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Journal

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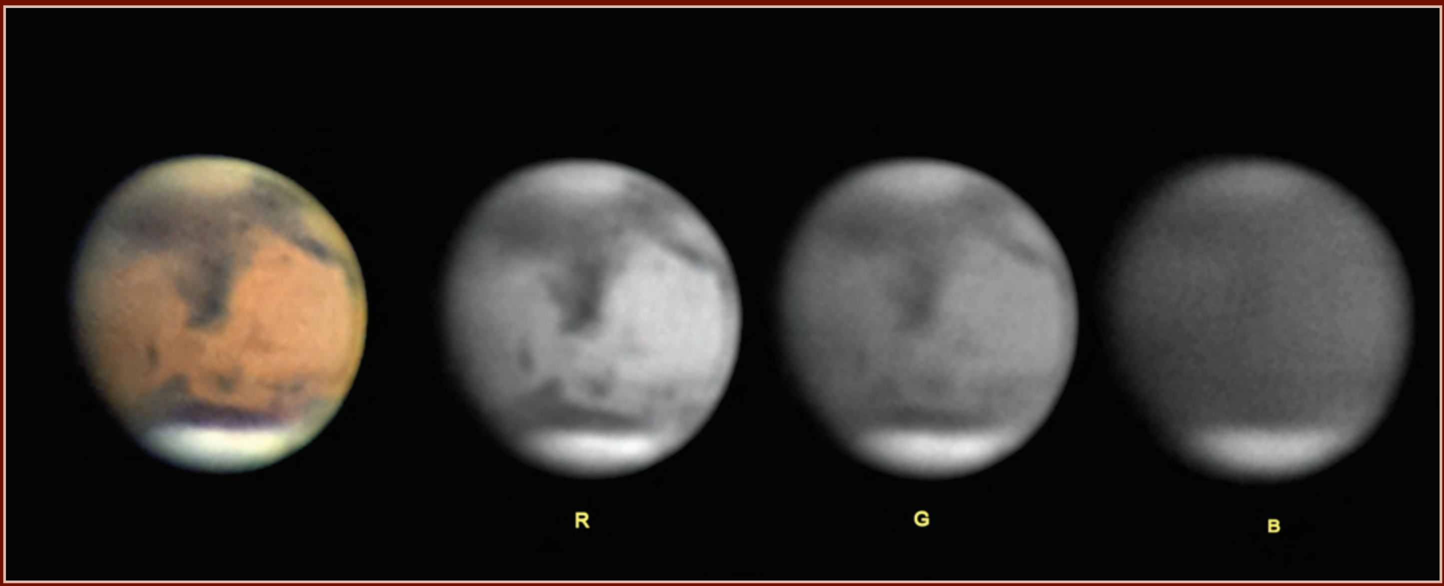

Le Journal de la Société royale d'astronomie du Canada

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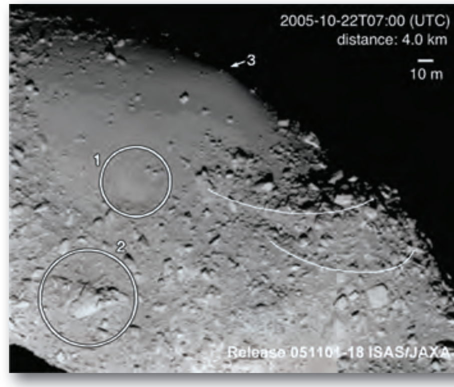

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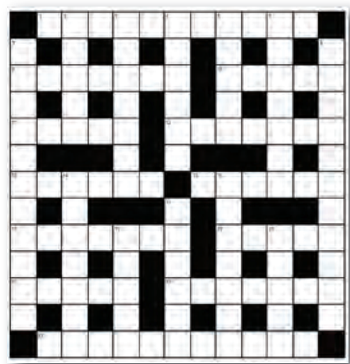

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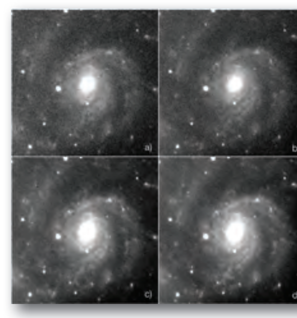

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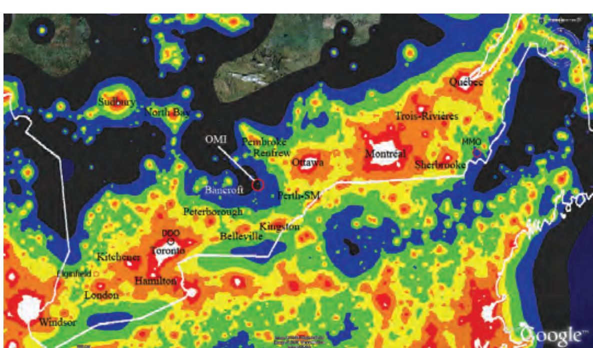

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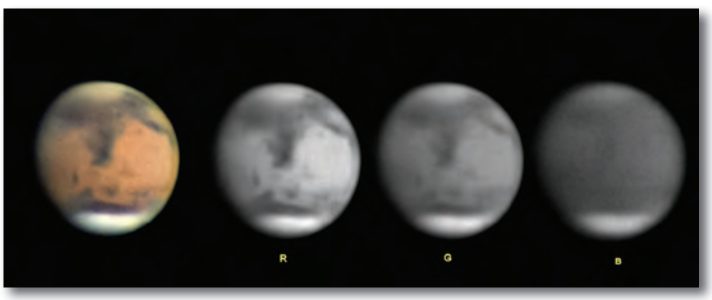

On the Front Cover:
Ottawa Centre's Rolf Meier was gearing up for the current opposition of Mars when he obtained this early image on 2009 December 9. Rolf used a C14 at f/45 and a Luminera SkyNyx 2-0 monochrome camera through Astronomik RGB filters. Mars aficionados will recognize Syrtis Major in the middle of the disk.

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COLUMNS

Executive Perspectives

by Mary Lou Whitehorne, First Vice-President, RASC

There is an old Chinese curse that goes something like this: "May you live in interesting times." There is more than one way to interpret this, of course. However, no matter how you look at it, the last couple of years have indeed been "interesting times" on the RASC National Executive Committee. The Committee has been busy juggling quite a few challenging issues, as we work to put the Society on a stronger footing to move into the future. One of the unfortunate drawbacks has been a necessary curtailing of other, more enjoyable activities in the RASC, like spending time communicating with our Centres and their members. There just are not enough hours in the day!

One thing we have noticed is the existence of a misperception among a number of our members about the "national RASC." Sometimes we hear comments referring to "us" (members and Centres) and "them" (the national arm of our Society). So I must ask the question: who is the national RASC? The answer to this question is four-fold.

1. **National Office:** This is the home of the day-to-day business of our Society. It is the RASC's physical address where records are kept and where a lot of work gets done. It is the hub for all of our financial transactions with members, Centres, subscribers, customers, advertisers, printers, and everyone else with whom we do business. It is the nerve centre for the production and distribution of publications, mailings, membership records, donations, and it's the place where a lot of phone calls and e-mails land. Here is where our one-and-only full-time employee works — Jo Taylor, our Executive Secretary. She is assisted by a part-time membership and publications clerk. It is a busy place!

2. **National Executive Committee:** This is a group of elected members of the Society. They can be from any RASC Centre, or be Unattached Members, and they can be from anywhere in Canada. They are all unpaid volunteers who have spent years working at the Centre and national levels for the good of the RASC. They do not work out of the national office. Most importantly, they are members of our Society and they almost always come from our Centres.

3. **National Council:** National Council is the governing body of the Society, and it carries out the functions and assumes the responsibilities of a corporate board of directors. National Council is made up of the national Executive Committee, the chairs of our standing and special committees, plus the representatives from our 29 Centres. All of these people are volunteer members, and they come from the Centres. In fact, most of National Council is comprised of Centre reps!

4. **National Volunteers:** Did you know that over 50 people volunteer each year to produce the *Observer's Handbook,* and the *Journal* has a volunteer staff of over 25? We also have a dozen

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.

Editor-in-Chief
Jay Anderson
203 – 4920 Dundas St W
Toronto ON M9A 1B7, Canada
Internet: editor@rasc.ca
Web site: www.rasc.ca
Telephone: (416) 924-7973
Fax: (416) 924-2911

Associate Editor, Research
Douglas Hube
Internet: dhube@phys.ualberta.ca

Associate Editor, General
Michael Attas
Internet: attasm@aecl.ca

Assistant Editors
Michael Allen
Martin Beech
Dave Chapman
Ralph Chou
Dave Garner
Patrick Kelly

Editorial Assistant
Suzanne E. Moreau
Internet: semore@sympatico.ca

Production Manager
James Edgar
Internet: jamesedgar@sasktel.net

Contributing Editors
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Suzanne Moreau
Maureen Okun

Design/Production
Brian G. Segal, Redgull Incorporated

Advertising
James Edgar
Internet: jamesedgar@sasktel.net

Printing
Maritime Digital Colour

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The Royal Astronomical Society of Canada
203 – 4920 Dundas St W
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Internet: nationaloffice@rasc.ca
Web site: www.rasc.ca
Telephone: (416) 924-7973
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national committees working on everything from the Society's observing-certificate programs to developing and approving new Dark-Sky Preserves in Canada.

The point I want to drive home here is that the national RASC is its members. It is no more and no less than RASC members. Almost everything that is done in this great Society is done by members, for members. So there really is no "us" or "them." Truth be told, there is only "us."

I will be the first to acknowledge that these are not readily self-evident truths. Our Society is large and has a long history. We have a complicated structure and operating system. All of it is described in our By-Laws and in various policy documents, available to members on the members-only section of our Web site (`www.rasc.ca/members.shtml`). But it's not exactly light reading! For those who care about our Society, it is worth spending some time with these documents to gain a deeper understanding of where we came from, how we got where we are now, and how our organization functions.

We are deeply dependant on the generosity of our member volunteers, whether at the local or national level. The focus of effort, and the point of view, is different depending on whether you volunteer at the Centre level or at the national level. For most of us, the action happens at the Centre level. From here, it's pretty easy to see what's going on, why it's happening, and how it works. Unfortunately, from the Centre level, much of what goes on at the national level is less clear and generally harder to fathom.

This is where your Centre's National Council Representative comes in. He or she is a member of National Council. One of her or his chief responsibilities is to keep Centre members informed and up-to-date on the whys and wherefores of Society activity at the national level.

From the national perspective, everything is done for the benefit of the Society as a whole. That includes our 29 Centres, without whom there would be no RASC. The point-of-view is necessarily different because the RASC is a federally incorporated body that is a registered charity. We are held to a very high standard and we have to abide by the rules as dictated by Canadian law. National Council, led by its National Executive Committee, works to ensure the Society does what it is supposed to do, and maintains its reputation, its integrity, its legitimacy, and its assets. National Council is responsible for the financial well being of the entire Society, as well as for its future stability, growth, and success.

I hope this helps clarify who and/or what the "national" RASC is. Simply put, it is us. I invite you to delve into our governing documents. There you will find a treasure trove of information about us, our history, objectives, what we do, how we do it, and why. Read and enjoy, for someday you may be National President during interesting times!

Quo ducit Urania!

News Notes/ *En manchettes*

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

Second Exoplanet Exhibits Chemistry for Life

Astronomers have detected the basic chemistry for life in the atmosphere of a second hot-gas extrasolar planet.

The Jupiter-sized planet known as HD 209458b is located in the constellation of Pegasus where it orbits a Sun-like star every 3.5 days. Spectral observations using the *Hubble* and *Spitzer* Space Telescopes recorded molecules of carbon dioxide, methane, and water vapour in the planet's atmosphere. Although not habitable, HD 209458b has the same chemistry that, if found around a rocky planet in the future, could indicate the presence of life.

"It's the second planet outside our Solar System in which water, methane, and carbon dioxide has been found, which are potentially important for biological processes in habitable planets," said researcher Mark Swain of the Jet Propulsion Laboratory. "Detecting organic compounds in two exoplanets now raises the possibility that it will become commonplace to find planets with molecules that may be tied to life."

Astronomers detected these same organic molecules over a year ago in the atmosphere of another hot giant planet called HD 189733b. The scientific data now permits astronomers to begin comparing the chemistry and dynamics of the two planets' atmospheres, and search for similar measurements of other candidate exoplanets. The relative amounts of water and carbon dioxide in the two planets is similar, but HD 209458b shows a greater abundance of methane than HD 189733b. This high methane abundance could mean there was something special about the formation of the recently measured HD 209458b.

Impact Data Points to Water on Moon

The *Lunar CRater Observation and Sensing Satellite (LCROSS)*

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.

mission successfully uncovered water on the Moon during the 2009 October 9 impacts into the permanently shadowed region of Cabeus crater near the Moon's South Pole. The collision created by the *LCROSS* Centaur upper-stage rocket resulted in a two-part plume of material rising from the bottom of the crater. The first part was a high-angle plume of vapour and fine dust; the second a lower-angle ejecta curtain of heavier material. Many RASC members in western Canada were watching the Moon at the time of impact, but nothing of the collision was visible to the eye.

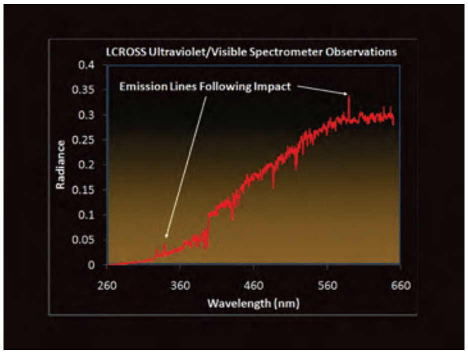

Figure 1 — Data from the ultraviolet/visible spectrometer taken shortly after impact showing emission lines (indicated by arrows). These emission lines are diagnostic of compounds in the vapour/debris cloud. Credit: NASA

"We're unlocking the mysteries of our nearest neighbour and by extension the Solar System. It turns out the Moon harbours many secrets, and *LCROSS* has added a new layer to our understanding," said Michael Wargo, chief lunar scientist at NASA Headquarters in Washington.

Scientists have long speculated about the source of vast quantities of hydrogen that have been observed at the lunar poles. Moon-based water and other compounds represent potential resources that could sustain future lunar exploration. *LCROSS* was launched 2009 June 18 as a companion mission to the *Lunar Reconnaissance Orbiter (LRO)* from NASA's Kennedy Space Center in Florida. After separating from *LRO,* the *LCROSS* spacecraft held onto the spent Centaur upper-stage rocket of the launch vehicle, executed a lunar swing-by, and entered into a series of long looping orbits around the Earth.

It traveled approximately 113 days and nearly 9 million km before the Centaur and *LCROSS* separated on final approach to the Moon. The Centaur impacted the lunar surface at 1.5 miles per second shortly after 4:31 a.m. PDT, 2009 October 9, with *LCROSS* watching with its onboard instruments. Approximately four minutes of data was collected before *LCROSS* itself impacted the lunar surface. NASA scientists estimate that the spacecraft detected 100 kilograms of water.

Paul Mortfield Catches *LCROSS* Crossing

Shortly after *LCROSS'* launch in mid-June 2009, Science@NASA reported that an Ontario-based amateur astronomer had photographed the spacecraft on its voyage to the Moon on June 29, just 11 days after launch. Using a remotely operated telescope, Toronto Centre's Paul Mortfield caught *LCROSS* speeding by spiral galaxy IC 3808. At the time, the spacecraft was some 480,000 km from Earth. NASA had invited amateur astronomers to help track the spacecraft, which would assist the American space agency in precisely determining the position of *LCROSS* in flight.

"I was quite surprised at how easy it was to find and follow using my 16-inch telescope. I didn't know what brightness to expect or even if it would be where the ephemeris predicted — but there it was. I saw it in my first 60-second exposure," Science@NASA quoted Mortfield.

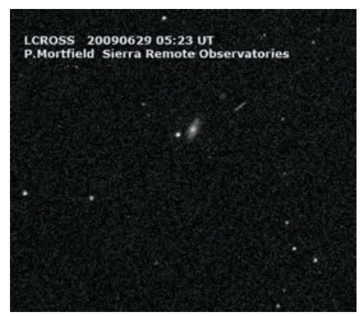

Figure 2 — *LCROSS* (pencil streak seen top, right) photographed on 2009 June 29 by Paul Mortfield of the Toronto Centre. The spacecraft is seen speeding past spiral galaxy IC 3808. Credit: Paul Mortfield

Mortfield estimated the brightness of the spacecraft to be 16th magnitude, similar to that of many near-Earth asteroids. He was not the only amateur astronomer to catch sight of *LCROSS* — Portuguese amateur Paulo Lobao also photographed *LCROSS,* using a 4-inch refracting telescope.

Farthest Galaxy Cluster Identified

Astronomers have uncovered a galaxy cluster about 10.2 billion light-years away in the constellation Cetus. Considered the most distant galaxy cluster yet, it was discovered by combining data from NASA's

Chandra X-ray Observatory, and optical and infrared telescopes.

The galaxy cluster is observed as it was when the Universe was only about a quarter of its present age. It is found at the cusp of when scientists think galaxy clusters can exist in the early Universe based on how long it should take for them to assemble.

The cluster, named JKCS041 beats the previous record holder by about a billion light-years. It was originally detected in 2006 in a survey from the United Kingdom Infrared Telescope (UKIRT). The distance to the cluster was then determined from optical and infrared observations from UKIRT, the Canada-France-Hawaii Telescope in Hawaii, and NASA's *Spitzer Space Telescope.* The *Chandra* data were the crucial piece of evidence as they showed that JKCS041 was, indeed, a genuine galaxy cluster. The extended X-ray emission seen by *Chandra* shows that hot gas has been detected between the galaxies, as expected for a true galaxy cluster rather than one that has been caught in the act of forming. Without the X-ray observations, the possibility remained that the object could have been a blend of different groups of galaxies along the line of sight, or a filament — a long stream of galaxies and gas — viewed front on. The previous record holder for a galaxy cluster was 9.2 billion light-years away.

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

Figure 3: The most distant galaxy cluster yet discovered some 10.2 billion light-years from Earth by combining X-ray data from *Chandra* plus optical data from the Very Large Telescope with optical and infrared data from the Digitized Sky Survey. X-rays are in blue, while the individual galaxies in the cluster are white in the optical/infrared data. Credit: X-ray: NASA/CXC/INAF/S.Andreon *et al.* Optical: DSS; ESO/VLT.

Feature Articles

Mass-Wasted Periglacial Features on Asteroid 25143 Itokawa Matched with Earth Analogues

W.C. Mahaney
Quaternary Surveys
26 Thornhill Ave
Thornhill ON Canada L4J 1J4
arkose@rogers.com

Abstract: Analysis of imagery from asteroid 25143 Itokawa released by the JAXA Science Team reveals prominent cold-environment mass-wastage landforms similar to those on Earth, including debris flows, patterned ground, stone-banked lobes, and talus. These morphological entities, not previously recognized in the published literature from the *Hayabusa* mission to Itokawa, are of significance because in the terrestrial environment they indicate the presence of permafrost and periodic release of meltwater. Given known orbital changes and high variation in aphelion and perihelion of Itokawa, the existence of periglacial landforms suggests periodic, if not episodic, changes in surface thermal characteristics of sufficient magnitude to melt permafrost. The presence of landforms requiring moisture further suggests that asteroids may have a detailed paleohydrological record, and with it, the possibility of either extant or fossil microbial life. Future sampling missions to asteroids should consider targeting evidence for water release and associated large macro-scale landforms.

Introduction

The assumption that impacts on asteroids result in poorly sorted, near uniform, and continuous sheets of regolith, with little differentiation beyond vibrational sorting leading to segregation of fines and coarse debris (Miyamoto *et al.* 2007), may have to be reassessed with the recent release of imagery (Figures 1-5) from the *Hayabusa* mission to Itokawa (`www.jaxa.jp`). Regolith here is used in the same sense as on Earth, referring to unconsolidated, undifferentiated, and largely incoherent loose rock material mantling bedrock, often partly weathered and with a surface soil in terrestrial environments. In the case of Itokawa (Miyamoto *et al.* 2007; Asphaug 2007), the entire mass on the asteroid is a loose assemblage of mineralic debris (Abe *et al.* 2006), of basaltic composition, ostensibly indurated with a high porosity of 30-40 percent (Cheng *et al.* 2007). Analysis of regolith evolution at the asteroid surface, however, reveals landform distributions apparently unrecognized by the JAXA science team and others who

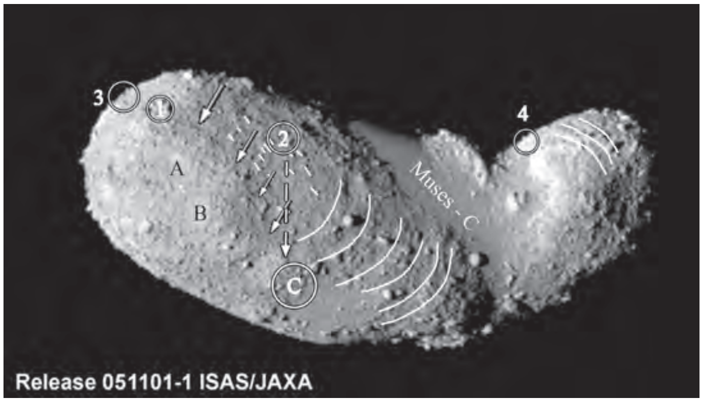

Figure 1 — Boulder mounds (1, 2, 3, and 4) with debris-flow levees following a course from (1) marked with solid arrows, ending at C. The mass-wasted feature is ~250 m in length with the levees visible on the available lower-resolution imagery. The boulder mound at (2) leads into a series of parallel channels that could either contain debris flows, which are beyond the resolution of the image, or are catchments that have directed meltwater toward sink C. Craters are the lighter areas marked A and B, presumably of a young age as depicted by lack of space weathering and retention of rim form. Lobate-shaped forms of pseudo-stone-banked lobes are delimited with parabolic curves to the right of the channels and to the left of the Muses-C area — a large depression infilled with fine gravel and sand, nearly devoid of large clasts. To the right of the Sea of Muses, the light-coloured channels, oriented north-south, originate in a mound of boulders at the top of the image, and may well mark meltwater release flooding to the south. Clast orientation similar to talus on Earth is shown with white lines oriented to southeast. Source: 051101-1 ISAS/JAXA.

