IMAGE-PACKED ISSUE

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Journal

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PROMOTING ASTRONOMY IN CANADA

April / avril 2010

Journal

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ROYAL ASTRONOMICAL SOCIETY OF CANADA

SOCIÉTÉ ROYALE D'ASTRONOMIE DU CANADA

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On the Front Cover:
Stefano Cancelli and Paul Mortfield combined talents to produce this stunning image of a section of the California Nebula. The image was acquired in October last year at Sierra Remote Observatories on an RCOS 16" f/8.9 telescope using an Apogee U16M camera. Exposure, in Hα, SII, and RGB wavelengths, totalled 21.5 hours. Hα was mapped to red and SII to blue; green was created by using a combination of Hα and SII.

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Executive Perspectives

by Mary Lou Whitehorne, First Vice-President, RASC

In my last column, I described the "us" that comprises our dynamic and shining RASC. We are a collection of motivated, interested (and interesting!) volunteers organized into a Canada-wide Society with 29 local Centres. The entire structure is a buzzing hive of activity at all levels, from Centre meetings to outreach events and star parties, to committee work, National Council meetings and our annual General Assembly. As a Society, we produce a number of high quality, authoritative publications that have gained for us an enviable global reputation. We are gaining solid traction in the area of light-pollution abatement through our dark-sky preserve programs. During IYA2009, we provided our fellow Canadians with an astonishing variety and number of "Galileo Moments" at many education and outreach events across the country, as part of a global celebration of astronomy. As a Society, we have many accomplishments and much to be proud of.

However, it's not all light and laughter. There are challenges lurking in dark corners under our starry skies. By now, you may have heard that the Executive Committee, with the support of National Council, is giving active consideration to hiring an Executive Director. Why? We have never had an Executive Director. Why should we suddenly need one now?

First, it's not really a sudden need. In fact, it's overdue. Let me explain...

This Old RASC House

We need management capacity. The RASC is a lot like an old house. If it isn't maintained, it cannot last. This Old RASC House has experienced a couple of decades of unintentional, benign neglect. By default, the Executive Committee provides essentially all of our management functions. They are volunteers with work, family, and other non-RASC commitments. These volunteer managers give of themselves to the best of their ability, but the scope of the task means that, for the most part, they have neither the time, the energy, nor the other resources to address many items that grumble in the background. Always, time and energy must be focused on those issues and initiatives that are critical to the Society's annual cash flow, like the production of the *Observer's Handbook, Observer's Calendar,* the

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Journal, and others. Add to this the budgeting, marketing, general operations, committee and council meetings, thousands of emails, and suddenly one has no time left for things like policy, procedure, and long-term planning (*i.e.* Where are we now? Where are we going? Where do we want to go? How do we get there?).

Like all deferred maintenance, these things can only be put off for so long before becoming a serious problem. We, the members, can choose to renovate This Old RASC House. Alternatively, we can choose to let it slowly fall apart around us.

The RASC Garden Party

To continue with the old house analogy, our Centres are comparable to the attendees at a garden party. From the garden, this 142-year-old house has a noble façade and looks sturdy and well built. National Executive Committee members will tell a different story. They have to live in the house, among its crumbling plaster and leaky pipes.

The Society itself, and the larger environment within which it works, has changed significantly in recent years. Our organization and operations have become increasingly complex. Members and National Council demand a higher level of service, responsiveness, and professionalism than was the case ten years ago.

The RASC is a combination of three operational entities:

1. A federally registered charity
2. A publishing house
3. A membership organization

Each of these three elements requires the attention and effort of the Executive Committee. We have a staff of only 1.6 full-time employees. We have made great progress in dealing with complex and difficult issues over the last three years, but there is a long way to go yet before we can call our situation stable. Many things remain "on the back burner." The Executive Committee is too busy coping with day-to-day issues on a best-able basis to give time and attention to some of the larger, more strategic tasks that now go begging. Under the present model, these larger issues will remain ignored to the long-term detriment of the Society. Essentially, we are not able to pay any attention to the long-term growth, health, and stability of the Society.

We need staff that can assume more of the management responsibilities, make more decisions, and act on them without involving the Executive Committee in day-to-day decisions. The experiences of the past several years have brought the Executive Committee to the unanimous conclusion that the RASC must have a full-time, paid Executive Director to undertake and oversee the multiple management tasks of running our charitable, publishing, and membership functions. To mix metaphors, our ship needs a full-time captain!

What about other, similar organizations, you may ask? How do they manage their affairs? There are two comparable astronomy organizations in North America: the American Association of Variable Star Observers (AAVSO) and the Astronomical Society of the Pacific (ASP). From their most recently published annual reports, we gather the following information:

AAVSO	ASP
• Has about 1300 members	• Has a paid Executive Director plus around 35 staff
• Has 12 - 13 staff	• Administers about $2 million per year in grants and donations
• Has a paid Director	• In 2008, its total revenue was $3.2 million
• Spent $873,000 on staff in 2007	• In 2008, it spent $2.6 million on "program services and support" (that includes staff salaries)
• Spent $37,000 on publications in 2007	
• Has an annual operating budget of about $1.2 million	

Both of these situations are very different from our situation of 4000 members, an annual operating budget of about $500,000, and a staff of 1.6. If we keep the status quo, what do we stand to lose? We risk losing our key national volunteers, through burnout. What can we gain from hiring an Executive Director? An Executive Director can provide the needed management capacity, continuity, stability, and eventually a degree of institutional memory.

We all love This Old RASC House and want to see it survive and thrive for another 142 years. Now we have some risks to weigh, and a big decision to make. It is a decision that will affect every aspect of our Society well into the future.

Stay tuned.

Quo ducit Urania!

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.

News Notes/ *En manchettes*

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

Kemble's Cascade Featured on APOD

Figure 1 — Kemble's Cascade in Camelopardalis. Image: *TheSky 6*.

Regular RASC viewers of the Astronomy Picture of the Day (APOD) Web site were treated to a double delight recently — first, a spectacular view of an asterism visible towards the long-necked constellation of Camelopardalis, and secondly, recalling that the featured asterism is named after a deceased, long-time, and respected member of The Royal Astronomical Society of Canada.

The Kemble's Cascade asterism contains about 20 stars nearly in a row, stretching over five times the width of a full Moon. The APOD description (2010 January 28) noted that the stars "...[t]umbling from the upper right to lower left in the picture...[were] made popular by astronomy enthusiast Lucian Kemble."

The RASC Calgary Centre's Web site posts the following brief biography of the former Society member:

> *Fr. Lucian J. Kemble, OFM, was born in 1922 on a small farm in southern Alberta. After spending four years during WW2 as a radio operator, he entered the Franciscan Friars in 1946. Ordained in 1953 after 7 years' study in Philosophy and Theology, he spent almost all of his priestly life in teaching and preaching. A member of the RASC for over 27 years, he worked with a Celestron 11 on Byers Mount in a shelter at St. Michael's Retreat, Lumsden, Saskatchewan. His main interest in astronomy was searching out deep-sky objects, of which he had over 5550 observed, drawn, and noted on file. ...Lucian passed away on February 26, 1999. He is sadly missed.*

Kemble was an active participant on the RASClist, the Society's email forum for its members. His postings were always welcome and enjoyed by many fellow astronomers.

Milky Way Hosts 15 Percent of Planetary Systems like Ours

Two astronomers have concluded that about 15 percent of stars in the Milky Way galaxy host systems of planets like our own, with several gas-giant planets in the outer part of their planetary systems.

According to Ohio State University astronomer Scott Gaudi, planetary systems like our own are not rare, but they are not in the majority either.

The find comes from a worldwide collaboration headquartered at Ohio State called the Microlensing Follow-Up Network (MicroFUN), which searches the sky for extrasolar planets.

The find is the result of statistical analysis based on some robust assumptions.

In the last four years, the MicroFUN survey has discovered only one planetary system like our own — a system with two gas giants resembling Jupiter and Saturn that astronomers discovered in 2006 and reported in 2008.

Gaudi noted that if every star had a planetary system like Sol's, astronomers should have found about six by now, but instead have only found one system.

Gaudi and colleague Andrew Gould, professor of astronomy at Ohio State, determined that the slow rate of discovery makes sense if only a small number of systems — around 15 percent — are like ours.

Planet Hunters Score Success

As many as six low-mass planets are circling two nearby Sun-like stars, including two "super-Earths" with masses 5 and 7.5 times the mass of Earth.

According to Steven Vogt of the University of California, Santa Cruz, and Paul Butler of the Carnegie Institution of Washington, the two "super-Earths" are the first ones found around Sun-like stars.

The team found the new planetary systems by combining data gathered at the W.M. Keck Observatory in Hawaii and the Anglo-Australian Telescope (AAT) in New South Wales, Australia.

Three of the new planets, with masses ranging from about 5 to

Figure 2 — 61 Virginis, one of only a handful of truly Sun-like stars that can be seen with the naked eye, has three low-mass planets orbiting it. Photo Credit: NASA Sky View

25 times the mass of Earth, orbit the bright star 61 Virginis, only 28 light-years away. The star can be seen with the naked eye under dark skies in the spring constellation Virgo.

A separate team of astronomers used NASA's *Spitzer Space Telescope* to discover that 61 Vir also contains a thick ring of dust at a distance roughly twice as far from 61 Vir as Pluto is from our Sun.

The second new system found by the team features a 7.5-Earth-mass planet orbiting HD 1461, another near-perfect twin of the Sun located 76 light-years away in the constellation Cetus.

The planet, assigned the name HD 1461b, has a mass nearly midway between the masses of Earth and Uranus.

It is now speculated that planets orbiting the Sun's nearest neighbours are extremely common.

According to Butler, current indications are that fully one-half of nearby stars have a detectable planet with mass equal to or less than Neptune's.

Vogt and Butler lead the Lick-Carnegie Exoplanet Survey Team. Radial-velocity measurements from ground-based telescopes are used to detect the "wobble" induced in a star by the gravitational tug of an orbiting planet.

The survey team has developed a publicly available tool, the Systemic Console, which enables members of the public to search for the signs of extrasolar planets by exploring real data sets in a straightforward and intuitive way. This tool is available online at `www.oklo.org`.

Companion Dwarf found in Big Dipper

Alcor, one of the stars that make the bend in the ladle's handle of the Big Dipper, has an M3-M4 dwarf companion. The new star is a faint, smaller, red dwarf, and is now named Alcor B. It was discovered using Project 1640's coronagraph, which blocks out the main star's light to see faint objects nearby.

Project 1640 is specifically designed to image planets orbiting nearby stars and to acquire low-resolution spectra of them simultaneously. It is currently the most advanced and highest-contrast imaging system in the world. It was successfully installed at the Palomar 200-inch telescope in July 2008.

After re-observing the new star some 100 days later, the Project 1640 team was able to show that the two stars orbit each other by their "common parallactic motion."

The idea of common parallactic motion suggests that nearby stars move in an annual, repeatable motion simply because the observer is on Earth and Earth is circling the Sun.

Long Range Plan (2010-2020) in Progress

The Canadian Astronomical Society/Société canadienne d'astronomie (CASCA) is well on its way towards developing the second, national 10-year plan for Canadian scientific research in astronomy. The new decadal review outlines the broad goals and directions of astronomical and astrophysical research in Canada. The plan looks forward to the 2020 time frame.

The work commissioned by CASCA is supported by the Association of Canadian Universities for Research in Astronomy (ACURA), the Natural Sciences and Engineering Research Council of Canada (NSERC), the National Research Council of Canada (NRC) and its Herzberg Institute of Astrophysics (HIA), and the Canadian Space Agency (CSA).

Formulation of the LRP2010 is a two-step process — a review followed by a prioritization exercise. The plan is focusing on the following seven areas:

1) Assessment of the state of astronomy and astrophysics in Canada in the context of available astronomical facilities and the direct support of ongoing research programs;
2) Assessment of secondary infrastructure, including demographic issues, critical to the success of the Canadian astronomical community;
3) Assessment of the state of the astronomy profession and its ability to take advantage of new opportunities;
4) Identification of potential new research directions or areas of opportunity and the types of facilities and support that are needed to pursue them;
5) Assessment of proposed new National and International facilities or programs, including space missions, and their relevance to the Canadian astronomical community;
6) Formulation of a prioritized list of facilities and programs that are essential to the success of the Canadian astronomical community; and
7) Creation of budgetary recommendations for facilities and

programs and, where possible, devise solutions to current funding challenges.

The final outcome of the review process will be an updated Long Range Plan for astronomy and astrophysics in Canada for the next decade.

A Long Range Plan author panel, selected by the CASCA President and Panel Chair (in consultation with agency designates and the CASCA Board) will deliver the final version of the LRP2010 and its associated recommendations to the President of CASCA. Estimated as approximately an18-month information gathering and assessment process, the public release of LRP2010 is expected in the fall of this year.

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

Feature Articles/
Articles de Fond

Aztec Constellations Preserved by Duran

by Robert S. McIvor (robertmcivor@ymail.com)

Abstract

The 1579 work of Friar Diego Duran is thoroughly researched, along with the Aztec paintings he preserved, in a quest for the identification of Aztec constellations.

Résumé

La recherche du frère Diego Duran en 1579, ainsi que les tableaux aztèques qu'il a préservés, sont évalués en détail dans le but d'identifier les constellations aztèques.

Introduction

In an article about astronomy among the Aztecs and Mayas of ancient Mexico, Coe (1975) identified three sources that preserve constellations depicted by Aztecs. They include the dotted patterns inscribed on the calendar stone by Aztec artists long before 1521, five asterisms or star groups drawn by Aztec elders for Friar Sahagun in 1558, and Aztec paintings that were preserved by Friar Duran in 1579.

It is remarkable that these sources survived, as most Aztec documents were destroyed after the conquest in 1521. The Aztec capital, Tenochtitlan, was razed to the ground as Cortes claimed Mexican land for Spain and Mexican souls for Catholicism. The zeal of some priests bordered on fanaticism, and a few made it their mission to obliterate all traces of Aztec culture. Temples were dismantled, rituals were forbidden, and church attendance was enforced.

The "Calendar Stone" was uncovered in 1790 by workmen digging beneath the Zocalo (the main square) of Mexico City (Figure 1). It once lay in front of the Great Aztec Temple. Lines join dots in a pattern at the seven o'clock position on the left side of the stone, and there is a pattern of three dots in a row at the one o'clock position. Coe described these patterns as "probable constellations." I reported on the patterns in a previous article (McIvor 2000) and suggested the first involved a group of stars straddling the ecliptic in Sagittarius (Figure 2), and the second appeared to be of α, β, and γ Aquilae. There are other dots on the calendar stone that I was unable to identify.

Figure 1 — Aztec Stone with Dotted Patterns (Nuttall, Figure 56)

The present article focuses on Aztec information in Duran (1579). Coe explains the reason for interest in Duran's manuscripts: "There is some curious information in the text and illustrations of Duran which might be interpreted as an indication of a kind of zodiac. According to him, each "month" or *veintena* in the Vague Year had its own planet or constellation, some of which he shows in the sky surrounded by clouds. These are also known as *veintena* symbols in other sources, such as the pierced bird for the 'month' Tozoztontli. This is clearly a subject that needs more research before it can be dismissed."

Three decades have passed since Coe's writing, and I am unaware of any research into Duran in response to Coe's challenge.

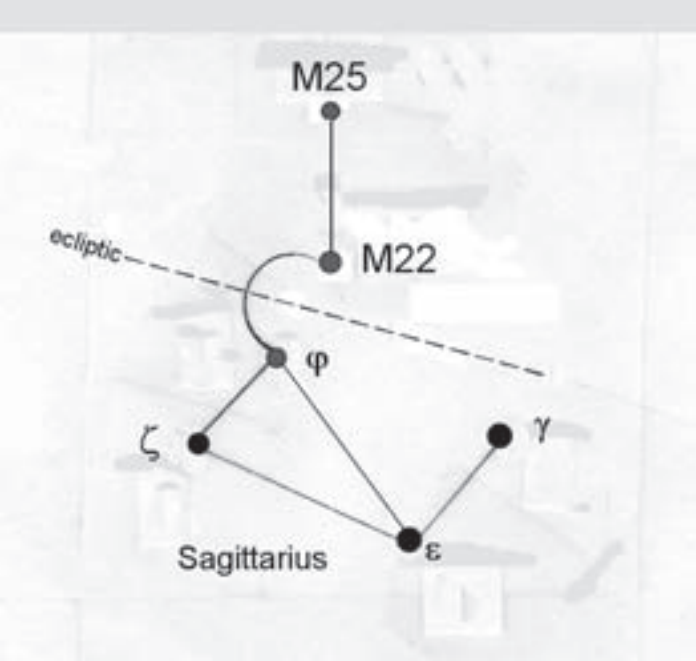

Figure 2 — Stars straddling the ecliptic in Sagittarius. From McIvor 2000.

This article hopes to fill that void by searching for information in Duran that might identify Aztec constellations.

Duran and his Sources

Diego Duran (*ca.* 1537-1588) came to Mexico in the late 1530s as a child with his parents. He grew up in Mexico and joined the Dominican Friars in 1557. He was fluent in Nahuatl, the Aztec language, which enabled him to converse easily with the common people. In 1579, he wrote two manuscripts entitled *The Gods* and *The Rites and the Ancient Calendar*. He tells us candidly what motivated him to write:

> *My sole intention has been to give advice to my fellow men and to our priests regarding the necessity of destroying the heathen customs which they will encounter constantly, once they have received my warning. My desire is that no heathen way be concealed, hidden, because the wound will grow and fester, with our feigned ignorance. Paganism must be torn up by the roots from the hearts of these frail people!*

Horcasitas and Heyden published an English translation of Duran's manuscripts in 1971. In their introduction to his works, they note:

> *Duran briefly describes the eighteen months of twenty days as well as the five useless days. Occasionally he refers to 'figures in the sky' by which he obviously means constellations and which indicate that each period of days was associated with heavenly bodies. The corresponding constellations are listed for some months but not for others. In some of the illustrations, the astronomical symbols are shown above the main drawing, within a ring of clouds. In others, the symbols are portrayed by the main figure itself. Unfortunately many of the symbols were lost when the manuscript was cut during binding" (1579:388).*

Horcasitas and Heyden tell us that Duran's manuscripts provide a "remarkably detailed description of the life of a vanished civilization" and "bear witness to long and painstaking consultation of reliable sources, both written materials and converse with living informants" (971:37). Duran relied on "pre-Columbian books known as codices. They had been executed in hieroglyphic writing on fiber paper or deerskin, folded in the form of screens. Their contents ranged from records of tax collection and history to ritual and calendrical matters. Those works, of which fewer than two dozen are extant today, were scarce even in Duran's time, the remnants of the once great Aztec libraries destroyed by overzealous Europeans. The surviving manuscripts had been hidden away by natives who wished to keep alive the old traditions (1579:37-8)."

Duran had copies made of these codices and preserved them in his manuscripts. He wrote how "those who with fervent zeal (though with little prudence) in the beginning burned and destroyed all the ancient Indian pictographic documents were mistaken. They left us without a light to guide us." He called them "history books worthy of being preserved" (1579:39). He described them twice as "hieroglyphic painting" and once as "native painting" (1579:455,464,413).

To understand the Aztec paintings, Duran sought out information from native informants. Horcasitas & Heyden remind us that "In the Mexico of Duran's time, thousands of men and women were still living who had been young in the days of the Conquest." Duran himself states that "not only today but in the past we have known of old men who were proselytizers, soothsayers, wise in the law, who taught and still teach the young folk, who are now being educated. They instruct them in the count of the days, and of the years, and of the ceremonies, and ancient rites" (1579:39)." Duran preserved pre-conquest Aztec paintings as well as information from Aztec informants who had personal experience and knowledge of pre-conquest Mexico.

I have identified five constellation figures in the Aztec paintings for particular "months" in their calendar. I will describe each painting in context, then attempt to plot the constellation figure among the stars. I have dated each Aztec month according to Sahagun (1569). He learned directly from Aztec elders that their year began on February 2. Duran thought it started on March 1.

