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Journal

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PROMOTING ASTRONOMY IN CANADA

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Gigantic Elephant Trunk—IC 1396

Journal

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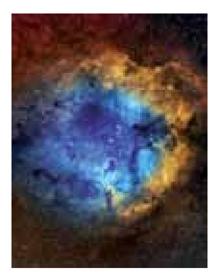

Front cover *— Lynn Hilborn of the Toronto Centre couldn't wait to put a brand-new Tokina 300-mm f/2.8 lens to work and 8 hours later had collected enough light for this stunning photograph of IC 1396. Lynn coupled the lens to an FLI ML8300 camera and exposed through three narrow-band filters. Exposure was 6×30 minutes at Hα wavelengths, the same in OIII, and 4×30 minutes in SII. IC 1396, also known as the Elephant Trunk Nebula, stretches across an area six times the size of the Moon in Cepheus. The nebula lies about 3000 light-years from Earth.*

Journal

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

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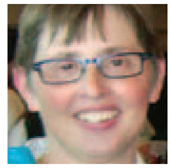
President's Corner



Mary Lou Whitehorne
President, RASC

Greetings once again to all you astronomy enthusiasts! Summer is over and we are into the new season of meetings and Society events. I thought I'd provide a brief update on a few things that have a bearing on our activities. Consider this a sample of what occupies the time and attention of the Executive Committee and our National Office staff. Read on—this is exciting stuff!

The RASC has a new fundraising guide!

Prepared by Executive Director Deborah Thompson, this new guide is provided as part of the Centres and volunteer support programme outlined in our strategic plan. The several purposes of the fundraising guide are:

- To help Centres and National Office understand their roles in relation to fundraising;
- To give volunteers a process for developing their fundraising plan;
- To give fundraisers helpful suggestions to assist in their fundraising efforts;
- To outline factors fundraising volunteers must consider as they engage in fundraising activities for the Society.

Why is fundraising important to the RASC? To quote directly from the guide:

> *"Fundraising is one of the most important activities for a not-for-profit organization to undertake. For the RASC, fundraising is central to the advancement of the charitable role of the organization and to realizing our mission and vision. Although fundraising is not a new role for the RASC, our ability to better share and strengthen our knowledge in this area will serve the Society well."*

If you or your Centre are wondering about fundraising, you now have a concise guide to lead you though the process. The fundraising guide and a tip sheet to help you get started can be found on the members' only portion of our Web site.

2. Three-year NSERC Grant Application

We have completed and submitted a joint RASC/CASCA/FAAQ three-year grant application to NSERC PromoScience to further develop and deliver the Web-based educational programme, Discover the Universe / À la découverte de l'univers, an interactive, on-line astronomy training programme for educators in remote and underserved communities.

The grant proposal executive summary describes the vision for this major, Canada-wide astronomy outreach initiative:

> *"Astronomy is a powerful tool for attracting young people to science. However, both schoolteachers and informal educators (youth group leaders, park interpreters, First Nations elders) often find astronomy intimidating to teach. This is especially true in poor or geographically remote communities that lack connections to universities or amateur astronomy clubs. To overcome this challenge, we will develop and offer a program of Web-delivered interactive astronomy training workshops and follow-up materials. Building on our successful 2011 pilot project, this interactive training will: (a) be easily accessible, in English and French, to educators who lack the resources to participate in traditional training programs, (b) provide educators with ready-made astronomy activities for their youth, and (c) let them build connections with professional and advanced amateur astronomers. Our program will give these educators the knowledge, tools, and confidence they need to teach astronomy. We estimate that we will reach over 16,000 young Canadians."*

3. New Not-for-Profit legislation in Ontario

The Government of Canada is bringing new legislation into force that governs not-for-profits and charitable organizations: The Canada Not-For-Profit Corporations Act (CNCA). As reported at recent National Council meetings, Canadian provinces are also expected to enact parallel provincial legislation in concert with the federal legislation. Ontario is the first province to do so. Its new legislation is expected to come into force late in 2012. This will affect all Ontario RASC Centres that are registered either as charities or as not-for-profits.

Some limited information about the new Ontario *Not-for-Profit Corporations Act,* 2010, is available on the Province of Ontario Web site. Topics include:

- The not-for-profit reform objectives
- Key features of the *Not-for-Profit Corporations Act*
- Organizations affected by the not-for-profit reform
- Impact on charities
- Information for directors and officers

Nationally, RASC plans to seek legal assistance to comply with the anticipated enforcement of federal legislation. We hope to be able to "template" the process to assist Centres with their part of the process. At the federal level, there is to be a three-year timeline for compliance. Our present understanding is that provincially there will be one additional year to comply with the provincial legislation.

4. More Federal Legislation

Canada is expected to bring into force its new anti-spam legislation, *Fighting Internet and Wireless Spam Act*, sometime this fall. Electronic (email) promotions and donation requests fall under this new legislation, so charities need to be aware of the new rules and regulations. We will keep you informed of developments as they unfold, so the RASC and its Centres do not accidentally find themselves in an uncomfortable position.

There! Wasn't that interesting? It might not be astronomy, but it does have an impact on how we do our astronomy. That's why some of us pay attention to the non-astronomy side of our business, so you can keep doing, and enjoying, your astronomy!

Quo Ducit Urania! ✶

The Royal Astronomical Society of Canada

Vision To inspire curiosity in all people about the Universe, to share scientific knowledge, and to foster collaboration in astronomical pursuits.

Mission The Royal Astronomical Society of Canada (RASC) encourages improved understanding of astronomy for all people, through education, outreach, research, publication, enjoyment, partnership, and community.

Values The RASC has a proud heritage of excellence and integrity in its programmes and partnerships. As a vital part of Canada's science community, we support discovery through the scientific method. We inspire and encourage people of all ages to learn about and enjoy astronomy.

News Notes / En Manchettes

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

Nobel Prize awarded for Universe's acceleration

Three astronomers are the recipients of the 2011 Nobel Prize for Physics. The Royal Swedish Academy of Sciences announced in October that the prestigious Physics prize for 2011 was being awarded to Saul Perlmutter and Adam Riess of the United States, and US-Australian Brian Schmidt, for their research on supernovae (Figure 1).

Figure 1 — The Nobel Prize winners for Physics: Dr. Brian Schmidt, Dr. Saul Perlmutter, and Dr. Adam Riess.

The researchers studied dozens of supernovae (specifically Type 1a supernovae) and found over 50 distant supernovae whose starlight was systematically fainter than expected. This "missing" light indicated to the astronomers that the Universe was expanding at an ever-increasing rate, rather than slowing, as had been expected.

The breakthrough that led to the Nobel Prize came in 1998. Two research teams, one headed by Perlmutter and another by Schmidt and accompanied by Riess, came to the same conclusion: that the expansion of the Universe was accelerating rapidly. Perlmutter led the *Supernova Cosmology Project*, which began in 1988, while Schmidt and Riess began work in 1994 on a similar project known as the *High-z Supernova Search Team*. The goal was to find and measure distant Type 1a supernovae—white dwarf stars that have accumulated material from a companion star and crossed the threshold for stability.

The brightness of these exploding stars—a single such supernova can emit as much light as a whole galaxy—is known to be roughly the same. This fact allowed the observing teams to deduce the supernovae distances from Earth, while the associated galactic redshifts indicated how fast they were moving. The two teams thought they would find that the more distant supernovae were moving more rapidly when compared to those nearby, which would show that the expansion of the Universe that began with the Big Bang was slowing down.

Surprisingly, the teams found the same opposite outcome—distant supernovae were in fact not moving more rapidly, which suggested that the Universe is destined for an ever-increasing expansion. The discovery of this expansion has changed humankind's understanding of the Universe.

Theorists suggest the acceleration may be driven by dark energy, but dark energy remains an enigma for now. It is currently understood that dark energy constitutes about three-quarters of the Universe.

Perlmutter was awarded half of the 10 million Swedish kronor ($1.48 million) Nobel Prize, while Schmidt and Riess share the other half. Perlmutter received his Ph.D. from University of California Berkeley in 1986, and joined the UC Berkeley Physics Department in 2004. He also serves as an astrophysicist at Lawrence Berkeley National Laboratory. Riess is a Professor of Astronomy and Physics at the Johns Hopkins University and a senior member of the Science Staff at the Space Telescope Science Institute, both in Baltimore, MD. Brian Schmidt is an astronomer at the Research School of Astronomy and Astrophysics at the Australian National University, formerly known as Mount Stromlo and Siding Spring Observatories.

MESSENGER spacecraft reveals scientific details about Mercury

Incoming data from NASA's *MESSENGER* spacecraft has shown scientists widespread flood volcanism similar to Earth while providing clearer views of Mercury's surface than ever seen before (Figure 2). The data from the spacecraft, the first to achieve orbit around Mercury, has also provided preliminary measurements of the planet's elemental composition and details about charged particles near the planet. These data can only be obtained from orbit.

Current imagery suggests that Mercury features a vast expanse of continuous, smooth volcanic plains surrounding its north polar region, covering more than six percent of the planet's total surface. Vents (or openings) have also been discovered measuring up to 25 kilometres across. These are suspected to be the source of some of the large volume of very hot lava that has rushed across Mercury's surface, carving valleys and creating teardrop-shaped ridges in the underlying terrain.

According to a NASA news release, new images reveal landforms on Mercury suggesting a previously unrecognized geological process. "Images of bright areas appear to be small, shallow, irregularly shaped depressions. The science team adopted the term 'hollows' for these features to distin-

Figure 2 — The 62-km rayed crater Kuiper as seen by MESSENGER*'s wide-angle camera. The smooth regions on Kuiper's floor and to its south consist of rock that was melted by the impact that created the crater. This impact melt ponded and solidified as smooth plains.*

guish them from other types of pits seen on Mercury," said the release. "Hollows have been found over a wide range of latitudes and longitudes, suggesting that they are fairly common across Mercury." Scientists suspect that the hollows could be actively forming today.

Chemical measurements from orbit reveal a higher abundance of potassium than previously predicted and indicate that Mercury has a chemical composition more similar than expected to Venus, Earth, and Mars. In addition, measurements of Mercury's magnetosphere have revealed the presence of plasma ions—mostly sodium. The planet's weak magnetosphere provides little protection from the solar wind, resulting in a very hostile surface environment with extremes in space weather.

The results of the Mercury data are reported in seven papers published in a recent issue of Science magazine. *MESSENGER*—the MErcury Surface, Space ENvironment, GEochemistry, and Ranging spacecraft—took more than six years to reach the innermost planet, achieving orbital insertion on 2011 March 18.