Figure 2 — Other mass-wasted sites are shown on the reverse side of Itokawa on image 051101-2, courtesy ISAS/JAXA. The circles (1, 2, and 3) outline rubble piles where troughs originate leading along slopes at variable distances through mixed chaotic terrain with channels winding around large boulders, as on magery from the *NEAR-Shoemaker* (2000) descent. One area right of centre, marked C, appears to be a sink. Arrows indicate troughs that may contain levees marking the outline of debris flows. Stone-banked lobes are indicated with parabolic lines.

have interpreted the available data.

At the end of November 2005, the *Hayabusa* spacecraft carried out a series of remarkable engineering feats, including precise navigation tests and two touchdowns on the asteroid surface, the latter sufficient to collect a small sample for return to Earth (Miyamoto *et al.* 2007). While the resolution of imagery taken by the cameras aboard the spacecraft is at a scale/resolution only sufficient to identify major and some minor landforms amidst the collection of rubble on the asteroid surface, some of the regolith is well segregated into distinct landform assemblages as shown in Figures 1-5. Earth-analogue examples of these landforms are illustrated in Figures 6-7 with information pertaining to their individual terrestrial environments.

Methods

The space imagery was provided by JAXA (Japanese Aerospace Exploration Agency). An arbitrary navigation field was established on Itokawa to set up an N-S field so azimuths could be calculated on a 0-360-degree polar diagram. Inclinations were established between 0 and 27 degrees taking the established maximum slope at 27 degrees (Scheeres *et al.* 2004) off the horizontal. Interpretation of periglacial landforms on Itokawa is based on representative landforms on Earth as shown in Figure 6A-E. Age of landforms on Itokawa follows estimates of tonal contrasts on imagery from old (dark) to young (light) on a relative-age scheme, based on nanophase Fe development as outlined by Hiroi *et al.* (2006). The fabric analysis from the terrestrial imagery was carried out with a Stereo32, version 0.9 program, copyrighted by Klaus Röller and Claudia Trepmann, Ruhr-Universität-Bochum, Germany, and freely available for educational purposes.

Results and Discussion

Grain-size calculations carried out (Miyamoto *et al.* 2007) indicate that the surface is covered with unconsolidated gravels, often as imbricated sheets as in streambeds on Earth. Fines are either electrostatically elevated and lost to space by solar-radiation pressure, ejected following impact, and/or taken up by filling holes created by enveloping larger gravels. The three major "smooth terrains" identified on Itokawa, the largest being the Muses-C region, act as topographic lows for the accumulation of fine-grade-size material, with slopes <8°. Above these depressions, the larger-size gravels, consisting of pebble- through boulder-size clasts, are aligned with directions parallel to local slope and gravity, their present spatial

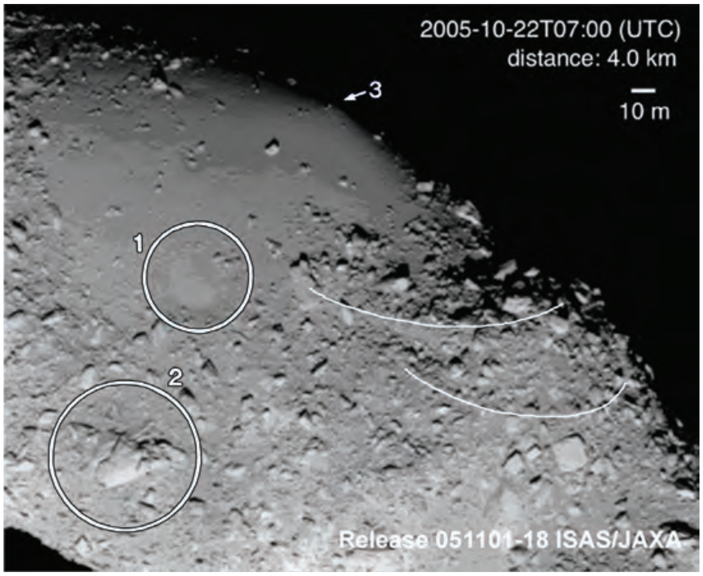

Figure 3 — Mixed coarse/fine material feeding into the sand/fine gravel depression is shown at the bottom of Figure 1, with the imagery at a slightly higher resolution. Site 1 shows an impact crater with fine material in centre, and coarser material beyond the rim; site 2 circles a 30-m-long clast with light bottom and darker top that could relate to shadow of incoming solar radiation or space weathering; and site 3 shows a small boulder in the sand/gravel sea. The clast in 2 is oriented with other clasts below it, the a-axis pointing northeast along an arbitrary horizon into the depression. The gravel mounds to the right have the distinct character of a stone-banked lobe, the front of which appears to be sliding into a depression. Both the up-lobe and down-lobe flanks show only chaotically oriented clasts quite apart from what is shown to the left in the figure. Source: 051101-18 ISAS/JAXA.

pattern compatible with prevailing slope and/or vibrations caused by meteorite impact. Granular convection models (Miyamoto *et al.* 2007), which explain gravel distributions on Itokawa, are supported by laboratory experiments on vibration tables and models of global shaking from meteorite collisions (Bruzzone *et al.* 2008). All these experiments and models rely on smaller particles descending along a slope angle that falls within the friction angle of the particles. Despite the higher inclination of coarse terrain (Scheeres *et al.* 2004), such particles remain in areas of higher gravitational potential (Fujiwara *et al.* 2006) until a future impact event results in their movement.

Despite the coarse accumulation of gravels into mounds and ridges, as shown in Figures 2B, C, and D in Miyamoto *et al.* (2007), there are also areas with pebble debris and finer matrix material, including sand and possibly finer silts and clays in Figures 2A, E, and F as presented by Miyamoto *et al.* (2007). As indicated, not all fine material escapes into convection cells below the asteroid surface. The corollary of rough terrain with landslide surfaces on Earth matches only part of the surface jumble of clastic debris shown in Figures 1 and 2, and in the higher-resolution imagery interpreted by Miyamoto *et al.* (2007). The remainder, where strong long-axis clast orientations match the slope, is more analogous with talus accumulations on Earth [although the slope angle is <27º (Scheeres, *et al.* 2004)], where gravity/slope-induced migrations of clasts are clearly different from the upended, shingled nature of stream beds (Miyamoto *et al.* 2007). There is a bit of both on the chaotic terrain, and presumably areas on the asteroid are partly in recovery from the last vibration event or permafrost melting event, and others are partially-sorted, where a small micro-gravity component has redirected the down-slope movement of clasts toward local depressions.

Coarse accumulations of large gravels into mounds and ridges on Itokawa is, in places chaotic, as indicated above, while in others grouped into forms resembling stone-banked lobes (Figures 1 and 3), landforms often observed in periglacial areas on Earth. Additionally, the presence of polygonal ground (Figure 4) argues for an active layer, complete with segregated ice lenses capable of sorting clastic material. These landforms on Earth owe their origin to a source of coarse and fine clastic debris, either sourced from moraine material or from mass-wasting processes, such as solifluction (Mahaney and Spence 1984; Viera and Ramos 2003). Similar structures, although with less relief, are present in the Dry Valleys of Antarctica (Mahaney *et al.* 2001) and all bear a close similarity to ridges on Itokawa. Given the close correspondence between mean surface temperatures on Itokawa (-73 °C) and in Antarctica (-65 °C), it is plausible that similar forms may equate to similar processes, the cold, dry climate of Antarctica (Mahaney *et al.* 2000, 2001) being not that different from the cold, barren, dry-frozen world of Itokawa. While permafrost likely assists in the development and evolution of stone-banked lobes in the middle-latitude mountains of Earth, and polar areas as well, current models of asteroid evolution do not consider the possibility of permafrost, or that of an associated active layer, occasionally forming due to a minor or major change in incoming radiation.

Close examination of Figure 1 shows chaotic mounds of large gravels. In the upper left of Figure 1, a debris-flow trough is observed, following a circuitous route approximately 250 m from northwest to southeast (direction on the figure is calculated using an artificial horizon to navigate from the source to termination). The boulder mound might owe its relief to fine material atop permafrost, with the active layer accumulating moisture and heaving, much as in boulder-cored frost boils (Harris & Matthews 1984) and polygons on Earth. Branching off the chaotic boulder mound, levee ridges on either side of the main drainage trough, outlined in the figure, show a distinctly finer texture than the terrain through which the debris-flow channel is cut, thus suggesting lower-flow regime, clast-charged meltwater discharge. The very fact that debris flows exist on Itokawa indicates the presence of permafrost, a frozen sediment bed over which meltwater could flow, suggesting at least one cycle of warming that produced sufficient discharge of meltwater to send a charged liquid mass down-slope for a considerable distance. Even if the debris-flow channel bed were to thaw, meltwater could flow easily over terrain shown in the close-up imagery of Figures 2A, E, and F in Miyamoto *et al.* (2007), where bulk density of the sediment appears high enough to retain moisture, not unlike debris flows in the tropical mountains of Earth (Mahaney 1990; Figure 6A). The fact that the levees remain in place argues for a recent age, as meteorite bombardment would have rearranged clasts into random or oriented clast distributions on the slope.

From another boulder mound to the north of the debris-flow system shown in Figure 1, a series of longitudinal ridges and troughs lie oriented south toward the near-termination area of the debris flow at site C (outlined with a black/white circle). These forms resemble channels cut by water, and their orientation indicates termination may be a sink area, where moisture generated by changes in the surface thermal regime of the asteroid is channelled. The retention

Figure 4 — Sorted nets, indicative of polygonal ground (marked by circles), representing present/former active-layer movement of clasts in permafrost.

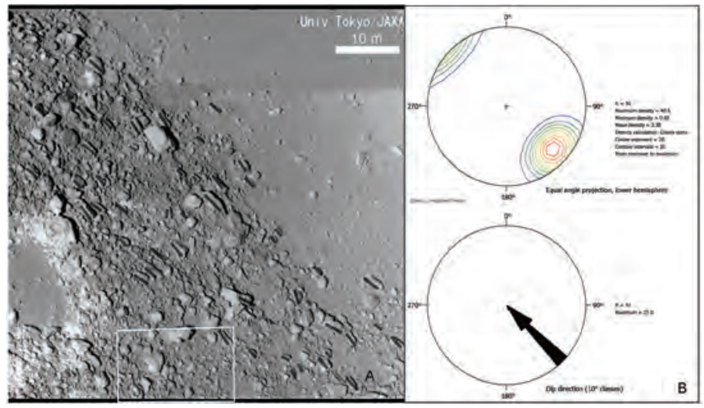

Figure 5 — A: Talus on Itokawa with clast azimuthal orientation marked in black; B: Clast orientation marked on arbitrary grid system with north at top of the image. Fabric analysis shows a narrowly constrained southeasterly vector approximately oriented 140° azimuth.

of water to the asteroid surface to offset the vacuum of space is explained below by recourse to chemisorption, particle energy, and crystal defects.

The terrestrial analogues shown in Figures 6A-E are from correlative terrestrial environmental settings that relate to the landforms extant on Itokawa. Figure 6A shows a debris flow on Mount Kenya (Mahaney 1990), in the Afroalpine area below the Lewis and Tyndall glaciers at 4200-4300 m a.s.l. Organic carbon from buried soils beneath the debris-flow levees yielded an uncorrected age of 920 ± 100 ^{14}C yr BP (GaK-11240). The levees probably formed from meltwater release from a mid-Neoglacial-age glacier retreat.

The stone-banked lobes in Figure 6B are formed from solifluction mass wasting (Mahaney, 1987) and have probable Neoglacial ages (<5 ka). In nearby localities on Niwot Ridge, forms such as these override 10 ka dated paleosols (Mahaney and Fahey 1980), formed in older solifluction debris. As on Itokawa, landforms like this require meltwater for lubrication and frost riving and/or glacial debris as source material. On Earth, gravity is the driving force, whereas on Itokawa microgravity affords only a minute driving force with slope providing only a coarse vector for movement.

Polygonal ground (Figure 6C), shown here at 3730 m a.s.l. on Niwot Ridge in the Colorado Front Range, is formed in regolith of Late Glacial age (10 ka) with little relief, but similar texture of lithic materials as illustrated on Itokawa. On Earth, the inner core of polygonal ground is mixed with minor organic carbon, whereas on Itokawa (Figure 4) the lithic materials presumably lack any appreciable organic carbon, although small amounts are possible. These terrestrial mass-wastage features formed when a central ice core was active, providing outward movement of coarse clastic material to form the ring-like structures. Lichen cover on the terrestrial clast-ring structures carry a plus 50-percent cover, indicating the polygonal ground was probably last active sometime in the mid-Neoglacial, when climate was colder.

Talus on Earth (Figure 6D), perhaps one of the most prevalent landforms in periglacial terrane, is the product of frost riving and accumulation of conical structures on valley sides. A slow creeping form of rubble with clasts oriented down-slope in response to gravity, talus fabric on Earth shows narrowly constrained azimuthal orientation (Figure 6E), while on Itokawa with clasts responding only to microgravity (millionths that of Earth), fabric is remarkably directed downslope even if the azimuthal range is somewhat greater than on Earth (Figure 5A site; Figure 5B fabric).

The evidence for the presence of water in isolated areas on Itokawa is something of a puzzle as to what produced the melting. At 0.19, the albedo of the asteroid is low, which implies that solar absorption is high when orbital variations take it across Earth's orbit and nearer to the Sun. The wide variation in perihelion (0.9533) and aphelion (1.6948) (`http://NEODyS25143-Itokawa`) leads to variable radiation receipt, possibly strong enough, when accompanied by solar-radiation outbursts, to melt underlying permafrost, thereby providing sufficient moisture to initiate mass-wasting events. Even if the asteroid has a paleohydrological record, it may have been necessarily short-lived, as seismic/vibration events will lead eventually to the redistribution of spatial networks of clasts, either randomly dispersed or aligned with the regional slope, *i.e.* talus-like terrestrial bodies (Perez 1989).

The presence of water/ice on Itokawa should come as no surprise, as ice is known in Eros (Bell and Mitton 2002), suspected in 4 Vesta (Asphaug 2007), and water/ice has been detected in asteroid 24 Themis (Campins *et al.* 2009). Confirmation of water/ice on 4 Vesta will come after spectral analysis of the asteroid when the *Dawn* probe arrives in 2010. As indicated by Humberto Campins and his group (Campins *et al.* 2006), the presence of water on the 24 Themis surface, as confirmed by near-IR spectra measurements over an entire rotational period, suggests among other things that previous impacts with water-laced asteroids might explain Earth's great amount of water. Further, what does the presence of water on 24 Themis indicate about its interior and the interior of Itokawa? Since water on 24 Themis is considered unstable, as on Itokawa, what is its source and age? Is chemisorption of water sufficient to overcome the vacuum of space? Moreover, since comets have bathed numerous asteroids for billions of years, recent investigations of the nuclear spectra of comet 162P/Siding Spring (2004 TU12) (Campins *et al.* 2006) indicates the presence of carbon compounds, organics, and silicates, suggesting remotely that the presence of life on Itokawa is something to consider. When living vegetative cells of bacteria genera are exposed to severe environmental conditions, they undergo sporulation and generate endospores (ex. *Bacillus subtilis*), which endure high-temperature extremes, including freezing, desiccation, radiation pulses, shock acceleration (Moeller

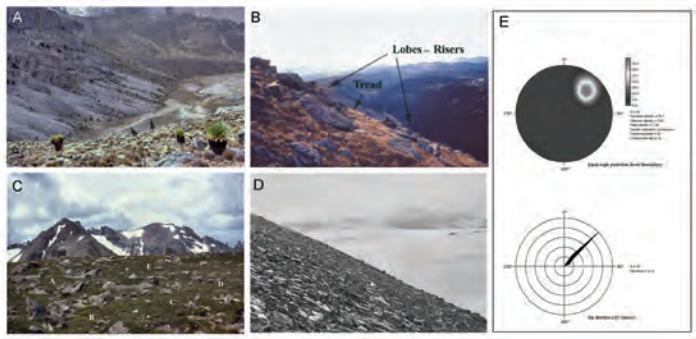

Figure 6 — Earth analogues of landforms observed on Itokawa: A: Debris flow on Mt. Kenya (Mahaney 1990), ~4200 m a.s.l., Teleki Valley, west flank of the mountain — age 960 ^{14}C yr BP; B: Stone-banked lobes, flanks of South Arapahoe Peak (~3500 m a.s.l.), Colorado Front Range, Middle Boulder Creek in middle ground, view to east.; C: Polygonal ground, Niwot Ridge (3739 m a.s.l.), D-1 station, Colorado Front Range; D: Talus below New Mountain (2100 m a.s.l.) astride the Taylor Glacier, Antarctica, with clast orientation marked in white; E: Narrowly constrained fabric analysis of the talus shows azimuthal orientation down-slope to the northeast.

et al. 2008), and biotoxic substances that would kill vegetative cell bacteria. Being metabolically inactive, endospores could endure long periods of space travel, although there are limitations (see Weber and Greenburg 1985). Hence, they are seeds waiting to encounter a favourable environment for growth.

Conclusion

Because water is the only geologic agent capable of producing debris flows, it may well be an agent that assists in the minor lubrication of stone-banked lobes in other areas on the Itokawa surface (Figure 3). Moreover, the presence of liquid water on what is considered to be a barren, dry world opens up the possibility of the presence of microbes (Mahaney *et al.* 2001), either extant or fossil, the probability of which is enhanced by the asteroid lithology where Fe exists in ample supply. As indicated by optical measurements (Hiroi *et al.* 2008), which show higher amounts of nanophase-Fe on darker patches of Itokawa relative to lighter surfaces, the chondrite olivine-pyroxene composition (Abell *et al.* 2007) is a lithology conducive to the development of microbes. As microbe physiology requires water in liquid form, together with iron for respiration processes, it might behoove asteroid researchers working on Itokawa to focus on the chemical composition of light-toned surfaces to determine if salts are present. Adsorption of water to surface clasts in the vacuum of space might be explained by recourse to surface particle energy, mineral orientation, pore presence, crystal defects and dislocations, and chemisorption (de Leeuw *et al.* 2000; Stimpfl *et al.* 2006; McFadden *et al.* 2007). Much as in the Dry Valleys of Antarctica (Mahaney *et al.* 2001), concentrations of salts in the near-surface environment of Itokawa would lower the freezing temperature of water to a point where microbial colonies might evolve and persist.

Acknowledgments

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Glossary

Clasts: Pieces of broken-down rocks.

Debris flow: Rapid flowage of mixed debris resulting from sudden torrential downpour in mountainous areas on Earth or possibly from melting of permafrost on Itokawa.

Imbricated gravels: Tabular clasts that overlap one another as shingles on a roof. In a stream bed, the effect of stream flow on flat pebbles is to align them in the down-flow direction.

Late Glacial: Time period at the end of the last glaciation on Earth, stretching from 12 to 10 ka.

Patterned (polygonal) ground: Sorted network of boulders, cobbles, and pebbles into circles, polygons, steps, and stripes characteristic of frost action in frozen ground.

Regolith: Unconsolidated, undifferentiated, and generally unweathered debris above bedrock. If weathered, regolith may be referred to as weathered regolith, soil, or paleosol material.

Solifluction: A type of mass wasting where waterlogged sediment moves slowly down-slope.

Stone-banked lobe: Mainly coarse clastic material forming lobes of frost-shattered debris. Often related to rearrangement of mass-wasted and till sediment, they have variable dimensions located on slopes of 5 to 20 degrees. The slow-moving mass is assisted by gravity and melting of permafrost. On Itokawa, with a fraction of Earth's gravity, clasts are presumably rearranged by slope configurations into azimuthally aligned masses.

Talus: Slope debris consisting mainly of coarse material formed by mass wasting. On Earth, talus generally forms a cone structure at the base of a steep declivity (downward slope). On Itokawa, with subdued relief, talus forms by rearrangement of clastic debris either from impact or from space weathering.

Pixellations IV — On the Merits of Long versus Many Short Exposures

by Jennifer L. West (westjl@cc.umanitoba.ca) and Ian D. Cameron (icamern@cc.umanitoba.ca), Winnipeg Centre.

Over the years, we've heard a lot of "opinions" as to whether a single long exposure is "better" than multiple short exposures stacked together. Richard Berry and James Burnell state in their book, *The Handbook of Astronomical Image Processing,* that "Under a dark sky, rather than shooting 60 integrations of 1-minute each, it would be better to take 10 integrations of 6 minutes each."

The authors assert that longer exposures are better because "each time you read out an image from the CCD, the sensor's amplifier adds another dose of readout noise to the signal." They point out that while taking a very long exposure (greater than 20 minutes) with a CCD is problematic due to guiding errors, build-up of dark current, hot pixels, saturation, and blooming, it is still best to take the longest possible single image feasible with one's equipment.