The Bird Constellation

Duran's reproduction of the Aztec paintings for month three (late March-early April) and four is shown in Figure 3. He notes

> *The image venerated at this time was a beautiful bird with a bone*

piercing its body. I understood it to refer to a star formation that appears in the heavens like a bird pierced with a bone. The imagination of the natives may be compared with that of the poets and the astrologers, who imagined they saw the sign of Taurus, made up of many stars. Thus these people imagined this sign in the sky.

Figure 3. — Illustrations from Duran for months three and four. The redness in the centre of the bird may represent α Tauri.

Horcasitas and Heyden add their commentary on Duran. "The constellation is shown in the form of a bird pierced with a bone. According to Duran, it can be identified as Taurus and is made up of a number of stars." Horcasitas and Heyden take Duran to mean that the Aztec Bird was a star group in the same sky area as Taurus. I share their view, although some readers may find Duran ambiguous.

Duran's figure is a bird pierced through with a bone and the same figure appears again in the sky for the following month. Presumably, the Sun traced a path through this constellation in two Aztec months when this calendar was composed. The Sun moves almost 40 degrees along the ecliptic in 40 days (two Aztec months) and this gives some idea how much the Bird figure extended along the ecliptic.

The bone is the obvious object to draw first and I decided to draw it as a simple straight line that must join a star above the ecliptic in Taurus to a star below the ecliptic in Taurus. That line must be angled the same as the bone in the drawing. I considered various possibilities and I think the line that meets these conditions best is the line that joins β Tauri above the ecliptic to 10 Tauri below the ecliptic (Figure 4).

Figure 4. — Bird figure in Taurus.

This line passes through α Tauri, a noticeably red star, and it is conceivable that the Aztecs interpreted Aldebaran's redness as the wound site where the bone pierced the Bird. The bone in the drawing is angled at about 43 degrees off vertical, and my line is some 40 degrees off vertical. This is a good match when you consider that Duran's drawing was freehand. In the drawing, the length of the bird is the same as the length of the bone. Since my line traversing Taurus is about 35 degrees in length, I take it that the actual bird figure measures some 35 degrees from beak to tail. A bird that size certainly takes up most, if not all, of our Taurus.

We can coordinate this Bird constellation with a star group mentioned in Sahagun (1569). He preserved five Aztec asterisms and the first was a cluster of nine stars (Figure 5) called Tianquiztli, or Marketplace. Coe and most investigators identify this cluster as the Pleiades (Aveni 2001). The Aztec elders illustrated the Pleiades as nine stars enclosed in an oval ring of stars. The ring is shaped like an eye, and is perfectly positioned for the eye of this Bird constellation in Taurus.

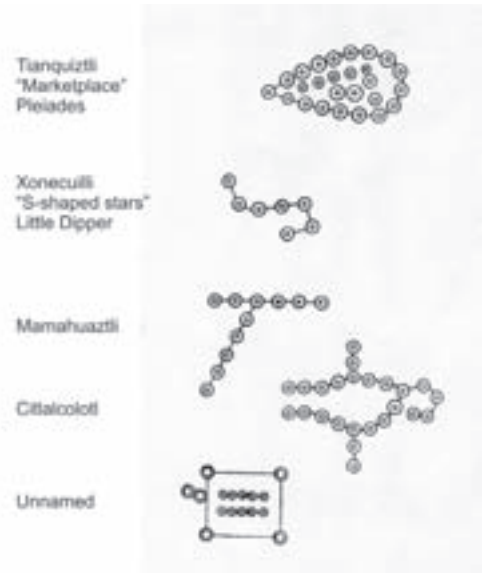

Figure 5. — The star cluster of the Pleiades shown as nine stars within an "eye" shape (Sahagun).

Duran writes that the Aztecs called months three and four "Perforation months" because they pierced themselves during this period to draw blood, and that this ritual was performed in imitation of the pierced Bird constellation. Liturgy, astronomy, and calendar were fully integrated in Aztec practice.

The Frog Constellation

Duran informs us that in month five (approximately our May), the

Figure 6. — Illustration from Duran for month five.

people prayed for rain, and in month six it "rained copiously." The Aztec painting for this month shows a man standing ankle-deep in water in a field, with one hand on a corn stock (Figure 6). The man holds a plumed device, which, with the man's vest, is scaly and leathery like the skin of a frog. The man is a god impersonator, and the texture of his clothing resembles frog's skin because he is impersonating a Frog constellation. He stands ankle deep in water, which suggests that the Frog is ankle deep in the Milky Way. It can be located in our Gemini, and the Frog's goggle eyes are probably the bright stars α and β Gemini (Figure 7).

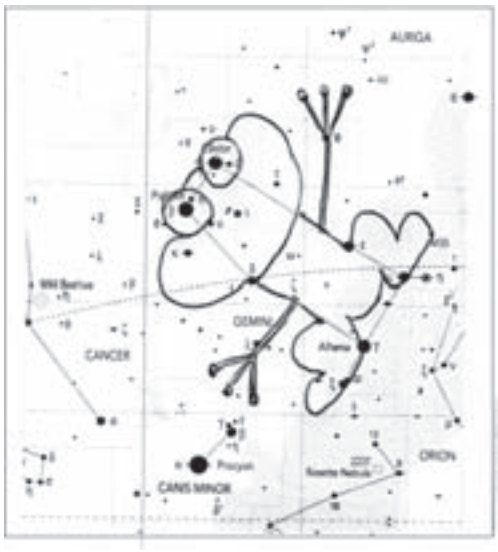

Figure 70 — Frog figure in Gemini.

As months five and six follow months three and four in the Aztec calendar, so their Frog (in Gemini) follows their pierced Bird (in Taurus) in the Aztec zodiac. The information on these two constellations is consistent.

The Butterfly Constellation

Figure 8 — Illustration from Duran for month one. The first month is symbolized by a "butterfly-motion" sign, which appears not in the sky, but underneath the Spanish inscription (Duran 1579).

For month one (early February), Duran interprets the Aztec painting, stating "the symbol venerated was shown in the form of a butterfly" (Figure 8).

We can calculate where this Butterfly constellation was located in the sky. We have the Bird figure in Taurus for months three and four. Duran has no constellation figure for month two (which must be in Aries), and the figure for month one must be in Pisces. The wings of the Butterfly can easily be positioned on the V-shaped pattern that pivots on α Pisces (Figure 9). This V-shaped pattern is already recognized in our own arrangement for Pisces, because we show it as the ribbon that ties together the fish with glittering tails. The Butterfly occupies about one half of Pisces.

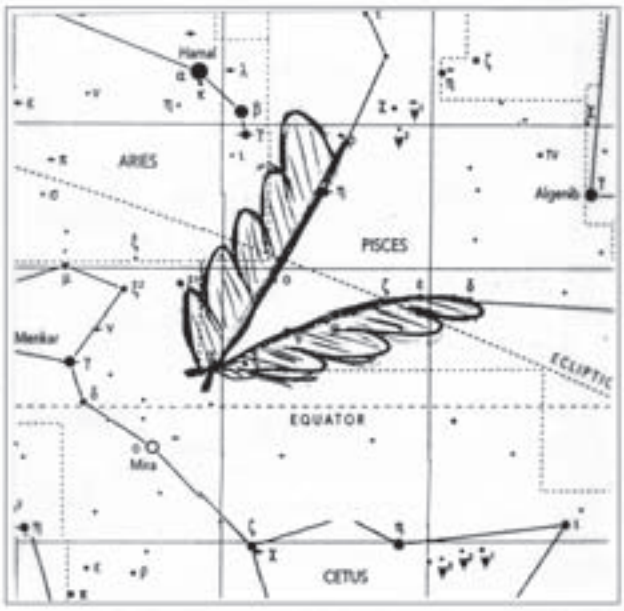

Figure 9 — Butterfly figure in Pisces.

The Death-Head Constellation

The Aztec month nine had a feast for deceased children, and month ten had a feast for deceased adults. The native paintings show a mummy in the sky for each month (Figure 10). The constellation figure for these months was probably a human skull. McDowell (1980) shows a crystal skull attributed to the Aztecs, and we know they used a skull as a day name in their calendar.

Figure 10 — Illustration from Duran for month ten. The figure in the upper left (a shroud-wrapped body) appears in illustrations for both months nine and ten.

This figure should be positioned about 120 degrees (six Aztec months of 20 days each) from Taurus, which would be in or about our Leo (Figure 11). It applied to two months, so I estimate it stretched almost forty degrees along the ecliptic.

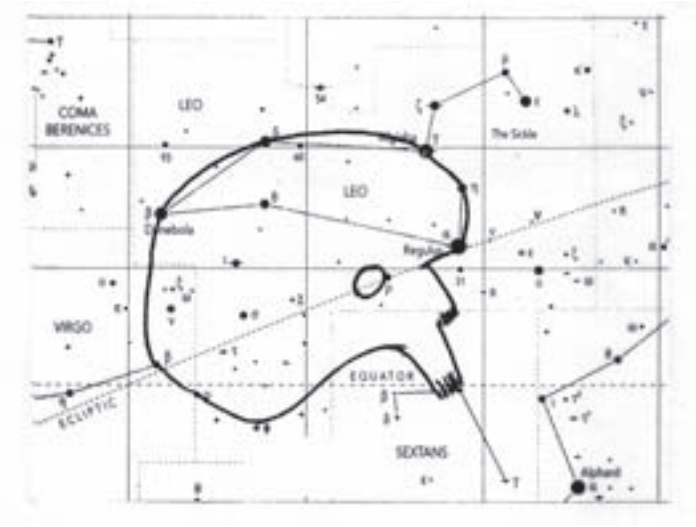

Figure 11 — Death skull figure in Leo and Virgo.

The Rattlesnake Constellation

For month 13 in the Aztec year, the native painting shows a rattlesnake with an impressive rattler in its tail (Figure 12). During this month, the Aztecs baked bread in the shape of this snake with dough used exclusively for ritual purposes. After a priest had consecrated these snake figures, they were eaten as communion bread, and the Aztecs believed they possessed healing properties. Frazer (1922) called this practice "eating the god," and compared it to the sacrament of the Eucharist and the Catholic doctrine of transubstantiation.

Figure 12 — Illustration from Duran for month 13.

This figure should be located about 200 degrees (10 Aztec months of 20 days each) from Taurus, which would be in the area of Ophiuchus and Scorpius (Figure 13).

Conclusion

Duran provides tantalizing information on several Aztec constellations. It suggests that their Bird constellation was a star formation in Taurus. With the Bird in Taurus, we can locate the Frog and Butterfly nearby, and tentatively plot two more constellations farther along the ecliptic.

It must be emphasized that our information is fragmentary, so

Figure 13 — Rattlesnake figure in Ophiuchus & Scorpius.

the attempts to draw these constellations are just that — attempts. However, the drawings enable us to picture a zodiac very different from our own (Figure 14). It included the gentle figure of a Butterfly bringing in the New Year, and a Frog cooling its heels in the Milky Way. However, it also had a Rattlesnake, a Bird pierced with a bone, and a rather sombre Death-head.

Duran described the constellations in the context of calendar and ritual. It is a reminder that among the Aztecs, astronomy was theology, and sky observers were astronomer-priests. Duran preserved these native paintings in order to refute Aztec religion, so it is ironic that we have gleaned what we can from his manuscripts to re-configure constellations that once mapped Aztec skies.

Figure 14 — A reconstruction of a part of the Aztec zodiac.

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An Initial Retrospective on the International Year of Astronomy 2009 in Canada

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Abstract: Canada's IYA vision, "*To offer an engaging astronomy experience to every person in Canada, and to cultivate partnerships that sustain public interest in astronomy,*" resounded with diverse partners, collaborators, and volunteers throughout the land, exceeding our ambitious expectations. More than 3600 extremely diverse events provided engaging astronomy experiences to more than 1.9 million Canadians, young and old. Extensive media exposure brought IYA awareness to millions more. IYA legacy activities, with a strong focus on improving opportunities for youth in underserved communities (inner cities, rural, Aboriginal, *etc.*), are underway, as we briefly describe. A longer final report, with extensive appendices, is being posted on the Canadian IYA Web site, as well as on partner Web sites.

Introduction

So long in the making, it is a bit hard to believe that the International Year of Astronomy 2009 (IYA) is officially over. As we catch our breaths and transition to *Beyond the International Year of Astronomy* (Beyond IYA) activities, it is natural to ask: How did we do? While perhaps still a bit close to respond with proper historical dispassion, the short answer is: we — no, YOU! — did well. We had a lot of fun sharing our passion for astronomy with members of our communities, and we laid foundations for improved education and public outreach (EPO) in Canada that can continue for years to come. Our short article aims to share a few highlights and anticipate some of the legacies.

A year-long, global education and public outreach (EPO) project, the International Year of Astronomy 2009 (IYA), was officially declared by the United Nations General Assembly, UNESCO, and the International Astronomical Union (IAU). While the IAU comprises 68 nations with some professional astronomy activities, IYA's educational vision was so compelling that 148 countries participated in this celebration marking the 400th anniversary of Galileo looking through a telescope and changing forever the way that we view the Universe and ourselves. IYA's global logo, *The Universe: Yours To Discover,* was inspired by a Canadian, and it motivated Canadian IYA preparations that began in late 2005 and soon led to the partnership of the Canadian Astronomical Society (CASCA), Fédération des astronomes amateurs du Québec (FAAQ), and The Royal Astronomical Society of Canada (RASC). As experience was gained, this partnership evolved to being guided by an Executive Committee with two members from each partner organization, plus the Programme Manager, who received invaluable advice from a larger Advisory Board. All decisions were by consensus, a process that worked extremely well, no doubt because the diverse experiences of team members helped us to analyze ideas and keep focussed on achievable goals. The three partners have committed to working together (at a less intense pace!) on ensuring that *Beyond IYA* astronomy legacies are realized. While the CASCA-FAAQ-RASC partnership was key, we cannot stress enough how vital the collaborations were with planetaria and science centres, government,

universities, other parts of the astronomical community, with parks, libraries, arts and cultural organizations, and many other elements of Canadian society.

Early on, we adopted a simple way of summarizing progress towards our overarching goal of offering an engaging astronomical experience, a *"Galileo Moment (GM)"* of personal astronomical discovery, to every Canadian, thereby using the wonder of the night sky to inspire an interest in the cosmos and in science in general. The fairly inclusive definition was meant to encourage both traditional (*e.g.* star parties, visits to planetaria, *etc.*) and non-traditional (*e.g.* attending art or musical events with strong astronomy content) approaches to help people reconnect with the cosmos. Event organizers reported the Galileo Moments achieved (that is, attendance), and a simple counter on our bilingual Web site increasingly captured attention as 2009 progressed. Formally, we celebrated passing the one million goal on October 27, but when all the late reports of earlier events came in, we now know it actually occurred much earlier in the year. By the end 1.93 million GMs were recorded throughout Canada.

Figure 1 — Galileo Moment geographical distribution across Canada.

Broadly speaking, programmes and projects in Canada fell under four themes:

- helping Canadians to reconnect with the sky (lots of star parties!);
- using art, music, theatre and images to bring astronomy to new audiences;
- making Canadians aware of outstanding frontier astronomical research underway in Canada; and
- supporting and improving formal and informal astronomy education, with a focus on youth in underserved communities (*e.g.* inner city, Aboriginal, rural).

Each of these themes had connections, implicit or explicit, to the international IYA Cornerstone Projects. Those developing Canadian IYA activities were encouraged from day one to consider how to ensure impact beyond 2009. In the following sections, a few examples provide a sense of the outcomes.

Reconnecting With the Sky

A high percentage of the GMs arose from the efforts of amateur astronomers, university and community observatories, and students, to go all-out to offer Canadians opportunities to see celestial objects through a telescope. These opportunities began in the middle of a Canadian winter, and ended with the New Year's Eve "Blue Moon," also in mid winter. In acts of "guerrilla astronomy," many took their telescopes to the people, in shopping mall parking lots, downtown sidewalks, and so on. Bilingual *Astronomy Trading Cards* and *Star Finders,* distributed for free at these events, were designed to pique the recipient's interest, leading them to continue to learn about the splendours of the Universe. *Astro Card* information also allowed people to register their name to be launched in 2010 aboard the Canadian Space Agency's NEOSSAT.

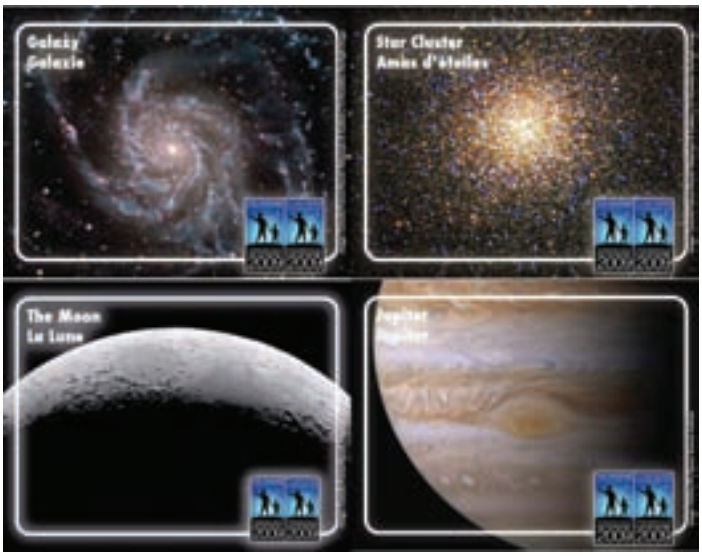

Figure 2 — Four of the set of seven AstroCards created by Jennifer West of the Winnipeg Centre.

Galvanized by the unique IYA opportunity, astronomers made impressive headway in efforts to provide more places where Canadians can enjoy the splendours of a dark sky, and to educate the public and municipal planners about deleterious impacts of light pollution on biota and energy consumption. Based upon guidelines widely distributed in 2008, four national and provincial parks newly designated by the RASC as Dark-Sky Preserves were added to the five they had recognized since 1999 and the two recognized by other organizations: Kouchibouguac National Park Dark-Sky Preserve, NB; Bruce Peninsula National Park and Five Fathoms National Marine Park Dark-Sky Preserve, ON; Mt. Carleton Provincial Park Dark-Sky Preserve, NB; Grasslands National Park Dark-Sky Preserve, SK.

The FAAQ laid the groundwork in 2008 for an innovative light-pollution-abatement approach by producing a draft proposal for outdoor-lighting regulations that all Québec municipalities could implement. The proposal was based upon material that led to the Mont-Mégantic International Dark-Sky Reserve designation. As described by Lacasse (2010), during IYA, the FAAQ organized a free one-day workshop, one each in Montréal and Québec City. Letters of invitation were sent through professional associations (landscape architects, town planners, engineers, *etc.*). From within a 150-km

radius of Montréal, 98 participants (compared to the ~30 predicted) attended, while 70 did so for Québec City. Positive participant feedback suggests this approach may be worth emulating in other provinces.

The children's book (written by Don Kelly) *Mary Lou's New Telescope,* provided free at events across Canada, was a well-received introduction for children to the effects of light pollution, while the Victoria RASC Centre developed a set of nine informative, light-pollution "trading cards" for adults for distribution at public events (see `http://victoria.rasc.ca/LPA/Default.htm`). All of these activities addressing light-pollution abatement represent an important legacy of IYA in Canada.

Figure 3 — One of nine light-pollution cards created by RASC Victoria Centre.

Reaching New Audiences

A striking feature of IYA in Canada was the number of events bringing astronomy to a much broader public — both children and adults — through music, art, imagery, and theatre techniques. Many national or regional hosts prepared radio programmes, broadcast by Radio Canada and CBC, linking IYA with broader cultural themes. Excellent local and national spots focused on upcoming IYA events. Archives ensure continued access to many of the national programmes.