Fewer mid-size near-Earth asteroids found

There are significantly fewer near-Earth asteroids in the mid-size range than were previously thought to exist according to observations conducted by the *Wide-field Infrared Survey Explorer* (*WISE*). The new findings, which reflect the most accurate census to date of near-Earth asteroids, also indicate that NASA has found more than 90 percent of the largest

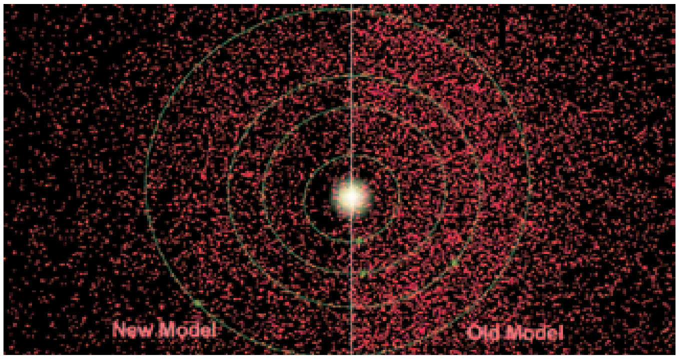


Figure 3 — There are at least 40 percent fewer near-Earth asteroids in total that are larger than 100 metres (330 feet). The Solar System's four inner planets are shown as large, green dots while the bright Sun is in the centre. Each red dot represents one asteroid (object sizes are not to scale). Image credit: NASA/JPL-Caltech

near-Earth asteroids (brighter than absolute magnitude 18), meeting the "Spaceguard" goal agreed to with the United States Congress in 1998.

New estimates based on these findings now show that there are roughly 19,500—not 35,000—mid-sized near-Earth asteroids between 0.1 and 1 kilometre. The improved understanding of the asteroid population suggests that the hazard to Earth could be somewhat less than previously thought (Figure 3). Scientists note, however, that the majority of the mid-size asteroids still remains to be discovered.

Although *WISE* discoveries reveal only a small decline in the estimated numbers for the largest near-Earth asteroids, which are 1 kilometre in size and larger, the data show 93 percent of that estimated population have been found.

WISE scanned the entire celestial sky twice in infrared light between January 2010 and February 2011. It snapped pictures of everything from distant galaxies to near-Earth asteroids and comets. NEOWISE, the asteroid-hunting portion of the *WISE* mission, observed more than 100,000 asteroids in the main belt between Mars and Jupiter, in addition to at least 585 near-Earth asteroids. The satellite captured a more accurate sample of the asteroid population than previous visible-light surveys, because infrared detectors could see both dark and light objects.

Scientists believe that the risk of a large asteroid striking the Earth before it could be detected and before warnings could be issued has been substantially reduced. However, the situation is different for the mid-size asteroids capable of destroying a metropolitan area if they were to land in the wrong place. It is estimated that are more than a million unknown smaller near-Earth asteroids that could cause damage if they were to impact Earth.

The results of the *WISE* observations appeared in a recent edition of the Astrophysical Journal..

Five of Saturn's moons congregate

The Cassini spacecraft has taken an intriguing portrait of five of Saturn's moons when they came together within its camera's field of view. The exceptional image (Figure 4) was taken in green light with the Cassini spacecraft narrow-angle camera on 2011 July 29. The view was acquired at a distance of approximately 1.1 million kilometres from Rhea and 1.8 million kilometres from Enceladus.

The five moons appear from left to right in Figure 4 as follows:

- Janus (179 kilometres) is on the far left.
- Pandora (81 kilometres) orbits between the A ring and the thin F ring near the middle of the image.
- Enceladus (504 kilometres) appears above the centre of the image and is brightly reflective.
- Rhea (1,528 kilometres) is bisected by the right edge of the image; it is Saturn's second-largest moon.
- Mimas (396 kilometres), the smaller moon, can be seen beyond Rhea also on the right side of the image.

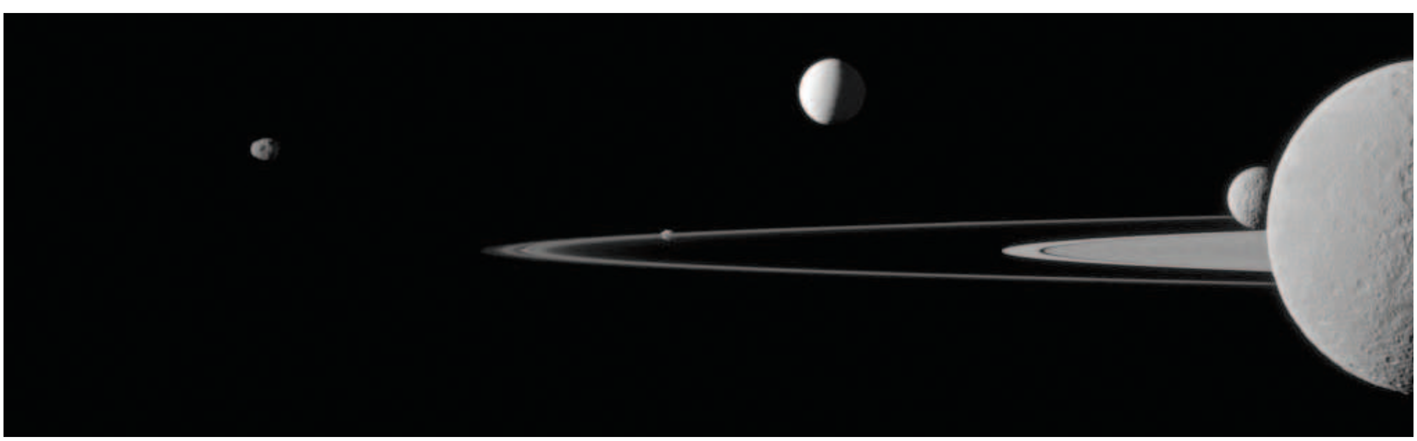


Figure 4 — Five Saturn's moons come together—Janus far left; Pandora between the A ring and the thin F ring near the middle of the image; Enceladus above the centre of the image; Rhea bisected by the right edge of the image; and Mimas seen beyond Rhea also on the right. Image: NASA/JPL-Caltech/Space Science Institute

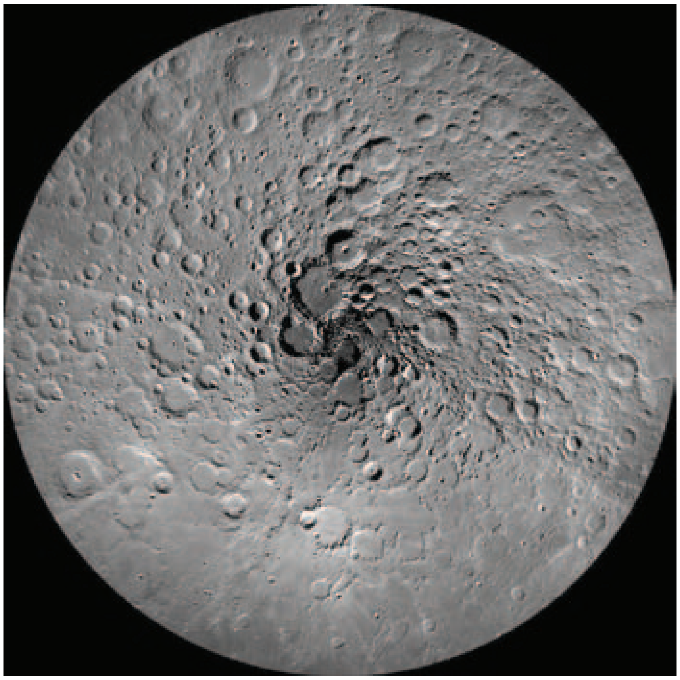


Figure 5 — A view of the Moon's north polar region (a mosaic composed of 983 images). Image: NASA/GSFC/Arizona State University

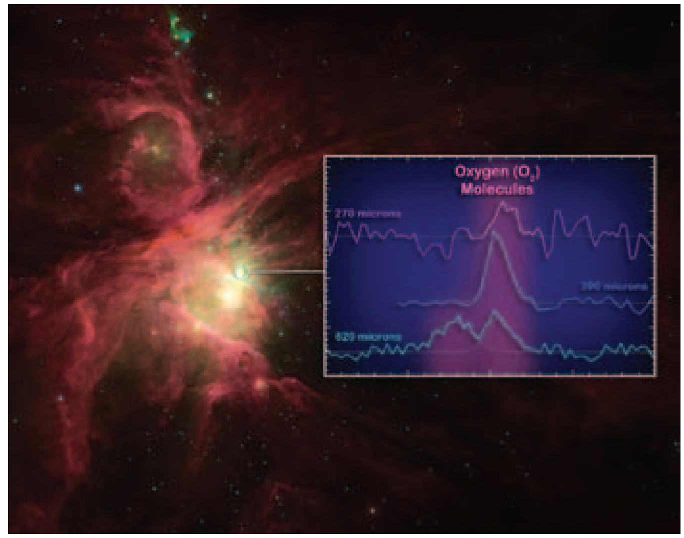


Figure 6 — A graphic illustrating where astronomers have found oxygen molecules near the star-forming core of the Orion nebula. The picture of Orion was taken by NASA's Spitzer Space Telescope at infrared wavelengths. Image: ESA/NASA/JPL

The view in Figure 4 looks toward the northern, sunlit side of the rings from just above Saturn's ring plane. Rhea is closest to Cassini. The rings are beyond Rhea and Mimas, while Enceladus, the most distant, is on the far side the rings.

Mosaic shows Moon's North Pole

The Moon features a north polar region of its very own and the Lunar Reconnaissance Orbiter Camera (LROC) has recently captured a detailed image of that polar region (Figure 5). Composed of 983 images taken over a one-month period during northern summer, the image shows the Moon's North Pole when it is best illuminated. In the mosaic, regions that are not illuminated are candidates for permanent shadow.

One of the primary scientific objectives of LROC's activities is to identify regions of permanent shadow and near-permanent illumination.

Oxygen molecules seen in space

Astronomers have found oxygen molecules in space near the star-forming core of the Orion nebula. The molecules, whose presence had been hinted at before, were definitively confirmed using the *Herschel Space Observatory*, a European Space Agency mission with important NASA contributions.

Herschel's heterodyne instrument for the far infrared was used to split apart light into its different submillimetre wavelengths from a specific region of the Orion Nebula. Astronomers recognized three distinct fingerprints of oxygen molecules in this spectrum. The three lines (Figure 6) show different ranges of wavelengths, with the signatures of oxygen molecules highlighted towards the centre (shaded in pink). ✶

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

Feature Articles
Articles de Fond

Since When Was the Sun a Typical Star?

by Martin Beech
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Welcum the lord of lycht, and lamp of day.