There are however many advantages of taking shorter exposures. These advantages include reduced tracking errors and the fact that each exposure represents a smaller time investment, so that if something goes wrong during an exposure (headlights, airplanes, cosmic rays, *etc.*), you have lost less time. Dark frames take up less of the night — instead of ten 20-minute darks, you may need to capture only ten 2-minute exposures. Short exposures also reduce the likelihood that very bright field stars will become saturated and introduce blooming errors. Lastly, taking many short exposures allows you to select the very best frames for inclusion in the final image, to its ultimate benefit.

Computer storage and processing power is another factor to consider. A large number of individual exposures can soon escalate into an unwieldy amount of data that require efficient management. Fortunately, hard-drive capacity and fast processors are relatively inexpensive and so this is not an impossible obstacle, though an automated workflow becomes essential when processing large numbers of images. The batch processing capabilities of software such as *ImageJ* are a lifesaver in these cases!

So the question we have, in practical terms, is *how much* of an advantage is it to take few long exposures versus many short exposures? Does this advantage outweigh the benefits offered by taking many shorter exposures? To test this question, we compared the results of summing many short exposures to summing fewer long exposures (or a single long exposure).

Our comparison involved examining the object-to-background ratio. In a digital camera, the target object will contribute photons that are collected at some level (counts) on the frame. The sky also contributes photons, which are detected as the background level in an image. If the object contributes more photons than the sky, then we will be able to distinguish the object from the background. A critical value that can tell us the quality of our image, then, is the difference between the signal level and the background level.

On the night of 2009 April 5, we imaged the spiral galaxy M101 for this experiment using the University of Manitoba's Evans 40-cm f/11 telescope located at Glenlea Astronomical Observatory. Our camera was a monochromatic Apogee AP47/U47 CCD cooled to a temperature of -36 °C.

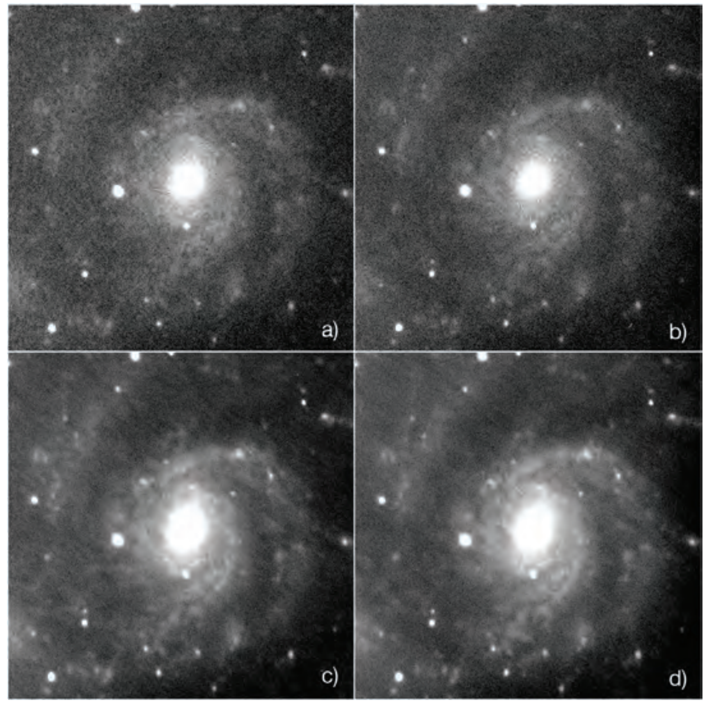


Figure 1 — Total exposure time 300-seconds (a & b) and 1500-seconds (c & d) of M101 taken on 2009 April 5 with an Apogee U47 CCD camera.

Figure 1a — A single 300-second exposure.
Figure 1b — Combination of five 60-second exposures.
Figure 1c — Combination of five 300-second exposures.
Figure 1d — Combination of twenty-five 60-second exposures.

We acquired thirty-five 60-second exposures and five 300-second exposures, along with appropriate bias, darks, and dark-sky flat-field frames. The data was processed using *ImageJ*. All images were converted from 16-bit integer to 32-bit floating-point format to eliminate integer rounding errors and to allow values greater than 65,535.

First, we created a master bias from an average of ten bias frames. Five each of both 60- and 300-second dark frames were obtained, bias-subtracted, and averaged to create master darks. Master dark-sky flats were created as described in West & Cameron (2008). The data frames were then dark subtracted and divided by the master sky flat.

We compared a single 300-second exposure to the sum of five of the thirty-five 60-second images (the selection of images was made such that the full-width at half-maximum (FWHM) would be most comparable). In addition, all five of our 300-second exposures were combined and compared to the sum of twenty-five of the 60-second images (Figure 1).

We measured the mean and standard deviation of an area of the image that contained mostly "sky"; *i.e.* as little emission from the galaxy as possible. We also plotted a profile diagonally across the image through the centre of the galaxy's bulge to see how the signal in the galaxy compared to the level of the sky background.

In both comparisons, we found that the combination of many short exposures had a higher overall value for the background level than did the comparable long exposures. However, the signal level for those short exposures (emission in the region of the galaxy) also had a higher value, such that in both cases, long or short exposure, the difference between background and signal was virtually the same.

The results of this experiment indicated that there was no significant difference between combining many 60-second exposures or fewer 300-second exposures to arrive at the same final cumulative exposure time. What would happen if we attempted the same experiment with even shorter exposures? We surmised that there may be some minimum threshold exposure that we had crossed with our 60-second exposure and that was important in the substitution of short exposures for longer. Since the camera we used was a cooled, professional-grade instrument, it may be that it is sensitive enough that 60 seconds provides a sufficiently long exposure time to cross that threshold. That may not be the case with, say, a commercial DSLR camera. Thus, we decided to repeat the experiment using even shorter exposures, with the Apogee and also with a commercially available camera.

We conducted the second experiment on the night of 2009 November 22. The sky-quality reading on that night was 20.4 mag/arcsec^2. Our target was the spiral galaxy M74 (the "phantom" galaxy). M101 and M74 are both diffuse, face-on spiral galaxies with comparable low surface brightness (Table 1). Their surface brightness makes them challenging objects to image and thus perfect targets for this experiment, since we are testing to see if we can find a minimum threshold of detection.

	Size (arcmin)	m_v	Surface Brightness (mag/arcsec^2)
M101	26′ × 26′	7.9	23.6
M74	11′ × 11′	9.4	23.2

Table 1 — Comparison between the face-on spiral galaxies M101 and M74. Although M101 has a higher integrated visual magnitude than M74, their difference in size means that their surface brightnesses are nearly identical. This makes the two galaxies comparable for use in our test. In addition, their low surface brightness makes them challenging targets in our semi-rural sky (sky quality on 2009 November 22 was 20.4 mag/arcsec^2). Data is from the *Observer's Handbook 2009*.

We once again used the Evans 40-cm f/11 telescope and the Apogee camera cooled to a temperature of -40 °C. This time we collected thirty 10-second exposures, five 60-second exposures, a single 300-second exposure, and a complete set of calibration frames (bias, darks, and dark-sky flats).

In addition, we also collected data using a Canon 20Da DSLR camera attached to a Celestron 8-inch Schmidt-Cassegrain telescope. The images were shot at medium resolution (3504x2332) in RAW mode. The ISO was set to 1600 and noise reduction was turned off. We collected forty-five 15-second exposures, twenty-five 30-second exposures, twelve 60-second exposures, and a single 300-second exposure. We also collected calibration frames with the Canon camera.

The Apogee images were processed as described for the April 5 experiment. We compared the sum of the thirty 10-second images to the sum of five 60-second images and to the single 300-second image. As before, we found that the background level in the single exposure had an overall higher value than the background in the summed images. However, the difference between the signal and the background was nearly identical in all three cases (see Figures 2, 3, and 4). The combination of the thirty 10-second images had a slightly lower signal (~7% lower), and visually the image looked slightly noisier. We believe that even these differences will diminish if a greater number of images is combined.

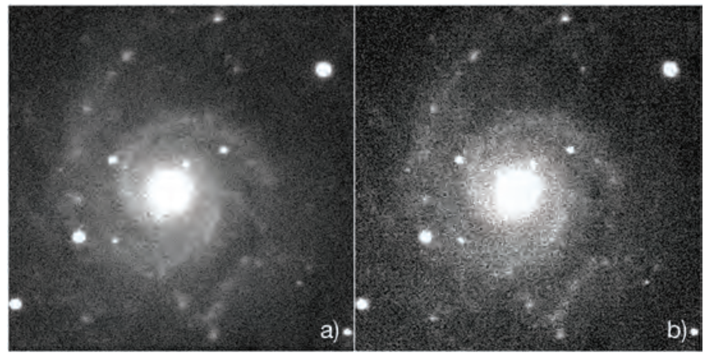
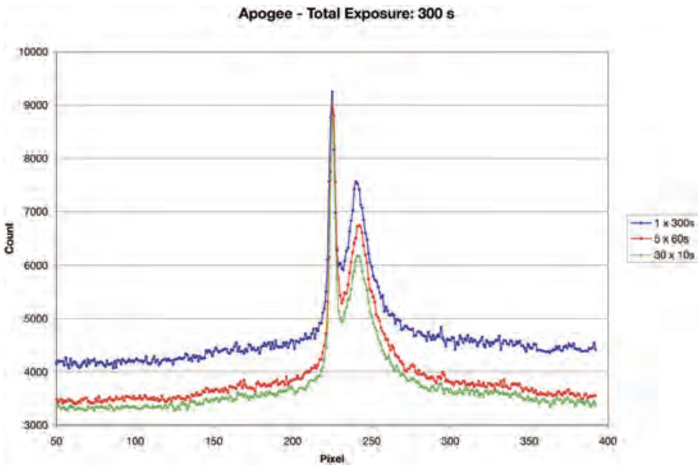


Figure 2 — Total exposure time 300-seconds of M74 taken on 2009 November 22 with an Apogee U47 CCD camera.

Figure 2a — Combination of five 60-second exposures.
Figure 2b — Combination of thirty 10-second exposures

We converted the RAW Canon images to 16-bit TIFF files using Apple's pro image-management software, Aperture. We then separated the images into the individual red, green, and blue colour channels using a batch-processing macro in *ImageJ*. We also cropped the images around the centre of the galaxy. Upon examining the calibration frames, it was clear that we could not use them for calibration since many of the pixels had a value of zero. This indicates that the Canon camera actually has a gain or threshold value below which no detection will register. As a consequence, the dark frames have so little signal, that many if not most of the pixels record a count of zero. This is an artificial zero level that is set by the Canon firmware, as all sensors will have at least some "dark-current" or thermal noise generated within the chip itself. When these zero values are substituted by the firmware, we have lost data, and so we cannot use those images for a correction.

Therefore, we restricted our experiment with the Canon images to the raw, unprocessed data. In addition, we compared the individual colour channels in order to retain the 16-bit data. We evaluated images consisting of the sum of twenty 15-second exposures, ten 30-second exposures, five 60-second exposures, and a single 300-second exposure. Figures 4, 5, and 6 show the results of these comparisons for the green and blue channels. The chip has different sensitivities to red, green, and blue light, being least sensitive in the blue channel. We chose to show you the results in the green and blue channels; the red channel has a signal intermediate to those two.



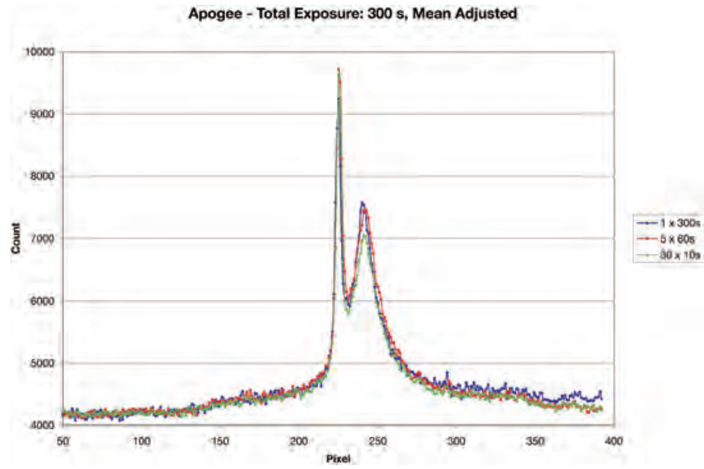


Figure 3 — Cut across the centre of M74 comparing the single 300-second exposure to the combination of five 60-second exposures and thirty 10-second exposures November 22 using the Apogee camera.
Figure 3a (Left) — Values shown here are the RAW values/sums of the single/combined images.
Figure 3b (Right) — The mean values of the backgrounds have been adjusted to the same level. The combination of the thirty 10-second exposures shows slightly less signal than the other two images.

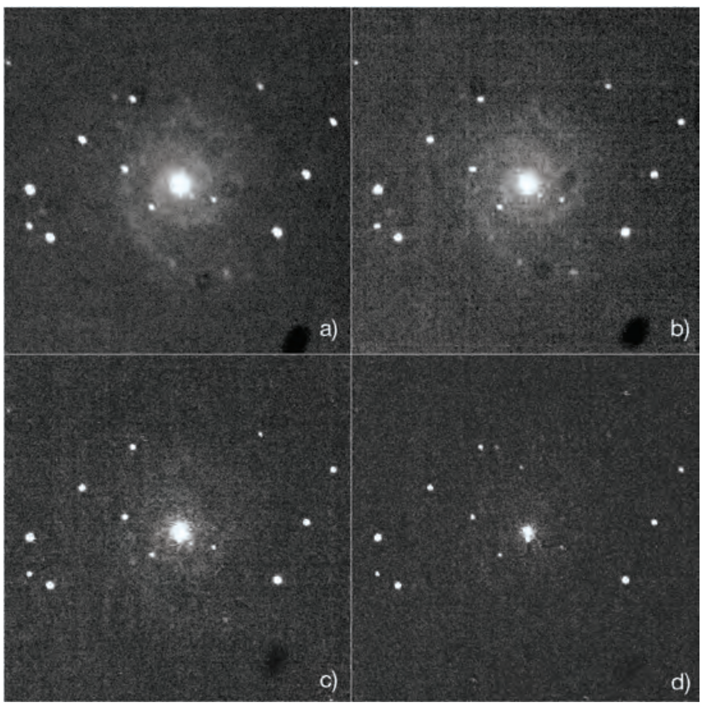


Figure 4 — Total exposure time 300-seconds of M74 taken on 2009 November 22 with a Canon 20Da camera, RAW mode, medium resolution, ISO 1600 in the green channel.

Figure 4a — A single 300-second exposure.
Figure 4b — Combination of five 60-second exposures.
Figure 4c — Combination of ten 30-second exposures.
Figure 4d — Combination of twenty 15-second exposures.

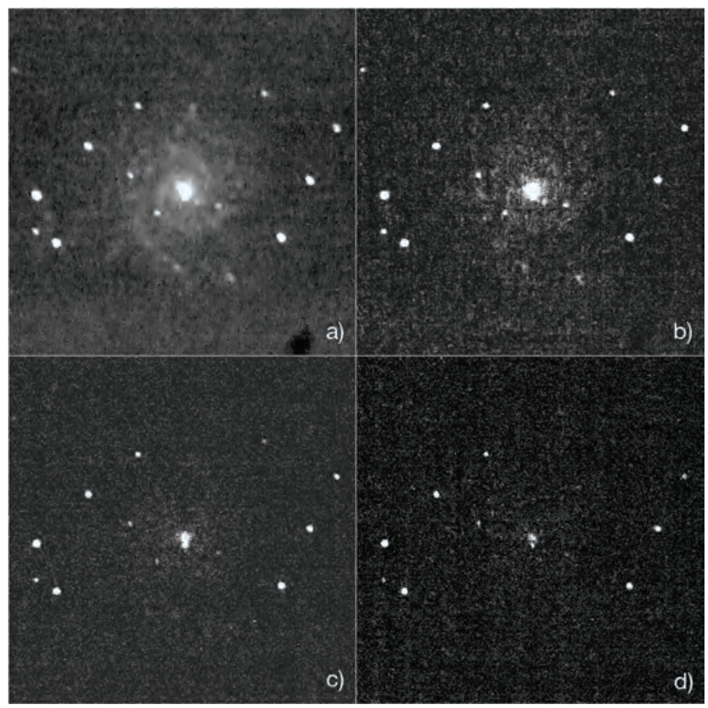


Figure 5 — Total exposure time 300-seconds of M74 taken on 2009 November 22 with a Canon 20Da camera, RAW mode, medium resolution, ISO 1600 in the blue channel.

Figure 5a — A single 300-second exposure.
Figure 5b — Combination of five 60-second exposures.
Figure 5c — Combination of ten 30-second exposures.
Figure 5d — Combination of twenty 15-second exposures.

We found that zero clipping occurred in all of the individual frames in the blue channel except for the 300-second exposure. In the green channel, all but the 300-second exposures and the sum of five 60-second exposures showed clipping. In cases where clipping occurred, the signal in the combined exposures fell far short of the signal in the single long exposure. In other words, some of the photons from the galaxy that actually reached the sensor were not recorded due to the artificial clipping in the camera itself, and so

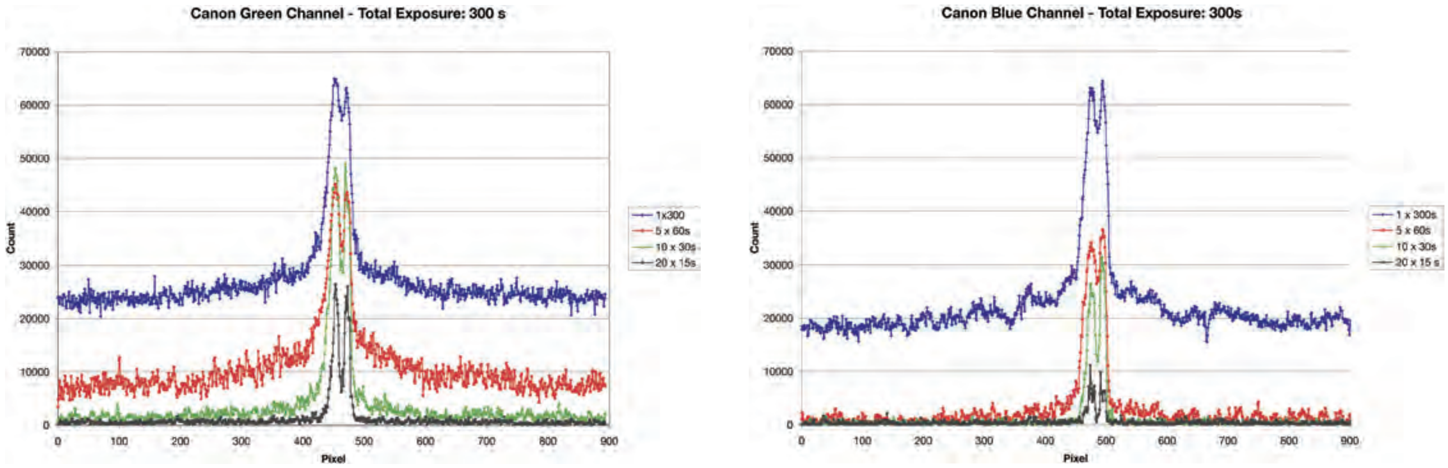


Figure 6 — Cut across the centre of M74 comparing the single 300-second exposure to the combination of five 60-second exposures, ten 30-second exposures and twenty 15-second exposures from November 22 using the Canon camera.

Figure 6a (Left) — Results for the green channel.
Figure 6b (Right) — Results for the blue channel. The blue channel is less sensitive than the green channel, so the zero-clipping is especially evident in the combination of 15-second exposures.

these photons could not contribute to the final combined image.

This result means that it may be possible to successfully combine many short exposures with this camera in a sky with an elevated background brightness (such as inside a city). The sensor needs to record a certain minimum illumination or it will clip to zero. If the sky brightness is high enough, no clipping will occur and, presumably, the photons from our galaxy will still be recorded. We would like to test this hypothesis for a future article.

Conclusions

We found that with our professional, cooled Apogee U47 camera, there was virtually no difference between taking many 60-second exposures compared to fewer 300-second exposures. There were only minor differences between taking many 10-second exposures compared to fewer 60-second exposures. Those differences seem to diminish as more exposures are included in the combination, and so we believe that a 1500-second exposure made up of 150 10-second exposures would be just as good as a 1500-second exposure made up of five 300-second exposures. In fact, it may be better, as the tracking errors would be significantly reduced and images taken during moments of bad seeing could be excluded from the final image.

With the Canon camera, it would seem that a minimum exposure time is needed to ensure that photons are recorded linearly (*i.e.* not artificially clipped). We believe it may be possible to combine many short exposures with the Canon camera and achieve a result similar to the Apogee if the sky brightness is high enough so that the chip records a level above the threshold during the time of the exposure. A suburban/urban sky may be an advantage in this case. Perhaps a pre-flash of the chip would achieve the same effect.

It would seem that there are no practical disadvantages (aside from computing power) to taking many short exposures *as long as the exposure is long enough that no clipping occurs and imaging is within the linear range of the detector.* This constraint is a function of your instrument and the conditions of your sky. Indeed, our conclusion is that it is most advantageous to combine many exposures with an exposure time as short as possible for the conditions.

Jennifer L. West received her M.Sc. in astronomy in 2003 and has just recently started her Ph.D. at the University of Manitoba. For the past five years, she has been working in the field as an instructor, outreach coordinator, and observatory technician. She has been an active member of the RASC Winnipeg Centre for several years, serving as National Representative, 2nd Vice-President, and Councillor.
Ian D. Cameron has an M.Sc. in astronomy from the University of Victoria and is the Director of the Observatory and Planetarium at the University of Manitoba. He has been a long-time supporter of the RASC and is currently a member of the Winnipeg Centre.