Many musical groups and orchestras in Canada presented programmes during the year that touched upon astronomy and its history. Canadian physicist Diane Nalini, who is also a talented jazz vocalist, issued her fourth CD, with songs all invoking astronomical imagery. Holst's perennial favourite, *The Planets,* was heard on stages throughout Canada, thereby creating opportunities for informal astronomy education. The Victoria Symphony's annual educational programme for 2009, *Music of the Spheres,* presented both on Vancouver Island and in Toronto, integrated astronomy with lively astronomy-themed music appealing to kids. Canada's world-renowned Tafelmusik Baroque Orchestra created *The Galileo Project,* which is an imaginative programme celebrating IYA through music, stunning images, choreography, and poetic and theatrical narration. An exemplary illustration of the deep historical, societal, scientific, and aesthetic dimensions of astronomy (Percy 2009), *Galileo Project* performances are continuing well beyond 2009 and in other countries and languages (Mexico, China). A video recording will soon be freely available to accompany the audio available on CBC radio archives. Both the Victoria and Tafelmusik orchestras created Teacher's Guides that integrated astronomy and music content in a curriculum-

Figure 4 — Tafelmusik Baroque Orchestra performing their Galileo Project concert in Banff.

appropriate and engaging manner for young people.

Using actors and theatrical techniques, *Galileo Live!* — the first live planetarium show to be co-produced by the Calgary, Vancouver, Winnipeg, and Montréal planetaria — demonstrated that a planetarium program can combine both science and the arts, and be funded and staged nationally. In total, 32,814 people attended one of the 579 presentations during the 10 months it ran. Audience acceptance and satisfaction were very high. *Galileo Live!* provided the program partners with further experience with the style of show they feel will be essential for good audience appeal, and for a high-quality educational theatre experience as Canadian planetaria move into the age of all-digital projection, another valuable IYA legacy.

Figure 5 — Poster for the Galileo Live! planetarium production.

As readers of this *Journal* appreciate, the beauty of astronomical images captivates people while inspiring curiosity about the Universe. Most of the readily available images come from international sources, yet Canadian astronomers, both professional and amateur, produce a wealth of superb images. For IYA, a group of amateur and professional astronomers and visual artists created a living,

Web-based collection of stunning Canadian images freely available for use during and beyond IYA (see www.galaxydynamics.org/iya2009). Image displays were mounted throughout Canada, in science centres, breweries, art galleries, airports, shopping malls, universities, *etc*. The art and images at many of these exhibits were complemented by public viewing of celestial objects offered by local astronomers.

Canadian astronomical imagery and themes also inspired the artists at Canada Post and the Royal Canadian Mint, who produced stunning postal stamps and a silver $30 IYA commemorative coin.

Figure 6 — Canadian IYA postal stamps featuring the domes of the DAO Plaskett and CFH Telescopes superposed on CFHT images and the Royal Canadian Mint $30 silver Commemorative coin.

In collaboration with the Planétarium, Montréal's Botanical Gardens created a unique IYA event, *The Magic of Lanterns: Traditional Chinese Astronomy,* that drew large crowds. Lanterns inspired by classic images from Chinese astronomy and instruments from the Beijing Ancient Observatory allowed visitors to explore the mythological and scientific dimensions of traditional Chinese astronomy and to see how they compare with Western science. Every Thursday evening FAAQ members provided telescopic viewing opportunities.

Sharing Canada's Astronomical Research Successes

IYA motivated professional astronomers to provide expanded opportunities for Canadians to learn more about the excellent, exciting research being done by Canadians using Canadian facilities. Many university and college astronomers and their students, along with scientists at government laboratories and observatories, organized diverse public lectures on astronomy and its connections to society through the fascinating, fundamental research questions being addressed today.

CASCA funded and organized *The Galileo Lecture Series* (GLS). It enabled communities large and small to bring top researchers from Canadian institutions (who were also excellent public speakers) to present their science in an engaging and compelling way. The two goals of GLS were to introduce the excitement and reach of modern astrophysics to non-traditional audiences, and to provide a legacy for the host and the greater community. Two competitions resulted in 22 GLS lectures in English or French during 2009. A list of lectures, as well as video and audio recordings of certain lectures, is available at http://iya.astrosci.ca. Many GLS lecturers gave additional talks based upon their GLS presentations in schools and other venues, which at a minimum doubled the reach and impact of the programme.

Figure 7 — A CASCA Galileo Lecture in Pangnirtung, Nunavut.

CASCA also partnered with the Canadian Association of Physicists (CAP) to provide a special joint lecture tour, with a focus on astronomy, for undergraduate students. By pooling the resources of the two societies, they were able to expand on the highly successful annual CAP undergraduate lecture tour, and bring the excitement of modern astrophysics to students and faculty at 31 colleges and universities.

The FAAQ organized an independent *Série de «Conférences Galilée»* in which nine French-speaking astronomers presented 23 public lectures throughout Québec during 2009 (see http://iya.astrosci.ca or www.faaq.org/2009/conferences.htm).

During National Science and Technology Week (15-25 October), and associated with IYA, Waterloo's Perimeter Institute organized the largest and most comprehensive science outreach event ever held in Canada, *Quantum to Cosmos Festival: Ideas For The Future.* Attendance at on-site events was 39,137, and organizers estimate that more than 1 million around the world have participated through a combination of live, on-line streaming, TV programs, archived versions, and derivative material.

Improving Educational Tools and Opportunities

Globally the IYA vision was that "Everyone should realize the impact of astronomy and other fundamental sciences on our daily lives, and understand how scientific knowledge can contribute to a more equitable and peaceful society" (www.astronomy2009.org/general). This philosophy underpinned many of the Canadian activities we've already described. We'll close our brief review with a few more examples designed specifically for Canadian youth.

Schools reach millions of young Canadians each year, so support for the school astronomy curriculum, and support for teachers, is a high-impact approach. During IYA, astronomers gave dozens of in-school and after-school programmes, and they gave presentations at science teachers' conferences, reaching hundreds of teachers in Ontario and Québec alone. Summer institutes on astronomy for school teachers were held in Halifax and Toronto, part of the global *Galileo Teacher Training Program.* And astronomy resources for

teachers were developed by astronomers and institutions across the country.

For instance, the National Research Council updated their popular *Canadian Skies* poster, with its information about Canadian ground-based astronomy, and activities for teachers and students. Throughout Canada, at teachers' conferences, in schools, and at public events, NRC distributed 11,441 posters (twice as many as during 2008), experienced a 30-percent increase in Web hits, and distributed 1100 RASC-FAAQ *Star Finders.* Emphasizing Canada's contributions to space astronomy missions, and thus nicely complementing the NRC poster, the Canadian Space Agency produced a new educational poster, *Secrets of the Night Sky,* to commemorate IYA. Since distribution began in June, students, teachers, and the public have received 6300 copies. Together these posters are reaching hundreds of thousands of young Canadians, providing another strong IYA legacy.

Figure 8 — The French version of an educational poster widely distributed by NRC.

Our early wish to celebrate, in a respectful and inclusive manner, knowledge of the skies held by Canada's First Nations, Inuit, and Métis cultures alongside current astronomy knowledge was rewarded in 2007 by the opportunity to partner with the leaders of the innovative Integrative Science programme at Cape Breton University and their associated Mi'kmaq College Institute. Through their leadership, we envisioned three projects that we believe lay the foundation for a long-term partnership that will benefit the often underserved youth of these communities, as well as all Canadians. At the core of the approach is the concept of uniting Elders and youth within a community through the sharing of night-sky stories. Throughout 2008, Mi'kmaq Elders and Cape Breton University artists and scientists prepared a beautifully illustrated video (narrated in Mi'kmaq, English, and French) to serve dual purposes. First, through digital technologies, to share with Mi'kmaq youth a traditional story illustrating how circumpolar motion of specific stars guided rituals important to community life, as well as how such stories nurture and reinforce relationships between people and the natural environment in which they live; and, second, encouraging by example other First Nations throughout Canada to follow suit by making their sky stories readily available to their youth (and, where culturally permissible, more widely).

The premiere of the Mi'kmaq video of *Muin and the Seven Bird Hunters* occurred at the IYA media launch on January 8 at the Canada Science and Technology Museum in Ottawa and is available for download from the IYA Web site, Cape Breton University, and `http://iya.astrosci.ca`. Throughout 2009, and continuing strongly in early *Beyond IYA* activities, the video is being extensively used to broaden understanding within and between cultures and communities.

The two other major components envisioned involve fostering greater respect for the environment by encouraging and supporting Aboriginal communities to act to preserve areas near their communities that currently have little or no light pollution, and to promote these "dark-sky" areas as an accessible cultural and scientific resource for community youth, today and in the future. And, finally but very importantly, to create visual educational pathways for Aboriginal children and youth who wish to pursue dreams and career aspirations to become scientists.

In an independent thrust, Aboriginal specialists at the Manitoba First Nations Education Resource Centre also created a First Nations IYA calendar based (predominantly) upon Cree knowledge that they shared with some 57 First Nations schools and their 10,000 students (`www.mfnerc.org/images/stories/FirstNationsJournal/Volume2/008_buck.pdf`).

Figure 9 — Mi'kmaq artist Gerald Gloade's *Reflections* capturing the Mi'kmaq belief that everything that happens in the sky is a reflection of what takes place on Earth.

These and many other activities are already inspiring numerous *Beyond IYA* efforts with Aboriginal education. To build upon and extend the impact of these efforts, the three partner organizations applied for funding to support coordinated educational efforts beyond 2009.

Many readers will know that it is relatively easy to do EPO in

schools, science centres, libraries, and other places where one finds youth who are already in the educational system. But there are many youth who do not have access to resources, and who are not reached by regular educational channels, for example, inner-city or remote rural youth, those in hospitals and institutions, those who are new to Canada and don't speak either official language, and so on. Our IYA (and Beyond) Underserved Youth Project aims to reach out to these young people who are invisible to the usual EPO approaches.

A three-year PromoScience grant from NSERC in 2009 allowed the partner organizations to hire a part-time coordinator who is developing partnerships with agencies and services that access these "invisible" youth. Ultimately, these service providers and the youth themselves will define what constitutes effective EPO for them. The Coordinator is also using a similar approach to help us further develop the Aboriginal Project. In parallel, effort is underway to improve materials available for formal and informal science education in Canada. The EPO committees of the three partners and enthusiastic volunteers and collaborators from IYA have many rewarding opportunities to make a big difference in the long haul, and it is our aim to foster that process through this grant.

Final Remarks

We are all too conscious that many wonderful, creative, effective, deeply appreciated IYA activities have not been explicitly mentioned in our short review, which in no way diminishes their importance to IYA's tremendous success in Canada. We hope we will be forgiven for the omissions necessary to meet length guidelines. Had the economic situation permitted more fund-raising success, more would have been accomplished. Nonetheless, as we look back only six weeks after the close of IYA, we feel that all the thousands of people — whose largely volunteer efforts led to some 3600 registered events, nearly 2 million Galileo Moments, and many millions more Canadians touched by astronomy information during IYA — may take great pride in what we collectively accomplished. IYA2009 was a great celebration of an epochal turning point in human history. Long may *Beyond IYA* efforts continue to bring to all Canadians the sense of wonder that connection with our Universe inspires!

Acknowledgements

Words cannot adequately express our thanks to each and every volunteer, collaborator, and participant who made IYA2009's success possible. While many people, not acknowledged as authors, made insightful suggestions that improved IYA, we would like particularly to acknowledge key contributions to IYA planning from members of the IYA Advisory Board: Randall Brooks, Ruth Ann Chicoine, Dennis Crabtree (the very effective first leader of IYA in Canada), Jeffrey Crelinsten, Jayanne English, Peter Jedicke, Margaret Kennedy, Pierre Lacombe, Phillip Langill, Robert Lamontagne, Lindsay Marshall, Bob McDonald, and Scott Young. We are particularly grateful to the Trottier Family Foundation, whose support enabled us to have a part-time Programme Manager for 21 months. In addition to the outstanding support received from RASC, FAAQ, CASCA, and many individual donors, we also gratefully acknowledge important support received from the CSA, Lumec Corporation, NRC, NSERC, *SkyNews,* and the University of Calgary Faculty of Science.

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Lunar Observing

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

I have been an amateur astronomer now for almost four years, which in many circles still gives me "Newbie" status. I tried to cover all bases with my observing and studies — deep space, planets, double stars, our Sun — a little bit of everything, and to see what was what out there. The one object I found myself returning to most often was our Moon.

New astronomers may pick the Moon for some of their first observations (you can't miss it in the sky), but probably move on from there without taking the time to understand what they are seeing, or learning what makes the Moon "tick." After all, it is only the Moon, and a far-off galaxy or star cluster should be more exciting, right?

It seems that for most astronomers the light from the Moon is considered an annoyance that gets in the way of observing the "good stuff," like galaxies, nebulae, and globular clusters. Yet, at public-outreach events, it is probably the main object shown through the eyepiece. Why? Because its structure is fascinating to look at.

Now, don't get me wrong. I do enjoy viewing deep-space objects that I can see well with my scopes from my location. I also enjoy solar observing with my PST (Personal Solar Telescope), and I like looking at the planets, when they are around. But, my main observing enjoyment is the Moon. At first, I had guilt feelings when I realized this — maybe I wasn't a "real" astronomer, since I would rather look at the Moon than the Lagoon Nebula.

So why am I an avid lunar observer? First of all, I enjoy observing physical structure and the Moon has plenty! Impact basins, old walled plains, craters of all size and description, wrinkle ridges, cracks (rimea), mountain-like structures, valleys and gouges, odd-ball formations, bits and pieces sticking up from the surface, and any combination thereof.

The Moon also provides observing possibilities not found with many other objects in the heavens. Live in a large city or light-polluted neighbourhood and can't drive those two hours to a dark-sky location? Not a problem; the Moon is bright enough to cut through all that.

The Moon can be viewed in a variety of seeing conditions that would otherwise keep you and your scope inside. When the seeing

Figure 1 — Stuart Heggie provided this image of a section of the waxing crescent Moon taken on 2009 November 22 from Flesherton, Ontario. He used a Point Grey Research Chameleon video camera with a Baader IR-cut filter through a Takahashi FSQ with an Extender-Q. Exposure was 30 seconds at 15 frames per second. This image is a combination of the best 150 of 450 frames, processed with wavelets using *Registax 5.0.*

is good, you can crank up the magnification and study the details of one small area. If the seeing is mediocre, you can back off the magnification and take in a larger area. I found that, even if seeing conditions are poor, I could still pull out the binoculars and view the Moon as a whole, and study how the major features relate to each other. No large "light bucket" scopes needed here. Most small refractors and reflectors are quite sufficient.

Then there is the ever-changing appearance of the lunar surface. The continually moving position of the terminator, the effect of libration or "wobbling" of the Moon, and whether you are viewing during the waxing or waning phase, all these add up to a different view of the lunar features from night to night. And, if you are viewing an area close to the terminator, this change can be noted from hour to hour.

I also discovered daytime lunar observing, in the morning when the Sun is up, but the Moon is still reasonably high in the sky. This occurs with the waning phase, a few days after the Moon is full. You will have to restrict yourself to a lower magnification, as the lunar surface has a paler appearance and the contrasts are not there for fine detail. You may be surprised at how many features are observable.

While observing you can always hope of spotting some sort of Lunar Transient Phenomenon (LTP), short-lived localized changes on the Moon's surface that may indicate some form of geological activity. Another viewing opportunity comes during an occultation, when a background star slides behind the Moon's limb, only to reappear on the other side some time later. Even better is a grazing occultation, when the star alternately appears and disappears as it moves along the saw-tooth terrain that defines the lunar limb.

Early on, I realized that, to make any sense of what was being observed on the Moon, the observer had to do some study of lunar history and geology. What formed these things, when, and why? How do they relate to each other, and how does the Moon relate to the Earth? For example, what causes the dorsa (wrinkle ridges) to form, and what made those concentric cracks next to the inside of the rim on the floor of Crater Pitatus? I discovered that, the more I learned about what I was observing on the Moon, the more I appreciated what I saw. (Admittedly, associating the many long and hard-to-pronounce names with the various features takes some getting used to!)

In my opinion, the book *The Modern Moon* by Charles Wood is a must. Wood covers the Moon section by section, providing background, history, and explanations for a multitude of features from the huge impact basins (maria) down to some of the smallest craters. Another useful book that I found is *The New Atlas of the Moon* by Thierry Legault (not to be confused with the book by Antonin Rukl). Besides having nice photos and descriptions of many of the Moon's features, it provides a full-page image, with overlays giving feature names, for each day of the lunation cycle, so you can have an idea of what might be observable on a given night. *Sky & Telescope's* laminated *Field Map of the Moon,* illustrated by Antonin Rukl, is another must for identifying lunar features and their names. The book *Atlas of the Moon* by Antonin Rukl has been considered the "Bible" for lunar observing, and is available in a revised version from Sky Publishing, edited by Gary Seronik. As well, there are computer-based lunar programs available.

The Society's Isabel Williamson Lunar Observing Program can be earned by completing 140 objectives related to observations of the Moon; each objective consists of many lunar observations. The guidebook is excellent. I have completed this program, and it forced me to locate, identify, and observe many features that one might otherwise overlook.

I am not advocating that everyone become a dedicated lunar observer. I only wish to point out that Earth's companion can provide observing and study opportunities that might be overlooked in the quest to chase down those illusive "faint fuzzies." And, if those "faint fuzzies" can't be viewed some night, for whatever reason, the Moon may just be sitting up there waiting for you.

Ken Backer is a member of the Mississauga Centre and does most of his observing from his back yard in Milton, Ontario. He developed an interest in astronomy only a few years ago — never too old to learn something new at 62 years of age.

Thirty Years of Chasing Eclipses

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

The first one in **1979,** was a bit of a surprise: I didn't so much as go to it, as it came to me. I had expected to go, because *Oppolzer's Canon* predicted that it would pass to the west of Winnipeg, near the Saskatchewan border, but by the time it was three years out, more recent calculations showed that it would pass over Winnipeg. And, it did.

It also passed over the Winnipeg School Board. In the weeks leading up to the eclipse, the Board engaged in a ill-informed dispute with the astronomy community about safely viewing the Sun. Local optometrists, just as ignorant as the school authorities, jumped into the fray in the pages of the *Winnipeg Free Press,* coming down on the side of "the only safe eclipse is one viewed on television." We must have had some impact however, as the schools in Winnipeg had their greatest-ever absentee rate — over 30 percent of students played hooky. To this day, I hear stories of how "Mom and Dad stayed home that day to show me the eclipse."

Figure 1 — The 1979 eclipse from Manitoba.

I was working for Environment Canada then, and the year before had put together a small pamphlet on the February climatology of the area. It proved to be popular, so much so that I was asked to give weather briefings to a number of groups that had travelled to Manitoba. It was a tough situation, as most of southern Manitoba was covered in low cloud, something we have a lousy ability to predict, even now. I don't remember much of the briefings, but they were pessimistic. Fortunately, it was unwarranted, as eclipse day dawned with nothing more than thin cirrus overcast. Even the temperatures cooperated, but I still hear stories from others who came to the province that tell of the bitter cold. Even at central eclipse, it was barely -8 °C!

Well, I did travel a bit for that one — a hundred kilometres to the central line, up near Lake Manitoba. I was loaded for bear with a polar-aligned (well, polar-estimated) C8, a full camera, lots of film, and a mostly clear sky. It was a marvellous first total eclipse — a big Z-shaped prominence hanging off the limb of the Sun. So many things happened, I couldn't keep track of them all, even though I knew about shadow bands, beads, and diamond rings, and what to watch. My attentions were completely diverted by the photography, especially after I kicked the power plug out of the C8 at the instant of second contact.

1983

Indonesia — what a place for an eclipse adventure. My wife Judy and I travelled with Jim Gall out of Toronto. By then, I had written up a weather study for the US Naval Observatory, so Jim took me along as a helper. The plans called for us to fly to Jakarta and then jump on an internal flight to Yogyakarta, leaving the rest of the tour behind to catch up later. Judy and I were going to be the scouting party, travelling to our hotel at Salatiga to make sure things were ready for us. By the time we reached Jakarta, we were too tired to go further, so abandoned our ongoing flight, and caught some rest.