– Gavin Douglas (1474-1522)

Abstract

The idea that the Sun is a typical or ordinary kind of star has been prevalent within the astronomical literature for at least the past 80 years, and yet the notion is entirely wrong. The Sun is not a typical star. Indeed, the Sun is an exceptional and rare type of star that supports a special kind of planetary system. It is demonstrated that even within the solar neighbourhood, the Sun is exceptional, and that the M dwarf star Proxima Centauri is a much better example of a typical or representative stellar object. It is suggested that, in the modern era, the continued description of the Sun as an ordinary, non-special, even run-of-the-mill kind of star is the result of a wrong and overly zealous application of the Copernican Principle.

The Sun is a star

By being such a common, everyday, and familiar sight, the Sun is often overlooked as a *bona fide* object of astronomical interest. There is perhaps a historical underpinning for this sentiment, and it should be remembered that it is barely 150 years since it became demonstrably clear, through spectroscopic studies, that the Sun is an actual star and, up to a point, *vice versa* (Tayler 1989; Arny 1990). One hundred and thirty-six years ago, for example, Arthur Searle commented in his *Outlines of Astronomy* (1875, 14) that "very little, indeed, is known of the stars." He later asserts (p. 53), however, that "observations with the spectroscope have also confirmed the belief previously grounded on the brightness and remoteness of the stars, that they are bodies resembling the Sun." Charles Young further writes, in his 1899 *A Text-Book of General Astronomy* (p. 184) that, "the Sun is simply a star; a hot, self luminous globe of enormous magnitude…although probably of medium size among its stellar compeers." With this statement, Young has confirmed the star-like nature of the Sun and has introduced yet another characteristic, stating that the Sun is "probably only of medium size." Accordingly, not only are stars like the Sun, but there is also a range of stellar sizes, and by implication, temperatures and masses as well. The fact that stars have varying degrees of energy output (that is luminosity) had already been established[1] about 60 years before Young wrote his text.

Hector Macpherson in his wonderfully named *The Romance of the Modern Astronomy* (1923, 185) picks up on Young's point by writing that, "the stars are Suns, This is a very good truth which we must bear in mind." Macpherson continues (p. 193) to explain, however, that the Sun is a dwarf, yellow star. William Benton in his 1921 *Encyclopedia Britannica* entry concerning the Sun also comments upon its size and notes that, "the Sun is apparently the largest and brightest of the stars visible to the naked eye, but it is actually among the smallest and faintest." The comments by Macpherson and Benton, while in contrast to those of Young, actually build upon the monumentally important results of Ejnar Hertzsprung and Henry Norris Russell, who circa 1910, independently introduced the idea of dwarf and giant stars along with what has become known as the HR diagram—a plot of stellar temperature versus luminosity[2]. In terms of stars being blackbody radiators (again a theory not actually established in its modern form until the appearance of the pioneering quantum mechanical model of Max Planck in 1900), the size (radius, R), temperature (T) and luminosity (L) are related according to the famous Stefan-Boltzmann law: $L = \text{constant } R^2T^4$. That the luminosity is further related to the mass of a star was a result established by Eddington (1924).

By arranging the stars in the HR diagram it is possible to begin comparing the Sun's physical characteristics against those of the stars in general. Accordingly, Simon Newcomb in his *Astronomy for Everybody* (published 1932) explains (p. 267), albeit rather tentatively, "what we have learned about the Sun presumably applies in a general way to the stars," and that with respect to the HR diagram (p. 274) he notes, "the dot for the Sun, class[3] G0, is in the middle of the diagram." With Newcomb's latter comment, we begin to see a new and quite specific picture of the Sun emerge: it is an average, middle-of-the-road sort of star. Indeed, this comparative point was specifically emphasized by Arthur Eddington in his book *The Nature of the Physical World*, published in 1935. Eddington writes (p. 164-5), "amid this great population [the galaxy] the Sun is a humble unit. It is a very ordinary star about midway in the scale of brilliance…. In mass, in surface temperature, in bulk the Sun belongs to a very common class of stars." To this he later adds (in classic Eddingtonian language), "in the community of stars the Sun corresponds to a respectable middle-class citizen." Extending Eddington's anthropomorphic scheme of stellar personification, Eugene Parker (2000) describes the Sun as being "a pedestrian star."

With the continued acquisition of data and the development of astrophysical theories, we see from *circa* the 1930s onwards the entrenchment of ideas concerning the Sun's relative characteristics. A few examples, all gleaned from the general literature, of how the Sun has been systematically "normalized" over the years are given in the list below:

- W.H. McCrea (1950): *Physics of the Sun and Stars*. (p. 58): "The Sun is a typical star," and (p. 106): "it turns out, indeed, that the Sun is a pretty average star in almost every respect."
- A. Deutsch (1962) in *Stars and Galaxies* (Ed. T. Page). (p. 44): "the Sun is a typical star, a hot sphere of gas."
- A.J. Meadows (1967): *Stellar Evolution*. (p. 109): "The Sun is so important to us that we tend to think of it as just a typical star. Yet its characteristics are perfectly normal."
- J.P. Wild (1976): *Focus on the Stars*. (p. 73): "the Sun is located in a nondescript place within a spiral arm of the Galaxy."
- C. Sagan (1980): *Cosmos*. (p. 243): "Our ancestors worshiped the Sun, and they were far from foolish. And yet the Sun is an ordinary, even a mediocre star."
- R.W. Noyes (1982): *The Sun: our star*. (p. 7): "it turns out that our Sun is very much a run-of-the-mill star… [and it] lies midway along the main sequence."
- H. Zirin (1988): *Astrophysics of the Sun*. (p. 1): "contrary to popular belief, it [the Sun] is a fairly large star; eighth brightest among the 100 nearest stars. Although it falls in the middle of the sequence of spectral classes, most stars are dwarfs of later and smaller types."
- C.J. Caes (1988): *Studies in Starlight: understanding our universe*. (p. 132): "The Sun, as far as can be detected, is simply an average star. Generally speaking there is nothing especially unusual about its physics. It is of average temperature for a star, of average brightness, and of average age."
- M. Zeilik and J. Gaustad (1990): *Astronomy: The Cosmic Perspective*. (p. 374): "What is the Sun? Basically, an ordinary star."
- Stephen Hawking (1995): Radio interview with Ken Campbell: "The human race is just a chemical scum on a moderate sized planet, orbiting a very average star in the outer suburb of one among a hundred billion galaxies." Cited in Deutsch (2011).
- G.J. Babu and E.D. Feigelson (1996): *Astrostatistics*. (p. 26): "Our solar system is located in a rather ordinary part of the Galactic disk.… Our Sun, formed 4.5×10^9 years ago[4], is a typical star and most of its neighbors are similarly low mass, middle-aged main sequence stars."
- L. Golub and J.M. Pasachoff (2001): *Nearest star; the surprising science of our Sun*. (preface): "Our Sun is a fairly ordinary star, a bit brighter than most but not exceptionally so. There are many stars much bigger and brighter, while most stars are smaller and fainter."
- S.G. Ryan and A.J. Norton (2010): *Stellar Evolution and Nucleosynthesis*. (p. 14): "the Sun is a typical star."
- C. Impey (2010): *How it Ends: from you to the universe*. (p. 160): "The Milky Way, our position in it, and the star we orbit aren't unusual or special."

While no pretence is made for completeness, and no specific criticism of the authors is intended, the examples given above were all found during an afternoon's visit to the University Library. While much has clearly been written about the Sun's relative stellar properties, I came across no book or article in my survey that even remotely suggested that the Sun might be "special" and/or "extraordinary." This situation strikes me as being absolutely remarkable, since it is patently clear that the Sun is both special, and far from being anything that resembles a typical star, it is indeed, extraordinarily special. In spite of much historical nay-saying, the Sun's essential characteristics are not average or ordinary, or indeed, those that one might expect from a naïve application of the Copernican Principle—sometimes also called the Principle of Mediocrity.

The (much abused) Copernican Principle

In its modern form, the Copernican Principle has become something that would have entirely horrified Copernicus. This shift in interpretation aside, the Copernican Principle is generally expressed in a form that asserts the non-favoured location and non-special viewpoint of humanity[5] within the Universe. That is, we are not privileged or even unique observers of the cosmos. The idea behind the principle is of general importance in the practice of science, and, for example, in the field of cosmology, appears to be demonstrably true: the Universe, on the large scale, is isotropic and homogeneous, and our general viewing circumstances are no different from those of any other potential observer in the Universe. Be all this as it may—the point is, we would argue, that an unguarded devotion to the Copernican Principle in the modern era has resulted in wrong conclusions being drawn about the Sun. The argument apparently runs along the lines that since, by the Copernican Principle, humanity, as observers of the Universe, is not specially located, so the star (the Sun) about which the Earth orbits, and from which humans observe, cannot be special, and therefore it must be an average sort of stellar object in a non-special, "nondescript" location within the Milky Way Galaxy. Such conclusions, as far as the Sun goes, are not logically propagated and, more to the point, are demonstrably wrong.

A number of authors, as illustrated above, have suggested that the Sun is a typical, or average star because it is located in the middle of the main sequence on the HR diagram. There are numerous problems with this deduction (the main one being, however, that it is an entirely wrong inference). First, the HR diagram is invariably shown as a plot of logarithmic quantities and this automatically compresses the range of values to be plotted (see the discussion in *e.g.* Spiegelhalter, Pearson, and Short 2011). If one drew the HR diagram with a linear scale, for example, the Sun would not be located in the (geometrical) middle-range of stellar luminosities and/or temperatures. Second, if one takes the (naïve) middling (arithmetic mean) value of any stellar quantity, then the resultant value is not a quantity typical of the Sun. For example, the range of stellar masses varies from about 0.1 to about 100 $M_\odot$, and the mid-way, arithmetic mean, value is accordingly 50.05 $M_\odot$—a quantity that is hardly the mass of the actual Sun. Third, and finally for this discussion, even if a star (the Sun or otherwise) is located at the mid-way point on the main sequence in the HR diagram, this does not mean that it must be the most likely or most typical star to be encountered within the Milky Way Galaxy.

What is typical?