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Outdoor-Lighting Regulation Workshop

by Rémi Lacasse, IDA Québec section coordinator (remi@astromirabilis.com)

The Québec section of the International Dark-Sky Association (IDA), a sub-committee of the Fédération des astronomes amateurs du Québec (FAAQ), was created five years ago, bringing the expertise and energy of around ten participants to the discussion table. The Committee included a few amateur astronomers, several architects, and engineers from different backgrounds, (*e.g.* the city of Montréal, Québec Hydro, and lighting manufacturers). At the start, we adopted the mission to develop awareness, mobilize individuals and groups, support involvement, and evaluate and underline specific actions aimed at light-pollution abatement.

In 2008, we decided to produce guidelines for outdoor lighting that could be implemented by Québec municipalities. It is based on what had been done in the Mont-Mégantic area, where the first IDA International Dark-Sky Reserve designation was earned. The goal of these guidelines was to facilitate the work of municipalities in establishing outdoor-lighting by-laws based on the Mont-Mégantic experience.

Figure 1 — A scene from the Québec workshop. Photo: Rémi Lacasse.

To promote the acceptance and implementation of the guidelines, we first had to find a way to communicate with municipal planners from diverse backgrounds. Last spring, the Québec section of the IDA developed and offered a workshop on the draft proposal for outdoor-lighting regulations that Québec municipalities could implement. The workshop was advertised by sending letters of invitation to the most likely parties through professional associations such as those maintained by landscape architects, town planners, engineers, and so on. The response was very good, and 98 participants with different interests, mostly professionals active in municipal planning and design, showed up from within a 150-km radius of Montréal. Considering that we had hoped for about 30 attendees, we were delighted — and pleasantly surprised — by their interest in our proposal. Buoyed by that success, and to develop awareness among municipal planners from other parts of the province, another workshop was conducted in Québec City in October. Seventy participants showed up.

The workshops format included four main themes:

- Bad outdoor-lighting consequences.
- What is an eco-energy concept?
- Introduction to the draft regulations.
- Samples of implementation.

Review of a multiple-choice feedback survey clearly showed that participants liked the format and were motivated toward light-pollution abatement. Based on that same feedback, we identified the following four critical success factors:

- Relevant information (provision and explanation of a basic lighting regulation)
- Credible speaker (Chloé Legris, engineer, Mont-Mégantic project manager.)
- Invitations sent through professional associations.
- Regional meetings (requiring only a day trip, thus limiting expenditures with no overnight stay required)

It was a rewarding team endeavour with lasting benefits from IYA2009. I hope that sharing it here will inspire other initiatives, given that a similar approach could work in other areas of Canada to enhance local decision-makers' awareness of light-pollution problems and solutions.

Should you want additional information, do not hesitate to contact me at remi@astromirabilis.com or by telephone: (819) 429-5516.

A Handy Red Light Indeed

by Curt Nason, New Brunswick Centre (nasonc@nbnet.nb.ca)

If you are like me, you spend many hours with a red light in your mouth while setting up and taking down a telescope or writing in a logbook. There are alternatives, such as a headlamp, but if you have observed with somebody sporting one, you learned quickly not to attract their attention while the light was on. Another alternative is available.

GloveLite was conceived seven years ago by Dr. Paul N. Smith of Bangor, Maine. As a private pilot, he was frustrated with trying to write on his kneeboard while maintaining night vision. A red light on a lanyard or clipped to his shirt would often be dropped or would not always provide illumination where it was needed. Frustration is the other parent of invention.

GloveLite is a black neoprene shell that fits over your thumb and forefinger, leaving the fingertips free; it secures with a Velcro strap around your wrist. Attached near the knuckle of each digit is a 5-candela red LED. A plastic, fingertip-size on/off button is located on the back of the hand. If you find the illumination to be too bright (I didn't), you can replace the pair of 3-volt 2016 batteries with a single 3-volt 2032 battery. Units are available in left or right, medium or large, and with green or white lights in addition to red.

I read about GloveLite in the local newspaper and contacted Dr. Smith through the product's Web site at `www.glovelite.com`. Although several potential users were suggested on the Web site, amateur astronomers were not mentioned. I suggested that he explore that market and I obtained a unit to try out. I found GloveLite to be comfortable and that it placed the light where it was needed when setting up my C8 or writing in the dark. After a few occasions of flashing myself, I learned to shut the light off before raising my hands toward my face.

I suggested two improvements to Dr. Smith, one of which has already been implemented. A dimmer switch would be nice but would likely add to the price and complexity. Since astronomers spend a lot of time outdoors in winter, an extra large size would be necessary to wear with gloves. The Web site now shows OverGlove is available and I intend to purchase one.

GloveLite costs $24.95 US plus shipping and can be ordered only through the Web site.

Curt Nason is well-known to Journal *readers as the author of Astrocryptic - surely the most challenging item in the JRASC.*

The One-Metre Initiative: An Update

by Frank P. Roy, The One-Metre Initiative (frank.roy@onemetreinitiative.com)

Abstract. A brief overview of the site for the planned One-Metre Initiative, a new Canadian world-class state-of-the-art telescope, is provided. It is to be located on a 400-metre plateau in the Madawaska Highlands of Ontario, a site with the darkest night skies in southern Canada. The site selection is described along with a visual impression and performance in terms of sky darkness and seeing. The OMI's impact on the area and on astronomy in Canada is discussed.

Introduction

The One-Metre Initiative (*JRASC April 2009*) is designed to produce a highly corrected 5-degrees^2 field of view (FOV) telescope and offer a level of performance not available by any other telescope on Canadian soil. The site chosen is at Mallory Hill, Ontario, believed to be the best site available in southern Canada. One of the primary criteria for choosing this site is its southerly latitude, necessary to gain access to the southern sky and especially the Milky Way. This is as far south as one can get in Canada and yet still have superbly dark night skies. The measured night-sky darkness, 21.80 mag/arcsec^2 (v), rivals some of some of the darkest night skies in the southwest US.

Figure 1 — The One-Metre Initiative location in southern Canada and the northeast USA.

Figure 2 — Mallory Hill looking southwest, with a granite outcrop.

Mallory Hill

The selection of the site, located 100 km north-west of Kingston as the crow flies (Figure 1), was based on several key criteria:

1. The darkness of the night sky
2. Seeing
3. Altitude
4. Local site conditions
5. Access

Altitude and local site conditions have a direct bearing on the seeing, which is actually more important than the sky brightness in terms of scientific potential. The terrain was favoured by lack of obstructions, a moderate altitude (382 m), good ground composition, a flat elevation in the west, and treeless surroundings to provide good natural seeing conditions. The proposed site was first selected from a sky-brightness map (Cinzano and Thiene 1998), and then further refined by examination of topographic maps (Figure 3) and a visit in early October 2007. Access to Mallory Hill (latitude +45° 01′ 37.4″, longitude -77° 05′ 57.4″, Figure 2) is by major highways and

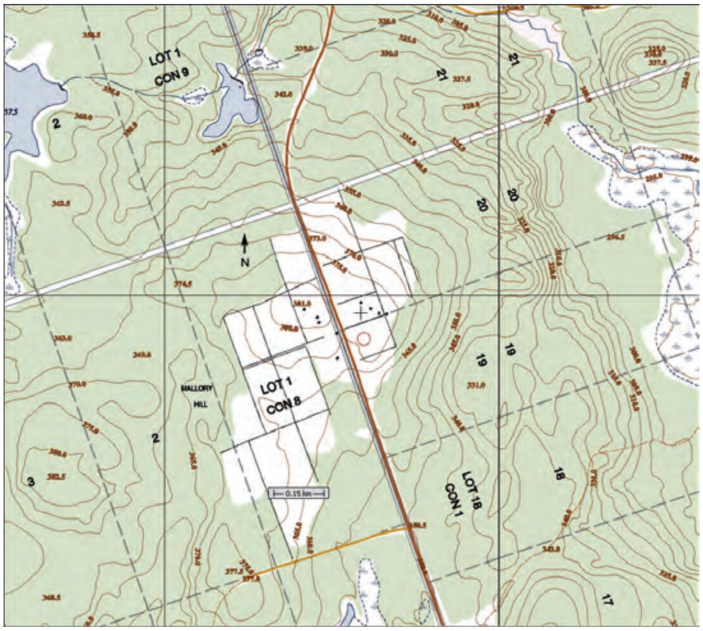

Figure 3 — Topographic map of Mallory Hill with a red circle indicating observatory location

a well-maintained paved secondary road. The hill is bare with some 80 acres of cleared land, mostly west of the actual site. The whole area is Precambrian in nature and must be the foundations of a very ancient mountain.

The owner of the property has allowed the use of 3.5 acres for the observatory. The site is not visible from the road, as it is lower and blocked by some trees. The name Mallory goes back to the original settlers of the hill, in the early part of the 20th century; it was originally accessed by logging roads. The name itself only appears on topographic maps.

Mallory Hill is in Frontenac County, North Frontenac Township, 16 km by road north of Plevna, the nearest town, with a population of ~150. The nearest significant community is Denbigh, 30 minutes to the north. The observatory site is on the boundary with Addington Highlands, Lennox & Addington County. A view of the hill (Figure 2) shows it to be a small outcropping of granite, with a low tree line to the southwest. Trees that interfere with air flow will be cut down. The road is on the extreme lower right of the frame and just visible. There is no power on the hill, thus no nearby lights; the closest are 5-6 km away and will be fully shielded when lighting by-laws come into place. There are no direct lights visible from Mallory Hill. The sky is remarkably blue during the daytime, even close to the Sun, indicating a low level of pollutants and particulates. There are no major populated areas west of the site, all the way to Georgian Bay, 250 km away.

Sky Brightness

Night-sky brightness is of great importance to achieving the highest-quality science. The site lies in a "Dark Peninsula" (Figure 5), a 50 × 66 km area just northeast of Bon Echo Provincial Park, as indicated by the sky-brightness charts of Cinzano and his colleagues (`www.lightpollution.it/dmsp`). On the sky-brightness chart, the region appears as black or 2 on the Bortle scale. The blue buffer zone is twice the size suggesting that this area will remain very dark for

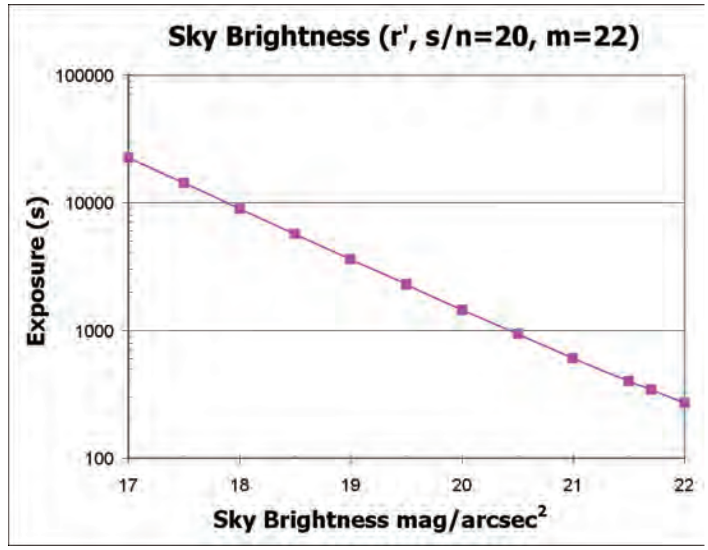

Figure 4 — OMI Equivalent s/n for different sky brightnesses. Mallory Hill is 21.80 mag/arcsec^2.

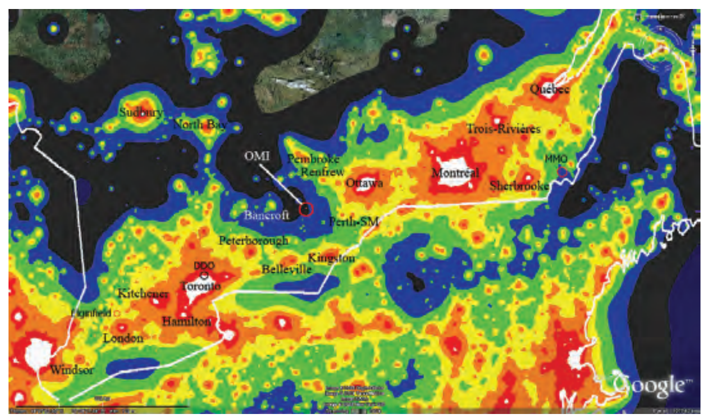

Figure 5 — Sky brightness at Mallory Hill in northeast North America with major observatories identified.

potentially 100 years. Bancroft, to the west, is visible as a 5-degree glow from Mallory Hill while the southern sky is marred by 3-degree bubbles from Kingston and Belleville. Only a very faint hint of a light bubble is visible from Toronto in the southwest but Ottawa creates a bubble some 10 degrees high in the east-northeast. Locally, Bancroft represents a problem in the western section and the little towns of Cloyne, Flinton, Northbrook, and Kaladar in the southwest section noticeably brighten the overhead sky. The central sector is hampered by Denbigh; how a town of 350 can have such a bright signature is astonishing. In this remarkably dark area, even the smallest town is a problem. It appears that Mallory Hill is in the sweet spot of the Dark Peninsula.

Almost 34 years ago, Richard Berry (1976) suggested this particular area, commenting "Unless the trend changes drastically [10%/yr], it is evident that few reasonably accessible dark-sky sites will remain by the end of the century, and that suburban and semi-rural skies will be seriously damaged by light pollution." Indeed this is exactly what has happened.

The area is rather undeveloped, in the heart of Cottage Country,

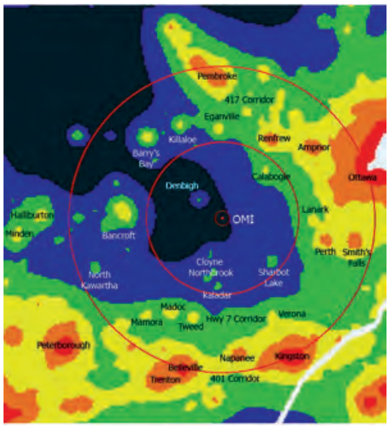

Figure 6 — The "Dark Peninsula" with 5/50/100-km-radii circles.

with a very low population density. The industrial and commercial sectors comprise about 1 percent of the economy of North Frontenac Township — indeed more people live in a typical small southern Ontario town than the entire Township! I personally have contacted all the townships in the area and they have agreed to enact strict lighting by-laws, once the observatory is established, to protect this great "gift."

Figure 4 demonstrates the exposure required to maintain a constant signal-to-noise ratio (s/n) under conditions of increasing the sky brightness. Mallory Hill falls on the right side of the curve with a measured sky brightness of 21.80 mag/arcsec^2. As the sky brightens, a longer exposure is required to maintain the same s/n ratio, clearly demonstrating the importance of a dark sky for maximum scientific yield. The 21.8 mag/arcsec^2 at Mallory Hill will permit cameras to reach the same s/n ratio with one-tenth the exposure of that at a dark urban (19 mag/arcsec^2) site. The recently closed David Dunlap Observatory has a sky brightness of ~16.5 mag/arcsec^2.

Seeing

Seeing is also of vital importance to achieving the highest scientific yield and the productivity of the observatory. There are two fundamental factors driving the local natural seeing:

- A smooth air flow over the site,
- Ground that absorbs minimal solar radiation and emits it rapidly at night

This particular site has several attributes that contribute to its expected mean seeing of 1.25″ FWHM (Full-Width at Half-Maximum) Delivered Image Quality (DIQ) with expected contributions of 1.10″ from natural seeing and 0.15″ from the observatory structure. The chosen site lies on a plateau at an altitude of 375 m with no higher elevations in the west, giving a smooth and gradual slope from the prevailing wind direction. The area is bare with some 80 acres of cleared land, mostly in the west. The ground has 12 inches of topsoil over granite bedrock, a combination that will minimize the absorption of solar radiation, and reradiate it fairly quickly at night. The granite bedrock is also an excellent foundation in which to anchor the 48-inch hollow pier.

All roads on site will be covered with white stones to reflect as much solar flux as possible. Any paved roads will be painted white. The control building will be north of the observatory, away from the prevailing air flow. The building will be heavily insulated to minimize thermal radiation. Every precaution will be taken to drive a smooth air flow over the dome and minimize any local thermal sources.

Figure 7 demonstrates the importance of good seeing. The exposure is adjusted to maintain a constant s/n as the seeing is degraded. With a mean seeing of 0.90″ FWHM, it takes about 936 seconds to reach magnitude 25 in the r´ with s/n = 3. Degrading the seeing to 2″ increases the exposure to 4131 seconds to reach the same s/n. Most backyard observatories rarely get better than 2″; they typically get 2.5-5″. Improving the seeing has a dramatic impact on the science. OMI is targeting 1.25″ FWHM but if 0.85″ could be reached, it would allow the exposure to be cut in half for the equivalent s/n!

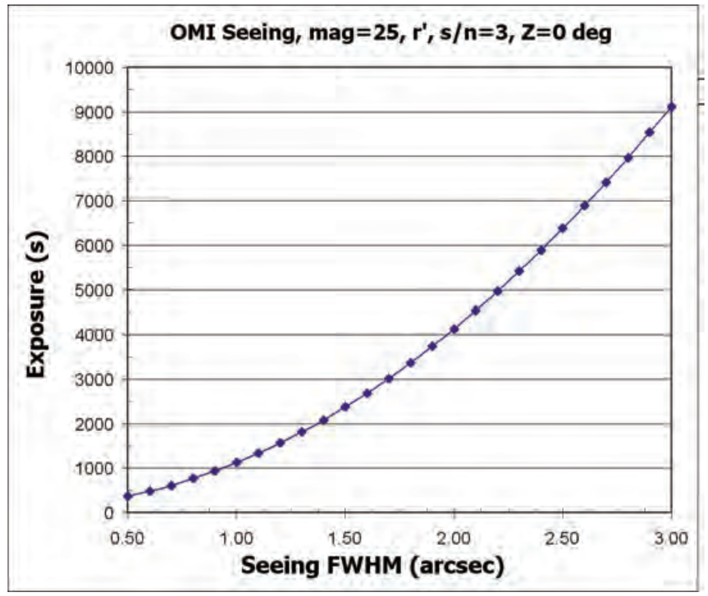

Figure 7 — OMI equivalent signal/noise ratio with varying seeing conditions.

Visual impressions

Surely the Dark Peninsula is as close to being a non-degraded natural sky as one could in hope for in southern Canada. Some 10,000 stars can be seen with the unaided eye, with a limiting magnitude of ~7.1. Stars can be seen down to the ground around almost the entire 360° horizon. The Milky Way stretches from horizon to horizon and casts a soft shadow. The vastness of the Milky Way is astonishing, and goes far beyond the outlines in star charts. At Mallory Hill, the Milky Way is seen right into the Great Square of Pegasus and as far north as Polaris. There is a great arm in the vicinity of Auriga, and the detail in Cassiopeia seems endless. The great hub of the galaxy spans at least 45 degrees and is crisscrossed with a wealth of dark lanes, where the star clouds seem to float. The Great Rift splitting the Milky Way at Serpens Cauda and Ophiuchus is extremely prominent.

The spiral galaxy M33 in Triangulum can be seen straight on, and its circular shape can be glimpsed. Unusual phenomena seem almost common — the Zodiacal Light, seen almost every night in the fall and spring, becomes a great pyramid-shaped cone hugging the ecliptic and stretching halfway up the sky in late twilight. Even the elusive Gegenschein has been glimpsed; it appeared much fainter than the faintest sections of the Milky Way and stretched some 90 degrees from east to west. The brightest section was directly south along the ecliptic, at the anti-solar point, spanning some 20 degrees in width. At first sight, I thought it was a faint extension of the Milky Way, but soon realized this could not be so, for the Gegenschein was not far from the South Galactic Pole. On a few occasions, sky glow was noted. This appeared as a general brightening of the sky from no particular direction, fading after midnight. During meteor showers, a great many very faint meteors can be glimpsed.

The Orion Milky Way is stunning to say the least. Being far in the south, it is usually hampered by ambient light. At Mallory Hill, the Orion area is black and sprinkled with a vast number of stars and a significant number of bright stars. I have never seen so many bright stars fill such a large part of the sky. The winter Milky Way seemed to be brighter than the more familiar Scutum star clouds and could be traced nearly down to the horizon.

Objects disappear within a few metres. You can hear people moving about nearby, but you cannot see them. Clouds appear as dark patches against the night sky. With the vast number of stars visible, familiar constellations seem almost lost. This is the sky as seen from Mallory Hill.

Weather Patterns, Climate, and Observable Hours

The climate and weather patterns are similar to the surrounding regions of Kingston (100 km) and Ottawa (about 100 km). Mallory Hill, on its 400-metre plateau, is about 3-5 °C cooler than Ottawa. With the Percent Frequency of Sky Cover at Midnight LST (Local Standard Time) weather data provided by Jay Anderson (Table 1), some interesting patterns emerge. We assume Mallory Hill will be most similar to Kingston, which has 25.5 percent frequency of clear-sky cover at midnight, but if we take into account the lake effect at Kingston, this figure could be several percentage points higher for our observatory site. There are about 2900 dark hours (excluding twilight) at 45 degrees latitude, so the percentage of clear sky translates into 740 clear dark hours annually, or 850 hours when the lake effect is taken into account.