The following day, we travelled to the airport to go onward. The flights were full — there was no room in the early flights to Yogyakarta. There was a waiting list, but even that had 20 names on it. I'd done a little travelling in my time, so when I approached the fellow in charge of the wait list, I included a $20 bill in my passport. He didn't take it, but did inform me that we were "at the top of the list." There seems to be a certain honour code that works in such circumstances — the bribe is only accepted if the results can be guaranteed. As it turned out, there was no seat available, and no money changed hands. We caught an afternoon flight.

"Just find a car and driver and go to Salatiga" Jim had instructed. "Keep the bill."

It wasn't all that hard. There was a bit of a rental agency in Yogyakarta, and the owner, sitting off to one side of the counter, spoke English and was more than willing to help out. In short order, a Jeep was obtained, instruction given to our non-English speaking guide and driver, and we were off. It worked better than expected — the driver, unable to make himself understood, simply took it on himself to be a guide. We visited ruins along the way, a batik store (where English-speaking staff helped us with communication), scenic overviews, and finally, our destination in Salatiga.

There was a certain amount of consternation when we drove into the hotel compound, as if the management suddenly realized that all of the foreigners were for real. Bookings had been made by Telex; there had been no scouting trip, so our arrival was confirmation that 30-plus others would soon be on their way. The entire facility had been booked for a three-day stay. The manager's daughter was quickly called to the front desk — she spoke English. We settled in to a comfortable room with a strange bathroom and geckos on the walls. Marvellous!

Salatiga is a small place, and word of our arrival soon got around, especially when 30 others showed up the next day. We were crazy —

the eclipse was a dangerous thing to watch, and the government and mosques had arranged special prayers for eclipse day so that no one would be on the streets. Islam does have distinctive prayers to be said at an eclipse, but they are treated as special natural events that show the power of Allah, and are not proscribed. We struck paydirt soon after we arrived: Salatiga had a Canadian-run English-language school and each one of us was asked to "take on" a student so that the students could practice their language skills. Those skills were already pretty good, which gave us three days of personal guiding and a tremendous initiation into Indonesian society.

Eclipse day was a challenge. It had rained buckets the day before, and now the wet had been replaced by heavy cumulus cloudiness. "Where should we go?" I was asked. We had selected a soccer field in town to watch, but the looming volcanoes a few miles away were also tempting. "I'm staying here," I volunteered, as did most of the group. A third of the group elected for the hill. Skies cleared marvellously over our soccer field when the cooling from the oncoming shadow made itself felt, about halfway between first and second contact, but the unfortunates on the hill were treated to an equally quick fog bank at the last moment. They had to scramble to an opening to see totality, but all managed successfully.

Our student companions were very frightened by the oncoming eclipse. Streets were completely empty of townsfolk and only the group on the soccer field and a small contingent of soldiers were out in the open. As second contact approached, we gathered the nearest students, holding hands in a circle, to give them the courage to watch the spectacle. When the eclipse corona emerged, the fear evaporated in an instant, replaced by a soaring wonderment. The students made it a very special eclipse.

Figure 2 — The eclipse field in Indonesia in 1983. Yes, you can look through that thing. Our guides are beginning to get apprehensive.

The soldiers also had a treat. We had been sharing the developing eclipse with them, passing out eclipse glasses, and showing them the encroaching Moon through our telescopes. After about 15 minutes, the sergeant in charge received a radio message, related to us by the students:

"Bring the troops in — it is nearly time for the eclipse."
"No one here seems to be concerned — they are all watching."
"No, orders are to come indoors. Bring them in."
"The foreigners are not anxious; we could stay out with them."
"Bring them in."
"Hello, hello, I can't hear you. Please repeat. Hello, hello?"
He turned off the radio.

The soldiers stayed with us. As soon as third contact was over, the streets filled, and we shared the remaining phases with children and adults as they came by.

1988

This one was on the Golden Odyssey — a Greek-crewed boat — and we were in the Sulu Sea, north of Borneo. It was our first experience with the luxury of a cruise boat.

Some years before, I had met a forecaster from Hawaii at a conference, and had conscripted him to help me with the forecasting on eclipse day. The Hawaii office had forecast responsibilities in the eclipse area, and so was familiar with the climatology. I telephoned the National Weather Service office from the ship on the day before the eclipse, and explained the situation. "We were expecting you," the technician answered. My contact had disarming news. "There is an easterly wave approaching you." he said. "It's a small one, but you have the choice of moving quickly and getting past it, or reversing direction to stay in front." Easterly waves are small clusters of thunderstorms, but they are characterized by relatively clear skies in front, in contrast to the endemic thin cirrus that usually haunts tropical latitudes.

Figure 3 — King Neptune gets a sacrifice as we cross the equator. The author is on the right; Leif Robinson, editor of *Sky & Telescope* at the time, is on the left.

That night was sleepless. We had agreed to meet on the bridge at 2 a.m. to make a decision. I couldn't sleep. Outside my window (it was a window, not a porthole), the stars alternately winked on and off. One moment, they shone brightly; a few moments later, they were nowhere to be seen. There must be a lot of cloud up there, I worried. At the appointed moment, I headed for the bridge. Outside, skies were completely clear. What had happened to the cloud?

Figure 4 — Decisions, decisions. On the bridge at 2 a.m. - where do we go?

"We were zigzagging down the centre line," the Captain explained. My disappearing star was simply a change in heading! Ahead we could see the occasional lightning flash from the approaching easterly wave. "What do you want to do?" the Captain asked. "Turn it around and go back along the track." I offered, more in hope than determination.

"Did you catch that?" the Captain said to the helmsman.

"Yes, sir."

"Do it."

It was a marvellous eclipse, with the last of the cumulus fading away just at second contact. When it was done, with the ship back on course for Manila, and the easterly wave catching up, we headed for lunch.

"What's that?" Judy shouted, in the middle of lunch.

"A waterspout!"

The easterly wave brought us another treat.

1991

1991 was the Big One — a nearly seven-minute eclipse that passed over Hawaii, Mexico, and much of Central America. Many eclipse-chasers cut their teeth on that one, because it was easy to reach from the U.S. We watched it at La Paz, the capital of Baja California, with a large group of *Sky & Telescope*-sponsored travellers.

By now, I had big responsibilities for evaluating the weather and finding an opening in the clouds, if need be. Fortunately, I had once worked in the Vancouver weather office, and they had their own satellite downlink. That meant that the office could capture and fax real-time satellite imagery to me in La Paz, and I put them up to the task.

But, I couldn't bug them too much, so we had to find a weather report and weather data locally. And that's how I found the marlingator.

It was in a bar, down the street from our brand-spanking-new hotel. It had the only satellite television in town, and satellite television meant the Weather Channel. The bartender was not sympathetic to our request.

"Women's mud-wrestling is on," he complained. "I'm dead if I switch to the Weather Channel."

"But there's no one in the bar," I observed. It was barely into the afternoon.

He capitulated. "OK, but only during the commercials." The Weather Channel broadcast wasn't much help.

Figure 5 — The weather briefing in the MarlinGator bar, 1991.

We had Environment Canada in Vancouver to help, and, in due course, the satellite images began to arrive. They were difficult to interpret after their passage through the fax machine, but I was able to make out the outlines of the continent and the position of the clouds. There was nothing headed our way — eclipse day would be easy. On the mainland, it was a different story, and since I'd agreed to do a little forecasting for the Calgary Centre's expedition over there, I worked up a plan for them. They had to do a little dodging, but they saw the eclipse.

As it turns out, the Vancouver office had a little software glitch, and the outlines of the continents were hundreds of kilometres off their correct position. The clouds I was seeing were somewhere in the Pacific. Oh well, it worked out for us. Observers on the centre line, some distance to the south of La Paz were mostly clouded out when the scattered cumulus cloud there suddenly formed a broken layer of stratus. That's when I formulated the First Law of Eclipse Chasing: stay out of mountains.

Figure 6 — Waiting for the eclipse at La Paz. No clouds here.

I watched a large part of the 1991 eclipse through a diffraction grating, admiring the flash spectrum, the coronal spectrum, and the hydrogen Balmer sequence — alpha, beta, and gamma. The flash spectrum isn't really a flash — it lasts for perhaps 10 seconds before the Moon covers the chromosphere, but the changes are dynamic. The coronal spectrum was a series of fluffy coloured donuts, each one representing a different element in the composition of the solar atmosphere. Bright diamonds of colour inside the coronal donut hole marked the location of the prominences, glowing in the intense colours of the red, blue-green, and violet Balmer spectrum. Highly recommended, but not at your first eclipse. Judy watched through the C8 we'd taken as carry-on baggage: marvellous views of the prominences!

Oh — the marlingator. The bar had a genetic oddity hanging over the front of the bar: an animal with a marlin head and an alligator back end. Never saw the likes of it again.

1994

This one can only be called the Great Bolivian Train Ride. It was the first eclipse that I scouted beforehand. Joel Harris (who runs an occasional eclipse tour) was going and I asked to go along. Landing in El Alto, the airport, is an interesting experience, as the runway is a touch over 4000 metres up and the landing speed in the thin air is very quick. So is adjustment to altitude, as the plane first landed at Santa Cruz, altitude 200 m, and then departed for El Alto, arriving less than an hour later. "Cabin altitude" in an aircraft is usually around 8000 feet, so landing on the altiplano requires an adjustment to ground pressure in the opposite direction of most other flights. As we turned toward final approach, the pressure altitude dropped to 10,000 feet, and as we flared for landing, to 14,000 feet (aircraft altitudes are still measured in feet). As long as you don't try any quick movements, it's quite tolerable, but you do some fast breathing until you've been on the ground for a while.

The Bolivians were very accommodating, and we were "attached" to a young man named Darius Morgan. Darius's dad owned the hotel on Lake Titicaca that we were going to use the following year; we had quite an adventure racing around the countryside in his Jeep. One evening, on the way back to La Paz from Oruro, I had him stop off the highway so I could look at the stars. If you haven't seen the southern skies from altitude, you haven't really seen the sky at its best. Constellations are impossible to identify because 3rd-magnitude stars look like 1st. Patterns are completely broken up, and then there is this incredible Milky Way that arcs across the sky. The Aymara Indians identify the rifts in the Milky Way in their star lore, much as we identify ancient Greek heroes in the patterns of stars. The quick tour we gave Darius must have made a big impression on him, as we'll see later.

The eclipse centreline was far out in the altiplano in Bolivia, and the roads were primitive and largely unmarked. Our choice: take a train to eclipse site. Bolivia had two passenger trains, and TravelBug, the outfit organizing the expedition I was to be on, had contracted for one of them. They were a bit of a concern, as Bolivia had a reputation for frequent breakdowns and a casual attitude to schedules. I'd ridden Bolivian trains before, when I hitchhiked through the area in 1968, but my carriage then was a boxcar with a choice of seating in or on. Schedule didn't mean much in those days. Rumour had it that a Japanese tour operator offered the Bolivians twice the price for the train a few weeks later, but to their credit, the Bolivians turned them down.

Figure 7 — Glorious skies from the Altiplano in Bolivia

The following year, we returned for the eclipse. The hotels had figured it out by then, and arbitrarily increased the room price, but you kind of expect that in eclipse travel. We boarded the train in the evening, and headed slowly out of La Paz. Bolivian railways use a narrow gauge, which caused our 12 cars to sway alarmingly as we chugged along the altiplano. That didn't work very well at dinner, a fancy affair that started with large bowls of soup — soup that followed the sloshing of the train as it was carried from kitchen to passenger. After the first two sittings, the kitchen staff gave up and substituted mugs. Early appetites had to wear a soup stain for the rest of the trip.

About midnight, we stopped. This was interpreted as a bad sign. We were inside the shadow track, but still many kilometres from the central line. The eclipse was in the early morning, just after sunrise, and no one wanted a delay. Besides, there was that magnificent altiplano sky and a lot of eager telescope users to test it out. Mutterings of "what's wrong?" turned to outright mutiny when no one could ascertain what the problem was. We were in a small village, but few dared to descend in case the train started again — which it did, about 4 a.m.

On the dot of 6 o'clock, we arrived at the eclipse site, a barren piece of altiplano covered with knee-deep tufts of grass. Dawn was approaching, and the last stars, teasing us with their clarity, were fading in the blue-shifting sky. We jumped out, scattering across the plain, setting up telescopes helter-skelter, while soldiers in the lead cars unloaded porta-potties. It turns out the engineer was told to deliver us at the site at 6 a.m., and his timing was perfect. Our stop overnight was simply because we were ahead of schedule.

After a very successful eclipse, with an incredible display of shadow bands, we re-boarded our faithful train for the return trip to La Paz. It took all day, most of it spent waiting at small towns. The government had stopped all train travel but ours before the eclipse, but now we had to wait our turn. After a sleepless night and a thrilling eclipse, we were beat, but no one slept with all of the adventure around them and the chance to explore small altiplano towns. Finally we arrived in La Paz, jumped into buses and headed for the hotel on the lake.

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Pen & Pixel

Figure 1— Edmonton's Luca Vanzella caught the rising Lenten moon on March 10 last year. Luca notes, "The *RASC Observer's Calendar* called it the Worm Moon. According to the *Farmers' Almanac,* "as the temperature begins to warm and the ground begins to thaw, earthworm casts appear, heralding the return of the robins." I might prefer the Crust Moon, "because the snow cover becomes crusted from thawing by day and freezing at night." The image is part of a time-lapse sequence overlooking the Alberta Legislature that can be seen at `www.vanzella.com/astro/astro/20080303_Lenten_Moon_Rising.wmv`. Luca used a Canon Rebel XTi, 300-mm lens, ISO 400, f/5.6 at 1/60 sec.

Figure 2 — Stuart Heggie produced this image of Cederblad 201, a dark nebula in the centre of Cepheus, using an SBIG STL 11000 camera on an Astrophysics AP155EDF Triplet Refractor with a 4-inch field flattener. Exposures were 34x5 minutes in L, 9x10 minutes in R, 7x10 minutes in G, and 6x10 minutes in B. The blue patch at the bottom of the picture is the reflection of light from the superimposed star in the vicinity. Just above the star is a dark patch of heavier and more opaque dust, while the brownish colour to the extended dust ribbon is due to the obscuration of all but the reddest light from the background stars.

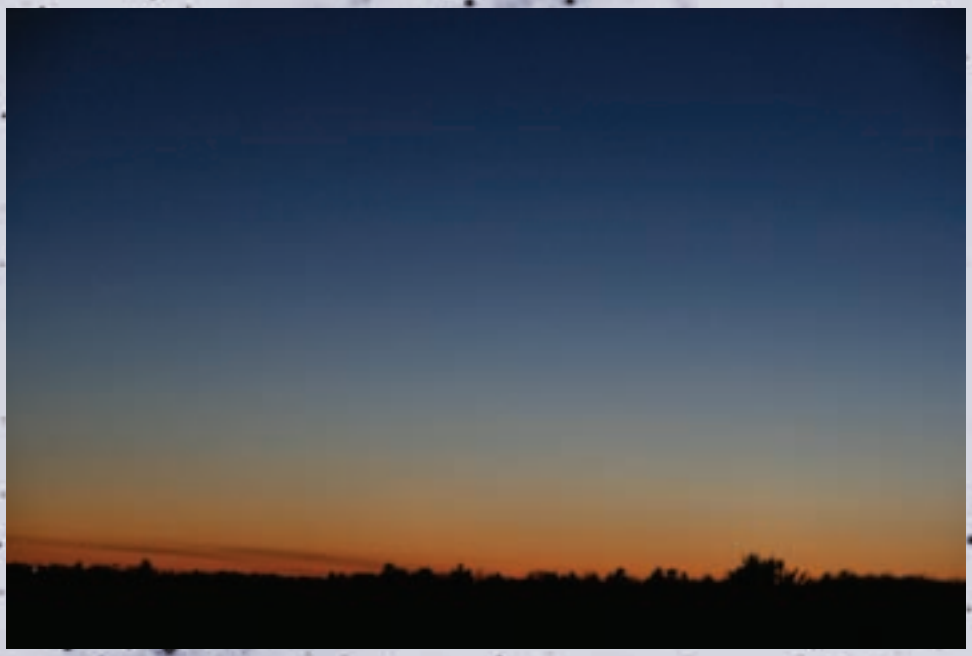

Figure 3: Mercury really isn't all that hard to find — provided you get out on the right date and have clear skies to the horizon. Rick Stankiewicz, President of the Peterborough Astronomical Association and an Unattached Member of the RASC, captured this image of Mercury on 2009 December 22. Rick used a Canon 400D and a Sigma lens at 300 mm. Exposure was 2 seconds at ISO 400 and f/5.6.

Figure 4: Jay Anderson lucked into this shot at the 2010 January 15 annular solar eclipse in Kenya. "I didn't even see this one until I looked at the camera." he notes. Canon T1i with 600-mm Tamron lens, f/5.6, ISO 1600, 1/500 second through a Baader 3.8 ND solar filter.

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Darius had been busy in the year since I'd seen him and the little star-show we'd had on the side of the road had had a big impact. The hotel now boasted a small lecture hall, and, after a late meal, we divided into groups of those who wanted to see a presentation on Aymara Indian star lore and those who wanted to use a telescope. The presentation was exquisite, exposing us to sky legends far different from our own western constellation-making efforts. The room was ringed with Celestron telescopes, and when the show was over, the roof rolled back, and the whole of the southern hemisphere sky was revealed. It was one of those moments when the spirit soars and the insignificance of little ol' Earth is branded on the soul. That "planetarium" still exists, and you can still go and watch that show.

1995

It took 45 hours of travel to see a 42-second eclipse. We were in India, and the memory that stands out is of a waiter from the hotel bringing me morning coffee and biscuits into the field where my telescope was set up. Great eclipse, with a chromosphere that stretched most of the way around the Sun — an artifact of the short duration of totality. The eclipse spectrum put on an even better show than 1991. Should be even better at the 14-second eclipse in Kenya in 2013.

Figure 8 — The idyllic eclipse site in India. The hotel pool deck is in the background.

1997

Even failed eclipses can be an adventure. This one was a bit unexpected when, a few months before the eclipse, I was asked to lead a small group to Mongolia. I was hoping to fly into the country from Beijing in a beat-up Ilyushin aircraft, but it was a brand-new Boeing 737. Darn!

Ulaanbaatar was one of the strangest cities that I've visited. Downtown was dominated by a huge coal-fired hydro plant, set amidst the grey monolithic architecture of Stalinist Russia. We stayed at the Edelweiss Hotel — boy, was that ever a mixed metaphor! In March, Mongolia can be pretty cold, but we were treated to early spring-like temperatures just a few degrees below zero. The Russians had abandoned Mongolia only the year before, and the whole economy had collapsed overnight. Unemployment was rife, and the population was barely getting by, in spite of the country's natural riches.

On the second day, I was accosted on the street by a fierce-looking bearded fellow who must have descended directly from Genghis Khan. I don't know what he said, but it wasn't friendly and it came with a bit of a shove. Our guide quickly intervened, said something, and suddenly I was embraced in a big bear hug and a huge grin. "What did you say to him?" I asked her. "I told him you weren't a Russian!" she replied.

The night before the eclipse, we were housed in a ger (also known as a yurt, but that's the Russian name) in a small town to the north of Ulaanbaatar. It was comfortable, though cool. Every hour, a young girl would come into the ger to add wood to the fire. At three, I arose to watch Comet Hale-Bopp in the crystal-clear northern sky. By five, it was snowing.