The Sun, from our collection of quotations, has been described as, "typical," "average," "run-of-the-mill," "ordinary," "mediocre," and "normal." All such expressions are apparently employed in the sense that if one picked a star at random within the galaxy, then it would be a Sun-like star, and/or if one measured a range of values for stellar mass, radius, temperature, and luminosity, then their averages would all somehow reduce to intrinsic solar quantities: 1$M_\odot$, 1$R_\odot$, T ~ 6800 K, and 1$L_\odot$, respectively. There are clearly a number of problems with such expectations—not least the fact that such expectations are wrong. When the Sun is described as being an "average" or "typical" star, it is rarely (in fact, never, according to the author's literature survey) stated with respect to what distribution of stars. There are, for example, some very obvious comparisons where the Sun would be an extreme and highly untypical object. To the stars in a globular cluster, the Sun would, in comparison, be an extremely young star with a very odd chemical composition (that is, high metal abundance). To the stars in a newly formed galactic cluster, the Sun would by comparison be a low-mass, low-luminosity, very old star, with a relatively low metal abundance. Even if we make a more sensible comparison, however, between the Sun's properties and those stars that reside in the solar neighbourhood, the Sun in no manner has typical stellar characteristics.

Statistically speaking, terms such as typical, most common, and average will only coincide if the objects being studied have a normal (or Gaussian) distribution, and the most important point about stars is that their mass distribution[6] is decidedly non-normal; indeed it is a strongly peaked negative power-law distribution in stellar mass, with the lowest-mass stars being by far the most numerous. As we shall see below, the most "typical" star within the galaxy, and the star most likely to be encountered or "picked" at random in the solar neighbourhood, is an M-dwarf main-sequence star—a star resembling Proxima Centauri with a mass of order 0.1 $M_\odot$.

The most complete catalogue of stars located close to the Sun with well-measured physical characteristics is that provided by the Research Consortium On Nearby Stars (RECONS). Table 1 is a summary of the RECONS dataset for the stars located within 10 pc [parsecs] of the Sun (see Henry *et al.* 2006 and www.recons.org). It is believed that the vast majority of stellar objects within 10 pc of the Solar System are identified within the RECONS catalogue (this result is probably not true, however, for the brown dwarfs, but they do not concern us here), and it is also believed that the dataset is representative of that which might be found in any region of the galaxy at the Sun's galactocentric distance of 8 kpc. A quick glance at the entries in Table 1 immediately indicates a predominance of low-mass, low-temperature, small-radii, *K* and *M* spectral type dwarf stars. The number of stars of mass *M*, within the RECONS 10-pc catalogue, is described by the mass function $N(M) = 4.6 / M^{1.20}$. If there were equal numbers of objects at any given stellar mass, then the exponent in the mass function would be zero, but, as it stands, of the 320 stars in the 10-pc survey, the Sun is among the top 25 most massive—the most massive star within 10 pc of the Sun is Vega, weighing in at 2.135 ± 0.074 $M_\odot$ (Yoon *et al.* 2010). The modal, most common, mass value in the 10-pc survey falls in the range between 0.1 and 0.15 $M_\odot$, and the median value, for which half of the systems have a greater mass and half have a smaller mass, is 0.35 $M_\odot$. That the latter results are further typical for the rest of the galaxy is revealed by the available data relating to the stellar initial-mass function (IMF), which describes the number of stars formed in a specified mass range. While the slope of the IMF varies in a complex manner according to the stellar-mass range, the peak number of stars formed is invariably (even universally) found to fall in the 0.1 to 0.5 $M_\odot$ range. (Bastian *et al.* 2010). Krumholz (2011) has further shown that the characteristic stellar mass can in fact be determined according to an expression composed of fundamental constants

Objects	Systems	O	B	A	F	G	K	M	WD	BD	Planets
369	256	0	0	4	6	20	44	247	20	28	15

Table 1 — Summary of RECONS data as published for 2011 January 01. The first column indicates the total number of known objects (stars as well as white and brown dwarfs) within 10 pc of the Sun, while the second column indicates the number of stellar systems (single, binary, triple, etc). Columns three through nine indicate the number of stars of a given spectral type (the Sun, included in the dataset, is a G spectral-type star). Columns ten and eleven indicate the number of white dwarf (WD) and sub-stellar brown dwarf (BD) objects. The last column indicates the number of planets so far detected. Data from www.recons.org.

(the speed of light, the gravitational fine-structure constant, and so on) and is only weakly dependent upon the intrinsic characteristics of the star-forming region (*e.g.* its temperature and density structure, and its metallicity). Indeed, the characteristic stellar mass, determined according to the fundamental fragmentation mass within a star-forming cloud, as derived by Krumholz, is 0.15 $M_\odot$.

Sun-like stars having $M \approx 1\ M_\odot$ and a G spectral type are found to make-up just 6% of the stars within the 10-pc volume. In contrast, the M spectral-type stars constitute 77% of the total number. In addition, the modal absolute magnitude for the stars in the 10-pc data set is found to be MV ≈ +13.5; a value some 8.5 magnitudes fainter than that of the Sun. Compared to the most typical (that is, ordinary, common, run-of-the-mill, pedestrian, *etc.*) star in the solar neighbourhood, the Sun is nearly 10 times more massive, 10 times larger, 2 times hotter, and 10,000 times more luminous. The Sun is not a typical star even within its own precinct.

How special is the Sun?

Given that the Sun is not an average, ordinary, or typical star within the solar neighbourhood, is it additionally special? By this, I do not intend the question to focus on humanity's existence being dependent upon it—because, in this sense, it is obviously very special and we would not exist without it. Rather, the question refers to its extensive characteristics, such as being a single star, and then a single star with an attendant planetary system, and so on. Again, one can turn to reasonably well known and reasonably well understood datasets to answer this question. Following Dole (1964) and Adams (2010), the answer to our question can be expressed as a probability. Accordingly, the probability P_{Sun} of finding a star within the galaxy having similar observable characteristics as the Sun can be written in the form of a Drake-like equation[7]:

$$P_{Sun} = 100 \times F_1\, F_{SB}\, F_Z\, F_P\, F_H \qquad (1)$$

The terms entering equation (1) relate to F_1, the fraction of stars with a mass equal to 1 $M_\odot$; F_{SB} the fraction of solar-mass stars that are single as opposed to being members of a binary or multiple system; F_Z, the fraction of stars with a metal abundance corresponding to that of the Sun at the Sun's location within the Galaxy; F_P, the fraction of solar-mass stars harbouring planets, and F_H the fraction of planet-harbouring Sun-like stars in which one (or more) might reside within the habitability zone. All of the terms in equation (1), in contrast to those in Drake's more famous equation, are reasonably well known. Looking at each quantity in turn, it is evident that $F_1 = 0.06$, corresponding to the fraction of spectral type G stars within the annotated spectral sequence distribution (see *e.g.* Table 1; Mihalas and Binney, 1981). To a good approximation $F_{SB} = 1/3$, with the majority of Sun-like stars being found in binary systems (such as in the case of our nearest neighbouring system α Centauri AB—see *e.g.* Beech, 2011). F_Z is again reasonably well constrained, and the Sun, in fact, has a relatively high metal abundance with, for example, the survey by Rocha-Pinto and Maciel (1996) indicating that within the solar neighbourhood, $F_Z = 0.25$ for $Z \geq Z_\odot$. Indeed, it should be noted that the composition exhibited by the Sun is not that corresponding to just any radial location within the Milky Way Galaxy; a condition that in fact negates the not uncommonly encountered statements that imply the Sun is somehow situated in an "ordinary" or "nondescript" region of the galaxy. The fraction of Sun-like stars supporting large planets is known to vary with the composition of the parent star (and hence galactic location), and following the study by Wyatt *et al*. (2007), the fraction of Sun-like stars with Jovian planets varies as $F_P = 0.03 \times 10^{Z/Z_\odot}$; which is to suggest that $F_P = 0.3$. And finally, the least well-known quantity is that relating to the finding of a planet within the habitability zone. At present this number may only be constrained via theoretical modelling; Gowanlock, Patton, and McConnell (2011) have argued that, for planet-hosting systems, $F_H = 0.05$. With our various quantities now in place, the following evaluation is found: $P_{Sun} \approx 0.01\%$. In other words, if one picked a star at random within our galaxy, then there is a 99.99% chance that it will not have the same intrinsic characteristics as our Sun and (basic) Solar System.

Clearly, the Sun is not an ordinary star. In addition, the special characteristics associated with the Sun and Solar System apply irrespective of the origins of life on the habitable planet—if we wish to include our own existence in the calculation, then P_{Sun} will be (according perhaps to one's bias) many orders of magnitude smaller. Irrespective of this latter addition, by any reasonable standards, the Sun and its attendant planets constitute a rare and uncommon type of system within our galaxy.

Conclusion and discussion

The main aim of this article has been to argue that, counter to common convention, the Sun is a special star, primarily, from an astrobiological viewpoint, for supporting a habitable planet, and that it is a decidedly non-typical type of star, with the most typical or ordinary kind of star within the solar neighbourhood (and larger galaxy) being something more like Proxima Centauri—a low-mass, M-dwarf, main-sequence star. In light of such arguments, it is high time, we suggest, to stop describing the Sun as a "typical" or "average" or "ordinary" star. It is not now, never was, nor will it ever be, a typical star within our Milky Way Galaxy. Not only is the Sun not a typical star, it is a rare and special type of solar-mass star, in that it is not located within a binary system, it is located at some 8 kpc from the galactic centre (a non-random location that links directly to its metallicity), and that it is the host star of a planetary system of which one planet resides within its current habitability zone. Furthermore, the Sun is actually a relatively young star for its position within the galaxy—most solar-mass stars situated within the galactic habitability zone (GHZ), a region located within the annulus having radii between 7 and 9 kpc from the galactic centre, are estimated to be at least of order 1 billion years older than the Sun (Lineweaver, Fenner, and Gibson 2004)[8].

In his recent far-ranging book *The Beginning of Infinity: explanations that transform the world* (published 2011), David Deutsch has taken specific aim at the philosophy underlying the Copernican Principle (and/or the Principle of Mediocrity). Indeed, he describes it as being a paradoxical, parochial, and philosophically limiting tool upon which to base any work. This author tends to agree, although this is not the place to discuss Deutsch's broader context. Such philosophical quibbles aside, it is argued, nonetheless, that the incorrect (now long-running) misconception that the Sun has typical, average, or ordinary stellar characteristics is a false deduction based upon the idea that there can be nothing special about the circumstances under which humanity has evolved to become an observer of the large-scale Universe. To deny the highly exceptional and unlikely manner in which the Solar System came about, along with its various specific characteristics and how intelligent life managed to evolve so rapidly on planet Earth, acts only to blinker and limit our understanding of life's very origins. With the latter being said, it should also be emphasized that there is no additional value to be associated with the Sun's rare and highly exceptional character—it is, quite simply, what it is observed and measured to be.