Annual Cover Statistics							
	Percent Frequency of Sky Cover at Midnight LST						
	Clear	Few	Scattered	Broken	Overcast	Partly Obscured	Obscured
Kingston	25.5	20.4	0.0	16.7	33.5	2.6	1.3
Ottawa	20.0	19.0	3.8	19.9	35.2	1.8	0.3
Peterborough	49.3	9.2	3.5	10.4	27.3	0.3	0.0
Toronto - Pearson	19.0	21.0	3.2	22.8	33.0	0.9	0.1
Trenton	19.5	21.9	4.5	18.1	34.4	1.5	0.2

Table 1 — Annual Cover Statistics for Nearby Cities
Note: The major airports - Toronto, Ottawa, and Trenton - are most reliable. Kingston has an obvious problem with non-reporting of scattered cloud. Peterborough seems out of line with its observations of clear skies.

Additional data from Environment Canada (1971-2000 average) confirms our expected 900 hours of clear dark skies per annum. Figure 8 shows the expected numbers of clear dark hours per month, estimated to be 887 based on Kingston data. Taking the lake effect into account could bring this number closer to 1000 hours.

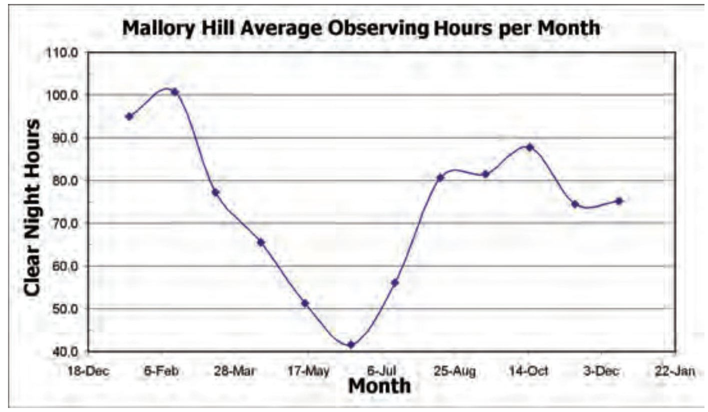

Figure 8 — Average observing hours per month based on Kingston weather data.

The University of Western Ontario will be installing a fully equipped solar-powered monitoring station at Mallory Hill in the spring of 2010. This will include a complete weather station, seeing monitor, cloud monitor, and sky-brightness monitor. The data will quantify and qualify the Mallory Hill site in terms of its scientific potential.

Tourism, Visitors, and the OMI Impact

The OMI is expected to become an important tourist destination for the area. The close proximity of millions of people within a 2-3-hour drive from a major observatory will have a positive impact on the exposure and popularity of astronomy in Ontario and Québec. Major discoveries made on Canadian soil will garner national media attention and thrust astronomy into the national limelight. This exposure will surely attract the attention of policy makers, politicians, and the like, and can only foster a greater appreciation for our place in the Universe and could potentially lead to more funding for Canadian astronomers!

The opportunity to visit a major astronomical observatory is very appealing to a broad section of the population, as evidenced from the visitor log at the Mont-Mégantic Observatory in the Eastern Townships of Québec. Annually, some 15,000 visitors visit the site, in spite of having no major access roads and a three-hour-plus drive from Montréal. Mont-Mégantic draws 85 percent of its visitor base from the Montréal area. The OMI has three times the population within a three-hour journey, suggesting some 45,000 or more annual visitors! Bon Echo Provincial Park, within a 30-minute drive of Mallory Hill, will be challenged to handle the increase in visitors. The park superintendent indicated that extending the shoulder season to accommodate the expected influx is a real possibility.

An increased tourism flux could have a significant economic impact on the area. Sépaq (Société des

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Pen & Pixel

Figure 1 — The open cluster M35 resides in a crowded subdivision in Gemini. This image by Winnipeg Centre's Jay Anderson shows the cluster with its neighbours. Tiny NGC 2158 lies just below M35, while NGC 2158 (lower left) and NGC 2175 (middle left) add a little colour to the scene. The image was a 16-minute exposure on ASA 200 film with a 300-mm f/2.8 lens taken on 2004 March 19.

Figure 2 — Jennifer West assembled this composite from 275 30-second exposures, capturing eight Geminids between 9:18 and 11:40 p.m. on December 13 last year. The scene shows the Winnipeg Centre's Glenlea Observatory. Jennifer used a Nikon 8-mm f/4 lens on a modified Canon 40D set at 1600 ISO. A time-lapse movie of the photography can be found at `www.youtube.com/user/astrogirlwest`. Visual observers counted 100 meteors in the same time period.

Figure 3 —The Toronto Centre's Kerry-Ann Lecky Hepburn and Paul Mortfield collaborated on this stunning image of vdB 141, a reflection nebula in Cepheus. Kerry-Ann and Paul used a 16″ f/8.9 RCOS telescope and an Apogee U16M camera. Imaging time was 6 hours (LRGB: 3:1:1:1) on 2009 June 5. The nebula is often referred to as the Ghost Nebula for its faint outlying companions, or the Cosmic Surfer, for more aesthetic reasons.

Figure 4 — IIC 342 lies only 10.5 degrees from the Galactic Equator and is heavily obscured by interstellar matter in the Milky Way. The galaxy forms a group with a few large and many dwarf galaxies called Maffei 1. Stuart Heggie used an SBIG STL11000 camera on an AP900GTO mount to break through that obscuration to obtain this fine image. Exposure was 10 x 10 minutes in L, and 4 x 10 minutes each in RGB for a total of nearly 4 hours.

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Établisement de Plain air du Québec) report in their 2008 August 4 press release that the Mont-Mégantic park pumped over $10 million into the local economy, mostly through spin-offs. Similar economic numbers could be generated by the presence of the OMI. Indeed this past July, when I visited Mont-Mégantic, I saw two new sub-divisions under development with lots for sale in the nearby town of Saint-Dame-des-Bois only 9 km from the Observatory! The Observatory and the connected Astrolab are the only thing happening in the area, an indication of the economic impact of Mont-Mégantic. Such close-by development could become a significant concern for future operation of an observatory.

Endorsements and Support

After several months of significant effort, endorsements and support for OMI have been garnered from all the nearby counties and many nearby municipalities. Local politicians, including representatives of five Ontario ministries, have acknowledged that the OMI will be important to the local economy, will help Canadian universities that offer astronomy programs, and will be a welcome addition to Canada's scientific assets. Local businesses, the tourist industry, and at least one centre of the RASC all support the idea enthusiastically. Extensive press coverage in newspapers, on TV, from radio interviews, and in magazine articles have given the OMI much needed exposure since October 2008. Three Canadian universities have expressed an interest in using the instrument.

In addition to moral support, the One-Metre Initiative project was granted $14,000 by the Frontenac Communities Futures Development Corporation (FCFDC). The grant was used in part to pay for a detailed optical analysis of the telescope, an error budget, and a draft of the Calotte dome. The FCFDC mandate is to spur economic development in the County of Frontenac. This County is in desperate need of economic development and the presence of a major astronomical observatory would be a welcome asset. The FCFDC recognized some five years ago that its spectacular night skies are a high-value natural asset to the county.

Enthusiasm and support for the OMI is overwhelming and extremely encouraging, showing the very strong support we have from the local communities and residents.

University Interest

Three Canadian Universities have shown strong interest in using the OMI. The University of Western Ontario will play a vital role in developing some of the science programs and will assist in telescope calibration *etc.,* as well as acting as the main repository for data. Paul Wiegert is our principal associate at Western. Western's main interest is minor planets, including NEOs. Queen's University in Kingston, represented by Stephane Courteau, has an interest in providing telescope time for graduate and undergraduates for a variety of astrophysical research projects. Queen's is the nearest university to the OMI, only a two-hour drive from the facility. The Université de Montréal has shown some interest, as the OMI will complement the MMO and relieve some of the time-allocation pressures on their 1.6-m telescope. The unique wide-field and high-throughput capabilities will benefit Québec researchers (CRAQ). René Doyon is the principal contact at UdeM.

Using the OMI

Certainly the OMI will be open to a broad audience and not just professional astronomers — indeed, a percentage of the available time will be dedicated to outreach and education. The facility is fully autonomous, using a queuing scheme that will permit users to input their observational requirements, leaving the computers to manage the details. Tools will be available for less-experienced users to make use of the One-Metre Initiative's vast potential. The OMI's ability to image very large and very deep fields quickly will permit the discovery of supernovae far beyond the capabilities of any amateur instrument — indeed, several supernovae per night are expected.

The OMI is designed as a dedicated imaging instrument, and here the opportunities are endless. A 100-minute exposure on the Coma-Virgo cluster centre will yield a million galaxies in its 5 degrees^2 FOV, reaching magnitude 25 in the r´ (622 nm, s/n=5)! Discovering comets will be commonplace with the OMI due to its exceptionally large FOV. With many hours of imaging stacked together, it will be possible to reach magnitude 28. Faint galaxies in such a field would reach back almost to the beginning of time and billions of light-years away.

Cepheid variables could be studied in M31 and M33 with ease. The entire Andromeda Galaxy could be imaged in three colors in about 3 hours to magnitude 25 (r´, s/n=3) using two frames to cover its extent. Such images will be enormous: 200 MB per colour yielding a 1.2-GB tri-colour image with a resolution of 0.76″/pixel, with an image size of 10,580 pixels × 21,120 pixels on a field 2.23° × 4.46°. This would generate a poster 3´× 6´ at 300 dpi! Half of the sky could be imaged down to magnitude 22 (r´, s/n=5) in a single eight-hour night. Such is the power of the OMI.

Conclusion

We have shown why Mallory Hill is the best site to establish a professional observatory in southern Canada in terms of sky darkness and very favourable local site conditions that will permit the best possible natural seeing. The easy access to the site and its extremely low operating cost, due to its autonomous nature and proximity, will provide a very high scientific return for an extremely modest investment.

Strong local support from the counties, townships, and politicians indicates that the OMI is now recognized as a potential economic and cultural asset to their communities. Neil Turok, Scientific Director of the Perimeter Institute, and René Racine, Canada's preeminent telescope man (Université de Montréal and the Thirty Metre Telescope), have both commented on the impressive design and potential performance of the One-Metre Initiative.

The OMI will be available to professionals and non-professionals alike and will open up vast possibilities with potential for significant discoveries. The astroimaging capabilities will be far greater than anything available to amateurs by a very wide margin. Probing 25th-magnitude galaxies could be commonplace and detecting 26th-magnitude stars will be fairly "easy." The images generated by the OMI will completely change the landscape and set standards by which astroimages will be gauged.

Having an important astronomical observatory within a reasonable driving distance to millions is bound to have a positive impact on astronomy, especially if the observatory makes important discoveries that will be covered by the national media. The ability to make astronomical discoveries on Canadian soil will excite the populace and instill a greater interest in the night sky and our place within the Universe. The high level of performance and technical ability of the OMI, together with a superb site, will permit such discoveries.

We are still seeking funding to move the OMI to the construction phase. The author would love to hear from anybody that can help in moving this forward.

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On Another Wavelength

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

The Bubble Nebula

When I think of a planetary nebula, the image that I usually have is of a white-dwarf star surrounded by some strange-shaped nebula with red and blue-green colours. What I do not think of is a nebula with a massive hot, blue, central star that is about to go supernova. The Bubble Nebula (NGC 7635) has been described by some as a planetary nebula, and others, well, are uncertain about its category.

The Bubble Nebula (Figure 1) appears to be a nearly perfect spherical shell of glowing gas and dust surrounding an off-centre, massive, Wolf-Rayet star known as BD+602522. BD+602522 is an O-type star several hundreds of thousand times more luminous than our Sun. There are only about 200 or so Wolf-Rayet stars known in the Milky Way galaxy. They are unusual for their hot surface temperatures, which range between 25,000 and 50,000 K, and for their stellar winds that expel gas at extremely high velocities. Although not shown clearly in Figure 1, the Bubble Nebula is actually one of three shells of gas surrounding the massive central star.

Figure 1 — Bubble Nebula, courtesy of Stephen Holmes, K-W Centre. The final image is composed of narrowband images based on exposures of 590 minutes in OIII and 630 minutes in Hα. Stephen used a QHY9 camera through an 8-inch f/6.4 GSO Ritchey-Chrétien on an EQ6 mount, autoguided with *KWIQGuide*.

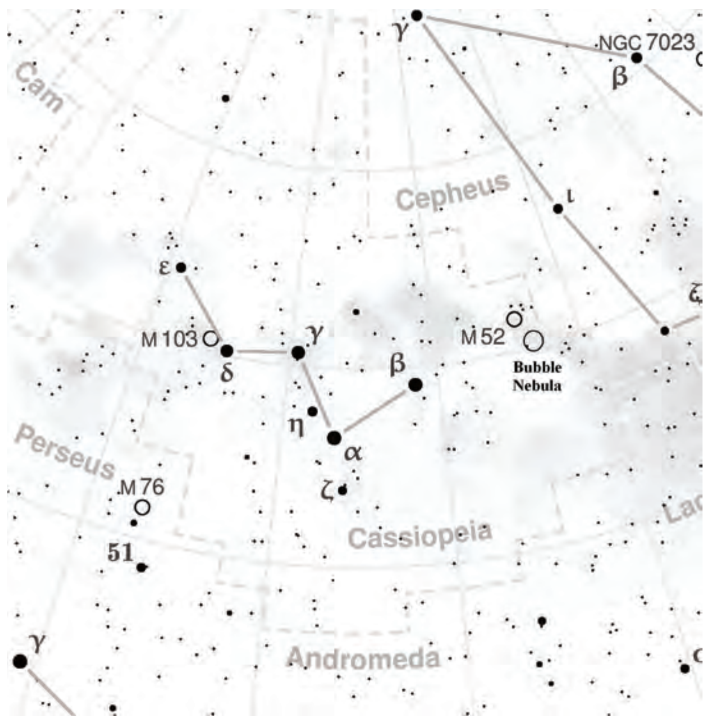

Figure 2 — The constellation Cassiopeia and the Bubble Nebula.

The first model of interstellar bubbles proposed by Weaver *et al.* (1977) described how such regions might form around a hot star with a strong stellar wind. The wind, flowing radially outward from the star, sweeps up the dust and gas in its surroundings, forming a bubble in the interstellar medium. The flood of ionizing ultraviolet light from the central star causes the region of compressed gas and dust at the periphery of the bubble to glow, giving the nebula its distinctive shape.

The Wolf-Rayet star inside the bubble is estimated to be approximately 45 times more massive than our Sun. It is continually ejecting mass through intense radiation pressure at its surface. As the heavier elements forged in the core of the star reach the surface, radiation pressure blasts them out in the stellar wind, creating an expanding envelope of gas. This envelope of gas is so thick that it obscures much of the star's brightness.

An interesting and unusual characteristic typical of Wolf-Rayet stars is that they display emission lines, whereas most stars display absorption lines in their spectra. The Bubble Nebula has been studied in the spectral bands from optical to infrared and radio. The emission lines have allowed us to identify several elements including helium, carbon, oxygen, sulphur, and nitrogen around this star.

The rate at which Wolf-Rayet stars lose mass is three to four times that of normal O- and B-type stars — so large that it significantly shortens the star's life. The Bubble Nebula is estimated to be only 300,000 to 400,000 years old and is expected to be a short-lived phenomenon. It is thought that, in general, massive O and B stars, which have as much as 100 solar masses, may evolve to become Wolf-Rayets just before they explode as supernovae. You can see an interesting simulation of this at `http://www.youtube.com/watch?v=wPqYsm8xOtQ`.

The Bubble Nebula, discovered in 1787 by F.W. (Sir William) Herschel, is not easy to spot by amateur astronomers, even though it is 10 light-years across. It can be found 11,000 light-years away near the constellation Cassiopeia in the direction of, and very close to, the open cluster M52 (Figure 2). With dimensions of 15′× 8′ and an apparent magnitude of +10, you will probably need a 10-inch telescope; the nebula is just barely visible as a faint shell around the star. To find the Bubble Nebula with your telescope, go to RA 23^h 20^m 48.3^s and Dec +61° 12′ 06″.

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

Second Light

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

Saturn's Biggest Ring

Every amateur astronomer has pointed his or her telescope at Saturn for a look at its beautiful ring system. Until recently however, the biggest ring of all had gone unnoticed. Anne Verbiscer and Michael Skrutski of the University of Virginia and Douglas P. Hamilton of the University of Maryland found a massive ring — as yet visible only in the infrared — using the *Spitzer Space Telescope* (see the 2009 October 22 issue of *Nature*).

The main rings visible in an average amateur telescope are the A and B rings (A being the outer one), separated by the Cassini Division. The inner edge of the B ring starts about half of Saturn's radius above Saturn, and the outer edge of the A ring ends about 1.25 Saturn radii above the planet. Current thinking is that the main rings are composed of the debris of a moon about 300 km in diameter that was struck catastrophically by another body about four billion years ago. The *Voyager* and *Cassini* spacecraft have discovered many other rings and small moons, and in particular, it has become clear over the past few years that the particles in the E ring originate with the plumes of water coming out of the "tiger stripes" near the south pole of Enceladus.

Reasoning that Phoebe, which with a mean diameter of ~215 km is by far the largest of Saturn's distant irregular moons, is likely the main source of debris in the outer system, Verbiscer set out to look for the heat signature of dust in the mid-infrared region of the spectrum. At that distance from the Sun, the equilibrium temperature of the dust is ~85 K, which produces peak radiation at ~34 microns. The *Spitzer* telescope has a detector sensitive to radiation at a wavelength of 24 microns —- a very good match to look for the dust — and they found a huge ring (see the figure for a demonstration of its size).

Phoebe is an interesting satellite in its own right. Its orbit is tilted by 5 degrees to the plane of the main rings, and moving backwards relative to them in a rather elliptical orbit. Any dust particles lofted from Phoebe (due to collisions of small bodies with the moon) will therefore be distributed in an extended torus with a vertical thickness of about 41 Saturn radii — which is a very close match to the observed ring.

Hamilton (a theorist who studies ring dynamics) modeled the effects of sunlight, re-radiation, and collisions on the ring particles coming from Phoebe and determined that they should extend from the outer edge of the main rings to the edge of interplanetary space — though the new ring as observed goes from 128 Saturn radii to 207 Saturn radii.

This new ring helps resolve another puzzle about the Saturn system: Iapetus' two-tone colour. Those of you who have read the book "2001: A Space Odyssey" will know that the dark leading edge of Iapetus features prominently in the plot (in the movies, the spacecraft stopped at Jupiter). Presciently, back in 1974, Steven Soter (now at the American Museum of Natural History in New York City) suggested that the colouring could come from Iapetus picking up particles as it went around Saturn in its orbit. Hamilton

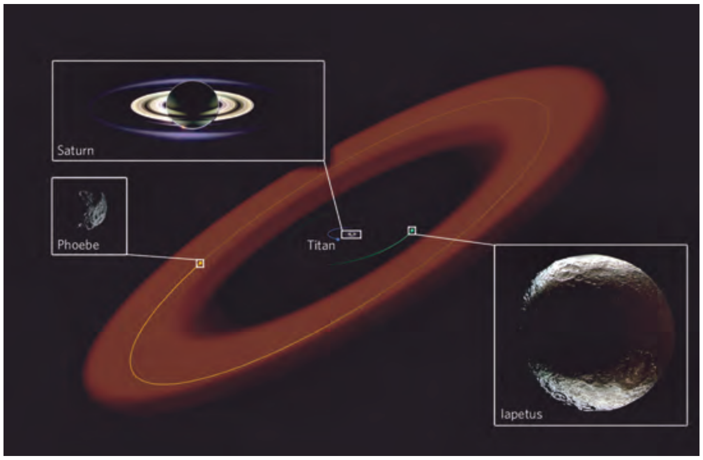

Figure 1— Saturn's mammoth ring. The orange ring is the newly discovered feature. Phoebe's orbit embedded in the ring is shown, as are the orbits of Iapetus and Titan. Barely visible in the centre is the traditional main ring system and Saturn (shown in inset). Figure courtesy Nature/NASA/JPL-Caltech.

calculated that over the history of the Solar System, Iapetus' leading hemisphere has picked up enough material from the Phoebe ring to coat it to a depth of at least 20 cm.

At this point, you are probably asking yourself why this ring hasn't been seen before, even if it is visible only in the infrared. The answer is that the ring is very diffuse. Hamilton estimates there are only ~20 ring particles per cubic kilometre! The reason it can be seen is that it's so huge — most sight lines encounter enough particles to build up a signal.

In fact, the ring's size almost prevented it from being discovered. The *Spitzer* field of view is tiny compared to the ring, and Saturn is very bright, leading to many diffraction spikes. While the ring signal was there, where it was supposed to be, the confusion of the spikes and other artifacts made the team hesitant to declare a detection. They then went to archival data, in which Saturn's irregular moons had been studied, to see if the ring signal was visible. Using a standard filtering technique, there was no ring, and the status remained unclear. Only when they used the unfiltered data was the signal (relatively) booming and the rest is history — literally. This is one for the text books.

So the next time you have Saturn in your eyepiece, spare a thought for the much bigger ring that you cannot see in optical light.

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

Through My Eyepiece

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

Fun, Go, and Galileo: Three Low-Priced 'Scopes

For quite a while now, the least expensive telescope that I could recommend with a clear conscience to a beginner has been Orion's StarBlast: a 114-mm f/4 Newtonian on a miniature one-armed Dobsonian mount, with a price of just under $200 US. With 2009 being the International Year of Astronomy, we've seen the introduction of several telescopes below this price point, hoping to catch the eye of the budget-minded beginner. Recently, I have been looking at (and through) three of these new scopes (Figure 1).