We — there were only 12 of us — jumped into our van and told the driver to head south, to catch the cloud edge somewhere ahead. Alas, the decrepit old van we had was too slow, and, after an hour, we gave it up. "Back to the north!" I ordered — maybe we could find the back edge of the cold front. He misunderstood. We ended up in the garbage dump on the north side of town, and by the time we were back on the highway, heading toward the Russian border, too much time had been lost. We watched the shadow pass overhead from the side of the highway, joined by a number of thoroughly inebriated locals, even though it was barely daylight. It cleared two hours later. We still talk about the "road to Irkutsk."

1999

The 1999 eclipse was billed as "the last of the millennium" but it was more noteworthy for its track across Europe than its date. Alas, much of Europe from England to Hungary was covered in cloud and the opportunity largely missed. But, Turkey was perfect.

Aram Kaprielian of TravelQuest and I scouted Turkey in 1998 and settled on a site near Diyarbakir in the south for his eclipse group. Diyarbakir is a city of 1.5 million of mostly Kurdish people. Its summers are fiercely hot with temperatures frequently climbing into the 40s. Such was the day we arrived, to be greeted at the airport by our guide dressed in a woollen sports coat.

Diyarbakir has a medieval air about it, derived in large part by its spectacular black basalt city walls, one of the largest and best preserved in the world. Built in Byzantine times, the walls are over 5 km long, 12 m high, and 3-5 m wide. Diyarbakir also has pickpockets, as I found out to my chagrin. After losing my wallet in the morning, we put on a brave face and headed south to explore a monastery near the Syrian border. The interior of the monastery exuded a peacefulness that made up for my earlier losses, but I couldn't relax. We were trailed into the monastery by a second group of tourists — four tough-looking guys — and after a time, I voiced my apprehension to our guide. "Don't worry." he said. "They're plainclothes police following us to make sure that you don't pull out a Kurdish flag or make some other fuss." At least they made it easy for us to get through the checkpoints.

We selected an eclipse site about 40 km outside of Diyarbakir, on a hillside that would allow a view toward the incoming shadow. In the near distance was a small village. I proposed that we visit the village to see if some of our tour could watch the eclipse from there, as many eclipse travellers like to immerse themselves in the

local culture.

It seemed almost deserted when we drove into the village; only a young boy and girl supervised our arrival. Soon an adult appeared, then another, and after they had a brief conversation with our guide, we were invited to descend and join the men for a discussion. Chairs appeared and we sat in a circle, answering and asking questions.

"Did they know about the eclipse?"

"Yes, they did."

"Could we come to the village in a year and watch it with them?"

A discussion, then "Yes, of course."

Their knowledge of the stars was surprising, but in a small village with no lighting, perhaps it was our preconceived notions that should be questioned. "Why are comets seen near the Sun?" I was asked. Wow! That's a pretty sophisticated question. We discussed planets, meteors, and thundershowers. We took group photos, individual photos, met the local mayor, and parted with a traditional Kurdish farewell — a kiss on each cheek. Except that I got the sequence wrong, went left when I should have gone right, and planted a kiss smack on the lips of a bearded old gentleman. They won't forget me in that village, I think.

The next day the police came. The mayor had been killed in a traffic accident and our guide's card was in his wallet. They seemed satisfied with the explanation.

We returned the following year with 200 friends. There was no question about our location, for the government had set up an observing site at a highway checkpoint, which turned out to be only a few tens of metres from the centreline. It wasn't our chosen spot, and there was no possibility of going to the village at that time. The Kurds came to us, with bright tents, music, dances, and laughter, but there were soldiers and weapons all around. It was tense for a time, when the military tried to put an end to the festivities, but the fortuitous presence of a movie crew from the National Film Board of Canada soon caused them to back off, and the celebrations went on.

It was a hot day — over 40 °C — and the Sun was merciless. Judy collapsed from heat stroke, the second time in two days, and she was soon immersed in ice and attached to an IV drip. Steve Edberg's wife Janet also collapsed, and suffered similar treatment. The emergency crew included Doctors from the local medical school, and they were on their best behaviour when they found out that my wife was a professor at a Canadian medical school. The two ladies struggled to their feet for totality, but it was a close call. I don't remember that eclipse very well. Judy has amazing memories and drawings, but forgot to put film in the camera.

I left the group with our guide to visit the village, while the rest of the crowd went back to Diyarbakir to celebrate. I had photographs of the deceased mayor for the family, and school supplies for the kids. We arrived at the same village square, but now there were two soldiers and a lieutenant, who spoke perfect English, at the meeting. "Just the regular village militia." my guide explained. Yeah, right. We made our greetings and transferred our gifts, but it was a sombre group compared to the year before. A young boy watched the proceedings for a time, and then turned his attention to the Sun, which he watched through a streaky piece of smoked glass until told to put it away. When we left, I got the kissing sequence correct.

Departure the next day was a welcome event, as we were going to Ankara where temperatures were closer to tolerable. As we pushed back in the 737, a group of soldiers saluted the aircraft. On the taxiway, more soldiers saluted, and as we turned to line up, yet another group. "Must be someone important on board." I volunteered. "The Chief of the Air Force," said our guide. The plane revved engines until it was shaking and then darted down the runway, pulling up into the steepest climb I'd ever experienced in a 737. "I wouldn't be surprised if we had a fighter escort," I said to one of my fellows, who sat next to a window. "Two Phantoms." he replied. "I can see their shadows on the ground." The muscular young man beside me had a pistol in a shoulder harness under his coat.

2001

Madagascar — a Joseph Conrad place, full of strange animals, exotic trees (especially the baobab), an exotic mixture of African and Asian cultures, overlain by a French veneer. Aram and I scouted the area in 2000 in a marathon of southern African countries: Zimbabwe, Zambia, South Africa, Botswana, Madagascar. The island of Madagascar has a wet side and a dry side, so of course we selected a site on the dry side, near a town called Morombe, facing the Mozambique Channel. Morombe was a little south of the centre line (which actually ran through a crocodile-infested river delta), so we were challenged to find a site a little closer to the main action.

Madagascar must have the worst roads in the world, so bad that no one uses them. Instead, vehicles drive on the sand beside the road, leaving the cratered pavement to goats and cattle. We elected to fly to Morombe to investigate the area around the centreline.

Our maps showed a rudimentary road heading north toward the eclipse axis, but, when we left the main road, we found nothing but tracks through the sandy soil of the thorn forest. We had a 4WD vehicle, but the transportation of choice locally was an oxcart, and the forest was criss-crossed with innumerable trails. We stopped at the first village, a collection of thatched huts surrounded by a thorn fence, and picked up a guide. He led us to a farther village, where we acquired another guide. It seemed as if there was only a very limited local knowledge of the surrounding landscape, but it may have had more to do with encroaching on another village's "territory" and the need for permission to continue.

Eventually we reached the Mangoky River, but the remote location, steep banks, and the warnings about salt-water crocodiles made us realize that there was no eclipse site to be had there. It was getting dark, so we returned to the last village and obtained permission to camp on the banks of a local stream. We were well prepared, with very mildewed tents, plenty of food, and sleeping bags. The sky was translucent that night, and the mosquitoes were voracious. Someone shared my sleeping bag, for the next morning I found a line of insect bites at intervals of a few centimetres that completely surrounded my waist. They took weeks to disappear.

The morning light revealed that we had camped on a sandbar beside a ford across the stream, and we were soon visited by local farmers, each carrying the one-bladed hoe that is common to southern Africa. Local custom dictated that we feed them, and we were soon in the midst of a dozen visitors, while our driver made breakfast. One of our number traded comments in French and dispensed medicines acquired from U.S. doctors specifically for the purpose. Anti-malarial drugs were very popular.

We told them our purpose and I used the sand to draw pictures of the coming eclipse, then only a year away. They had no problem understanding that the Moon would cover the Sun — after all, this was a society that was much more in touch with the stars than is

possible in our light-bathed cities — but were surprised to learn that stars would be visible in the daylight during the eclipse.

With no site to attract us along the Mangoky River, we elected to bring a tour to the beaches north of Morombe. A camp would be constructed from local materials, food and cooks would be brought from Tana, beds and blankets would be provided, and portable toilets and showers would be constructed. To maximize the eclipse duration, the camp would be located a few kilometres north of Morombe — a site easily reached by driving along the beach.

Decisions made, we travelled southward through the baobab trees, following a sandy trail that ran parallel to the coast. We stopped for the night at Andavadoaka, a small fishing community on the coast. There was a rudimentary hotel there — a series of brilliantly hued huts, raised on stilts, overlooking a steep cliff with a sandy beach below. The sunset was perfect, and we positioned ourselves so that it sank below the horizon framed by a sea-level cave in an offshore rock. Dinner was the fish we helped catch that evening.

I want to be buried in Andavadoaka.

I returned the following year, landing in Morombe with our eclipse group after a one-hour flight from Antananarivo in a Twin Otter. I was on the last flight in the mid-afternoon, bringing up the rear so to speak. Vehicles were loaded with eclipse gear and suitcases, and we were off along the beach.

Except that someone forgot about the tide.

It was dark when we finally reached the site four hours later, and the camp was barely visible in the few lights. Wheeled luggage doesn't travel across sand very well, and it was a very tired set of last arrivals that finally found a place to sleep and a late meal. True to their word, our local representatives had built a large eclipse village of grass huts, each one containing two cots and a thin — very thin — blanket. Judy and I scavenged the bottoms of our suitcases to find all of the clothes that we could, but the cold still managed to penetrate to the bone. I gave up after midnight, and stepped outside, nearly falling over my wife, who had already decided that the night was lost. It wasn't.

The stars were still there, the same ones from a year earlier, but now they were joined by Comet LINEAR, hanging in the sky above the dunes. We snuggled up for warmth, and explored the night sky until dawn. Today the memories of those stars, that magical location, the Magellenic Clouds, and the comet are some of our most treasured reminiscences.

Figure 9 — The Morombe Eclipse Camp in Madagascar.

Morning was a bit of a surprise — there were over 200 of us at the camp, and only one cook and cook stove. Meals were long-drawn affairs, with barely enough food, but the day was cloudless, the beach was pristine, and the water an incredible blue-green. Eclipse preparations were languorous, as we had all day to prepare. It was a rousing success, and the still-partially eclipsed Sun sank into the sea to bring it all to a reluctant end. When we were done, the camp and all of its pieces were turned over to the locals for their use. We went on to other adventures and other places.

Madness

Eclipse-chasing is a bit of madness. I have many more stories; you've only sampled nine that I have under my belt. The stories aren't about eclipses, but about travel, people, incidents, and adventure. I love watching the Sun slip behind the Moon, but I love even more the magical places where I go to see them all.

Jay Anderson is the Editor-in-Chief of the Journal. *He has been to 22 eclipses.*

Middleton Mountain Observatory - A Backyard Project

by Bryan Kelso, Okanagan Centre (vandbkelso@shaw.ca)

In November of 2000, I retired and moved to Coldstream in the north Okanagan in British Columbia. There was only one street above us at the time, and the Milky Way was quite visible on a clear night. However, the building boom started in our area the next year and houses were being built on the mountain above us with a great flurry. Along with this came the cobra street lights and a growing light pollution. The tarps that I hung around my observing pad were just not doing the job of keeping out the light. I initially decided to order the plans for a roll-off-roof observatory from *SkyShed,* but a visit to Jack Newton's B&B observatory at the southern end of the valley convinced me that I should build a domed observatory instead.

OK, so where did I start?

A search on the Web found Charles Baetsen's site, where he gave details of the six-foot dome he had constructed. Since one of my hobbies is woodworking, I had all the tools needed to get started building an eight-foot (inside diameter) dome for a corner of my backyard, beside a twelve-foot retaining wall we had constructed (more about this later).

Following Charles' example, I first cut out the rings for both the wall and the dome. This was done using a template and a flush-cut-bit-equipped router mounted on a piece of plywood. I used a

radius of 4 feet from the pivot to the bit. The template was then used to roughly cut out a set of partial circles using a hand-held sabre saw; these in turn were cut to the same size as the template using a flush-cut router bit. The partial circular pieces, made of ¾-inch plywood, were then laminated together using glue and screws, forming a complete circle. Two additional circles were made from the plywood for the base and top of the wall. Because the base was attached to a concrete pad, the circle pieces were cut from pressure-treated 2 × 8-inch planks.

Figure 1 (left) — Cutting the circle template.
Figure 2 (right) — Routing ring pattern - base

Figure 3 (left) — Fitting ring together
Figure 4 (right) — Ring for base of observatory wall

Two more rings were made out of ⅝-inch plywood for the base of the dome. These rings were ½-inch larger than the wall rings so that a skirt could be fastened from the outside. The rings were separated by blocks 3¼-inch high. A sixth ring was constructed using ½-inch plywood, cut into two pieces, for the centre part of the dome. I was unable to find information on how wide the slot should be on the dome, so I chose 30-inch spacers at the back part of the dome frame, leaving the front clear for the observatory door.

Figure 5 — Rings for base of Dome and centre supports.

The next step was to cut ribs for the dome. These were cut with a 4-foot inside radius using ½-inch plywood; they were then fitted to the base of the dome ring and to the centre supports. Despite my best efforts, the two sides of the dome were not 100% symmetrical, and each rib had to be custom fitted. The ribs were fastened using framing anchors so that the dome could be dismantled for reconstruction on the top of the observatory wall.

Before I could site the newly constructed observatory, I had to attend to an old retaining wall that had been built in the back yard in 2000, and which was beginning to collapse. A huge job, to say the least! All the old wall material had to be removed and new material brought in, but I took the opportunity to have the contractor install underground electrical wires, prepare the ground for a 10 × 10-foot cement pad, and sink a 12-inch Sonotube 4 feet into the ground for the pier.

Figure 6 — Frame of the dome
Figure 7— Ground prepared for cement pad

When the contractor was finished with the backyard, there was no access for heavy equipment. A pumper truck had to be used to pump the cement from the street below our house, over the roof, to the pad area. Once the cement had cured, the base ring was brought around from the workshop and fastened to the pad. The pier was constructed of four pressure-treated 2 × 8-inch planks, 8-feet long, nailed into a square tube. The Sonotube was removed and the pier positioned in the centre of the hole. The outside of the hole was then filled with concrete to ground level so that the pier would not be touching the cement pad. Cross-pieces were then fastened inside the ring, and decking planks were screwed to the crosspieces and the ring.

Figure 8 (left) — Base ring and pier installed
Figure 9 (right) — Starting the installation of the floor.

Alas, it was at this time of the construction that I fell off the wall, cracking my pelvis! It was spring before I could resume the project. With the arrival of warmer weather, I finished the floor and wall framing. The wall is just less than six feet high. The track was constructed out of 1/4-inch steel strapping on edge, with pieces of 90° steel welded to the strapping and bolted to the top ring of the wall. One-quarter-inch mahogany plywood was nailed to the studs to form the outside of the wall. This was covered with tarpaper and vertical vinyl siding attached to the exterior. Six casters were then fastened to the bottom ring of the dome and the rings placed on the steel track.

The next step was to finish the pier. The top was cut 44 inches from the floor and the centre filled with concrete. Two steel rebar

Figure 10 (left) — Applying 1/4-inch mahogany plywood
Figure 11 (right) — Finished wall with vinyl siding and the dome base ring in place. Note the fence on the top of the wall, constructed at the insistence of my wife so that I would not fall again.

rods were inserted vertically into the concrete for strength and a ½-inch aluminum plate was fastened to the top. A machined steel plate with a cylinder welded on top allowed the mount of my CGE 11 to slide over it and be bolted in place. This in turn was bolted to the aluminum plate on the pier. This plate had slots cut into it to allow for some mobility for polar alignment.

Next came a steel entrance door with a deadbolt. The ribs for the dome were then re-installed on top of the dome ring. A 12-inch plywood skirt was fitted around the double-dome ring to keep the elements out. A skin of 1/4-inch plywood was nailed to the ribs, overlapping the top of the skirt. The joints were filled with Bondo filler and a 4-inch strip of fibreglass cloth and resin placed over the seams. The whole dome was then painted with fibreglass resin for waterproofing, and the dome was given two coats of enamel paint and three coats of latex.

Figure 12 (left) — 1/4-inch mahogany plywood fastened and to be filled with Bondo and fibreglass
Figure 13 (right) — Dome with several coats of ribs resin and paint.

The shutter door was constructed in two pieces — a hinged door that opened out, and a sliding door that slipped back over the top of the dome. This allows the viewer to look overhead, just past the zenith. The fitting of the sliding door gave me the most trouble. The ribs for the door were made of two pieces of ½-inch plywood, laminated together. I fastened a piece of ⅛-inch-thick aluminum strapping, 1½-inch wide, on the bottom of this so that it projected under the lip of the centre rib of the dome. Two strips of "slippery tape" (Lee Valley) were put on the inside of the door to help it move more easily. The pulley system I installed does not work as I expected, and I have to use a stick to open and close this part of the shutter door.

Figure 14 (left) — Rib of shutter door with aluminum strapping under lip of dome centre rib.
Figure 15 (right) — Shutter with pulley system

The inside of the dome is painted with a flat black latex paint. Figure 16 shows the finished observatory and shows my 11-inch CGE mounted on the pier.

The only two problems I have are the difficulty with the upper shutter door and a slightly out-of-round track for the dome that causes it to stick at one point.

Figure 16 (left) — Finished observatory
Figure 17 (right) — Eleven-inch Celestron CGE

Walter A. Feibelman, IYA2009, and the RASC

R.A. Rosenfeld, Roy L. Bishop, Mary Lou Whitehorne & James Edgar
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The temperaments, actions, and initiatives of scientific and cultural organizations matter. An institution that lives up to a progressive mandate in benefitting others benefits itself. Corporate kindnesses — which depend on individuals doing decent things in the name of an organization — can have unexpected consequences. These are not the fruits of premeditated, bloodless calculation for material gain, but are motivated by a sort of justice, to "get things right" — a plain desire do the right thing. Accept a paper proposal solely on merit, and years later a speaker may be moved to make a donation as unexpected as it is significant, out of gratitude and a genuine fondness for the sponsoring organization. In 1977, an ex-pat American amateur radio astronomer residing in Australia took part in our General Assembly, where he delivered a submitted paper in the lecture hall of the former McLaughlin Planetarium. Four years latter an "anonymous donor" gave the RASC a large monetary gift. The speaker and donor were one and the same, none other than the famous pioneer of radio astronomy, Grote Reber (1911-2002) — he was elected an Honorary Member in 1988 (Creighton 1977; Broughton 1994, 80; Covington 1988).

Nearly three decades later, fortune and Urania smiled yet again on the RASC through a not dissimilar train of events. This time our benefactor was Walter A. Feibelman (1925-2004). Walter Feibelman's generosity allowed us, half a decade after his bequest, to be generous in our turn, enabling the extended funding of many of our IYA programmes. Walter Feibelman can be said to have materially enabled many of the over one million "Galileo Moments" logged in Canada last year. Why was he so well-disposed towards us?

The simple answer is that he *was* one of us.

Joining the RASC in 1953, Walter Feibelman remained a member for over half a century (Clark 2006). During that time he published ten research papers in this *Journal,* from "Orionid Meteor Spectrum and Automatic Spectrograph," co-authored with Emmerich in 1964, to the 1999 "The open cluster(s) containing P Cygni" as part of a team with David G. Turner (former *Journal* editor) and colleagues. Walter Feibelman valued the *Observer's Handbook* highly, both as a working compendium, and as a reference, and was delighted when his major achievement in planetary research (Feibelman 1967) was acknowledged in its pages (Feibelman to Bishop [1985-1989]).

