch telescope from a parking lot in Boulder, Colorado! He was able to determine the planet's density, the first time this had ever been done, thereby putting constraints on what it might be made of. Given the small budget available to him at the time, Dr. Charbonneau helped set up the Trans-Atlantic Exoplanet Survey, using such small instruments to inspect hundreds of thousands of stars for "hot Jupiters," and he found four more.

Dr. Charbonneau suggests this is a special time in history, dating to at least ancient Greek times, when long-standing questions about life elsewhere may be answered. It's an innate human question and the possibility of answering it, he feels, unites scientists and non-scientists. We have already found life in "alien" environments on, and even in, Earth, and this would seem to bode well for the chances of finding it elsewhere. The Universe may, indeed, be teeming with life. If so, Dr. Charbonneau's comment that "I'll be a biologist by the end of my career," may very well come true!

Dr. Charbonneau has won numerous awards, from the prestigious Alan T. Waterman Award of the National Science Foundation for his development of innovative techniques for exoplanet discovery and characterization, to *Discover Magazine*'s Scientist of the Year in 2007. He is currently a Professor of Astronomy at Harvard University and an astronomer at the Harvard-Smithsonian Center for Astrophysics.

Finally, I asked about opportunities for amateur astronomers in the burgeoning field of exoplanet studies. There are plenty, and increasing numbers of amateurs are now well enough equipped to observe rare and scientifically valuable transits. In one case, for example, the professionals discovered an exoplanet, using an alternative method, but didn't have time to check for transits. Amateurs did have the time and were asked to check it out. They looked and found the planet transiting. With this new information, the pros were able to observe the transits and then characterize the planet's atmosphere. A classic case of pro-am cooperation! To get involved yourself, check out `www.transitsearch.org`.

Not far from where I am writing stands a 4-inch telescope. "You!" I am thinking, (meaning, actually, "Me!"), "You could be doing some important observing. Aperture is no excuse!" Something to think about, thanks to Dr. Charbonneau.

Phil Mozel is a past librarian of the Society, and was the Producer/Educator at the former McLaughlin Planetarium. He is currently an educator at the Ontario Science Centre.

Gizmos

by Don van Akker, Victoria Centre (dvanakker@gmail.com)

Gizmos: The Twinning of Venus

Figure 1 – The Binocular Mirror Mount (Mark 2). Set the eyepieces to a convenient height and aim by tilting the mirror. The frame is one leg of an old barbeque. A barbeque has four legs so you have four tries at getting it right.

Pointing binoculars down at a mirror to look up at the sky is a very old idea. I have wanted to try my version ever since I acquired a surplus truck-type side mirror that seemed to be just about the right size. I held off because I thought that an observer looking down through binoculars at the sky reflected in a mirror would have the same problem as an observer using a Dob – that it is very difficult to relate what you are looking down at in your eyepiece to what you are looking up at over your head. It wasn't until I added another old idea that things came together.

It was a great little project and all that was needed to build it were the aforementioned mirror, a piece of pipe, an O-ring, a few odd metal brackets, and a barbeque.

And binoculars, of course, and a green laser because it's the green laser that makes it work.

Green lasers have been getting some bad press of late. They are banned from some star parties and airports and in the wrong hands they can be quite nasty, but then so can shoelaces. But at night, in the dark, a green laser is a finger that can touch the stars and mounted on binoculars it reflects from the mirror to show you precisely where you are pointed and what you are looking at.

The green-laser bracket is easy. I started with a 3/4 × 6" PVC nipple (a short piece of pipe threaded on each end) available in the plumbing department. I cut the threaded ends off and drilled three holes equally spaced around one end and two more down the length to align with the holes in a standard 3×3 corner bracket. All the holes were tapped for 10-24 thread and that was about it. The green laser is held at one end by an O-ring jammed in tight, at the other end by three 10-24 thumb bolts and the corner bracket is screwed on with two more 10-24 bolts. This is a great little project all by itself. Bolted to the tripod socket of a pair of binoculars it makes them easier to use on any kind of mount.