Orion FunScope: 76-mm f/4 Newtonian

Several companies have come out with similar 76-mm f/4 Newtonians on a small version of the StarBlast mount, all selling for around $50 US. Of these, I like the Orion version best, since it comes with a red-dot finder. The SkyWatcher version has an awful 5×24 optical finder, and the Celestron version has no finder at all. Even though Orion's little scope has quite a wide field of view with its standard 20-mm Kellner eyepiece, it is hard to aim without some sort of finder.

The main advantage this little scope has over earlier versions is its nice Dob-type mount, which is smooth and solid in operation, compared to the shaky aluminum tripods usually found on beginner's scopes. The Orion can be set on a solid table, but also has a standard 1/4-20 socket on the bottom, so it can be mounted on a heavy-duty camera tripod.

Optically, its spherical 76-mm f/4 mirror leaves a lot to be

Figure 1 — Left to right: Orion FunScope and GoScope; in front: Galileoscope.

desired, but works quite well with the 20-mm and 10-mm Kellner eyepieces provided, yielding modest magnifications of 15x and 30x. This was fine for viewing our Moon and Jupiter's moons. The wide-field views of fall favourites like the Pleiades, the double cluster in Perseus, and the Andromeda Galaxy were really excellent. This telescope also proved to be a lot of fun in daylight when used as a long-distance microscope. By viewing with my back turned to the subject, it even gave erect images!

In comparison to the standard 60-mm department-store telescope, the FunScope offers more aperture, a wider field of view, a much better mount, and a more compact size. I like it!

Orion GoScope: 80mm f/4.4 Achromatic Refractor

Following the success of the mini-Dob mount used in the FunScope, Orion adapted it to several other optical tubes through a standard Vixen/Synta dovetail. These include an 80-mm f/4.4 achromatic refractor and a 100-mm f/4 parabolic Newtonian, each costing $100 US, and a 90-mm f/13.9 Maksutov-Cassegrain at $200 US. I tested the 80-mm refractor version.

What do you get for the extra $50? An optically superior telescope. Because of its larger aperture, longer focal length (350 mm), and better quality objective, it delivers much sharper images with significantly better contrast. It comes with the same 20-mm and 10-mm eyepieces and red-dot finder as the FunScope. The mount is the same as well, but the tube attaches to it via a Vixen dovetail. Focusing is by a rubber-covered knob that moves the objective up and down the tube, a rather odd arrangement. I was able to detect the two major belts on Jupiter with the 10-mm eyepiece (35×), which weren't visible in the FunScope. There was quite a bit of chromatic aberration, which is only to be expected with a short-focal-ratio achromat like this, but it was not really obtrusive.

On the whole, this felt like a much better quality instrument than the 76-mm FunScope, something a serious amateur astronomer might choose as a highly portable "grab and go" scope.

Galileoscope: 50-mm f/10 Achromatic Refractor

This is the least expensive of the three telescopes, at $20 US, but by far the most interesting and unusual. The Galileoscope was designed specifically for IYA2009 by a team headed by Rick Fienberg, former editor of *Sky & Telescope* magazine.

The Galileoscope is, like Galileo's own telescopes, a small refractor with a long tube that focuses by sliding a smaller tube inside. There is where the resemblance ends; the rest of the telescope is something Galileo would have died for. First of all, the objective is a high-quality 50-mm f/10 achromat. This is an excellent lens, delivering sharp, high contrast, and colour-free images. Secondly, it comes with a nice 20-mm Plössl eyepiece, as well as an achromatic 17-mm Galilean eyepiece.

The Galileoscope comes in kit form (Figure 2). Bare bones instructions are included, but there is a nice colour-illustrated instruction booklet available in PDF format on the Galileoscope Web site at `www.galileoscope.org`. Assembly takes about 15 minutes, and is quite easy except for the care needed in assembling the small lenses used in the eyepieces. The main eyepiece is a 20-mm Plössl, yielding 25×, supplemented by a 17-mm achromatic Galilean eyepiece, a negative doublet that can be reconfigured as a 2× Barlow lens.

Figure 2: The Galileoscope in its box.

The tube of the Galileoscope is roughened and baffled on the inside, making for good contrast, and has a 1/4-20 thread on its base for mounting on a camera tripod, which is not provided. The supplied 20-mm eyepiece worked very well on its own, but less well with the Barlow, as it raised the exit pupil and made eye placement very critical. I ended up using one of the 10-mm Kellners from the Orion scopes for my best views of the Moon and Jupiter at 50x. There was a wealth of detail visible on the Moon, and I could just make out the North Equatorial Belt on Jupiter, though Jupiter was at a low altitude when I made my test. The telescope has a simple gun-sight finder moulded in, which was hard to see in the dark. A couple of dabs of white paint would help.

The down side of the scope is that the shipping charges to Canada are actually more than the telescope itself: $24 on a $20 item! It was a pleasant surprise that there were no hidden brokerage charges. It would make sense for a Centre to order a bunch of these, as there is a price reduction for bulk purchases, as well as a drop in average shipping costs. I gather a number of clubs are doing this, and then handing out the scopes to kids at star parties. A minor drawback is that it does not provide enough focus travel for a diagonal to be used, but then Galileo never used a diagonal either. In fact, diagonals for refractors have only come into common use in the last 50 years.

The kit can also be used as an optics lab, as there is an optics experiment booklet available on the Web site, plus a very nice observing guide. It can be disassembled and reassembled many times, since it uses no glue and requires no tools. This scope is extremely successful as a multifaceted educational tool, as well as being a nice little telescope, quite remarkable for its modest price.

In summary, if someone is seriously interested in astronomy, a 114-mm or larger Dobsonian is still their best entry point. For an older child or someone who is not quite sure about astronomy, the scopes reviewed here all provide an inexpensive first step, which is much more pleasant than the standard shaky Christmas trash scope. In general, you get what you pay for, and the GoScope at $100 is much better than the FunScope at $50. The Galileoscope is really something special: an educational tool that is also a successful telescope.

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 *and the* Orion Sky 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. Penny Morrill

During the era of the *Apollo* Moon missions, astronauts visited the Sudbury, Ontario, area to train on the Moon-like landscape. Canada has many other such "stand-in" sites for other worlds, including Mars. These are scattered across the country as part of the *Canadian Analogue Research Network,* and mimic one or more conditions, such as the temperature, chemistry, geology, permafrost, putative biology, *etc.,* of other places in the Solar System. For example, Labrador has a lunar site, while at MARS (the McGill Arctic Research Station), situated on Axel Heiberg Island, arctic research is conducted in a Mars-like temperature setting. Another Martian analogue exists on the west coast of Newfoundland and is the home-away-from-home of Dr. Penny Morrill.

Even though Dr. Morrill would have us believe that she was "horrible in the arts," by grade three she excelled at math and science, and approached her studies using a capacity for logical thinking. She eventually went on to obtain a Ph.D. at the University of Toronto doing research in such areas as isotope geochemistry, biogeochemistry, and hydrogeology, and is currently an Assistant Professor of Environmental Geochemistry at Memorial University of Newfoundland.

In work supported by the Canadian Space Agency and the Natural Sciences and Engineering Research Council (NSERC) of Canada, Dr. Morrill applies her expertise to the Mars analogue site in Gros Morne National Park. Staying in a cabin outside the park, she drives daily to a barren, Mars-like setting of rocks and boulders, with the easily eroded terrain cut by valleys and steep slopes. The orange colour everywhere hints at the prevalence of iron, while the very occasional plant is a reminder that this is still Earth. Dr. Morrill describes it simply as "Beautiful."

Gros Morne National Park is also scientifically fascinating. Five hundred million years ago, rocks from Earth's mantle, responding to plate tectonics, were dumped on the continental crust here. Rocks such as these exist in only a handful of other places on dry land.

But there is more. Milky-white water percolates through the rocks and precipitates out mounds of carbonate "fluff." Dr. Morrill says you can practically watch these beautiful mounds grow right in front of your eyes. It is therefore possible to stand with one foot on ground that is brand new and the other on mantle rock that is half a billion years old. This water/rock combination that she has observed may provide clues to help in the search for life on other worlds.

The preliminary search for life on Mars has become the search for water. Find the latter and maybe you have found a habitat for the former. Similarly, is there life in the water of the Mars-like Gros Morne site? It would have to be a hardy breed, for the chemistry of the water changes as it flows through the rock. In a process known as serpentinization, the water reacts with the iron and magnesium in peridotite causing the pH to climb so high as to be somewhat similar to household bleach. With the low oxygen levels in the water, Dr. Morrill was shocked to find that, yes, simple life forms are holding on, even here.

Dr. Penny Morrill

These extremophiles, *Archaea,* live in what would be a death trap for most organisms, and are unlike any with which most of us are familiar. Superficially similar to bacteria, they have a different physical structure and genetic makeup. They are able to utilize energy sources, such as ammonia, metal ions, and hydrogen gas, that are beyond the metabolic reach of most organisms. Various species have been found deep under Earth's surface, buried below kilometres of Greenland ice, near hydrothermal vents, and in water hot enough to cook a lobster. (Hmm, perhaps Mars isn't looking so inhospitable after all!). Methanogenic varieties found in the guts of humans are responsible for, er, well, flatulence. Nonetheless, the discovery of methane in the atmosphere of Mars has people wondering "Where did it come from?" Might it have been produced by life or by decaying biomass (also indicative of life)? What about geologic processes? Dr. Morrill would like to shed light on these possibilities by determining exactly what microorganisms are present, how they harness local energy sources, how they survive in such inhospitable conditions, and whether life on Mars might be similar.

I asked for her thoughts on the likelihood of Martian life. She refused to be pinned down, saying that more work (such as her own) needs to be done so that ultimately the proper instruments may be sent to Mars to give us, hopefully, the conclusive answer. Part of her work involves testing instruments and techniques that could be used for finding life on other worlds. For example, she is testing an instrument on the *International Space Station* that is used for determining sterility but that could be further developed to detect Earthly contamination on planetary probes or, ultimately, modified to detect life on Mars. The Gros Morne rocks will be searched for signs of very early terrestrial life as well, so her research also has applications for determining how life evolved on *this* planet.

Based on work such as this, our probes will continue to leave for the Red Planet. In the summer of 2012, the roving *Mars Science Laboratory* will evaluate the suitability of past and present environments for supporting life. The *Astrobiology Field Laboratory* and landers with deep-drilling capability may follow.

Dr. Morrill is clearly having fun (I know: she said so!). Not only is her research applicable to two worlds, she enjoys escaping from the lab to do research in a vacation spot so beautiful that some would have it designated as one of the seven natural wonders of the world. Working on the third planet, while pondering the fourth, she has two grand hopes: first, that her Earth-based research proves useful in pointing the way for space-based investigations and, secondly, that she gets her hands on material from a Mars sample-return mission. In the meantime, she continues her work at Gros Morne and collaborates with NASA's Astrobiology Institute. Perhaps one day she will have the chance to work at MARS. It would be nice if she also had the opportunity to work *on* Mars.

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.

Astronomical Art & Artifact

R.A. Rosenfeld[1], James Edgar[2]
contact: randall.rosenfeld@utoronto.ca

Who Keeps Knighting "Sir" Edmund Halley?

Abstract: Edmund[3] Halley was recognized in his time as one of the greatest astronomers, and his reputation has never suffered subsequent "eclipse." The principal landmarks of his life and career have been well known for centuries. Unlike his difficult friend Sir Isaac Newton, Halley was never knighted by his late Stuart or early Georgian masters, yet references to him as "Sir" Edmund Halley abound in both the serious and popular astronomical literature, from the first half of the 19th century right up to IYA2009. When, where, and how did this error arise, and what accounts for its staying power?

A True Tale

The estimable Archivist of the RASC does his best to avoid purveying fiction as fact to the worthy readers of our *Journal*. The Society's National Secretary, in his avatar as the *Journal*'s Production Manager, exercises due vigilance to indeed ensure that the Archivist doesn't inadvertently turn fiction into fact. It is a relief to report that the Archivist on the whole doesn't lead his readers[4] too far astray. As Aristotelians and others were fond of saying (Grant 1994, 189-219), nothing is perfect in the sublunary world, and a condition of doing astronomy as an earthbound hominid is that mistakes will happen.[5]

Some while back, while copyediting one of the Art and Artifact columns, the Production Manager encountered the following statement: "The 1986 apparition of Halley's comet included a celebration of Sir Edmund Halley's work." This statement prompted the Production Manager to direct a formal enquiry to the Archivist: "Yo Bro! Do you have a definite date when Edmund Halley was knighted? I don't believe he was..." (email of 2009 June 29). The Archivist had no date; and was, in consequence, living in a state of historiographical sin, from which the sharp eye and quick action of the solicitous Production Manager could redeem him, if he, the Archivist, could exercise his free will to admit the error, and correct his path. He readily accepted his culpability, amended his fault

(Rosenfeld 2009b, 165), and has gratefully thrived to contribute more columns.

What is curious in all this, is that the Archivist's previous mention of Edmund Halley in print correctly refers to the great man as "Dr. Halley" (Rosenfeld 2009a, 11). And, at the time the Archivist fell into error, he knew full well that none of the succession of clerics who held the position of Astronomer Royal were knighted (Flamsteed to Maskelyne, 1675-1811; the reign of knights commenced with G.B. Airy in 1835). A bit of reflection could have prevented the error. He reflected not, and committed the blunder. It struck him then, as it does now, that this is a strangely easy mistake to make, one possessed of an uncannily suggestive plausibility. It is like a Venus flytrap waiting for one whose critical historical sense has been wearied by a looming deadline. Before exploring why this mistake is so easy to make, it would be interesting (and doubtless comforting to the Archivist) to qualitatively sample its incidence. Is the Archivist in good and reputable company?

Knighting of Halley Within the RASC

Our hapless Archivist is in very good company indeed. Peter Broughton and Alistair Ling, two veteran and valued astronomical writers of superior accomplishments (certainly superior to the Archivist), have been caught by the same trap (but only once; *JRASC* 89 [1995], 19, and *JRASC* 93 [1999], 70, respectively). Peter Broughton's case nearly parallels that of the Archivist. In his paper on the first predicted return of Halley's Comet, published in the *Journal for the History of Astronomy* (Broughton 1985), the historian of the RASC did not refer to Halley as "Sir Edmund." That he succumbed a decade later demonstrates as nothing else the beguiling quality of the error.

"Sir Edmund" appears in the valuable chapter on comets in the 2007 *Observer's Handbook* (215), but the spurious knighthood is corrected in later editions.

The RASC was even responsible for a concrete epigraphic manifestation of the error. In southwestern Newfoundland is a plaque, which reads:

> "Presented to the people of/ Tors Cove/ to mark the first general assembly of/ the Royal Astronomical Society of Canada/ to be held in Newfoundland/ and/ the visit to Tors Cove in the Year 1700/ of astronomer/ Sir Edmond Halley/ of Halley's Comet Fame/ 4 July 1994/ St. John's Centre/ Royal Astronomical Society of Canada" (JRASC 89 [1995], 19).

Arguments can be made for correcting, and *not* correcting the plaque. Speaking of the latter alone, the fictitious knighthood is now part of the history of the modern commemorative event. To correct the plaque is to sanitize what actually transpired on that day. Halley's visit and its public acknowledgement are part of the astronomical history of Canada. Their witnesses should be left undisturbed.

Knighting of Halley beyond the RASC: NASA, the ESA, and...

On the various NASA Web sites one can find "Sir" Edmund Halley on 13 different pages, dating from the beginning in the 1990s to the present (see Appendix 1).The ESA scores somewhat better, the fictitious knighthood appearing in only two of its Web pages (again, Appendix 1).

What of "Sir" Edmund in the medium of print? Here the harvest is rich indeed.

Among professional historians of science and astronomy, the gathering includes Silvio Bedini (1975, 418), Ramsey and Licht for their well-received study of C/-43 K1 (Comet Caesar) (2000, xv, 70), R. Grove (1997, 151), J.K. Katgert-Merkelijn (1997, 42), von Stuckrad (2000, note 76, p. 121), and Bergland (2008, 62). To this list can be added the names of the prominent architectural historians, Cherry and Pevsner (1983, 414). Professional astronomers and other scientists writing on the history of science include the distinguished astronomer Jean-Claude Pecker (2001, 268, 285), A.D. Andrews (1993, 31), M.R. Kidger (1999, 221), M. Faintich (2008, 63), and V. Gornitz (2008, 416).

Among the professional astronomers and scientists who have knighted Halley in technical papers, monographs, textbooks, and semi-popular treatments, are numbered A.E. Fanning and D.H. Menzel (1966, 26, 29), T.M.L. Wigley (1981, 450), G.D. Watt and A.S. Webster (1990), R.J. Newburn and M. Neugebauer *et al.* (1991, 1337), P.A.L. Chapman-Rietschi (1995, 337), G.L. Verschuur (1997, 85), L.N. Hand and J.D. Finch (1998, 147), D. Vinkovic and Z. Andreic *et al.* (2000, 50), B.E. Blank and S.G. Krantz (2004, 127), T.W. Hartquist, J.E. Dyson and D.P. Ruffle (2004, 4), C. Toner and J. Goodrich *et al.* (2004, 657), K. Kendig (2005, 317, 321), W. Millar (2006, 48), P.J. Thomas and R.D. Hicks *et al.* (2006, 315), G. Faure and T.M. Mensing (2007, 487). Ironically, the error appears in the American Association for the Advancement of Science's Benchmarks for Science Literacy (1993, 325).

Like so much of the best in contemporary astronomy, lines can be blurred between professional standards and amateur achievements. Sadly, it can apply to errors as well. Prominent amateurs who have knighted Halley include R.J. Livesey (1996, 64), D. Berthier (2003, 67), R. Mollise (2006, 103), and M.J. de F. Maunder (2007, 180). The Archivist is happy to discover that he is not alone, though of course he remains penitent.

None of the above are poor historians or scientists in their respective fields; their work is worthy of serious attention. None of us, professionals and amateurs, are idiots. What, then, is the historical origin of Edmund Halley's fictitious knighthood, and why is this error so insidious?

Origins

A spot check for this paper of books and articles contemporary with Halley (1656-1742) indicated, to no one's great surprise, that the error was not made in his lifetime. This conclusion was confirmed through the powerful electronic search capabilities of Chadwyck-Healey's Early English Books Online, and Gale Cengage Learning's Eighteenth Century Collections Online. Equally unsurprising, the principal early authors of memoirs on Halley's life are innocent of the invention, including De Mairan (1747), Martin (1764), and Delambre (1827). Court culture, and all it presupposed of rank, patronage, and nice distinctions of title still marked most cultures in Halley's day, and for the better part of two centuries thereafter. The court was a social factor of "doing science" then as much as it was in Galileo's day. People during the "Enlightenment" would have been careful to get their honourifics right. As Halley's younger contemporary Jérôme Lefrançois de Lalande (1732-1807) remarked of German society during his astronomical mission to Frederick the Great's Berlin, his being received at court meant that: "I can appear everywhere, I can go everywhere among the Germans who are so jealous of precedence and of rank, and enjoy a rank which they esteem much, and to which they attach great importance."[6] And, for those who are wondering, Halley is not knighted in the current authoritative treatments of his life and career, including Ronan's article in the Dictionary of Scientific Biography (1972), Yeomans' in the Biographical Encyclopedia of Astronomers (2007), or Sir Alan Cook's magisterial biography (1998), and his entry on Halley in the Oxford Dictionary of National Biography (2004).[7] None of these can be blamed for furthering the fictitious knighthood in the literature.

Where, then, did it originate?

The earliest instances we can find occur in American astronomical texts from the age of John Quincy Adams (1767-1848) and Andrew Jackson (1767-1845), such as William Augustus Norton's *An Elementary Treatise on Astronomy* of 1839: "Halley's Comet is so-called from Sir Edmund Halley..." (120). President Adams would have had no difficulty understanding the functioning of European court culture and the social requirement to be accurate about titles, but the same could probably not be said of President Jackson, and many of his contemporaries. The world of the English middle and upper classes may have been a mystery to Americans at large, and it probably seemed reasonable to assume that any prominent Englishman must be a knight or a lord, particularly one who was a servant of the crown and moved in circles with the gentry and nobility. Everyone knew of the famous Sir Isaac Newton, so certainly his friend, the only slightly less famous Edmund Halley, must have been a knight as well. This is a clue to one of the reasons the fictitious knighting occurred then, and continues. It can come as no surprise that the error seems to have first arisen in the United States. It took a long time to do so in England, but arise it did in the post-Second World War period, and surprisingly, its incidence is on the increase among Halley's fellow countrymen.

Why the mistake?

There are a number of reasons the error could have begun, and continues to thrive. Chief among them is the simplest, namely, that to us, Halley's knighting seems plausible enough. He was an important natural philosopher in an age when it was not unheard of for such men to be knighted in England.[8] Add to that Halley's enjoyment of royal patronage supporting his voyage to St. Helena, the award of an Oxford M.A., his highly exceptional and successful naval research career, the award of half-pay status, and his appointment as Astronomer Royal, and the plausible seems persuasively probable. Placing a "Sir" before Edmund Halley sounds right. It's too bad it isn't.

Another reason could be the company Halley kept, notably Newton's. The two men are indelibly connected in the stereotyped potted versions of the "scientific revolution" we all carry in our heads. It's almost as if an attractive force (!) causes Newton's knighthood to migrate to Halley. The process is not conscious, and is probably most apt to arise when the writer or speaker is tired, or distracted.

The very plausibility of Halley's having been knighted is what renders the error so insidious. It is an easy mistake for an intelligent, generally informed writer on astronomy to make.

Halley's scientific legacy includes important predictions of a periodic comet (1P/Halley) and the 1761 and 1769 transits of Venus. If we are to venture a prediction on our part, it is that the fictitious knighting of Edmund Halley will continue unabated into the foreseeable future.