Walter Feibelman never stopped being an "amateur" in the finest sense, even during his career as an assistant research professor in physics and astronomy at the University of Pittsburgh (1956?-1969), research scientist at the Optical Astronomy Division of the Goddard Space Flight Center (1969-2002), and an emeritus astronomer at NASA (2002-2004; Oergle 2005). The bulk of his over 170 refereed research papers used data from the *International Ultraviolet Explorer* (a very long-lived and productive space observatory 1978-1996). He said that, armed only with a first degree in physics and never formally trained as an astronomer, he entered that world "through the back door," a connection he was glad to share with Roy Bishop, a Ph.D. in physics, who had also never taken a formal astronomy course. His other research astronomical interests (and they were many), included meteoritics, in which he was encouraged by RASC members and distinguished meteoriticists Ian Halliday and Peter M. Millman, and variable-star research, on which he collaborated with James B. Kaler, Lawrence H. Aller, as well as the aforementioned D.G. Turner. Given those interests, it comes as no surprise that Walter Feibelman was a long-time member of the AAVSO. Our sister organization also fittingly benefitted from his generosity; the new accommodation for visiting astronomers at their headquarters in Cambridge, Massachusetts, is officially called "The Walter A. Feibelman Suite."

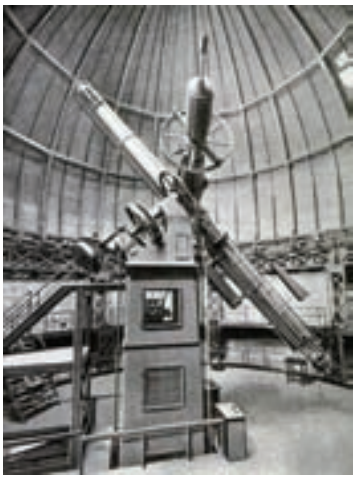

Figure 1 — The photographic telescope at Allegheny Observatory used by Feibelman, *circa* 1914.

Walter Feibelman was most proud of his major achievement in planetary research, which was no less than procuring, for the first time, solid photographic evidence for the existence of a faint ring of Saturn, the E ring, well out beyond the bright A ring (Feibelman [1967]; see Roy Bishop's diagram in the 2010 *Observer's Handbook,* 224). Keep in mind this was achieved with the non-CCD technology of the time, employing the film emulsions then available, and requiring that exposures be tracked manually. This work of Feibelman's had not always received the notice it deserves, which is why he was pleased with its mention in the *Observer's Handbook,* but a recent comprehensive article on the history of the pre-*Pioneer 11* detection of the faint Saturnian rings by the noted historian of planetary astronomy, Richard Baum, FRAS, sets the record straight, and firmly gives Walter Feibelman his due (2009). It is worth quoting the account there *in extenso:*

> *During the edge-on presentation [of Saturn's rings] in 1966 Walter A. Feibelman of the Dept of Physics, University of Pittsburgh conducted a photographic investigation based on the idea outlined by [E.E.] Barnard in 1909: 'One fact that impressed me is these observations which were all made with the [Yerkes] 40-inch telescope,' Barnard said, 'was the unusual brightness of the crepe ring. It is precisely what should have occurred, however, for the ring was seen very obliquely, and a great brightness would result from the fact that the same number of luminous particles were compressed by perspective into a much smaller space, and must therefore appear brighter...'... Adopting this rationale on six nights between 1966 October 27 and 1967 January 16 Feibelman took about fifty exposures ranging from 5 to 30 minutes in duration with the 30-inch (76-cm) Thaw refractor [by Brashear, Warner & Swasey] of the Allegheny Observatory. Two plates show attenuated extensions of the almost edge-on ring system coming out from the glare of the grossly over-exposed image of the planet,* ***to more than twice the known ring diameter*** *[our emphasis]. This, Feibelman surmised, represented a tenuous outer ring seen only when the area*

density of ring particles is greatest, i.e., edge-on to the line of sight. Gerard Kuiper (1905-1973) obtained photographic confirmation of this observation in 1966 December and 1967 January with the University of Arizona's 61-inch (1.5-m) reflector. Designated the E ring, it was subsequently verified by Pioneer 11 [Baum (2009), 198].

Figure 2 — The Cassini spacecraft caught this view of Saturn's E ring during an extended period in the shadow of the planet, looking back toward the Sun. Image courtesy NASA.

This is a good early illustration of Walter Feibelman's style of experimental design, which here paid big dividends. He saw promise for further advance from a suggestive observation by a reliable observer of the past (Barnard), he used similar instrumentation (a top-of-the-line long-focal-length refractor) under like conditions (rings edge-on), he took full advantage of subsequent developments in recording technology (half a century of photographic improvements), he employed his own mastery of those technologies used to their limits, and interpreted the results intelligently, and boldly. This is a model that could be recommended today.

George Ellery Hale's famous statement about amateurs seems most apt to describe Walter Feibelman:

He works because he cannot help it, impelled by a genuine love for his subject and inspired by an irresistible influence, which he seeks neither to justify nor to explain. His reward lies in the work itself and in the hope that it may contribute something to the advancement of knowledge [Hale (1976), 180].

Walter Feibelman doubtless saw something of those qualities in us, making us worthy of his beneficence. Using his generosity to extend our IYA outreach is a fitting way to excite that spirit in others.

Acknowledgements

The lead author wishes to thank Richard Baum for discussion of the history of the discovery of the outer faint rings of Saturn, and sending a copy of his paper in advance of publication. This research has made use of NASA's Astrophysics Data System.

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The Very Long Baseline Array (VLBA)

by Rick Stankiewicz, Peterborough Astronomical Association (stankiewiczr@nexicom.net)

Hawaii's Mauna Kea is home to many astronomical wonders, in particular, some of the world's largest telescopes. On a trip to the summit in February 2006, our tour included a side trip to a unique piece of scientific equipment. If you have seen the movie "Contact," you will have an idea of what I am talking about. However, the antenna in this article is part of the Very Long Baseline Array (VLBA) — there are ten such antenna dishes, placed from Mauna Kea in Hawaii, to St. Croix in the Virgin Islands. These antennae are smaller than the giant Deep Space Network dishes. Every location of the VLBA has a single antenna that is 82 ft. (25 m) in diameter, weighs about 240 tons, and is almost as high as a 10-story building when pointing straight up.

Figure 1 — The Mauna Kea VLBA antenna.

The VLBA antenna (Figure 1) on Mauna Kea is the only "telescope" there not located at the summit. We had to drive a bit off the main access road to check out this complex at the 3720 m (12,205 ft) level — in fact, you could not even see it from the road. It was a very impressive site. A map of the locations of the ten antennae is attached to the fence surrounding the complex (Figure 2).

These radio antennae are run by the National Radio Astronomy Observatory (NRAO) in Socorro, New Mexico. This array of antennae is like having an 8046-km-wide eye to look at the Universe. They reputedly are able to produce the sharpest images of any Earth- or space-based telescope. The precision is such that they can reach a resolution of less than one milliarcsecond (1/1000th of an arcsecond). This is equal to being able to read a newspaper

Figure 2 — A map of the locations of the VLBA. Image courtesy of NRAO/AUI

headline in Vancouver from Ottawa! To top this, they can apparently reach even higher resolution when they work in concert with other antennae around the world on specific projects. This array saw "first light" in May 1993, after more than seven years of construction and $85 million (US) in spending.

The VLBA has been involved in many discoveries over the years. Some of the accomplishments include: super-massive black holes, radio jets, low-luminosity galaxies, an accretion disk in NGC 3079, and microquasar flares.

For more information on the VLBA, see `www.vlba.nrao.edu`.

Rick Stankiewicz is a long-time lover of astronomy, who grew up near Cambridge, Ontario. He is currently the President of the Peterborough Astronomical Association, and an Unattached Member of the RASC. Rick lives south of Peterborough, near Keene. He is well known to Journal readers and enjoys sharing his astronomical experiences whenever possible.

Be...in New Brunswick

... for something new in some place old, something old in some place new. The New Brunswick Centre invites you to attend the 2010 General Assembly at the University of New Brunswick campus in Fredericton. RASC NB proudly celebrates its tenth anniversary by hosting this venerable event in Canada's Picture Province for the first time, at an institution that is celebrating its 225th anniversary. We promise great food and great fun, served up with Down East hospitality at a cost that will make you smile.

Fun 'n' Food

Fredericton is inland but is situated along the scenic Saint John River, "The Rhine of North America." We will bus you to two historic Maritime locations for photo-op scenery, education, a chance to escape the inland summer heat beside Nature's air conditioner, and have you back in time for dinner. There are limited seats for each, so register early to book yours.

- St. Andrews by-the-Sea sailing and Kingsbrae Gardens — Sail Passamaquoddy Bay aboard the 72-foot *Jolly Breeze,* where you are likely to see seals basking, whales busking, and eagles daring. Shop and sightsee in the quaint seaside Mecca of St. Andrews, and then experience Kingsbrae Garden with its variety of gardening styles and Jurassic-era Wollemi tree.

- Bay of Fundy Tides Tour — See the awesome power of the highest tides in the world. Walk among the Hopewell Rocks "flowerpots" at low tide and return after lunch in nearby Alma to view the incoming tide. (We are negotiating to have the new Moon moved ahead a week to enhance your experience, but no luck so far.)

Meanwhile, back in Fredericton:

- **William Brydone Jack Observatory / Museum** — This diminutive building, where the first true longitude coordinates in Canada were determined, is located on the UNB campus and will be open for guided tours. It still has the mahogany and brass Merz refractor, as well as antique astronomical and engineering instruments.
- **Wine and Cheese Official Opening** — Meet and greet your RASCally friends and browse the poster displays in the Wu Centre foyer.
- **Get your kicks on the pitch** — Work up an appetite by participating in, or cheering on, the West vs. East soccer match. We apologize if you were expecting traditional moose-back polo. The moose have weekends off, by contract.
- **RASC BBQ & Lobster Boil** — Of course, there will be lobster, and you won't have to bob for them. If you prefer breasts to tails and claws, we also have chicken burgers. After dinner, join

us for awards and game entertainment.

- **Non-denominational Sunday church service** — A first, perhaps, at the campus chapel. Expect some stellar hymns, and it wouldn't hurt to pray for a calm Annual Meeting.
- **Closing Banquet** — Traditional New Brunswick fare, and featuring a presentation by the Prince of Tides, Dr. Roy Bishop. If you took the trip to Hopewell Rocks you will appreciate the experience even more.
- **Hospitality Suite** — Thursday through Sunday evenings at the residence. Where the real astronomy happens.

Tentative Schedule of Events

Wednesday, June 30

- National Council BBQ & Kitchen Party (National Council Representatives, Executive, and their co-delegates only)

Thursday, July 1

- St. Andrews Sailing & Kingsbrae Garden Tour
- National Council Meeting #1
- William Brydone Jack Observatory / Museum Tours (2)

Friday, July 2

- Bay of Fundy Tides Tour
- William Brydone Jack Observatory / Museum Tours (3)
- Posters Available for Viewing
- Wine and Cheese Reception / Official Opening
- Awards Presentation

Saturday, July 3

- Paper Sessions #1 and #2
- Helen Sawyer Hogg Lecture
- West-East Soccer Match
- RASC National Bar-B-Que & Lobster Boil
- Awards Presentation

Sunday, July 4

- Non-denominational Church Service
- RASC Annual Meeting
- National Council Meeting #2
- Paper Session #3
- Closing Banquet
  - o Keynote by Dr. Roy Bishop
  - o Awards Presentation
  - o 2011 General Assembly Presentation

Registration and Accommodations

Visit our Web site `www.rasc.ca/ga2010/index.shtml` for information on registration and accommodations rates, cancellation fees, and deadlines. You may register on-line or by mailing the form.

A block of single and double rooms has been reserved for a limited time in the Lady Dunn Residence. These are classic dorm rooms with bed, desk, chair, closet, and shared bathroom facilities. The nightly

hospitality suite will be on the lower floor of this residence. A second on-campus accommodation option is the Suite Style Residence Building, where a few 2- and 3-bedroom suites are available.

Book your accommodations by calling the main line at UNB Accommodations, (506) 453-4800, or by email (see our Web site). Indicate that you are attending the RASC General Assembly and the type of room you desire. If you plan to extend your visit to New Brunswick and make day trips from Fredericton, you may book your GA room for a number of days before or after the GA. Simply inform the UNB Accommodations staff when you book your room.

Transportation

UNB is 12 km from Fredericton International Airport. We will be pleased to pick you up and return you for your departure between Wednesday, June 30, and Monday, July 5. Just send us your travel arrangements with your registration. If you plan to rent a vehicle, see our Web site for directions to UNB.

Call for Papers

See our Web site for details on submitting proposals for papers and posters. We are pleased to offer simultaneous translation services for invited papers, the Hogg Lecture, and one of the paper sessions on Saturday. Preference will be given to French speakers for that session.

Contacts

If you have questions that cannot be answered through our Web site, you may contact:

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On Another Wavelength

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

IR Andromeda

There are lots of things that we know about the Andromeda Galaxy — just check Wikipedia. There are also a few things that we are just beginning to see and understand — just check the arXiv's (Block *et al.* 2006). Andromeda is a fascinating spiral galaxy; it has all the features one could hope for — including "cannibalizing" its neighbours. Well, that is how galaxies grow, isn't it? There appears to be an on-going stream of matter feeding into the central bulge of Andromeda. This is what happens to dwarf galaxies that get too close.

Andromeda is the nearest spiral galaxy to the Milky Way, at 2.5 million light-years away. On a clear moonless night, it can be seen as a faint smudge (apparent magnitude 3.4). To find Andromeda with your telescope, go to RA 00h 42m 44.3s and Dec: +41° 16′ 9″ (Figure 1). A faint smudge, Andromeda has been known and observed for some time: in 964 by Abd al-Rahman al-Sufi, Simon Marius in 1612, Charles Messier in 1764, and Sir William Herschel in 1785.

Figure 1 — The constellation Andromeda and M31.

Isaac Roberts took the first photograph of Andromeda in 1885. The spiral structure came as a great surprise, and he concluded that a distant planetary system was being formed. Debates over the nature of M31 continued for many years until 1925, when Edwin Hubble, studying Cepheid variables with the Hooker telescope, calculated the distance to M31. The distance was so great that it could only be another galaxy far from the Milky Way.

We, that is, the Milky Way, are on a collision course with Andromeda. The big event is scheduled to happen in about two or three billion years. Both sides are bulking up for the match. The odds are the galaxies will merge to form a giant elliptical galaxy. This is not a contest, but, as a comparison, it is worth making.

In the last few years, astronomers have observed thin sprinkles of stars extending beyond the main disk of Andromeda that are actually part of the galaxy itself. The galaxy appears to have an extended disk that makes it more than 220,000 light-years in diameter, compared to previous estimates that ranged from 70,000 to 120,000 light-years across. In comparison, the Milky Way is about 100,000 light years in diameter.

Even though Andromeda is estimated to have perhaps a trillion stars, far more than our Milky Way, it is now thought that Andromeda and the Milky Way are approximately equal in mass. How does this happen? It seems that the Milky Way has more invisible dark matter than Andromeda.

Dark matter has a strange effect on galaxy rotation rates. The gravitational effects of dark matter tend to give galaxies higher rotation rates much farther out than expected. Measurements of the rotational velocity of Andromeda show a peak of 225 kilometres per second around the core, dropping down to 50 km s^{-1} at a distance of 7000 ly. The velocity then increases back to 250 km s^{-1} at a distance of 33,000 ly, and finally slowly declines farther out. How far out? Based on these rotation rates, it would appear that Andromeda's disk spans at least 260,000 ly — nearly twice the size of the visible disk seen in photographs. Things are not always the way they look.

In the infrared, Andromeda is very different. Approximately 33 ly (10 kpc) from the centre there is a well-known dust ring. Images acquired with the Infrared Array Camera on board the *Spitzer Space Telescope* (Figure 2) show that inside this ring and somewhat offset from the centre is a second dust ring with dimensions of 1.5 by 1 kpc. The two rings appear to be density waves expanding throughout the disk. With computer simulations, it has been demonstrated that both rings may be the result of a galaxy that plunged directly into the core of Andromeda. The Andromeda Galaxy has 14 known dwarf galaxies nearby, of which the best known are M32 and M110.

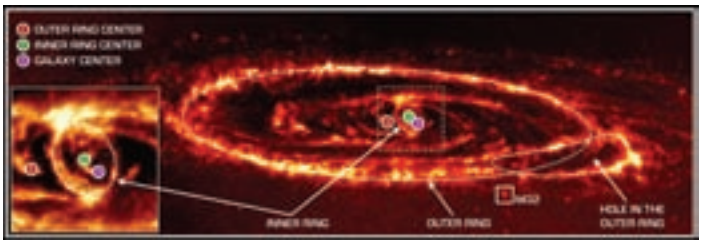

Figure 2 — The Andromeda Galaxy M31 observed with the Infrared Array Camera 11 on board the *Spitzer Space Telescope* at a wavelength of 8 microns. Image: NASA.

Evidence suggests the dwarf companion galaxy, M32, is the most likely candidate that would have collided head-on approximately 200 million years ago. In fact, M32 may have once been a larger galaxy that lost much of its stellar material. The collision not only created the ring structures in Andromeda, but also stripped more than half

the mass from the smaller M32.

There are some suggestions that when (and if) Andromeda and the Milky Way collide, our Solar System may be ripped out and end up as part of Andromeda. If you want to see your future, take a look at Figure 3. Even better, get your scope out and take a look — where you might be in a couple of billion years.

Figure 3 — The Andromeda Galaxy, courtesy of Ron Brecher, K-W Centre. The image is 9x10 min through an AP 105-mm f/5 refractor. The camera was a QHY8, controlled with *Nebulosity 2* and guided with the *KWIQGuide* system (175-mm finder with QHY5 guide camera) using *PHD* guiding software.

References

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

Second Light

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

A Plethora of Planets

It now seems hard to believe that just 15 years ago the field of searching for exoplanets was in disrepute for an unbroken string of false detections. Late in 1995, that ended with Michel Mayor and Didier Queloz's discovery of what is now known as a "hot Jupiter" orbiting the star 51 Pegasi (1995 *Nature* 378, 355). Three recent papers show just how far we have come (Charbonneau *et al.* 2009 *Nature* 462, 891 — the December 17 issue, Swain *et al.* 2010 February 4 issue, and Li *et al.* 2010 February 25 issue).

Dave Charbonneau (a Canadian at Harvard) has helped to set up a network of 8 identical 40-cm telescopes to monitor 2000 nearby M dwarf stars, using accurate photometry to find the periodic dips in light curves that mark the transit of a planet across the face of its parent star. Using this "MEarth Project," he and his collaborators discovered the planet GJ 1214b, which has a mass of 6.55 Earth masses, and a radius of 2.68 times Earth's radius. Planets in this size range have come to be called "super Earths," but this particular one has some very interesting properties.

The planet's density is about 1/3 of Earth's, at 1.87 gm/cm^3, which is very close to Pluto's density. The only other known transitting super Earth (CoRoT-7b) has a density much closer to that of Earth. Charbonneau initially argues for a water-dominated composition, but there are a couple of caveats. A key uncertainty is the radius of the star, which appears to be 15 percent bigger than models predict. If the models are correct, the planet's radius is 15 percent smaller, and the density would be somewhat greater than half the Earth's. A more extended, cloudy atmosphere also could make the planet appear larger, and its core may be more like Earth and CoRoT-7b, but Charbonneau makes the case that such an atmosphere is likely to have dissipated already. On the other hand, the atmosphere might arise from outgassing from the planet, and not be primordial at all. At this point, we just do not know.

Another very interesting aspect to GJ 1214b is its potential temperature. Based upon the distance from the star and some assumptions about its albedo, it is likely in the range of ~390 K-550 K, which is cooler than Venus is (though Venus is far warmer than its equilibrium temperature because of its thick carbon dioxide atmosphere). Further

study of GJ 1214b's atmosphere by larger and space-based telescopes will likely answer some of the questions about it.

The next paper, by Mark Swain of the Jet Propulsion Laboratory and his colleagues, presents a near-infrared emission spectrum of the atmosphere of the transitting planet HD 189733b, obtained from a *ground-based* telescope on Mauna Kea (NASA's Infrared Telescope Facility). This is the first time that such a spectrum has been obtained from the ground, and it appears to show the signature of methane in fluorescence (this is seen in the atmospheres of Jupiter, Saturn, and Titan). The IRTF has a diameter of just 3 m, so it is not by any means a large telescope, and the instruments have not been optimized for work on exoplanets. That it is able to do this is quite striking and bodes well for future observations, particularly with the infrared-optimized Gemini 8-m telescopes on Mauna Kea and in Chile.