The rest was even easier. It was built on one leg from an old barbeque. The square tube lent itself to bolting on hardware and the bend was perfect. A short piece of flat bar made the binocular-mount bracket at the top and a short angled bracket made the mirror-mount bracket at the bottom. I put it together and mounted the whole thing on a good, solid photo tripod. I pointed it at a wall, looked through the binoculars and adjusted the thumb bolts until the laser beam hit the center of the field of view. A piece of cake.

It took a long time to get dark.

But when it did the laser was fabulous! It reflected from the mirror and needled into the sky. I turned it to Venus, I put that beam directly on her, I put my eyes to the eyepieces and discovered – that Venus has a sister!

Figure 2 – The green-laser bracket is a nice little project in its own right and has many uses for aiming binoculars or telescopes or even cameras. It is mounted on a standard hardware-store repair angle. The binoculars and laser together bolt to the frame with a purpose-made bracket.

Figure 3 – Both the mirror and the frame show evidence of a former life. They are bolted together with a short piece of angle, cut and filed to suit.

What I really discovered was that an ordinary mirror actually has two reflective surfaces, one on the back, the "second surface" where the mirror coating lies, and another on the shiny face, the "first surface." I discovered that when this mirror is at an angle to the line of sight both surfaces will reflect and both surfaces will form an image and that those images will not line up.

So where am I with this?

This was the Mark 1 version. The arms were short so the mirror was close to the binos. It was compact, but unfortunately the mirror was too close and had to be angled the wrong way. It worked well straight up, but to see the horizon you had to stand on your head. It seemed kind of pointless.

The Mark 2 version is what you see in the figures. The arms are much longer because I hoped to minimize the twin sister effect by increasing the distance between the binocular objective and the mirror. It might have worked had I got it out to a mile or so. It certainly didn't work here.

The Mark 3 version isn't finished yet. It will have somewhat shorter arms than the Mark 2 and, glued right on top of my truck mirror, it will have a "first surface" mirror ordered on the Internet. This mirror will have the silvering on the front surface, which will give only one reflection, and I will be able to search the sky in comfort and Venus will again be alone.