In the course of research for this paper we ran across the existence of a Sir Edmond Halley's Freehouse and Restaurant of Charlotte, North Carolina (www.halleyspub.com). Our plans for further research into this question vital to the past, present, and future of astronomy clearly requires that the *Journal*'s Production Manager, the Archivist, and the *Journal*'s Editor-in-Chief [yeah! — Ed.] conduct field research in situ. We will be looking for donors to contribute towards the cost of that expedition. For the sake of comparison, the same team should also carry out investigations at The Edmund Halley Pub in Leegate, London, to really assess the difference a fictitious knighthood can make in the real world.

The Editor apologizes for allowing such a florid style to grace the otherwise sedate pages of this Journal, *but notes that the work was probably stoutly constructed over a surfeit of Guinness.*

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Appendix 1. "Sir" Edmund Halley on NASA and ESA Web pages

NASA:
Astronomy Picture of the Day (APOD): 1996 July 6 - Edmund Halley's Greatest Discoveries
`http://apod.nasa.gov/apod/ap960706.html`
StarChild: A Learning Center for Young Astronomers

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/edmond_halley.html
JPL SUMMARY DESCRIBING COMETS (NASA, Jet Propulsion Laboratory, "Our Solar System at a Glance," NASA Information Summaries, PMS 010-A (JPL), June 1991.)
http://er.jsc.nasa.gov/seh/comets1.html
THEMIS: What is THEMIS?
http://www.nasa.gov/pdf/147795main_what_is_themis.pdf
THEMIS: Understanding Space Weather — The Earth's Magnetosphere 04.25.06
http://www.nasa.gov/mission_pages/themis/auroras/magnetosphere.html
THEMIS: Understanding Space Weather — Two Models: THEMIS Decides Which One is Right 04.25.06
http://www.nasa.gov/mission_pages/themis/auroras/two_models.html
VENUS Transit 2004 Sun-Earth Day - Background Reading: Math
http://sunearth.gsfc.nasa.gov/sunearthday/2004/vt_stu2004_venus_back_math.htm
VENUS Transit 2004 Sun-Earth Day — Background Reading: History
http://sunearth.gsfc.nasa.gov/sunearthday/2004/vt_edu2004_venus_back_his.htm
IMAGE Education Center: Imager for Magnetopause-to-Aurora Global Exploration - Why were scientists so excited by transits of Venus?
http://image.gsfc.nasa.gov/poetry/venus/VT5.html
IMAGE Education Center: Imager for Magnetopause-to-Aurora Global Exploration - S. Odenwald & B. DePontieu, "Calculating the Astronomical Unit During a Transit of Venus Using Satellite Data"
http://image.gsfc.nasa.gov/poetry/transits/TRACEvenus.html
IMAGE Education Center: Imager for Magnetopause-to-Aurora Global Exploration - ibid, "Calculating the Astronomical Unit During a Transit of Mercury Using Satellite Data"
http://image.gsfc.nasa.gov/poetry/venus/TRACEmerc.html
Technology Through Time: Living in the Atmosphere of the Sun. Issue #51: The Transit of Mercury
http://sunearthday.nasa.gov/2007/locations/ttt_transit.php
STARDUST EPO materials
http://solarsystem.nasa.gov/educ/docs/2-stardst-ch02.pdf

ESA:
"Today in Space History", February 10, portrait caption (*n.b.* "Edmund" in text, but "Sir Edmond" in portrait caption!) http://www.esa.int/esaSC/SEM5FRXEM4E_index_0.html
"Today in Space History", November 8, text and portrait caption http://www.esa.int/esaSC/SEM5X11A90E_index_0.html

Notes:

[1] RASC Archivist, 203-4920 Dundas Street W, Toronto ON M9A 1B7
[2] RASC National Secretary
[3] Halley's Christian name can be found spelled either "Edmund", as here, or "Edmond". A recent study by Hughes & Green (2007) has established the historical validity of *both* orthographies.
[4] The rumour that this group is limited to three old astronomers, a rusting robot, and an hedgehog in the Western Isles, is patently false.
[5] For the sake of discussion we will assume that the Archivist is a hominid.
[6] "Je puis paraître partout, entrer partout, et jouir, parmi les Allmands qui sont si jaloux de préséance et de rang, d'un rang qu'ils estiment beaucoup et dont ils font grand cas" (Dumont 2007, 19). Translation by Rosenfeld.
[7] Curiously, none of these investigate the phenomenon of the fictitious knighthood.
[8] It is important to remember that not all scientific worthies were so honoured, *e.g.* Royal Society fellows John Evelyn (1620-1706) and Robert Hooke (1635-1703). We have not done a scientific survey, but it is possible that most of the Halleys, Evelyns, and Hookes were not knighted (many were Anglican divines), and when they were (*e.g.* Christopher Wren), their prowess in natural philosophy may not have been the principal reason. Our expectation that these men could and possibly would be knighted for their science really applies more to the period of the Herschels, particularly John (1792-1871).

Carpe Umbram

by Guy Nason, Toronto Centre (asteroids@toronto.rasc.ca)

Is Barbara Duplicitous?

"Ah ba ba ba ba Barbara Ann
Ba ba ba ba Barbara Ann...

Went to the dance, lookin' for romance
Saw Barbara Ann, so I thought I'd take a chance
With Barbara Ann..."

From "Barbara Ann," written by Fred Fassert, 1961.
Best-known recording: The Beach Boys, 1965
© Songs of Windswept Pacific

Thanks to a unique method that uses the European Southern Observatory's Very Large Telescope Interferometer in Chile, astronomers recently have been able to measure sizes of small asteroids between the orbits of Mars and Jupiter. Their observations suggest that asteroid 234 Barbara has a complex shape, best modelled as two bodies that may possibly be in contact (Figure 1). The International Occultation Timing Association (IOTA) took up the quest to determine Barbara's true nature when it was learned that an extraordinarily good occultation opportunity would present itself on 2009 November 21 along a path that would cross northern Europe, Bermuda, and central Florida (Figure 2).

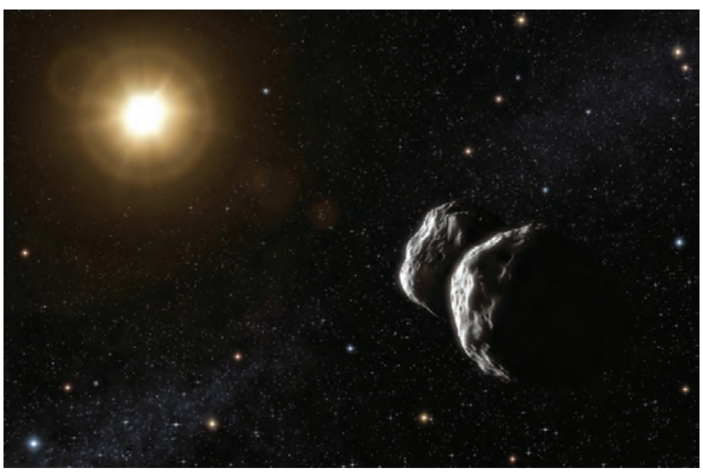


Figure 1

Accordingly, the call to telescopes went out to IOTA members on both sides of the Atlantic. In North America, it was decided to combine the Barbara expedition with IOTA's Annual General Meeting in order to attract as many occultationists to the path as possible. When I learned of this, I immediately started making plans to attend, but soon that dream was shattered by a sudden commitment that kept me close to home for the weekend in question. However, Canada would still be represented by Mike Hoskinson

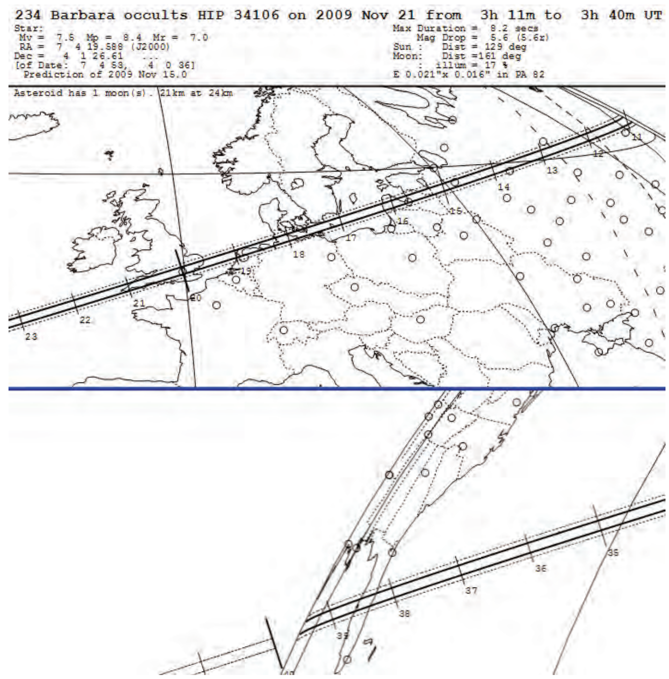


Figure 2

(RASC Edmonton Centre), who decided to fly to Orlando, not only to participate in the occultation and the meeting, but also to witness the launch of Space Shuttle *Atlantis* (STS 129) to the *International Space Station* earlier that week.

Others from across the USA joined the hunt. In Europe, seven observers, scattered across Germany, Austria, the Czech Republic, and Britain, "signed on." One observer in Bermuda, Eddie Mac, was also on board. The vast majority of stations would be clustered in the Orlando region in central Florida.

Thanks to the ingenuity of Scotty Degenhardt (`http://scottysmightymini.com`) of Columbia, Tennessee, who developed a small and affordable stand-alone occultation kit called the Mighty Mini, most of the Florida stations would be unattended. As plans developed, it became apparent that as many as 52 stations might be set up and operated by only 8 observers! A few single-station observers would also participate, bringing the potential total to more than 55 (Figure 3).

Of course, in the world of occultation timing, the best-laid plans are frequently scrambled by weather and Murphy's Law. Clouds during the afternoon limited the time available for the full deployment of unstaffed kits. Murphy, who just loves occultations, did in a number of people, including Edmonton's Mike Hoskinson. Mike got tripped up by a combination of clouds that interfered with setting up and pre-pointing one unattended station, suspect batteries that forced him to delay recording at the other, and difficulties getting the target star on screen at his staffed site. In the end, he abandoned his staffed location and hurried back to the one remaining unattended site to start the recorder, but arrived two minutes too late.

Figure 3

To date, only 28 stations (only?!) have filed successful reports: 3 from Europe and 25 from Florida. One of Scotty Degenhardt's unattended Mighty Minis clearly recorded a double occultation (`http://scottysmightymini.com/PR/20091121_234_BarbaraDegenhardt.wmv`). From it he produced a very definitive light curve (Figure 4).

Brad Timerson, IOTA's Results Coordinator, posted a preliminary profile, called a sky-plane plot, which showed that asteroid 234 Barbara had a very unusual shape (Figure 5). What does it mean? Could Barbara be a single heart-shaped rock? Perhaps (Figure 6). Could the plot reveal the profiles of two overlapping rocks in close proximity to each other? Perhaps. Scotty has made it very clear that, although he generated the two-rock profile, he is not claiming that Barbara is a binary asteroid. Yet. He states only that the data collected so far supports the possibility, but not the probability. Clearly, more study is required before this question can be answered with confidence, one way or the other.

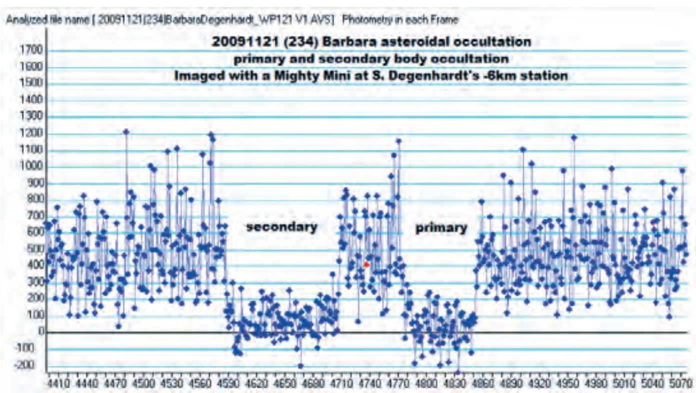


Figure 4

Fortunately, we shall soon have two more opportunities to observe occultations by Barbara from North America. In fact, by the time you read this, the question might have been settled. Shortly before dawn on 2009 December 14, asteroid 234 Barbara will occult an 11.7-magnitude star in Monoceros along a path across the USA from the Carolinas to Oregon. Again, on 2010 January 10 UTC (January 9 local time), a similar star in Orion will be occulted on a path that also enters the continent in the Carolinas, but rides a steeper angle that takes it into southern British Columbia at 20:46 PST on January 9. As I write this, I and other occultationists across North America are clearing our schedules and making travel plans to help solve the mystery. I'll have an update in this space in the next issue.

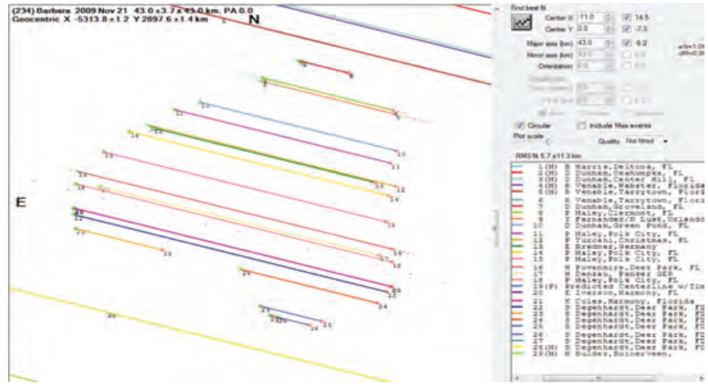


Figure 5

I need to stress that no one is claiming Barbara's duplicity based on the evidence to date, except perhaps the professionals at ESO. Scotty and I both feel, however, that it is a distinct possibility. Everyone on both sides of the issue is looking forward to results of the next two occultations, which we hope will settle the matter.

One thing is certain, however: If asteroid 234 Barbara turns out to be binary, the name of 234b is already known: Ann, of course!

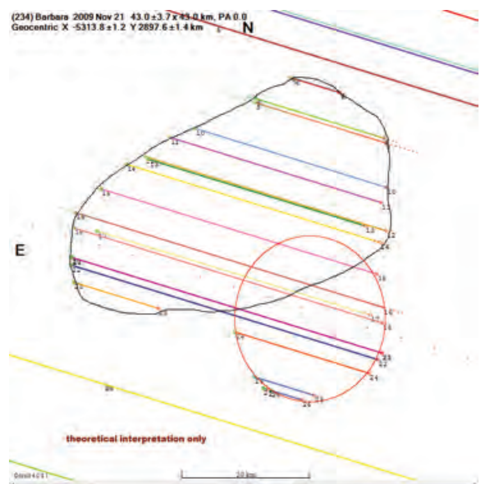


Figure 6

* * * * * * * * * * * * * *

Both experienced and new occultationists are encouraged to visit IOTA's Web site at `www.asteroidoccultation.com` to search for asteroidal occultations in their area. More information about IOTA and its recommended methods of recording occultations can be found at `www.lunar-occultations.com/iota/iotandx.htm`. Happy hunting!

Guy Nason currently lives in Toronto. He joined The Royal Astronomical Society of Canada in 1985 and has served on Toronto Centre Council continuously since 1986 (currently Coordinator of Observational Activities). He joined the International Occultation Timing Association (IOTA) in 1990, and successfully observed several lunar-grazing occultations, total lunar occultations, and — so far — 11 asteroidal occultations. He owns and operates Gneiss Hill Observatory at his cottage, 80 km northwest of Kingston, Ontario.

Gizmos

by Don van Akker, Victoria Centre (don@knappett.com)

Bahtinov on the Cheap

By now everyone who's interested has probably heard of the Bahtinov mask. This is a focus aid for imagers that looks like the cover of a shower drain gone wrong — a circle the size of your objective that has diagonal slots on one half and vertical (horizontal?) slots on the other. You point your scope at a star, put this over the end, and diffraction spikes line up to tell you when you are in perfect focus. Just like that.

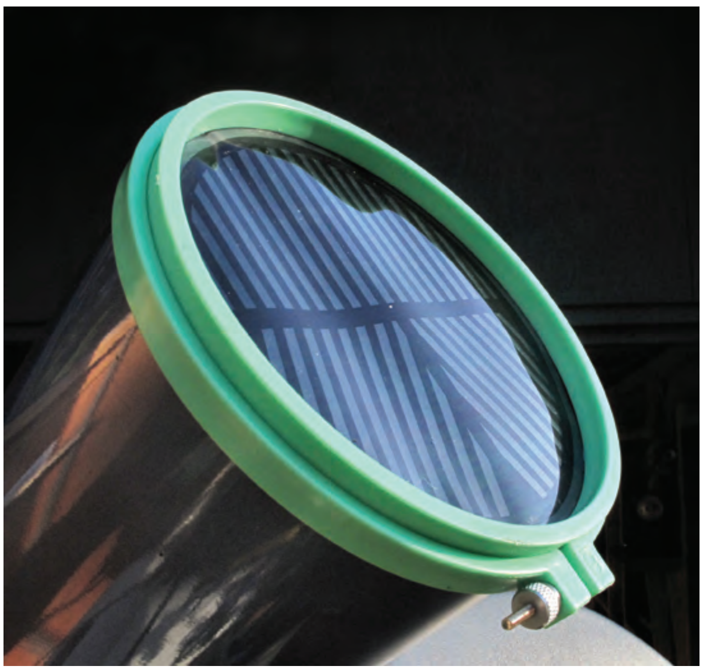


Figure 1 — The Bhatinoff Mask. I found an embroidery hoop that was a perfect fit for my scope. The transparency was glued to the face of the inner hoop and trimmed with a utility knife. Then the outer hoop was put on and offset to leave a rebate that seats nicely over the edge of the dew shield. Tightening the outer hoop left the transparency badly distorted, but this seemed to make no difference in actual use.

Yeah, right.

I am a sucker for gimmicks and almost every astro-gimmick that comes along eventually finds its way to the shelf in our observatory. There it stays, unused, to become, eventually, astro-trash.

We don't need more trash.

Yet the Bahtinov mask looks interesting. I'd really like to try one. But they are custom ordered and made specific to your scope, so, once you buy it, it's yours. Or you could make one and spend hours with a utility knife painstakingly cutting it out — but that sure seems a lot to go through just to try it.

The design part is easy. There is a wonderful Bahtinov mask generator at `www.astrojargon.net`. You input focal length, aperture, the edge thickness, size of the central obstruction (if there is one), and a few optional factors that you can play around with, you push "Generate!" and there it is, ready to print.

But there is one tiny little hitch. This program produces a vector file and it does not print. Photo and graphic programs print only raster files (don't feel bad about looking this up, I had to) so there is probably nothing in your computer that will print this. Even a screen grab doesn't work because it won't scale correctly.

The solution is called *Inkscape*. This is a very capable vector-graphics program that I will explore more thoroughly one day, but for our purposes now it has two wonderful attributes. It prints vector graphics and it's free. Find it at `www.inkscape.org`.

So now you have a Bahtinov mask printed on a sheet of paper. This looks nice but is not very useful. And even if you spent the time with the utility knife it would be so fragile that it still wouldn't be very useful. The quick and easy solution? Take your printout to a copy shop and have them copy it onto overhead transparency film. Cut out the circle, glue it to a ring that fits over the end of your scope and wait until it gets dark.

I tried this out on a 130-mm f/8 refractor. I pointed it at Altair. You need something bright because you can't buy optical grade transparency film. The results are in the photos. The vertical lines produce one set of diffraction spikes and the diagonal lines another. Because they come from different parts of the lens they don't line up unless they are perfectly in focus.

How perfect?

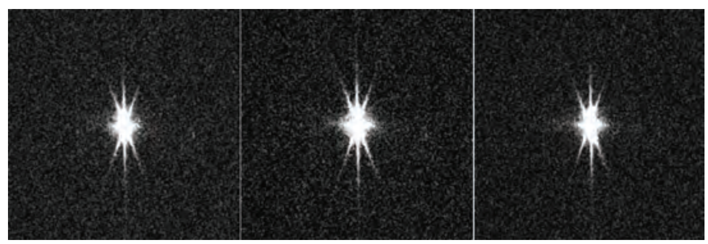


Figure 2 — Left: inside focus .015″; middle: at focus; right: outside focus .015″

The accompanying photos show Altair through the mask on a night of good transparency but dismal seeing. I used CCDSoft in focus mode and watched the centre spike move left or right as I moved focus in or out. Even through my distorted piece of cellophane, it was remarkable how sensitive this was. The sweet spot for an f/8 scope is theoretically about .008″ deep (and in the real world, probably twice that) and even with very poor seeing it was easy to get within this range in moments instead of the many minutes of tinkering I often do with highly ambiguous software focussing tools.

So is the Bahtinov mask the final answer? I don't think there is a final answer, but this gets as close as anything I've tried so far.

I'm going to play with it some more...then I'm going to spring for the laser-cut version.

Don and Elizabeth van Akker are members of the Victoria chapter and observe together from their place on Salt Spring Island. Don answers questions about Gizmos articles so why not try one on him at dvanakker@gmail.com.

Gerry's Meanderings

by Gerry Smerchanski
Winnipeg Centre (smerch@mts.net)

Folk Tales and Telescopes

As with all human endeavours, it is inevitable that some myths, half-truths, and legends will arise in astronomy. Like the tales of 100-mpg carburetors, the world of telescopes has its share of wild claims for certain optical devices. These are usually associated with some of the more notable names and manufacturers of the equipment we use. Most of us have been exposed to claims of the incredible performance of the legendary 3.5-inch Questar telescopes. The one I tried was excellent, but some of these barroom claims defy modern optical theory. It does what it was designed to do, but it is not some magical instrument that defies the laws of optics. Yet the legend lives on about this wonderful telescope, which would give the best views possible if you could only find one. The faithful still put out want ads for this scope and high prices are exacted for the few that go on sale.