The final paper, by Shulin Li of Peking University and her collaborators there and at the University of California at Santa Cruz, reports an analysis of the properties of a recently discovered planet, WASP-12b (the discovery was reported by Hebb *et al.* 2009 *ApJ 693,* 1920). WASP-12b is orbiting only 3.1 stellar radii above the surface of its parent star, which means that it is subject to very large tidal forces. The planet's radius is substantially larger than those of other hot Jupiters, and only tides seem to provide sufficient energy to puff it up so much, so Li decided to investigate. What she found is that the planet must be losing mass to its star at a rate of ~10^{-7} Jupiter masses per year. Given that its mass is just 1.4 $M_{Jupiter}$, this is an uncomfortably large rate, as the planet would evaporate in about 10 million years. Moreover, the tidal dissipation is so great, given normal assumptions, that it would spiral into the star on the same timescale. Astronomers tend to get very uncomfortable when they find objects in what appears to be a transitory state that is very short compared to expected lifetimes, which for an M star is of the order of 100 billion years. Li concludes that the mass loss is inescapable, but she suggests that the tidal heating the planet is experiencing now may be transient. The planet is in an eccentric orbit, which it should not be, given how close it is to the star — the orbit should rapidly circularize. She postulates that there may be a second planet that is pumping WASP-12b's eccentricity, and complex dynamical reactions recently drove it into its current state. She makes some interesting predictions, too. The material flowing into the star should reflect starlight and emit its own light. At about the ten-percent level, this will differ from what is expected from a spherical planet, and it may be detectable observationally. The infalling gas also should produce an accretion disk with a temperature of 3000-4000 K, which might produce marginally observable line emission from CO molecules in the disk.

As the Kepler mission, which is targeting 150,000 stars in its search for orbiting planets, continues (see `www.kepler.nasa.gov` for updates), we will find yet more surprises, and hopes are high that sometime in the next few years an Earth-mass planet will be found orbiting a Sun-like star at distance comparable to Earth's distance from the Sun. Amazing progress for just 15 years.

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)

Brasch's Law

Klaus Brasch is, quite simply, my oldest and best friend. We first met 52 years ago when we were both 17. Astronomy was what first drew us together, but we soon discovered many other interests in common, especially music and science fiction. Though we've gone our separate ways over the years, we somehow manage to stay in touch, and, when we do get together, we always continue the dialogue that began so many years ago.

A few years ago in *SkyNews,* Terry Dickinson, who's been Klaus's friend almost as long as I have, published an editorial concerning Brasch's Law. This states how bad the odds are against Canadian astronomers, given the cold in winter, the mosquitoes in summer, and the clouds all year round. Recently I undertook a semi-quantitative study of Brasch's Law as it applies to me, and would like to present my results here.

We start out with 365 potential observing nights in the year. Following Brasch's Law, we rule out all nights in the three worst months of winter, December through February, which leaves us with 275 nights.

Figure 1 — Klaus and Maggie Brasch in their observatory in Flagstaff, Arizona.

Secondly, we have mosquito season. That wipes out about two whole months, leaving us with 215 nights.

Now reality sets in. No matter how keen we are as astronomical geeks, we do have lives, which mean family, work, and social activities. Let's allow another month for these, bringing us down to 185 nights.

Now add the reality of the Canadian weather. Thanks to Attilla Danko's Clear Sky Charts, I have accurate statistics for my observing

location, Foxmead Observatory. The actual numbers for my site show either planetary or deep-sky observations possible on 29 percent of nights, bringing us down to just 54 nights.

So, how does this forecast compare with what I actually have achieved? Over the past six years, I've averaged 73 sessions a year, rather better than predicted, despite serious health problems.

Several things have contributed to my high totals. First, I now live in the country, and dark skies are just a step outside my door. Secondly, having a large telescope always ready to go in a SkyShed POD encourages short observing sessions on iffy nights. Thirdly, my Coronado Personal Solar Telescope adds many daytime observing sessions; there seem to be many more clear days than nights, and it's a lot warmer in the daytime. Also, no mosquitoes!

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. Brigette Hesman

"How do you know if you don't go?" Into space, that is. This was the question Dr. Brigette Hesman asked herself at an early age. She knew how to do something about it, too: become an astronaut. "That would be the ultimate thing to do: to go into space and see other worlds." In preparation, she attended Space Camp in Huntsville, Alabama — twice, once at her parents' expense and once at her own. The astronaut thing didn't quite work out, but Dr. Hesman isn't complaining. Being an astronomer allows her to "go" anyway, at least in a virtual or observational sense, and to pursue questions dating from her youth: "What's out there?" "Is it different?" "Are there other beings in the Universe?"

Undergraduate studies in astronomy and physics at York University gave her a start, and allowed Dr. Hesman to focus some attention on satellite communications. With an NSERC scholarship in her hand, she then went on to complete a Ph.D. at the University of Saskatchewan (2005), where she examined the carbon-monoxide profile in the atmosphere of Neptune. She also thought Mars was pretty cool, and — while never pursuing the Red Planet as a topic — did many interviews during the rover landings.

Further opportunity came as a post-doc at the Goddard Spaceflight Center, where she observed Saturn at various wavelengths using a spectrometer, tracing out the dynamics of the planet's atmosphere. She explains that, while the upper atmosphere of a giant planet may sometimes seem calm, deeper down there may be a lot of activity, akin to a swan seeming to effortlessly float about a pond while just below the surface, the legs are paddling like mad. Hydrocarbons, specifically ethane and acetylene, were her target. Theory predicted that atmospheric ethane would be long lasting and would have a constant profile across latitudes. Acetylene, on the other hand, would be more concentrated near the equator. Dr. Hesman found that these hydrocarbons actually peak in abundance at Saturn's south pole. Reality is obviously something quite different from the models! That "something" is likely a Hadley cell, whereby

Figure 1— Dr. Brigette Hesman.

atmospheric gases in the equatorial regions rise, travel to higher latitudes, and then sink back to lower levels in a kind of monster-scale conveyor belt. Such a system operates on Earth, where it is driven by solar heating.

Hydrocarbons are important as tracers of winds, and provide clues about how an atmosphere works. On Neptune, for example, it turns out that there is both an internal and external source of carbon monoxide. Observations Dr. Hesman made from Mauna Kea indicate that the external CO was brought to Neptune hundreds of years ago by an impactor. Correspondingly, CO was also detected after the Comet Shoemaker-Levy 9 impact with Jupiter in 1994.

Moons come under Dr. Hesman's scrutiny as well. She has looked at the ratio of carbon-12 to carbon-13 in the ethane in the atmosphere of Titan, the principal satellite of Saturn. Such observations provide clues to the molecular abundances in the early solar nebula, and help determine where in the Solar System the planets actually formed.

Dr. Hesman does occasionally "leave" the Solar System. While still an undergrad, and with her supervisor Dr. John Caldwell, she attempted to image a brown dwarf for the first time. Brown dwarfs are like super Jupiters in size and give off light and lots of heat. Most people at the time were looking for these as faint stellar companions that impart a characteristic wobble to their larger companion stars. Dr. Hesman wanted an image. The plan was to obtain such an image in infrared with the *Hubble Space Telescope* using selected infrared filters and a model of the light around a bright star that could be

subtracted to reveal the faint companion. (Amateurs have used a similar technique by placing obstructions in the focal planes of their eyepieces.) She was on the cutting edge for such work and before there really was the proper equipment for doing so. Nothing like being innovative! The group she worked under hit the jackpot on the first attempt, finding Gliese 229B, but was unsuccessful in the pursuit of other brown dwarfs.

Currently, Dr. Hesman is working in the massive effort to upgrade the Very Large Array (VLA) in New Mexico to the *Expanded* Very Large Array (EVLA). The original twenty-seven-dish radio telescope system worked at frequencies from 500 MHz to 50 GHz but in narrow, discontinuous bands. The new upgrade will have the dishes working from 1 GHz to 50 GHz, and will allow images to be acquired at all frequencies in that range. Dr. Hesman explains that this is like the *Hubble Space Telescope* pictures that are colour-coded to highlight different chemical compounds in the target object. The EVLA will allow Dr. Hesman to expand her studies of the outer Solar System at microwave wavelengths.

The device allowing this to happen, known as a correlator, goes by the name WIDAR (Wideband Interferometric Digital ARchitecture). It is being built at the Dominion Radio Astrophysical Observatory near Penticton, British Columbia, under the auspices of the National Research Council, and will be capable of performing 10^{12} calculations per second. Just as well: the EVLA will produce 100 times more data than its original incarnation and dump it into the correlator at a rate equivalent to 48 million simultaneous telephone calls! Initial operations are scheduled to begin in March 2010.

Recently, Dr. Hesman and one of her summer students used the VLA to study ammonia on Jupiter in support of the *Juno* mission. This solar-powered spacecraft will orbit Jupiter for a year, studying its gravity, magnetic field, and atmospheric composition to help investigate the origin of Jupiter and the Solar System itself. During the course of this work, a comet apparently impacted Jupiter unobserved, but left a visible stain that was discovered by Australian amateur astronomer Anthony Wesley. When Dr. Hesman looked for an ammonia signature, none was detected: there was no sign of an impact. This suggests that the impactor did not penetrate as deeply into the Jovian atmosphere as infrared astronomers had predicted.

As a number of astronomers do, Dr. Hesman has been involved in various educational activities, such as helping out at the campus observatory as an undergrad and doing outreach while working on her Ph.D. She encourages young people to follow their dreams and pursue their crazy ideas. She benefits as well because, "If you talk to kids, they keep you young." What goes around, comes around, as it was Dr. Hesman's high school math and science teachers who provided much encouragement in the early days.

I had one more question to ask but was a bit hesitant — I wasn't sure how it would be received. You see, I had a mental image of Jodie Foster, in the movie *Contact,* listening to audio signals from the VLA. I forged ahead anyway. "No," I was told, "we don't ever listen to the signals we receive. Actually, we don't even do SETI work at the VLA. The SETI work really needs to be done at lower frequencies than we work at." Nevertheless, I was told that posters of the movie are plastered up all over the place, and it was a real feather in the VLA cap to get that kind of exposure. In fact, one of her VLA colleagues, Bryan Butler, was the scientific advisor on the film.

So, while no one is plugged into cosmic audio, it seems clear that Dr. Hesman is nonetheless quite nicely tuned into the Universe.

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

Gizmos

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

Binos and Bottles

This binocular mount is built around a video head that we bought years ago so that we could use our large binoculars on a tripod. It worked extremely well horizontally and up to about 45 degrees, but above that, where all the good stuff is, you needed more joints in your neck than most people have. So the video head languished in a closet, until recently when I tried this idea.

It's pretty simple as bino mounts go. There are no arms and levers and articulating bits, just the binoculars on a ball head at the end of a pipe with a counterweight at the other end, that see-saws over a tripod.

In use, it holds your binoculars where you want them, and when you're finished, it knocks down quickly to a tripod, a piece of pipe, and a bottle of soda pop.

If you have a video head in your closet, perhaps from the summer you spent filming everything in sight, building this is easy. You start with a 4-foot length of 1-inch electrical conduit. Conduit is a thin-wall galvanized steel pipe ideal for this, because it is substantial but not overly heavy. It also comes with set-screw-type coupling sleeves, of which you need two.

The first sleeve gets mounted on the video head. If it's like ours, it has a snap-in shoe that screws to a camera. Mount the sleeve to the shoe with a hose clamp, which, while not very elegant, is easy and effective. Before you do that, file out the flange on the inside of the sleeve that centres it when it's being used as intended.

Mounted on the video head, you now have a fitting through which the pipe will slide for balance and will lock in place with a setscrew.

The ball head to the end of the pipe is a little more complicated. For this, you sacrifice a broom handle that is a smooth-sliding fit inside the pipe. Cut a 3-inch piece off the end, drill a hole down the centre, and then cut it in half on about a 45-degree diagonal. Drive a T-nut onto one of the square ends and turn a long bolt up through both pieces and into the base of the ball head until it bottoms. Slide the whole assembly into the end of the pipe and tighten by turning the ball head. As the bolt threads down through the T-nut, it draws everything together and forces the diagonal surfaces past each other so that everything wedges tight.

If you figured it out from that explanation, go to the head of the class. Everyone else look at the picture.

The counterweight is the easy part. You need a two-litre soft-drink bottle. The cap is a very snug fit into the second coupling sleeve (I had to tap it in gently with a hammer), but force it all the way in and seat it against the flange. Fill the bottle completely

Figure 1 — The bino mount in use.

with water, screw the coupling sleeve/cap down onto it, and gently tighten the setscrew. The other setscrew locks the whole thing to the pipe.

Make sure the bottle is full, because sloshing water will increase the damping time of the mount. Use the two-litre size for large binoculars and the one-litre size for smaller ones. The caps are the same size so the bottles are interchangeable.

In use, balance the mount by sliding the pipe in the video head. Set the clutch knob on the video head to provide just a slight drag. Hold the binoculars in one hand while you operate the lock knob on the ball head with the other. A few minutes to get the hang of it, and you're on your way.

A great way to explore the sky!

Figure 2 — The coupling sleeve mounted on the video head.

Figure 3 — The wedge assembly. The most difficult part of this is drilling the hole exactly down the centre of the dowel. It wants to go off to one side or the other. Use a centre punch (or a nail) to make a dimple and drill half in from each end. Keep trying till you get it right. Our broom handle is a lot shorter now.

Don van Akker observes with Elizabeth from their place on Salt Spring Island. He would be glad to help you with this or any other Gizmos project. Contact him at dvanakker@gmail.com and he'll tell you what a T-nut is.

Astronomical Art & Artifact

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RASC Catalogue of Meteorites — First Supplement

Abstract

A recent donation has increased the size of the collection and varied its contents, particularly in the area of "impactites." The recent accessions are presented here.

Introduction

The RASC Archives continue to benefit from the generosity of the anonymous RASC member, whose earlier gift of meteoritic materials formed the greater numerical part of the objects in the first installment of this catalogue (Rosenfeld 2009). Among the meteorites in this second installment, the fragments of Zagami (RASC M10) and of Allan Hills 76009 (RASC M11) are the most compelling (and not, incidentally, the physically least prepossessing). What is essentially a modest sprinkling of Martian dust is now housed at the National Office, as part of the RASC Archives.

The bulk of the present additions, in every sense, are the "impactites" (RASC I3-I8). Several museum-quality specimens fittingly boost the specimen count from Canadian sources. The shattercone from the Charlevoix Impact Structure (MI5) is particularly notable in this regard (for a good introduction to shattercones, and why they are important, see Bevan 1998).

Anyone curious to explore "on the ground" the Canadian source astroblemes of the impactites catalogued here would be well advised to turn to Chuck O'Dale's (Ottawa Centre) first-hand accounts: `http://ottawa-rasc.ca/wiki/index.php?title=Odale-Articles`.

Catalogue

The catalogue fields consist of: **1.** inventory number; **2.** type and origin; **3.** provenance; **4.** dimensions; **5.** weight; **6.** form; **7.** appearance; **8.** state of preservation; **9.** bibliography. Given the limited size of the collection, a little more detail can be supplied in the fields than is usually the case in catalogues. This is not to be taken as a sign of the relative importance of the specimens in the RASC collection; rather it attests to the opposite. It should also be noted that characterizations of the objects are referred to descriptions of the type specimens, or other properly analyzed specimens in the literature, for samples from none of the RASC specimens have been subject to extensive laboratory analysis. This catalogue has been prepared with the needs of the amateur uppermost, rather than the professional.

Meteorites

10. **1.** RASC M10.20091130; **2.** Zagami, Martian (shergottite), Zagami (Katsina) Nigeria (11°44′N, 7°5′E), witnessed fall 1962 October 3, *ca.* 18 kg; **3.** Anonymous gift 2009 November 30; **4.** Range of fragment sizes φ scale 2-3 (Wentworth size class=medium to fine sand), largest fragment 0.2×0.1×0.05cm; **5.** 0.02 gr; **6.** Irregular forms; **7.** Colour range: N 7/ Light Gley to N 4/ Dark Gray (Munsell); **9.** Not previously published; Grady (2000), p. 541; IMCAEM `www.encyclopedia-of-meteorites.com/meteorite.aspx?id=30386`;

Figure 1 — The new members of the RASC meteorite collection; a: RASC 15; b: RASC 15 detail; c: RASC 16; d: RASC 16 detail; e: RASC 17; f: RASC I8 polished face; g: RASC 18.

MBDB http://tin.er.usgs.gov/meteor/metbull.php?code=30386

11. **1.** RASC M11.20091130; **2.** Allan Hills 76009 (ALH 76009), L6 Chondrite, West of Allan Nunatak on the edge of the Polar plateau, Victoria Land, Antarctica (76°42′26″S, 159°07′43″E), find 1977 January 20 (U.S.-Japan Joint Antarctic Expedition), 407 kg; **3.** Anonymous gift 2009 November 30; **4.** Range of fragment sizes φ scale 2-4 (Wentworth size class=medium to very fine sand), largest fragment 0.2×0.2×0.15 cm; **5.** 0.041 gr; **6.** Irregular forms; **7.** Colour range: 10Y 8/1 Lt. Gn. Gray to 10Y 4/1 Dk. Gn. Gray, with sparse inclusions at 5YR 6/8 Reddish Yellow (Munsell); **9.** Not previously published; Grady (2000), p. 66-67, 547; IMCAEM www.encyclopedia-of-meteorites.com/meteorite.aspx?id=1316; MB 56 (1979), 165; MB 76 (1994), 101; MBDB http://tin.er.usgs.gov/meteor/metbull.php?code=1316

12. **1.** RASC M12.20091130; **2.** Brahin, Pallasite, PMG, Gomel', Belarus (52°30′N, 30°20′E), find 1810, 823 kg; **3.** Anonymous gift 2009 November 30; 4. Two fragments: a) 0.462×0.429×0.249 cm; b) 0.559x0.462x0.163 cm; **5.** a) 0.065 gr; b) 0.050 gr; **6.** a) Irregular triangular form; b) irregular lanceolate form; **7.** Typical attractive yellow crystalline olivine inclusions in an iron-nickel matrix; **8.** Good state of preservation; 9. Not previously published; Grady (2000), pp. 113-114; IMACEM www.encyclopedia-of-meteorites.com/meteorite.aspx?id=5130; MB 44 (1968), 99-100 (Bragin, paired); MBDB http://tin.er.usgs.gov/meteor/metbull.php?code=5130

Impactites

13. **1.** RASC I3.20091130; **2.** Black Onaping (Suevite), Sudbury Impact Structure (46°36′N, 81°11′W), 1850±3Ma; **3.** Anonymous gift 2009 November 30; **4.** 10.10×4.37×0.99 cm; **5.** 59.9 gr; **6.** Slice, polished (matte) on broad faces; **7.** Weathering present on narrow faces, most concentrated on one of the longer faces; **8.** Good state of preservation; **9.** Published in www.encyclopedia-of-meteorites.com/meteorite.aspx?id=35310; also see PASSCEID www.unb.ca/passc/ImpactDatabase/images/sudbury.htm; Ames *et al.* (2002); Rousell & Brown (2009)

14. **1.** RASC I4.20091130; **2.** Shattercone (Malmian Limestone), Steinheim Impact Structure, Baden-Württemberg (48°41′N, 10°4′E), 15±1Ma; **3.** Anonymous gift 2009 November 30; **4.** 3.47×2.55×0.91 cm; **5.** 7.2 gr; **6.** Irregular fan-shaped; **7.** Faces with long surface exposure have a light tan patina and occasional surface speckling caused by an overlay of dark material (lichen?). Relatively recently exposed faces are chalk-white in appearance. All surfaces have a typical mild abrasive feel; **8.** Good state of preservation; **9.** Not previously published; PASSCEID www.unb.ca/passc/ImpactDatabase/images/steinheim.htm; ECIS www.impact-structures.com/germany/steinheim.htm; Skàla & Jakeš (1999)