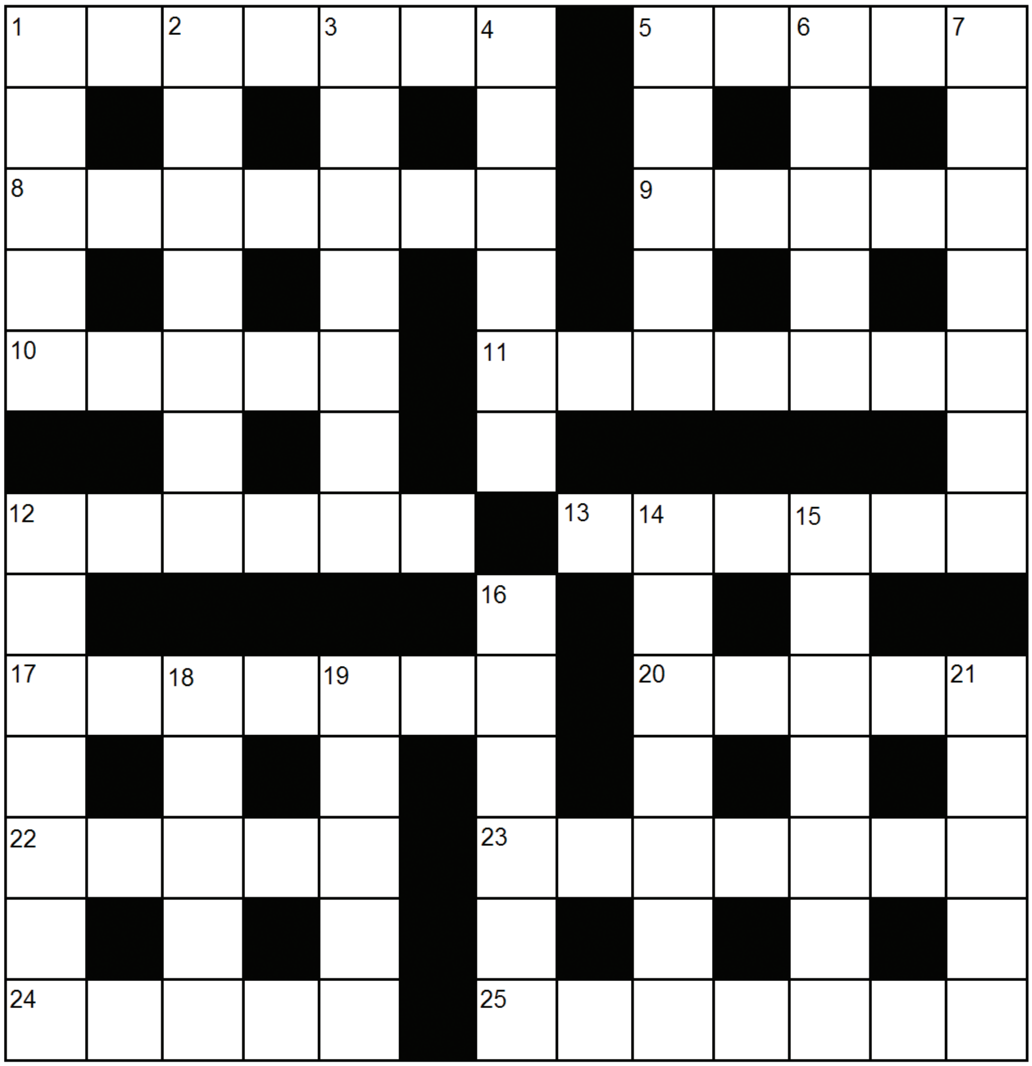
If you build just the green laser bracket, it works equally well on a Dob and makes aiming the Dob a whole new experience.

If you want to build the whole thing, Google "first surface mirror" to see what is out there. You might also Google "binocular mirror mount" to see a few other versions of this project. Look at them all before you decide what yours will be like.

Don van Akker and his friend Elizabeth are members of the RASC in Victoria. They observe from their place on Salt Spring Island. Don would be glad to hear about some of your projects. Contact him at dvanakker@gmail.com.

Astrocryptic

by Curt Nason



ACROSS

1. One may be open to cute SLR arrangement (7)
5. Short department head starts a measurement to the bottom of a crater (5)
8. Wrecked catamaran then nurse left deserted area (7)
9. Farrow lost her head observing Sagitta (5)
10. Castor and Pollux outwit the poles (5)
11. Image shifts so affix a guider (3-4)
12. Transient observing targets somehow cost me dearly (6)
13. Moon located in joint Columbian-Canadian project (6)
17. All sail off to the southern observatory (7)
20. Percival Lowell initially turned out for a KBO (5)
22. Times change around Jupiter (5)
23. Kelly plants a trick after a page in the Handbook (7)
24. I hear a reply received from Alpha Vulpeculae (5)
25. Hot suns turn to brass (2,5)

DOWN

1 Premier editor involved in high-tech antimatter experiment (5)
2. Muse's elementary derivative at no 92 on the table (7)
3. Ran between Titan and Saturn before it could cross the Sun (7)
4. Season began a letter sooner in Paine's age (6)
5. Common star type staggers forward or leaves (5)
6. Mirror glass reveals reflection/emission in Pyxis briefly (5)
7. Matthew is happily hiding the radio astronomy Nobelist's directory listing (6,1)
12. Dove in the heavens to bum coal fragment (7)
14. I set up a misguided orbiter of Saturn (7)
15. A CIA nut oddly dropped from Lacaille's mariner compass (7)
16. Asteroid 80 has pop potential (6)
18. Observing locations to the south with backing of SETI (5)
19. Pointer gives real return around the first of September (5)
21. He produces acorns audibly and news notes (5)