There comes a moment in any study at which point one must ask, will the arguments being presented make any difference? The answer drawn by the author in this case is "probably no." While this old curmudgeon grumbles his complaints about the way other authors have described the Sun, it is also his guess that the idea, and indeed more worryingly from a scientific perspective, the apparent desire for the Sun to be an ordinary, non-exceptional star located within a nondescript region within the galaxy is too deeply entrenched to change any time soon. Ultimately, however, the thoughts of the old curmudgeon will hopefully take positive form (as all curmudgeons believe their words should), and future lay-readers, students, and astronomers will appreciate the Sun for what it really is and describe it appropriately: the Sun is a non-typical, highly exceptional star located within a quite specific region of the Milky Way Galaxy. ✶

The army of wrongness rampant in the world might as well march over me.

- Truman Capote (1924 – 1984), Breakfast at Tiffany's

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(Endnotes)

1 This was evident as soon as the first (believable) stellar parallax measurements were published in 1838/9. Indeed, since the star Vega (as observed by Friedrich Struve) was found to be some 2.2 times further away than 61 Cygni (as observed by Friedrich Bessel) and yet was 6 magnitudes brighter, it must have a greater intrinsic luminosity.

2 Here we betray a theoretical bias, since observationally the diagram is a plot of absolute (or apparent) magnitude versus spectral type. The various quantities are, of course, equivalent, but not in any straightforward fashion.

3 The Sun's spectral class is now taken to be G2

4 We note here that the only average or middling quantity that the Sun apparently has is that of its age—in the sense that in terms of its main-sequence lifetime it is middle-aged. This characteristic, ironically, raises interesting and difficult questions with respect to the apparently rapid appearance of life on Earth.

5 In contrast to its modern usage, Copernicus would have been appalled by the idea that the Earth, Sun, and humanity were not special, and indeed that they were not unique and highly favoured entities.

6 The mass distribution is the most important quantity since, on the main sequence, where stars spend most of their lifetime, the radius, luminosity, and temperature are all determined by the amount of stellar material.

7 The parallel here is to Frank Drake's famous equation for estimating the number of extraterrestrial civilizations within the Milky Way Galaxy.

8 Lineweaver, Fenner, and Gibson (2004) also point out that, at the present epoch, the GHZ is composed of less than 10% of the stars that have ever formed within the Milky Way.

A Midsummer Night

by Robert Dick, Ottawa Centre
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In June 1986, I wrote an article for our Ottawa Centre newslettter, *AstroNotes*. I came across it again this year and thought readers of the *JRASC* might be interested in my long-ago experience using a high-end image-intensifier starlight scope.

I think there are many astronomers (both amateur and professional) who dream of seeing, with their unaided eyes, the sky filled with all the stars on their charts. The stars in this dreamlike vision would reach down to the eighth or ninth magnitude. Gone would be the fumbling with a dim red light and fussing and shuffling with large dew-soaked cardboard star charts. All the stars would be "up there" before your eyes. Many observers have taken wide-angle time exposures of constellations; indeed the all-sky mosaic on *Desktop Universe* by Ottawa's Peter Ceravolo and Doug George is a prime example. Although the photographs can resemble the appearance of the sky, they cannot give the true impact of the view.

Visions of this kind might have remained a dream were it not for the rapid development of enhancements to night vision. To extend our view into the depths of darkness, we use binoculars and telescopes, but these instruments give views of the sky through only a small porthole. They do not provide a mural-like display. The starlight is there, if only our eyes were more sensitive to see it.

On 1985 August 16, I got a visit from Dr. Paul Feldman, then of the Herzberg Institute of Astrophysics. He brought with him a small khaki carrying case. What was inside would transform the dream into reality. In the case was a starlight scope—and I could borrow it for the weekend!

The Scope

A starlight scope amplifies the brightness of a scene. Unlike infrared scopes that "see" by illuminating a scene with long-wavelength light or by the thermal radiation emitted by an object, a starlight scope "sees" by intensifying the faint starlight or moonlight that reflects off objects in the scene, giving a more realistic view than is provided by their infrared counterparts.

Paul's unit had three main parts: a binocular unit with 2.5-cm-diameter objective lenses; the image intensifiers; and the eyepieces. There was also a battery pack about the size of my fist that was connected to the scope through a short power cord. The binocular unit Paul had borrowed was about 10-cm long and 10-cm wide. It was clipped to the brow of a helmet that was worn by the observer. The power pack was attached to the back of the helmet with Velcro pads; together with the binoculars, the unit weighed about a half kilogram.

The objective lenses could be focussed for distance and the eyepieces could be adjusted for the observer's prescription. The binoculars did not magnify the image and the light gain was not adjustable.

Observations

The image through the binoculars had a slight greenish tint due to the phosphor on the imaging screen, and though not bright, it did break down the observer's dark adaptation. Relatively "bright" scenes like the night sky had a fine-grain texture of very small scintillating speckles. The speckles became more obvious when very dark scenes were viewed.

The image intensifier was most sensitive to the red and infrared light. This did not affect its performance for terrestrial use, but it did affect the relative intensity of some stars, making cool red stars looked brighter.

I took the unit out to my cottage near the Rideau Ferry, 80 km south of Ottawa. That weekend, the night sky was very dark and transparent. The view up the lake was stunning. Individual trees three km away were seen quite clearly. A small flashlight pointed at the opposite shore about a half km away illuminated the tree line as if it were a brilliant searchlight. I watched a family of wild mink swimming down the lake and there were several frogs sitting passively along the shore, patiently waiting for a meal. Although the scenes were not bright, there were no deep shadows and wildlife was seen clearly in the trees and under bushes going about its business.

Looking towards the southwest down the lake, the stars of Libra and Ophiuchus stood over the water with the points of light reflected off the placid water. There were many stars in the area where few stars are usually seen.

I set up my telescope in the large field behind my cottage and began a more careful study of the starlight scope's performance. The device worked best when used without any other optical aid. The stellar limiting magnitude was stunning at ninth magnitude. (My unaided eye limit was about sixth magnitude.) When coupled with my 11×80 binoculars, stars were resolved across the centre of globular clusters and small faint clusters were suddenly rich with stars. The use of binoculars, however, increased the grain or speckles in the image. The unit did not work well when coupled to my 8-inch f/5 or 12.5-inch f/4 reflectors. The dramatic increase in image grain washed out any benefits provided by the brighter image.

Under the dark rural skies, my attention was continually attracted to the glowing bands of the Milky Way. With the starlight scope, the number of stars increases many fold. The Milky Way did not get any brighter since the glow is due to the accumulation of individual stars that are too dim to be detected visually, not the nebulosity between the stars. The unit only reduced the lower limit for star visibility. I did not notice any change in the outline of the Milky Way when the starlight scope was used. This observation confirms that the rivers of light we see in the Milky Way are not due to diffuse nebulae.

Many of the bright Messier objects were visible with no more than the starlight intensifier. M57 "appeared" as a fourth magnitude star, and M13, M92, and M5 were very easily seen. Other Messier objects: M11, M30, M2, M15, and M22, were no challenge. The Dumbbell Nebula (M27) however was not detected with any confidence and the Veil Nebula in Cygnus was not seen at all. Perhaps their light was over-powered by the stars that became visible with the image intensifier. The galaxies M31 and M33, in Andromeda and Triangulum respectively, and NGC 253 low in the southeast, were very easy to see. The core of M31 did not dominate the image as it does without the image intensifier.

When the Ring Nebula (M57) was observed through the starlight scope alone and then through my 11×80 binoculars, it appeared as a star. With my 8-inch reflector feeding light into the device at 115×, the Ring appeared brighter than the purely naked-eye view, though the image grain increased dramatically. At that magnification, the background sky in the field of view was very dark even with the image intensifier. This dark background allowed my eyes to become more dark-adapted but the view was awash with twinkling speckles that confused my view of the faint Ring. It seemed to me that the resulting view was worse than what I would see without the unit. The human eye could detect smaller and more subtle detail without this starlight scope.

More stars were seen in M13 with the starlight scope when it was observed through my 8-inch at 115×, though the high level of grain in the image was barely tolerable. The tenth-magnitude galaxy northeast of M13 was brighter, but it also was awash with twinkling speckles that reduced the apparent contrast in the image.

The starlight scope allowed me to see the galaxies M81 and M82 in Ursa Major without my binoculars. I observed the Whirlpool Galaxy in Canes Venatici (M51) through my 11×80 binoculars with and without the image intensifier; there was an improvement with the starlight scope.

I tried to determine the limiting magnitude of stars seen through the starlight scope using the Tirion Atlas 2000 and the Catalogue 2000 as references. To both my delight and dismay, the limiting magnitude using the intensifier was well beyond the Atlas 2000 limit and I had to revert to my old SAO Atlas. Unfortunately, I did not have an SAO catalogue with more detailed colour information. Although I could see stars that were not on the charts, there were some charted stars that were not visible. I assumed most of the dim stars on the charts were plotted correctly. At the limit of the charts, I could see faint red stars but not the dim blue stars. I estimated the limiting magnitude for the starlight scope was about ninth magnitude, and even fainter for red stars.

Some stars on these charts were not where they should be. There may have been errors in the manual plotting of these stars on the SAO chart. Users of these old star charts should be aware of the possibility that some fields are a little amiss.

If keen observers had the long-term use of one of these devices, they could check the positions of dim stars and objects very quickly. If they determined the colour response of their unit, they might be able to check for gross errors in the spectral classification of dim stars—a time-consuming project if spectra must be obtained by objective-prism spectroscopy. Perhaps it could be done more easily by direct observations using image intensifiers.

During the two clear nights that I used the starlight scope, there was no visible aurora. However, since the device was sensitive to red light, I did not think that the appearance of an aurora would be enhanced with the unit.

The last set of observations I will discuss here are rather intriguing. The Earth is continually bombarded by meteoroids, and the number of meteors we can see rapidly increases with fainter limiting magnitude. With the starlight scope, I could see at least eighth-magnitude meteors; even though the field of view was only 45 degrees, I counted at least one meteor per minute, and there were several occasions when I saw three within one second.

I hope these few comments have done justice to my impressions of the starlight scope. The device does enhance the appearance of the night sky, but for detailed examination of deep-sky objects, I would opt for a good telescope at a dark site. The limiting magnitude and spectral response of the unit raised a number of possibilities for unusual observing projects, including variable-star and nova-search programmes, in addition to those mentioned above. All that stands in the way of widespread acceptance of this technology by amateur astronomers and stargazers is the cost—the unit Paul had borrowed cost a little less than $30k.