Other legendary scopes are the 5-inch Schmidt-Cassegrains from Japan Special Optics (JSO). These low-volume Japanese scopes appeared on our shores in the early 1980s and disappeared within a decade. As something of a "clearing house" for information on these scopes, I have run across some remarkable claims. Those who have heard of JSO telescopes usually get the idea that they are very good telescopes — incredibly well made with very good optics that have a consistency of performance from scope to scope that large manufacturers could only dream of. JSO scopes seem to deserve this legendary reputation of being excellent telescopes. However, with any well-made instrument that has a favourable reputation, there have been some claims that I have found surprising and that seem to go beyond what is expected. Being a rare telescope only enhances its reputation. One such claim that caught my interest was that the 5-inch (125-mm) JSO Schmidt-Cassegrain was the equal or even superior to a Takahashi FS-102 in image quality. I have owned several JSO SCTs over the years and still have one. Even though it doesn't see much use, it is such a delight to use and such a good-performing conversation piece that I couldn't part with it. However, I have looked through a Takahashi FS-102 and thought its imaging superior. Therefore, I arranged to do a side-by-side test of the two so I could reconcile my perspective with the tale.

While not direct rivals, the two scopes do occupy the same general telescope niche of being rather small high-quality instruments. However, as the photo shows, they approach their task with very different designs. The JSO is a traditional Schmidt-Cassegrain employing a moveable main mirror for focusing. The Takahashi is a straightforward fluorite apochromatic refractor. They are similar in light gathering (JSO at125 mm with obstruction vs. Takahashi at 102 mm unobstructed) and even the focal length and ratios are not too dissimilar, with the JSO being an f/9.6 (1200-mm focal length) and the Tak being an f/8 (820-mm f/l). Some measurements of the obstruction and some quick calculations show the light-gathering ability of the JSO to be about 25 percent more than the Tak. The big

Figure 1 — Two different approaches to small telescopes.

difference in dimensions is obvious from the pictures, and, despite being similar in weight (JSO at 4.12 kg and the Tak at 5 kg), the demands on a mount are quite different, in that the JSO with its short polar moment is far easier to manage and would be more stable on any given mount.

When it comes to pushing telescopes to their limits, it is hard to find a more demanding target than high-powered planetary viewing. Jupiter was the most suitable target for this test. Despite

Figure 2 — Looking down the business end of the two telescopes.

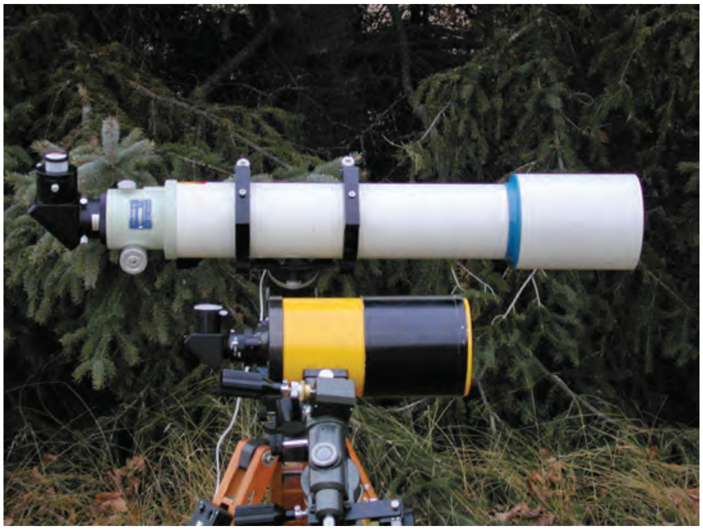


Figure 3 — Compact SCT's are an easier load for a given mount. They also keep the eyepiece height range within smaller limits.

not getting very high for northern hemisphere observers, Jupiter's available detail was sufficient and revealing. Jupiter and its moons were observed using a variety of eyepieces and my favourite planet-watching setup, employing a binoviewer. The JSO gave a fairly crisp view with the most subtle colour on the disc of Jupiter. Its moons appeared quite star-like; the amazingly smooth focuser on the JSO made finding the very well-defined in-focus image a breeze. This definite "snap focus" is often regarded as a sign of good optics.

The Takahashi image took on a slightly different look with the moons having that "little round ball" that we come to expect from smaller telescopes that have larger Airy discs. This appearance is pleasing to some (me included), but one must remember that this image with a "dimension" does not represent the diameter of the stars or even some moons. The point of focus also was well defined with this scope. The view of the planet with the Tak was very good. In fact, it was decidedly better than the view through the JSO. Many back-and-forth observations were made over the course of several nights, and the views of the planet's disc were simply sharper and the contrast better in the Takahashi than in the JSO. This is not to say the view through the JSO was bad — it still was as good as many achromatic scopes in this size range — but the clarity, colour rendition, and contrast of the Tak made the JSO look as if there was a very thin haze when viewing the planet. This was the case with both the binoviewer and with single eyepieces.

The next target was M13, and here again the Takahashi, with better-defined and sharper stars, gave a slightly more pleasing view of the globular cluster. However, the extra light-gathering ability of the JSO helped to make the views more comparable and there was little to choose in viewing clusters through either scope. At certain magnifications, the view through the JSO was preferable to that of the Tak. However, the wider field of view of Tak gave it an aesthetic advantage, at least as far as extended objects were concerned.

The last type of target for evaluation included various nebulae. Here again, there were ambiguous results. The JSO's extra light-gathering helped it better reveal some of these faint fuzzies. However,

Figure 4 — The old fashioned rack-and-pinion focuser of the Tak was stiff in the cold, while the buttery-smooth JSO focuser had mirror shift.

the contrast of the Takahashi made up for any lack in light gathering, and if the object was barely above the background sky-brightness level, then the greater contrast of the Tak was most appreciated. Again, the narrower field of view of JSO worked against this scope in rendering nicely framed views of some of the larger objects.

It should be noted that the JSO was designed to use the common Japanese standard .956-inch eyepieces and can use the North American standard 1.25-inch format eyepieces (1.25-inch format was used for this test), while the Tak was set to also use the 1.25-inch format but can easily use the 2-inch format. The JSO could be cobbled together to use the 2-inch format but severe vignetting would result. The JSO gives its sharp views with a more constricted apparent and true field of view.

The Takahashi proved to be the more versatile and capable scope with superior planetary views. It held its own against the larger scope on clusters and had a slight edge on faint fuzzies — especially if they are larger. It should also be noted that colours were better rendered by the Takahashi. It is difficult to take pricing into account here as the JSO is no longer offered for sale. JSO used prices compared to Takahashi used prices make the JSO the definite bargain at about a half to a third of the Tak.

The JSO is a very fine 5-inch SCT, but it does not do magic or perform beyond the technological boundaries that limit all optics. However, the Takahashi FS-102 is truly a superb scope that has all the benefits of an apochromatic refractor. Yes, it is dated, with a less-than-totally-smooth and effortless focuser (it got stiff in the cold). Its rack-and-pinion focuser lacked the precise feel of modern two-speed Crayford focusers. The JSO has the most amazingly smooth micrometer-style focuser that is only marred by some mirror shift. The fit and finish of these two old-style Japanese scopes is very good, and would only be a disappointment to those expecting a modern look.

These telescopes are old-school competence instead of the modern approach of style over substance. However, the issue of the extravagant claim of a "lowly" mysterious SCT performing better than the vaunted apochromatic refractor seems to be just a myth. At least that was the case with these two very fine telescopes.

Gerry Smerchanski is an eclectic member of the Winnipeg Centre whose basement is stuffed with all manner of old telescopes, binoculars, and other optical gear. He can often be found expounding on the mysteries of optical design over a beer.

Society News

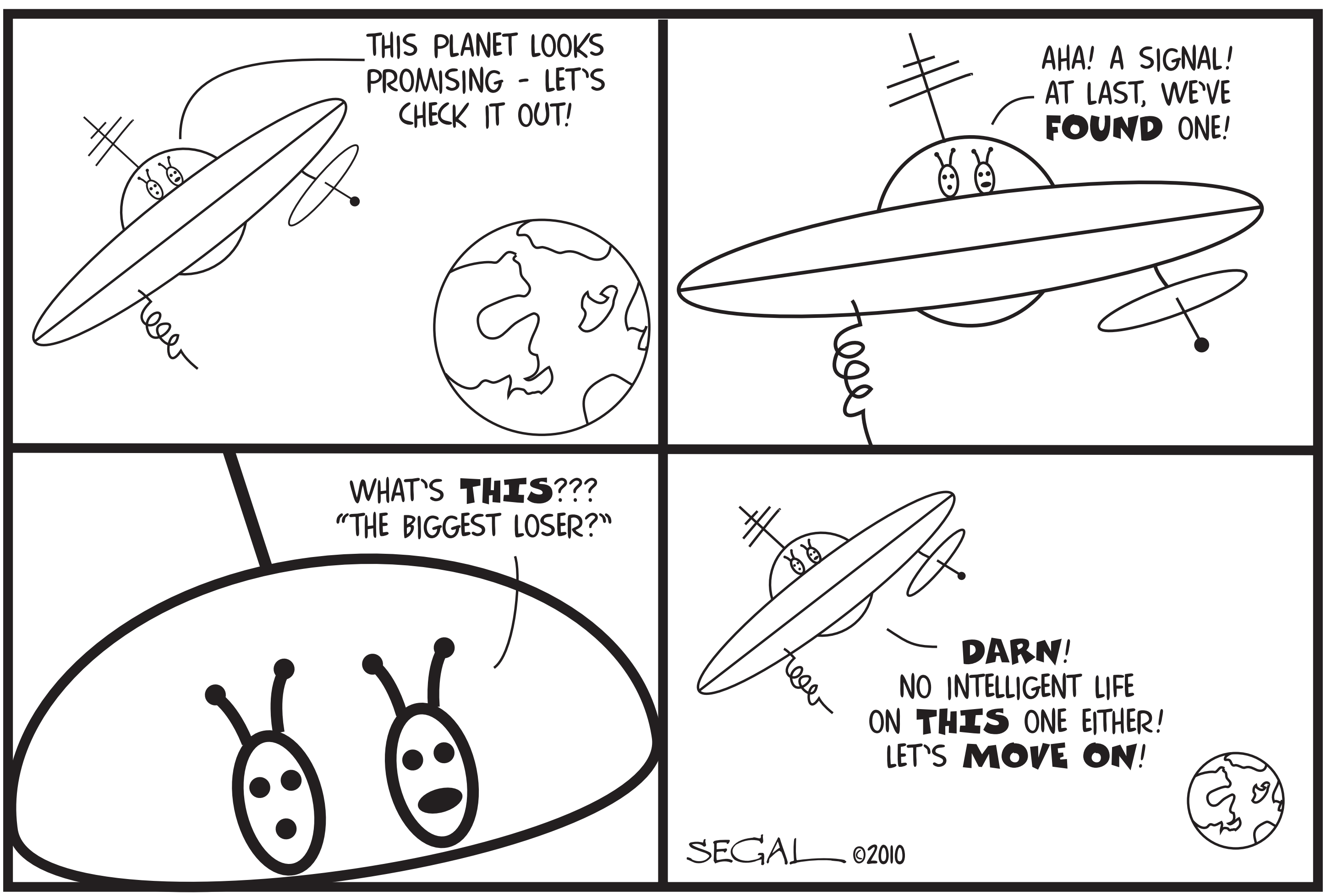
by James Edgar, Regina Centre (jamesedgar@sasktel.net)

Here's the scoop from the recent National Council meeting, held by teleconference on November 21:

- Randy Attwood, Dave Lane, and Mayer Tchelebon have been named as Trustees to the Helm Fund
- The RASC will continue the partnership beyond IYA2009 with the FAAQ and CASCA, with a focus on Education and Public Outreach
- The Executive Committee will search for a Manager to invest the Society's designated funds
- The Centre Projects Funds and Speaker Travel Assistance Program have been combined and replaced with the new Public Speaker Program — more news on this in the New Year
- Three initiatives from the Constitution Committee, to reform the existing By-Laws (streamline and adopt a Policy Manual); to formulate a Dismissal Policy; to develop a revised Family Membership program
- Approved a budget request from the Education Committee to sponsor two awards for the Canada-Wide Science Fair 2010
- National Council approved four policy initiatives from the Light-Pollution Abatement Committee — Dark-Sky Preserve (DSP) Guidelines to Outdoor Lighting; RASC DSP Guidelines; Urban Star Park (USP) Guidelines to Outdoor Lighting; RASC USP Guidelines
- Council approved a proposal to refresh and streamline the Society's promotional materials
- The Executive Committee proposed a plan to establish an Executive Director for the Society
- A Green-Laser-Pointer Committee was formed to address the issues surrounding responsible use of GLPs

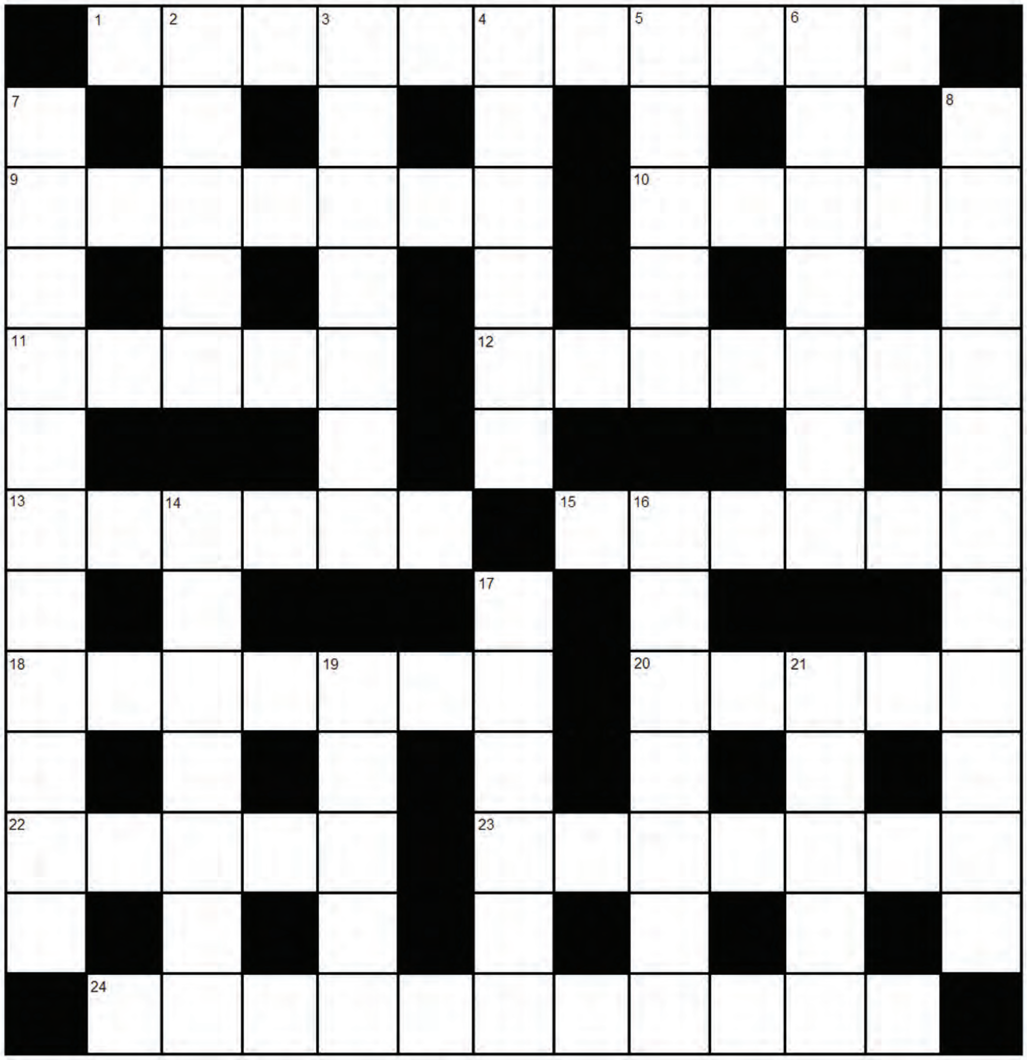
The unofficial Minutes and Motions flowing from the National Council meeting (NC094) are posted on the Members Only area of the Web site at `www.rasc.ca/private/minutes/index.shtml`

We extend sincere condolences to Brian Segal, layout designer for the Journal and our cartoonist. Brian's mother passed away on Monday, 2009 November 9.



Astrocryptic

by Curt Nason



ACROSS

1. Where to scope out a variable star over boy (11)
9. Talk in a roundabout way of the giant's belt (7)
10. Does peering through telescopes today hold sauce? (5)
11. Nix orbits ten AU from a plutino (5)
12. A proton is a non-clue perhaps (7)
13. We hear he is a gem of a RASCal in St. Johns (6)
15. Underachievers set this for a magnifier (6)
18. Misguided rant about weird sex with a popular GoTo scope (7)
20. Prize awarded in physics imaging in the Celaeno-Bellatrix region (5)
22. Hadar renamed for an age of revolution (5)
23. Kodak films log drop mix-up (4,3)
24. Astronomy education centre built on unstable mature plain (11)

DOWN

2. I followed a secret agent to find a steady-state theorist (5)
3. Draco's third evolves late in the first of November (7)
4. Put potassium iodide in French wine before Giotto first landed on Mars (6)
5. Optic aberration is the theme of this clue (5)
6. Stellar lifetime plotter gets less back in 75% rule (7)
7. RASD member properly returned endless nude to ATM pitch in Richmond Hill (5,6)
8. Telescope support in slow transition to locate the Hooker (5,6)
14. Greatest source of water from a gap in Saturn's rings (7)
16. Run Alan around to see the eclipse (7)
17. Rather hot stellar type not left out of a Yale star catalogue (5)
19. I ran around after Tuttle's first Perseid afterglow (5)
21. Pub crawl around astrophysics and former IAU president (5)

Great Images

Winnipeg Centre's Mike Karakas captured this image of a mid-winter sun pillar from Winnipeg's Assiniboine Park in January - a phenomenon that proved to be very common during the cold snaps in the month. Sun pillars are caused by the reflection of light from plate or column ice crystals. Because they are a reflection, they take on the colour of the light source.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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* Deceased 2009 August 11

CENTRE ADDRESSES/ADRESSES DES CENTRES

The most current contact information and Web site addresses for all Centres are available at the Society's Web site: **www.rasc.ca**

Belleville Centre
c/o Greg Lisk, 11 Robert Dr, Trenton ON K8V 6P2

Calgary Centre
c/o Telus World of Science, PO Box 2100 Stn M Location 73,
Calgary AB T2P 2M5

Charlottetown Centre
c/o Brian Gorveatt, 316 N Queen Elizabeth Dr, Charlottetown PE C1A 3B5

Edmonton Centre
c/o Telus World of Science, 11211 142 St, Edmonton AB T5M 4A1

Halifax Centre
PO Box 31011, Halifax NS B3K 5T9

Hamilton Centre
576 - Concession 7 E, PO Box 1223, Waterdown ON L0R 2H0

Kingston Centre
PO Box 1793, Kingston ON K7L 5J6

Kitchener-Waterloo Centre
305 - 20 St George St, Kitchener ON N2G 2S7

London Centre
c/o Peter Jedicke, 82 Barrydale Cres, London ON N6G 2X4

Mississauga Centre
PO Box 98011, 2126 Burnhamthorpe Rd W, Mississauga ON L5L 5V4

Centre francophone de Montréal
C P 206, Station St-Michel, Montréal QC H2A 3L9

Montréal Centre
18455 Meloche St, Pierrefonds QC H9K 1N6

New Brunswick Centre
c/o Paul Gray,1068 Kingsley Rd, Birdton NB E3A 6G4

Niagara Centre
PO Box 4040, St. Catharines ON L2R 7S3

Okanagan Centre
PO Box 20119 TCM, Kelowna BC V1Y 9H2

Ottawa Centre
1363 Woodroffe Ave, PO Box 33012, Ottawa ON K2C 3Y9

Prince George Centre
7365 Tedford Rd, Prince George BC V2N 6S2

Québec Centre
2000 Boul Montmorency, Québec QC G1J 5E7

Regina Centre
PO Box 20014, Regina SK S4P 4J7

St. John's Centre
c/o Randy Dodge, 206 Frecker Dr, St. John's NL A1E 5H9

Sarnia Centre
c/o Marty Cogswell, 6723 Pheasant Ln, Camlachie ON N0N 1E0

Saskatoon Centre
PO Box 317 RPO University, Saskatoon SK S7N 4J8

Sunshine Coast Centre
PO Box 577, Sechelt BC V0N 3AO

Thunder Bay Centre
286 Trinity Cres, Thunder Bay ON P7C 5V6

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c/o Ontario Science Centre, 770 Don Mills Rd, Toronto ON M3C 1T3

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

Aquila's stars are a treat in themselves in a wide-field exposure, but this image by Edmonton Centre's John Mirtle brings out another treasure in the area - Barnard 142 and 143 - the "E" nebula. Found about three degrees northwest of Altair, and about 2000 light-years distant, the dark nebulae are visible to the naked eye and binoculars in dark skies. John used a Takahashi FS-60C refractor at f/4.4, an SBIG ST-10XME camera, and Astrodon filters from the summit of Mount Kobau to capture this wide-area view. Exposure was 4x10 min in each of RGB.