My PST and Me

(Okay, bad grammar but it rhymes.)

by Ken Backer, Mississauga Centre (kbacker@iprimus.ca)

I read somewhere that you haven't really done any stargazing until you have observed the Sun. With that in mind, and looking forward to another area of astronomy, I put in my order for a PST with a local scope store. The happy day came when it arrived, and after making a mount for an alt-az tripod, I was ready to start observing the only star in our entire Universe on which I can see surface features.

PST is short for Personal Solar Telescope. It was put on the market a number of years ago by Coronado as an entry-level scope that opened up solar observing to the average backyard astronomer in the narrow hydrogen-alpha (Hα) wavelength band without breaking the bank. It is in this Hα light that you can see the chromosphere of the Sun and prominences (partially ionized clouds of gas buoyed up and connected to the surface by the Sun's magnetic field). Sunspots visible in white light can also be seen in Hα.

I have had my PST for a couple of years now and if what they say is true – that your favourite scope is the one you use the most – then it is the PST. There seems to be more possibilities throughout the day for observing than in the evening before I go to bed. I'm sure there are often clear skies after midnight, but I seldom have a get-together with my scopes that late (besides, it disturbs the racoons and rabbits frolicking in our back yard). And, daytime observing during the winter is sure warmer than observing after the Sun goes down!

At first, I simply observed the Sun for the sheer enjoyment of it. Prominences, yea, really neat stuff! And, the surface features – dark lines of filaments, sunspots, bright active regions – all were cool to look at. I found it was like going fishing, you never knew what you would catch when you went out. Some days the Sun was as uninteresting as a red cue ball; other times all kinds of things were going on. And, just because I couldn't catch anything in the morning didn't mean something wouldn't be "biting" later in the day. Many prominences would resemble familiar objects, just like the clouds do. Using my imagination, I could see animals, trees, birds, and other items of fantasy. I decided to begin sketching these and to keep a log of what I observed.

I started talking about my solar observing to friends and family, showing interested ones the Sun through my PST, and was surprised to find that most people didn't realize that the Sun was a star, and that everything we observe in our Solar System – planets, asteroids, moons – is only possible because of the light that it emits. People would ask me things about the Sun, and I would ask myself questions realizing I really didn't know much about how this big ball of light worked. I knew gaining knowledge about the Sun would be gaining knowledge about stars in general and would enhance my solar observing.

Learning about the Moon had a kinship with geology, not too bad. Learning about the Sun has a kinship with astrophysics. Now there's a word to scare your average backyard astronomer! Starting from the standpoint of "the Sun is a big ball of hydrogen with a nuclear reactor at its core," I went on from there.

I discovered most good astronomy books that cover our Solar System have a section on the Sun. I found information on the Sun's layers, solar cycles, solar winds, differential rotation, surface features such as sunspots and filaments, prominences, coronal mass ejections, and useful facts, figures, and diagrams. This was supplemented by various Web sites on the workings of our star and observing it in the hydrogen-alpha light part of the spectrum.

James Edgar captured this image on 2010 July 24 with his new Canon S90 camera, shot through the eyepiece of his Coronado PST; f/4.9, 1/125 sec at ISO 80. Adobe Lightroom 3 was used to sharpen the image. While sunspots are absent, as they have been for a couple of years, there is much activity along the limb.

After piecing together all this information, I discovered I had enough knowledge to amaze or bore anyone at a party with statements like, "Due to its differential rotation the Sun's magnetic field becomes distorted, enabling large flux tubes to break through the photosphere creating sunspots." It could also help me fend off the Sun-is-going-to-fry-the-Earth-get-out-the-tinfoil-hats doomsday folks.