Photons are free but seeing them can be expensive. ✶

Robert Dick is best known to Journal *readers as the RASC's dark-sky crusader and Chair of the Light-Pollution Abatement Committee.*

The Starmus Experience

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Wow! There is no easy way to summarize the experience of attending Starmus, a conference held this past June 20-24th in Tenerife (Canary Islands, Spain) to celebrate the 50th anniversary of Yuri Gagarin's flight into space, the first for mankind beyond the confines of our little blue planet. Starmus was the vision of astronomer Garik Israelyan, who wanted to celebrate by bringing space exploration, astronomy, art, and music all under one roof for one large event. The result was an amazing five days of talks, presentations, tours, and meals with a group of people from many walks of life, all of whom shared a common interest.

Our attendance to this event was one of perfect timing. Kathryn—as most of the RASC now knows—discovered her first supernova, 2010lt, on 2011 January 2, making her the youngest to make such a find by improving on the record of Caroline Moore, who was 14 at the time of her first. Caroline was the reason Kathryn became interested in the idea of hunting supernovae and wanted to do what Caroline had done. What followed the discovery, however, was an international blitz of media interest in her story that went well beyond anything we could have imagined. It was during this media frenzy that Kathryn's story caught Garik Israelyan's attention. What better way, he thought, than to have his conference opened officially by a youngster who had gained international headlines due to her work in astronomy. With that, Kathryn, along with her parents, received an invitation to attend Starmus on Tenerife! Our first reaction was "how can we make this happen" and then it was simply "how can we not make this happen"? Spain, here we come!

After a 24-hour trip from Halifax, through Toronto and Madrid, to Tenerife, we arrived about 6 o'clock on Sunday evening. The conference was held at the Abama Golf and Spa Resort on the southwest coast of Tenerife—a beautiful facility that was all you could ask for in a vacation spot and with excellent meeting spaces to boot. We were greeted by name and handed a glass of champagne. Our bags were taken to our rooms while we checked in and received a quick tour of the facilities. Not long after, we went for a refreshing evening dip in one of the seven pools and then to sleep, to recover from the long journey and to get rested for the start of the conference on Monday.

Each day, the talks and presentations started after lunch, allowing time for morning tours of the island. Monday was the official opening; the first speaker, IAU President Richard Williams, began the sessions with a talk "Five Key Astronomical Discoveries of the Past 50 Years." Following this, the

Figure 1 — Jill Tarter talking with Kathryn about her supernova discovery and her future in other areas of astronomy such as radio and X-ray, following the VIP dinner. Photo by Paul Gray

organizing committee welcomed everyone, inviting each to give their thoughts on the conference and why we were all there. Among the speakers were Garik Israelyan, Brian May (former member of Queen), Alexei Leonov, and Buzz Aldrin. Then it was Kathryn's turn to take the stage. Garik made the introduction and a round of applause greeted her as she took a seat in Brian May's chair in front of the microphone. Quite comfortably, Kathryn spoke of how excited and honoured she was to be at Starmus, and thanked Garik and the organizers for the invitation. She spoke about how honoured she was to be able to announce that Starmus is now officially open; as she did so, the 400-plus attendees erupted in applause and whistles, while Garik had a huge smile and hug for Kathryn. She did an amazing job for a 10-year-old speaking in front of 400 people, and now she and her parents could relax as her big public event was done. It was something to note the huge change Kathryn has undergone in her ease and comfort in speaking in public and talking to most anyone now after the past six months.

The afternoon was rounded out by amazing talks by our own Leslie Sage (see his column in the 2011 October *Journal*), Jill Tarter (Life in the Universe: Is there anybody out there?), Michelle Mayor, and Buzz Aldrin. Only Day One and already the talks and atmosphere of the event were unbelievable. The underlying theme was quickly becoming one of "how we are on this lonely little planet, that it is all we have," and "we are not going to survive very long as a civilization the way we are going." Jill Tarter summed it up best when she noted that change in how we, the human species, see ourselves, starts with us. Until we stop seeing it as us and them, east and west, we are doomed. Her one request of all attendees was to go home and change their Facebook profile to list themselves as Earthling—we are all Earthlings.

The evening was time for socializing and a VIP dinner held in an outdoor restaurant at a banana plantation. Cocktails were served, leaving time to mingle with many of the key speakers and guests, followed by a five-course meal. The highlight of the night for us was when Jill Tarter came looking for Kathryn and her first words were, "I saw you on *YouTube* and you did a great job!" They carried on a conversation about Kathryn's many interests, including and beyond supernovae hunting. Jill tried to encourage her to consider radio and other non-optical astronomy someday. The night would be the first of many where Kathryn would enjoy a bedtime past midnight! Talks usually went till 7 p.m., so all dinners were quite late.

Tuesday morning, we ventured offsite to pick up a rental car for the rest of the conference and the few days afterward, to do the tourist thing. Before returning for lunch, we stopped at Karting Tenerife, the local track for competitive karting and some fun down time for both Kathryn and Dad. This would be Kathryn's first experience on a real kart, and Dad's on a competition kart. Much fun was had, and by the time we left, Paul was holder of the fastest lap for the day. Back to Abama for lunch where we would eat with other attendees on the patio overlooking the Koi ponds and water garden. Next table over from us were Garik and a few others, with the just-arrived Neil Armstrong.

The afternoon talks began with Jack Szostak (The Origins of Life), Richard Dawkins (Exobiology and Religion), and Kip Thorne (Black Holes: The Most Luminous Objects in the Universe but No Light); all were jaw-dropping lectures that were both captivating and, at times, made your head hurt. Kip Thorne described how scientists are trying to measure gravity waves that result when one of the stars in a system of binary black holes is consumed by the other; ten percent of the mass of the smaller is thrown into space, creating a gravity wave in the process. To detect such waves requires monitoring a pair of orthogonal laser beams on a 4-km baseline, searching for an oscillation that is 1/100th the width of an atom! Later, in the evening, the highlight was a talk by Russian cosmonauts Yari Baturin and Sergei Zhukov.

Tuesday wrapped up late with a bus tour to a Star Party that was held at 2400 m above sea level in the crater of Mount Tiede. This would be the first of a number of trips up the mountain during our time on the island. Several telescopes were set up, and refreshments were offered inside one of the few local buildings within the national park. We enjoyed clear skies that night, and a few of us managed to take a number of images, myself included, with thanks to David Chapman for loaning me his MusicBox EQ tracking device. Kathryn enjoyed the views, though she spent much time speaking to interested attendees about her interests. She was asleep by the time our bus arrived back at Abama, around 1 a.m.

Figure 2 — Although this photo was taken at 12:30 at night, a tired Kathryn does not look it as she gets to pose with Neil Armstrong following the Gala Dinner. ©Max Alexander/Starmus

Whale-watching was first on the agenda for Wednesday, and we joined 16 others on a twin-hulled catamaran built for 50. Our watch-mates were British, Greek, Russian, and Canadian, making for many interesting discussions and friendships during the three-hour cruise. It was a beautiful day to be on the water, and we saw a number of porpoises and a total of three dozen pilot whales in a number of pods. The most interesting pod was sleeping, bringing their heads to the surface to breathe every few minutes, and so we were able to drift along at will in their company.

We returned to Abama in time for lunch, ready for the talks at 3 p.m. that again were a set of speakers no one was going to miss! It began with a lunar trio, Bill Anders (*Apollo 8*), Jim Lovell (*Apollo 8* and *13*), and Charlie Duke (*Apollo 16*). The three spoke one after the other and answered questions together at the end. Bill spoke about the early Apollo missions, while Jim spoke about 11-14 but mostly about the firsthand accounts of *Apollo 13*. Charlie told of the later missions including *Skylab* and *Apollo/Soyuz*. Watching the interaction of the three of them as well as with the other astronauts and cosmonauts was as much entertainment as the talks themselves. Following the break, Brian May gave very sombre talk titled, "What are we doing in space?" This again fit in well with the underlying theme that we are one planet, one race, human among many species, and that we better get our act together.

The evening wrapped up with the Gala Dinner, held on the green outside the lower restaurant on the Abama resort, overlooking the ocean from the cliffs. Cocktails at 8 p.m. started the evening and once again we had the chance to meet many of the attendees and speakers. The highlight for Dad was when Kathryn was introduced to Michel Mayor, Kip Thorne, and Adam Burrows, all of whom had many questions for her about her supernova, from how she found it, to what type it was, and how far away. Adam and Kip each had much to tell her about what would become of her supernova and encouraged her to keep looking. At one point, Kip referred to "talking to his good friend Stephen" just the other day about what occurs on the event horizon of a black hole and Adam made sure that Kathryn knew Kip was talking about Stephen Hawking! An amazing five-course meal with lots of wine, toasts, and speeches ensued, until desert was finally served, just past midnight. By that point, Garik had taken Kathryn and was introducing her to many people at the head tables. The highlight of the night followed, when Kathryn went with a number of others for a photo shoot; she had her photo taken with Neil Armstrong.

Thursday took us up Mount Tiede once again, this time for a tour of the observatories. After climbing the narrow switch-backs to the 2400-m level, we crossed a mountaintop crater through the lava flows and sand dunes, truly another world! The road was narrow and it was amazing to watch tour-bus drivers pass each other with only an inch or two between the side-view mirrors when meeting head-on! The tour included solar observing in H-alpha with a nice refractor set up on a pier, though the quiet sun did not show much, only a couple spots and one prominence. We toured four of the observatory buildings at this location, including the 0.6-m and 1.0-m telescopes, and drove past the SLOOH Telescope. It was late afternoon by the time we arrived back at Abama, missing the talk "Explosive Astrophysics" by supernova guru Adam Burrows. After a very late lunch, we refreshed with a dip in the ocean at the resort's beach—21˚C water! Kathryn and Susan returned to the room for a well-needed nap, while Paul returned to the talks for the 108-Minute Round-Table Discussion. The event was broadcast from the floor of the 10-m telescope on La Palma. Hosted by Leslie Sage, it had a panel made up of most of the keynote speakers of the conference. The 108 minutes was selected to match the duration of Yuri Gagarin's first flight into space.

Friday was the final day and the climax of Starmus. Participants were bused to the MAGMA conference centre in La Playa De Americas—an amazing venue that would also be home to lunch, the afternoon event, "50 years in Space: Poyekhali!" and of course, the VIP dinner and closing concert! The afternoon was an incredible production in a theatre setting that was being taped and broadcast by Spanish television. Speakers for the first-flight segment were Alexei Leonov and Victor Gorbatko. The second segment, the Moon, had Neil Armstrong, Jim Lovell, and Bill Anders. Each would be interviewed by the emcee and then have time to speak freely. Between each speaker, there would be video highlights with music from each of their missions, displayed on three large screens. The atmosphere was simply wonderful. The closing

Figure 3 — Adam Burrows (left) and Kip Thorne (right) always had time to talk to Kathryn during the week and offered much encouragement to continue her search for supernovae. Photo by Paul Gray

came with all the keynote speakers and organizers being called to the stage to receive a thank-you gift. Kathryn stood with Jill Tarter and Brian May; her gift was a die-cast model of the rocket that launched Yuri Gagarin on his first flight, presented to her by Alexei Leonov.