15. **1.** RASC I5.20091130; **2.** Shattercone (charnokitic gneiss), Charlevoix Impact Structure, Charlevoix, Quebec (47°32′N, 70°18′W), 342±15Ma; **3.** Anonymous gift 2009 November 30; **4.** 23.55×15×6 cm; **5.** 2250 gr; **6.** Specimen displays discernible horsetailing (lightly to moderately well-defined *striae*), indications of a cross-sectional curve, and apical features; **7.** Obscuring yellowish light-brown weathering product over most of the faces. Fractures reveal the characteristic light and dark foliated bands of the underlying rock; **8.** Good state of preservation; **9.** Not previously published; PASSCEID www.unb.ca/passc/ImpactDatabase/images/charlevoix.htm; Robertson (1968)

16. **1.** RASC I6.20091130; **2.** Shattercone (quartz arenite), Sudbury Impact Structure (46°36′N, 81°11′W), 1850±3Ma; **3.** Anonymous gift 2009 November 30; **4.** 12.9×12×4.7 cm; **5.** 760 gr; **6.** Lightly defined *striae* (less well detailed than in RASC I5), and apical features present; **7.** Rosé and light-yellow exterior colouration, dark weathering product over *ca.* 65% of faces. Abrasions to weathering layer reveal brighter yellow colour of rock; **8.** Good state of preservation; **9.** Not previously published; PASSCEID www.unb.ca/passc/ImpactDatabase/images/sudbury.htm; Rousell & Brown (2009)

17. **1.** RASC I7.20091130; **2.** Shattercone (quartz arenite), Sudbury Impact Structure (46°36′N, 81°11′W), 1850±3Ma; **3.** Anonymous gift 2009 November 30; **4.** 15×10×3.8 cm; **5.** 680 gr; **6.** Lightly to moderately defined *striae* (better detailed than in RASC I6), and apical features present; **7.** Light-yellow exterior colouration, with an overlay of light-grey weathering product over most of the faces; **8.** Good state of preservation; **9.** Not previously published; PASSCEID www.unb.ca/passc/ImpactDatabase/images/sudbury.htm; Rousell & Brown (2009)

18. **1.** RASC I8.20091130; **2.** Brecciated cobble (grey suevite), Wanapitei Impact Structure (46°45′N, 80°45′W), 37.2±1.2Ma; **3.** Anonymous gift 2009 November 30; **4.** 7.2×10×3.8 cm; **5.** 90 gr; **6.** Hemisphere, porous, one polished face (matte); **7.** Off-white with grey flecks; **8.** Friable; **9.** Not previously published; PASSCEID www.unb.ca/passc/ImpactDatabase/images/wanapitei.htm; Dressler (1982), 80-87; Koeberl, C. & Montanari, A. (2009), 22-23

Addenda and corrigenda to the original catalogue (Rosenfeld 2009)

Whyte (2009), 57-91 should be added to the references for RASC M1. In the catalogue entries for RASC M4 and RASC M6, the speculation regarding the presence of traces of a fusion crust may be misplaced (Rosenfeld 2009, 210). In both cases it is more likely to be a weathering crust. The captions to figures 6 and 7 mistakenly identify the objects as meteorites; they are tektites.

Acknowledgements

The author wishes to thank the donor of the anonymous gift of meteorites for reading over this paper and catalogue, Ron St. Martin and Barry Matthews (Ottawa Centre) for assistance, the Specula astronomica minima for the generous loan of lab equipment, and the *Journal*'s editor for his forbearance. This

research has made use of NASA's Astrophysics Data System.

Abbreviations

ECIS = Ernstson Claudin Impact Structures
PAASCEID = Planetary and Space Science Centre, Earth Impact Database
IMCAEM = IMCA Encyclopedia of Meteorites
MB = Meteoritical Bulletin
MBDB = Meteoritical Bulletin Database

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  php?code=5130
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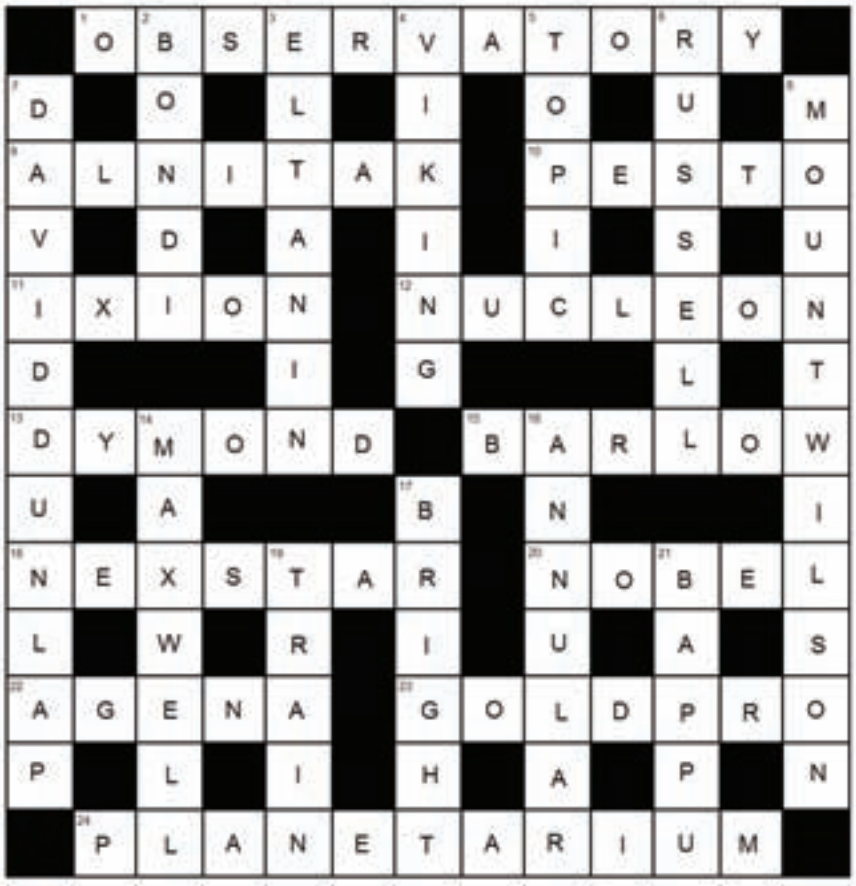
Astrocryptic Answers

by Curt Nason

The solution to last issue's puzzle



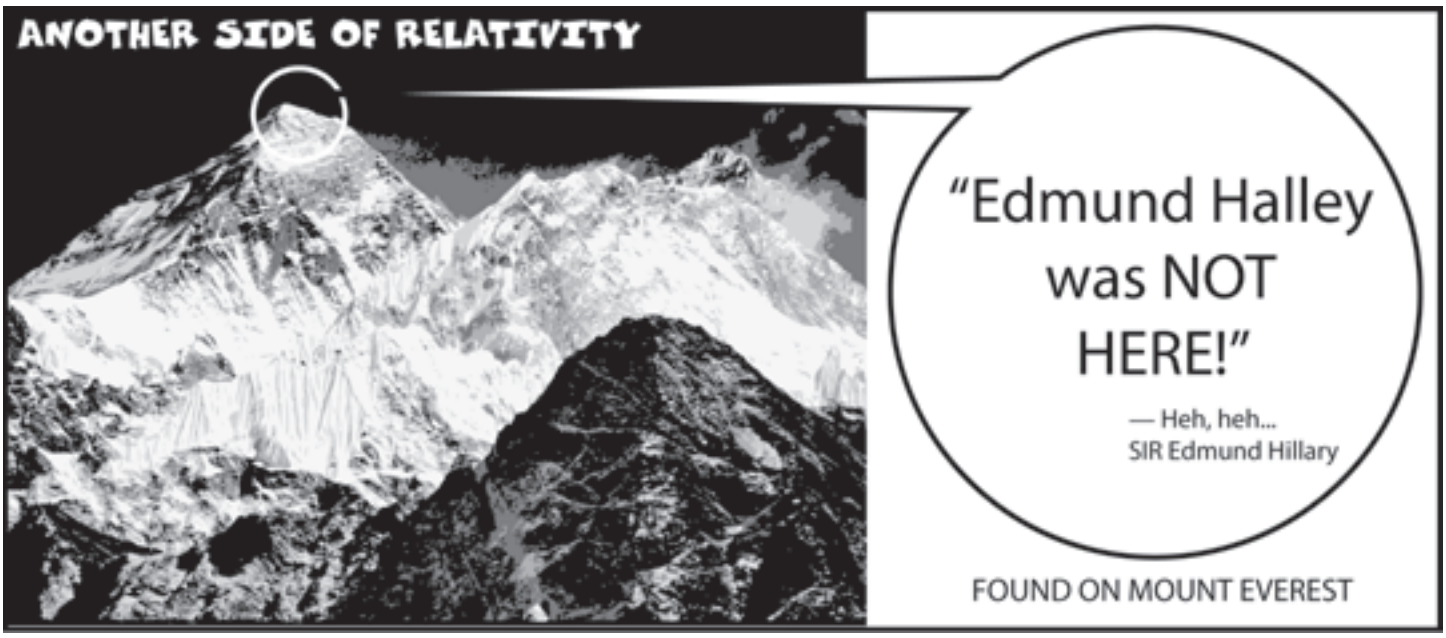
Society News

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

We have new signage at National Office, as shown in this picture. Three other signs are in place at outside doors and interior hallways.

In the last issue of the *Journal,* our exceedingly zealous Archivist, Randall Rosenfeld, and I wrote a feature article about various writers mistakenly knighting "Sir" Edmund Halley. In response, we immediately received a letter from Mary Lou Whitehorne (1st Vice-President) saying that the real Knight, Sir Edmund Hillary sounded so close that the mistake just "come[s] very easily to the tongue," as it were. Another writer, Michael Attas (Associate Editor of this *Journal*), penned this response:

> *What a delightful article in the latest JRASC! The "florid" style (in Jay's words) does not succeed in concealing a mass of research and scholarship. Well done, both of you.*
>
> *One possible explanation that you didn't mention for the error was the existence of another Knight, Sir Edmund Hillary. Their names are so similar that the "Sir" part might credibly roll off the tongue for Halley as well, as if by accident. But that doesn't make sense as a source for the older occurrences. So, this theory might explain persistence, but not origin.*
>
> *Thanks for the fun.*
>
> *Mike*
>
> *Michael Attas*
> *A Sock Editor, JRASC*



Reviews/Critiques

The Lives of Stars, by Ken Croswell, pages 72, 23 cm × 31 cm, Boyds Mills Press, 2009. Price $19.95 US hardcover (ISBN: 978-1-59078-9).

Ken Croswell is an astronomer, with a Ph.D. from Harvard, who has decided to use his astronomical knowledge to write popular articles and books on astronomy rather than remain in the academic and scientific "rat race." The result has been a series of enlightening articles appearing in *Astronomy* and *Sky & Telescope* magazines, and, more recently, a series of colourful, table-top books designed to educate young novices to some of the more interesting aspects of astronomy. *The Lives of Stars* is his latest effort.

The scientific research literature that Croswell produced in association with his Ph.D. work seems to be typical, jargon-rich writing that follows in the footsteps of many scientific papers, promulgating the standard grammatical errors (dangling gerunds, split infinitives, redundancy, *etc.*) that make published works in astrophysics either tiring or unreadable. His popular writing, on the other hand, avoids all such stumbling blocks and brings a much-needed breath of fresh air to the field. Any one of his books and articles provides a wonderful source of information for novices, and the writing is highly recommended.

I first encountered Ken when I did a telephone interview with him a few years ago in connection with work I was doing on Polaris. The resulting piece that he assembled for an article in *Astronomy,* based upon interviews with astronomers studying the Pole Star, was a work of art, and, unlike most media interviews, faithfully captured the known facts on the star as well as the sentiments of those upon whom he based his story. It is those two characteristics, accuracy and a reliance on inspired ways of describing old ideas, that raise Croswell's writing above the rest of the field. I truly love the writing style evident in *The Lives of Stars* as well as in his other works, and strongly recommend them to anyone wishing to enthuse young future astronomers about the wonders of astronomy.

As the title suggests, *The Lives of Stars,* after first introducing readers to the nature of stars, traces the various evolutionary stages that stars of different original mass can pass through, from star birth to star death, ending with the inevitable link between the creation of heavy elements and life in space. Nothing appears to have been missed, and I was delighted to find that even Cepheids are included, both as a post-red supergiant stage (perhaps not the case for Polaris?) and as distance indicators to other galaxies. Included are a variety of historical snippets woven into the text to provide both background and inspiration regarding the manner in which scientific ideas are generated, following careful observational studies. The age level for potential readers is indicated as nine or older, but the writing is also suitable for "more senior" astronomers.

The Lives of Stars contains many glorious colour views of objects related to stellar evolution: the Horsehead Nebula, T Tauri stars, young and old star clusters, H II regions, planetary nebulae, the Crab Nebula, the Veil Nebula in Cygnus, and even an extragalactic supernova. Also included are faithful schematics of planets and brown dwarfs, as well as an all-colour Hertzsprung-Russell diagram, with all stars identified and the various stellar characteristics described in exciting fashion in an accompanying two-page chapter. Nothing is neglected, and the contents might easily substitute for the appropriate chapters of an introductory textbook on astronomy for non-science specialists. It is similar in some respects to table-top books designed to show off the best astronomical images, but the writing is what makes it more than worth its small list price. Boyds Mills Press has done an excellent job in producing *The Lives of Stars,* and there is very little to criticize in the finished product.

The descriptive portions of *The Lives of Stars* are what make the book special. A number of quotes are reproduced in the publicity blurb for the book as well as in the on-line site, to which I refer interested readers. My personal favourites are his comparison of the present rate of the Sun's expansion from evolutionary effects as "about as fast as your fingernails grow," his manner of describing the absorption lines in stellar spectra by "different elements remove different wavelengths of light, thereby imprinting themselves on the star's spectrum," and his comparison of the properties of Cepheid pulsation with "musical instruments in an orchestra." Copyright restrictions limit the number of words from Croswell's books that can be quoted directly, so you will have to purchase your own copies to enjoy them to the full. *The Lives of Stars,* only 72 pages from title page to the end of the index, can be read easily in one evening, including time spent in rereading those delightful passages that describe well-known concepts from a fresh and evocative perspective.

Try as I might, I could only find one poorly phrased section of *The Lives of Stars.* Early in the text in the section "Star Light, Star Bright," stellar parallax is described with reference to the Earth being on different sides of the Sun in summer and in winter. The goal is to describe how astronomers measure the distance to the bright star Sirius from its parallactic shift, the slight displacement in its location in the sky caused by viewing it from opposite sides of Earth's orbit. Even if the complicating effect of proper motion is excluded, the parallactic shift for Sirius is best observed in spring and fall, not summer and winter, when the angle between Earth, Sun, and Sirius is close to 90°. Aside from that minor quibble, *The Lives of Stars* is a delight for any eager reader. Perhaps that should be the case, given that the entire contents were vetted by a fifth-grade student from Pagosa Springs, Colorado!

I give *The Lives of Stars* my top rating for enjoyment and educational value, and will probably donate my review copy to a local library in order to maximize its beneficial value for enthusing young readers wishing to learn more about astronomy. *The Lives of Stars* is the eighth book of its type published by Ken Croswell, most of which deal with stars or planets. I can only look forward to further books in the series.

David G. Turner

David Turner is a stellar astronomer at Saint Mary's University, and also book review editor for the Journal.

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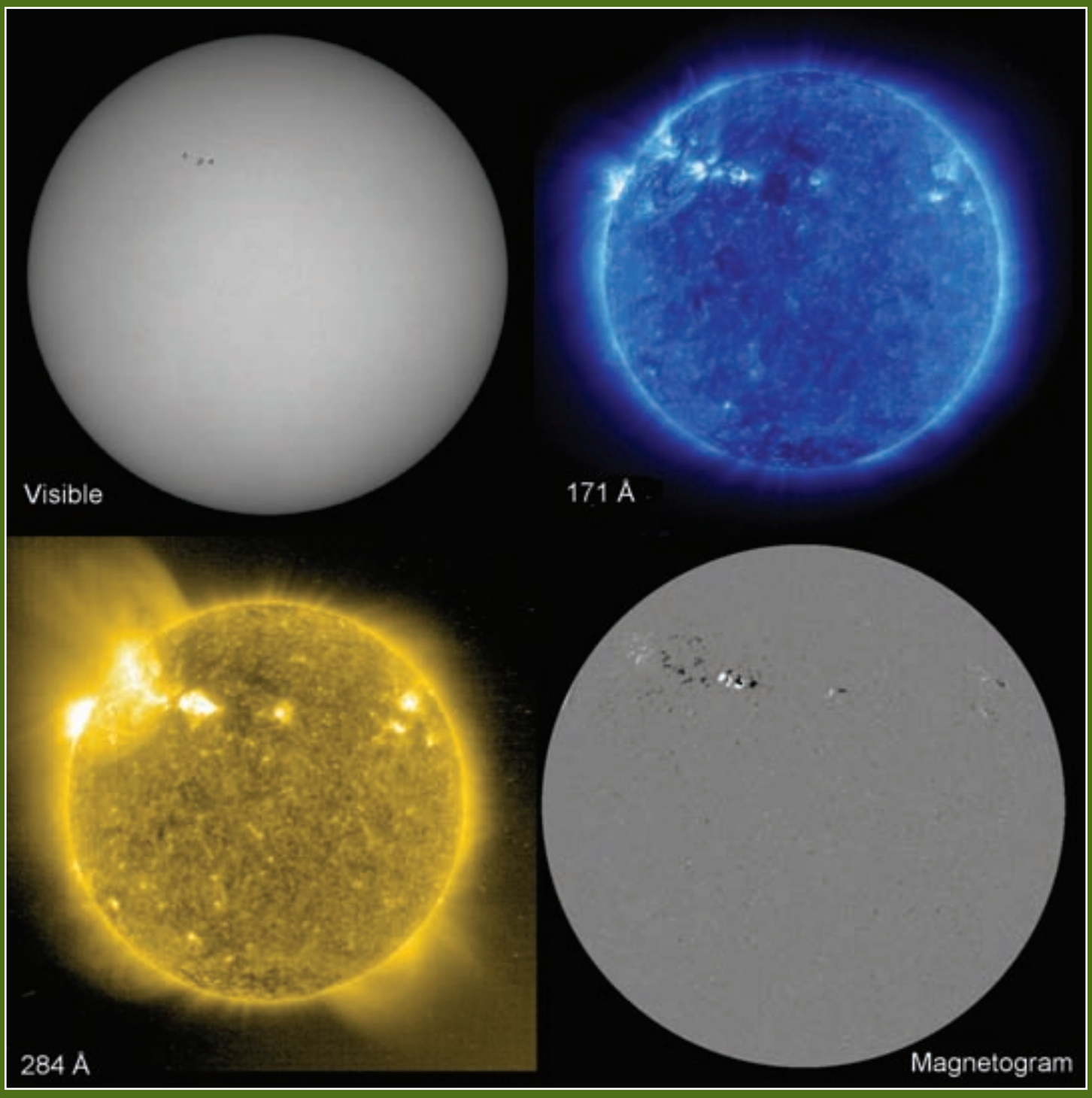

The Sun is back! These images, taken February 6 by the Solar and Heliospheric Observatory (SOHO), show that the solar cycle has left its extended minimum and activity is increasing in frequency and intensity. High-latitude sunspots (top left) are now a regular daily occurrence, and ultraviolet sensors show growing activity (top right; bottom left). Magnetograms (bottom right) show that the photosphere's magnetic fields have switched polarity to the new cycle (white areas=north magnetic poles; black=south magnetic poles), as they should. Auroral activity should begin to climb in the coming year. Images courtesy NASA/ESA (SOHO).