True scientifically oriented observers can move up to a book called *Astrophysics of the Sun* by Harold Zirin. From what I understand, this book is good bedtime reading (if you are suffering from insomnia). With this book and other advanced information, you could be the first in your astronomy group to learn the Hale-Nicholson rules of sunspot progression and grouping, how to calculate Zurich sunspot counts, organize prominences and filaments into classifications, work out solar flare statistics, all complete with more formulas and graphs than someone working on an anti-gravity machine.

Which brings me back to my PST. After swimming in the above and throwing myself a life vest I took out my PST, pointed it at the Sun, and said, "Gee, that's pretty!"

But, it did whet my interest in how our star stands up to others in the Universe. According to a diagram by Hertzsprung-Russell, the Sun is classified as a spectral type G2, luminosity class 5. It sits in the middle of the road of the mainstream of stars. It is well behaved, nothing special, does not have a companion, but it is the only star we have, so we should be grateful that it will be around for the next few billion years. If viewed by an observer in a different planetary system it would be just another white field star.

(I wonder if those other-world observers have developed the concept of constellations and our Sun is part of some star grouping that depicts an aspect of their culture.)

The Sun is also the standard for rating the size of other stars, our star being considered "one solar mass." A star's mass has everything to do with its composition, core temperature, how long it lives, and how it ends its life. One of the best and concise explanations for this can be found in the June 2010 issue of *Astronomy* magazine. For those of you into atoms and isotope structures, this article also covers the carbon-nitrogen-oxygen cycle of what makes a star run.

Meanwhile, back at the PST. I am out observing the Sun – and sketching a nice prominence group made up of a short hedgerow, a disparition brusque, and a thing that looks like a chicken – and my mind is going back to some of the scientific facts I have learned about the makeup of our star and other stars. I believe knowledge of what one is observing enhances the experience, like watching the birds at your feeder. What kind of feathered friend is it and what are its characteristics? And I can't help but wonder if on a planet in another system there is an entity out observing their sun (or suns) with some instrument and exclaiming "That's neat!" in whatever language they use.

The PST is a good little scope and it works well. It has sparked my interest in solar observing and the need is there for a larger solar telescope with a longer focal length, larger aperture, and a more narrow hydrogen-alpha band filter. My wife informs me the need is also there for having our bathroom redone... Oh well!

Rather than recommend any books – although *The Cambridge Encyclopaedia of the Sun* is considered to be one of best overall – I am going to include some Web sites that I have visited that will provide plenty of information on understanding the workings of our star and enhance your experience should you add solar observing to your astronomy interests.