Dinner was the usual remarkable spread of food, drinks, and deserts along with great company from many across the globe. Our table had three Russians, one Scot, one Brit, one Lithuanian, and three Canadians! There was plenty chance to mingle, and Kathryn spent the time talking to many people, even signing some autographs. Photo opportunities abounded, and she made the most of a chance to get one with Adam Burrows and Kip Thorne together.

Following dinner, we returned to the theatre for the Sonic Universe concert featuring Tangerine Dream and special guest Brian May, formerly lead guitarist of the rock group Queen. The show started with Brian joining Tangerine Dream for three or four songs, one that Brian wrote in honor of Yuri Gagarin for the event. Another was a new song that incorporated radio sounds recorded by Garik Israelyan from his studies of stars. The concert highlight for many of those in attendance was a solo encore by Brian May in which he was joined by the drummer to bang out the famous *We Will Rock You!* The excitement in the theatre was off the scale, and long after the concert, many of us felt like we were in space ourselves. What an amazing week!

Since we travelled this far, we decided we should make a bit of a vacation and so stayed a few extra days beyond the conference. With our rental car, we had the freedom to venture out and do what we wanted. Some more let-down time was in order, so a trip to the local Siam Water Park started our day on Saturday. We later elected to escape the heat of the afternoon,

Figure 4 — It seems another world in the crater on Mount Tiede at 2400 m above sea level. The sand dunes make one feel like they are not on Earth. Kathryn is sitting on a larger boulder just right of centre. Photo by Paul Gray

so at lunchtime we headed back up Mount Tiede on our own time, at our own pace to explore the crater, its lava flows, and the sand dunes. This location has been used as a set for a number of films and is truly a location that looks like another planet. The lack of trees and plants, roads, cars, and so on means you have no perception of distance or size within the sand dunes. Kathryn insisted on a walk (hike) to a nearby set of boulders that turned out to be over 500 m away and larger than a house. She was surprised and impressed. We crossed the crater floor onto the lava flows and then to the dry lake bed that, once a year during spring melt, fills with water for four or five days.

On Saturday evening, Paul revisited the mountaintop for the fourth time, this time in the company of new friends, Richard and Lara. At 2400 m, the trio spent two hours observing under amazing conditions while taking a few images. Returning to the parking lot, they were treated to the Milky Way in vivid glory. The Sagittarius star cloud was a bright spot that actually looked a dull yellow. Paul's goal was to get two decent images of the night sky: one of the southern Milky Way region, and one of the Milky Way from the southern horizon to the top of northern Cygnus with an 8-mm fisheye lens.

Our final full day was spent playing tourist in town, shopping, and enjoying our last chance to visit the resort's pools and gardens. As we relaxed, we were able to say goodbye to many of the organizers who were so helpful throughout the week, to Garik, and to the other speakers.

Starmus was truly a trip of a lifetime, one that we will vividly remember for a long time. It is a trip that came much by chance, the random opportunity that began with Kathryn looking for and finding an exploding star that no one else had noticed. It was a chance, in that after three years of not supernova hunting, Dave Lane would once again start to image galaxies, this time not for Paul, but for Kathryn to scrutinize. It was chance that the list of target galaxies Paul sent Dave for those first few runs would happen to be in a part of the sky that was harbouring an unknown supernova, now known as 2010lt. It was also chance that Starmus would happen in the year when Kathryn was old enough to have that interest to search for supernovae.

However our trip to Starmus is also one of Family—a family with a daughter who had taken an interest, even if only a little one, in a field that her father had done before. It is also one of family on a scale of the RASC. Many people in the RASC in

Figure 5 — Scorpius and Sagittarius from Tenerife at just over 2000 m above sea level. Image is a single three-minute exposure taken with a Canon Xsi, 18-55mm lens at F4.6 at 1600 ISO. Tracking was via a MusicBox EQ on loan with thanks to David Chapman.

the New Brunswick and Halifax Centres, along with the Saint John Astronomy Club, supported us, making this trip happen in many ways. The National RASC helped support the trip, which came as a complete surprise to us. To all of those people, to the Saint John Astronomy Club, to the RASC Halifax and New Brunswick Centres, and to the RASC itself, as well as many individuals, we Thank You! We hope this article has provided you some insight into what an amazing event Starmus was and that someday in the near future you can hear more of our stories from Tenerife at a talk somewhere near you! ✶

Paul Gray has been a member of the RASC since 1988 when he joined at the age of 16. He has been known to search for supernova (finding seven) and observe dark patches of nothing (dark nebulae) and is the author of the Dark Nebulae section in the Observer's Handbook. Having been a member of the Halifax and New Brunswick Centres, he is still considered the northern branch of the Delmarva Stargazers from the mid-Atlantic USA where he once lived. Now he enjoys imaging from his dark backyard in New Brunswick.

Kathryn Aurora Gray is almost 11 years old. She has been a member of the RASC for one year. Her interest in astronomy began with attending star parties with her parents, her first when she was only six months old. She enjoys watching meteor showers, looking for constellations, and supernova hunting (she found her first in January 2011), which she says is because of Caroline Moore from the USA, who found a supernova at age 14; as Kathryn said "If she can do it I can do it!"

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.

Hubble and Shapley—Two Early Giants of Observational Cosmology

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Observational cosmology of the first decades of the 20th century was dominated by two giants: Edwin Hubble and Harlow Shapley. Hubble's major contributions were to the study and classification of individual galaxies with large telescopes, whereas Shapley is best remembered for his work on groups and clusters of galaxies using telescopes of more modest aperture.

Harlow Shapley was a gregarious man who liked telling stories, was a fine dinner companion, and obviously enjoyed having lived the American dream. Born on a hay farm in the Ozarks, he ended up as the Director of the Harvard College Observatory. I never met Hubble, but from his biography (Christianson 1995), he sounds like a rather remote character with a pseudo-Oxford accent. Hubble graduated from Oxford in 1913, just as the British Empire reached its apogee and before it started to bleed to death during the Great War. In his autobiography Shapley (1969, p. 57) writes, "Hubble just didn't like people. He didn't associate with them, didn't care to work with them." Hubble had a sharp legal mind, which he applied with great success to the problems of observational cosmology. A friend of Hubble's once wrote, "After scoring a debating point, he would light his pipe, flip the match into the air so that it described a circle, and catch it, still burning as it came down." Like a good lawyer, he was able to use observations to present particularly convincing arguments. Good examples are Hubble (1936, p. 118), where he simultaneously plots the images of galaxies and their spectra to illustrate the velocity-distance relationship, and the "tuning fork" diagram (Hubble 1936, p. 45) that beautifully illustrates the transition from elliptical through S0 to spiral morphologies. He did this in such a convincing way that it was not noticed for half a century that S0 galaxies are typically only half as luminous as E and Sa galaxies, thus providing strong evidence against his speculative hypothesis that lenticular galaxies constitute an intermediate evolutionary stage between elliptical and spiral galaxies. Although we now associate Hubble's name with the tuning-fork diagram, Block & Freeman (2008) have shown quite convincingly that these ideas actually originated with J.H. Reynolds and others.

Edwin Hubble (1889-1953) and Harlow Shapley (1885-1972) were both born in Missouri and recognized as rising stars by George Ellery Hale, who hired them to work at the Mt. Wilson Observatory. Hubble remained there for his entire career, while Shapley left for Harvard in 1921. According to Christianson (1995, p.149) "Hubble was privately anxious for Shapley to go. He was not accustomed to standing in anyone else's shadow, especially one whose conduct he considered obnoxious and whose ambitions matched his own." For his outstanding work, Shapley was awarded the RAS Gold Medal in 1934, Hubble received this same medal in 1940. Later Hubble was awarded the Bruce Gold Medal of the ASP in 1938; Shapley received that award in the following year.

Both men will primarily go down in history for a single great discovery. Shapley (1918) is remembered for using the distribution of galactic globular clusters to show that the centre of our Milky Way system is located far from the Sun in the direction of Sagittarius. The importance of this transition from a heliocentric to a galactocentric paradigm was comparable to the change from a geocentric to a heliocentric Universe proposed by Copernicus in 1543. Shapley (1969, p. 60) himself regarded this discovery that the Sun (and hence mankind) was peripheral, rather than central, as one of the most important thoughts that he had ever had. Hubble's name will forever be associated with the discovery in 1923 of Cepheid variables in the great Andromeda nebula, which resolved the longstanding debate about the nature of spiral galaxies. Here, there is also a link to Shapley (1914), who had previously hatched the hypothesis that Cepheids were pulsating variables, rather than binaries, as had previously been thought.

The careers of these two scientists diverged with Hubble's main contributions involving the classification and distance determination of individual galaxies using the world's largest telescopes. On the other hand, Shapley is perhaps best remembered for his work on the distribution and clustering of galaxies, which he studied with wide-field telescopes of relatively modest aperture. Hubble's longest (but perhaps least influential) paper concerned the large-scale distribution of galaxies over the sky. From deep studies of over 1000 small fields thinly distributed over the sky north of declination -30°, Hubble (1934) found that (1) absorption by dust causes a deficit of galaxies at low galactic latitudes and (2) the distribution of galaxies on very large scales is homogeneous, *i.e.* there is no indication of a super system of nebulae. Perhaps his deepest insight (Hubble 1936, p. 82) into the nature of galaxy clustering is contained in the statement that "The groups (such as the Local Group) are aggregations drawn from the general field, and are not additional colonies superposed on the field." Hubble (1936, p. 77) also adds that "Pending definite information, it is supposed that the frequency diminishes as the population increases, over the whole range of groups and loose clusters to the great clusters themselves."

Because Hubble's survey sampled only widely distributed very small fields, it was not suitable for the study of the large-scale distribution of distant clusters of galaxies. Nor could Hubble's sparsely sampled data provide much information on the structure and distribution of chains and clusters of galaxies across the heavens. On the other hand, Shapley's wide-field and all-sky surveys were particularly well suited to the study of galaxy clusters and their distribution. Perhaps Shapley's greatest contribution to astronomy was the Shapley-Ames (Shapley & Ames 1932a,b) catalogue of the brightest galaxies in the sky, which was mainly based on observations with small, wide-field telescopes. On the other hand, Hubble is probably best remembered for his classification system for galaxies and for determining the distances to the nearest galaxies using the Mt Wilson 100-in. telescope.