`prairieastronomyclub.org/halpha`

`eaas.co.uk/news/solar_features.html`

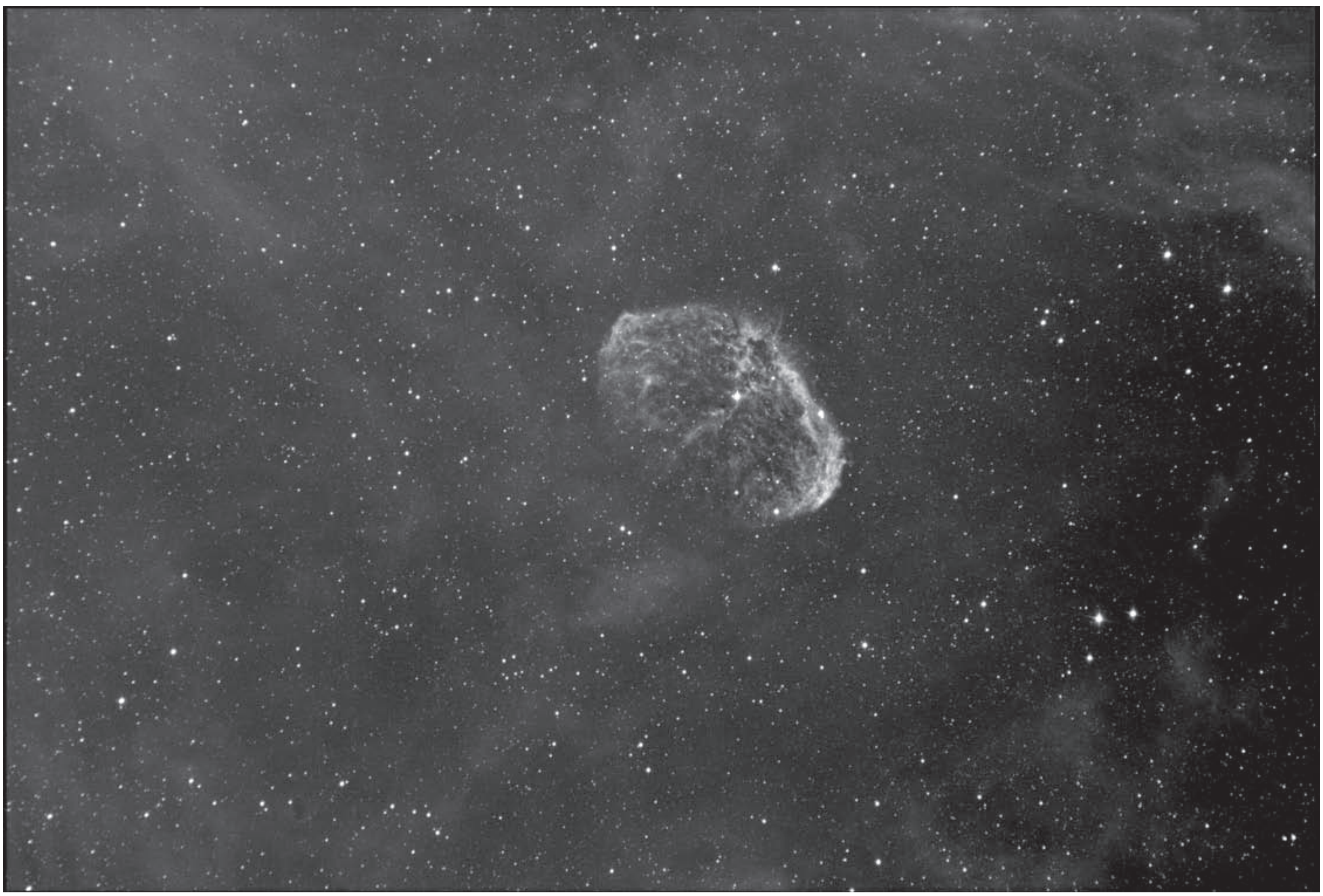
`users.telenet.be/j.janssens/Halha/Halfaeng.html`

`alpo-astronomy.org/index.htm (solar section)`

`spaceweather.com`

Ken Backer is a member of the Mississauga Centre, and gets suntanned observing with his PST from his backyard in Milton, Ontario.

Great Images



Jim Chung trapped the Crescent Nebula in hydrogen-alpha light from his Toronto backyard on July 28 using an f/6 AstroPhysics Traveler telescope on an AP400 GTO mount. The image is constructed from 18 600-second exposures (total 3 hours) taken with a QSI532 CCD camera through an Astrodon 3-nm Hα filter.

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Edmonton Centre
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Vancouver Centre
1100 Chestnut St, Vancouver BC V6J 3J9

Victoria Centre
3046 Jackson St, Victoria BC V8T 3Z8

Windsor Centre
c/o Greg Mockler, 1508 Greenwood Rd, Kingsville ON N9V 2V7

Winnipeg Centre
PO Box 2694, Winnipeg MB R3C 4B3

Great Images

Kevin Black of the Winnipeg Centre waited over 20 years to capture this image of lightning beneath the summer Milky Way. “It was a rare treat to see an intense thunderstorm moving perpendicular to my location, with the Milky Way rising above the storm,” he says. The photo is a 4-minute exposure on a Canon 5D with a lens set at f/4.5 and 31 mm focal length.