Plots of the projected distribution of galaxies in the Shapley-Ames catalogue over the sky provided three profound new insights: (1) There is no concentration of galaxies towards our own Milky Way system, (2) galaxies are distributed in a very clumpy fashion with major flattened clusterings, such as the Virgo super cluster, and (3) Shapley & Ames (1932a) discovered "high latitude vacancies"—structures that are nowadays referred to as "voids." Regarding the discovery of such voids, Shapley & Ames (1932b) write: "The vacancies [in the distribution of galaxies] are important. They are not due to the insufficiency of the survey, for over the whole sky the search has been thorough and the plates adequate. Nor are the barren regions, such as that at $\lambda = 20^{\circ}$, $b = +50^{\circ}$, the result of heavy obscuration, as in low latitudes, since nebulae fainter than the thirteenth magnitude appear in average abundance in these high latitude regions." Shapley (1930) was also able to show that clusters of galaxies are not distributed at random, but are concentrated in super clusters. The greatest of these super clusters in nearby regions of the Universe is the so-called Shapley Concentration (1930) [see Proust *et al*. (2006)]. An intrinsic limitation on Shapley's studies of the large-scale structure of the Universe was that his data only provided two-dimensional mapping of the distribution of clusters over the sky. The first tentative steps towards study of their three-dimensional distribution were based on the studies of the radial velocities of large numbers of galaxies at intermediate distances by Gregory & Thomson (1978) and Joeveer *et al*. (1978). Our present understanding of the nature of the large-scale distribution of galaxies resulted from the large and homogeneous three-dimensional mapping by de Lapparent *et al*. (1986). This work revealed that galaxies are distributed throughout the Universe in enormous frothy bubbles and chain-like structures. The properties of dark-matter particles determine the structure of this cosmic web.

Finally, it is of interest to note that Hubble's galaxy classification system excluded both the most luminous galaxies (quasars) and the most numerous objects—dim spheroidal galaxies. The first of these dwarf spheroidals, the Sculptor and Fornax systems, were discovered by Shapley (1938).

In Hubble's obituary, Humason (1954) wrote: "He was sure of himself—of what to do, and how to do it." On the other hand, Shapley's (1969) motto seems to have been "I always worry." They were clearly very different men.

I am indebted to David Block, Bonnie Bullock, Brenda Parrish, and Virginia Trimble for their kind help. ✶

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A Vintage Star Atlas

by Ken Backer, Mississauga Centre
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Recently, some friends from out of town dropped by for the day and presented me with a gift they purchased from a used bookstore. The book was titled *A New Star Atlas* by R.A. Proctor, B.A., F.R.A.S. This seventh edition of the Atlas was published in 1914 by Longmans, Green, and Company of London, but the first edition came out in 1880. From the preface, I gleaned that the maps are essentially unchanged from the first edition. I had a collection of 12 star charts from 1880, how cool is that!

Figure 1 — A New Star Atlas

Inside the cover, written in pen, is a name I believe to be the previous owner of the atlas–Geoffrey W. Bell—with the date July 1921 (has anyone heard of Geoffrey W. Bell?). For that matter is anyone familiar R.A. Proctor, the author? The inside page states he is the author of other books, such as *Saturn and its System, The Sun, and The Moon.*

Later, after our friends had been fed, watered, and sent on their way, I started to peruse my gift. This vintage atlas contains 12 star charts covering both the Northern and Southern Hemispheres. Each chart (Figure 2) is a numbered sphere that covers two pages with indications where one chart should join another (in between each chart is a blank white page; this must be for cloudy nights). There appears to be no declination or ascension markings, only degree numbers and Roman numerals around the circle. Arrows are present to show precession. The author states that his atlas should be relatively accurate until 1927.

There are two keys or legends on each map. One shows star magnitudes, with a separate symbol for nebulae; the other is

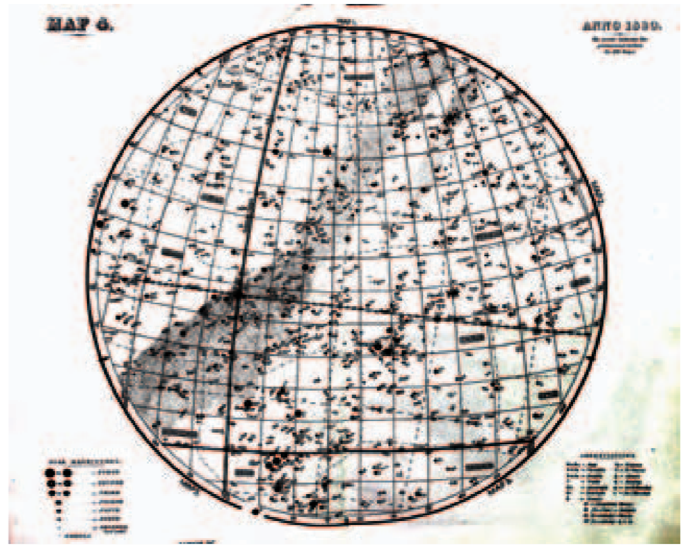


Figure 2 — A sample chart from A New Star Atlas

abbreviations used in the charts. Interestingly, the symbol for a second-magnitude star is a white Saturn with rings inside a black circle. There are no symbols for galaxies of course (Edwin Hubble had yet to make his discoveries), or for globular clusters, open clusters, and all the other heavenly objects we are familiar with on modern star charts. They are all labelled nebulae.

The abbreviation key had letters for red, variable, and five classifications of double stars—double, triple, quadruple, quintuple, and suspected. And, there are symbols for whose classification it is—Piazzi, Struve, Dunlop, Herschel, and Messier. All Messier objects are classified as nebulae. Apparently, previous editions had Flamsteed numbers but had been dropped for this edition.

Admittedly, I had trouble following these charts even when looking at well-known features like those in Orion. But, I would probably have difficulty reading a book in old English as well, until I became familiar with how it flowed. Going through this atlas in the age of computerized scopes felt like describing a hand-crank telephone to somebody over a Blackberry.

I sat back and tried to imagine myself in the early 1900s, using this atlas to guide myself around the stars while observing through my...my what? I have no idea what type of telescope an amateur astronomer would be using back then. My mind envisioned a lovely hand-made brass affair sitting on a solid wooden tripod, but I don't know the accuracy of my imaginings. In an era when many new astronomers probably can't read a modern sky chart, thanks to GoTo scopes, this is a real relic from the past—and a welcome addition to my astronomy library. ✶

Ken Backer is a member of the Mississauga Centre and bows his head in prayer for clear skies at his home in Milton, Ontario.

Night-Sky Poetry from Jasper Students

by Mary Lou Whitehorne,
President, RASC

Jasper National Park held its official Dark-Sky Preserve (DSP) declaration event on 1 October 2011, at the historic Maligne Lake Chalet. As RASC president, I had the pleasure and honour of attending and participating in this event. I was hosted by Tourism Jasper, and delivered a short talk about the RASC: what it is, what it does, why its work is important, and concluded with a few words about the tremendous value and impact of our partnership with Parks Canada through the common goal of preserving the night environment. It was a wonderful afternoon and evening! Jasper National Park and the Town of Jasper are delighted to be part of this DSP partnership with the RASC.

A local teacher, Paulette Blanchette Dube, was aware of Jasper's upcoming DSP celebrations. She challenged her students to a competition to write poetry about the night sky and what it means to them. Two of the three winning middle-school students attended the VIP event and read their poetry to the audience. It was very well received by the crowd.

I am happy to present to JRASC readers the winning poetry of three young sky-watchers from Jasper Junior/Senior High School: Tannin Standing, Donal Beauchamp, and Justin Saat. I know you will enjoy it! ✶

Figure 1 — The invitation to the launch of the Jasper Dark-Sky Preserve inauguration.

Bright liquid colours
Poured across the empty dark
Stars freckle the night

– Tannin Standing, Grade 9

La nuit est le seule temps que
je peux être en silence.
Je regarde aux étoiles et je pense
De mes temps préférés
Avec mes amis, ma famille
Mon père, ma mère. Pour moi la
nuit est le plus beau
Temps de la journée. La nuit
Est quand tu es relaxé.
C'est une partie de la journée
Avec les étoiles et
Les Aurores Boréales.
La nuit est le temps tout
Le monde et en paix.

– Donal Beauchamp, Grade 8

Spirit in the sky
Over the ocean glowing
Fly high in the sky

A crescent shaped light
It sparkles like a diamond
Shooting in the night

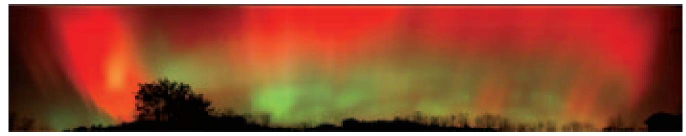
– Justin Saat, Grade 7

Figure 2 — Maligne Lake.

Figure 3 — Maligne Lake Chalet.

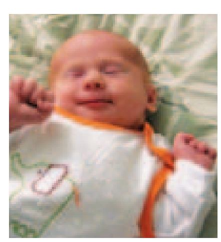
Great Images

by Dave McCarter, London Centre
(dmccarter@sympatico.ca)



Above, is a single frame image from a panorama shot (full image, top right), showing the western end of the auroral arc. When this was taken the aurora extended from the west-southwest to the east, over 180 degrees, with some red emission high overhead and beyond the zenith. Dave McCarter used a Nikon D70s with an 18 to 70mm zoom lens set at 18mm and f3.5. The exposure time was 15 seconds at ISO 1600. The panorama was made up of five overlapping images taken immediately one after the other, a span of just about a minute and a half. I took 333 separate images that evening, some showing just a hint of green aurora, while others were full of colour. What a great display! View it larger here: www.astro.uwo.ca/~rasc/images/Aurora24Oct2011mid

Birth Announcement



Shayna Brynn Davis was born on 2011 October 13 to Winnipeg Centre member Naomi A. Davis. Both mother and daughter are doing well.

On a special note, baby Shayna was included as an associate member on Naomi's membership renewal. As of 2011 October 31, and at 18 days of age, Shayna holds the distinction of being the youngest ever member of the RASC.

Congratulations and best wishes go out to Naomi and a great big WELCOME to Shayna!!

Personal wishes can be sent to naomiad@shaw.ca ✶

Figure 1 — Ron Berard caught Winnipeg Centre member Cliff Levi enjoying the views through his 18-inch Obsession Telescope during a recent auroral display at the Ste. Rita dark site used by local RASC members. The panorama was composed of three exposures, each 30 seconds at ISO 1000. Ron used a Nikon D90 with a Nikkor 20-mm lens at f/5.6. Cliff was illuminated by a red LED head lamp.

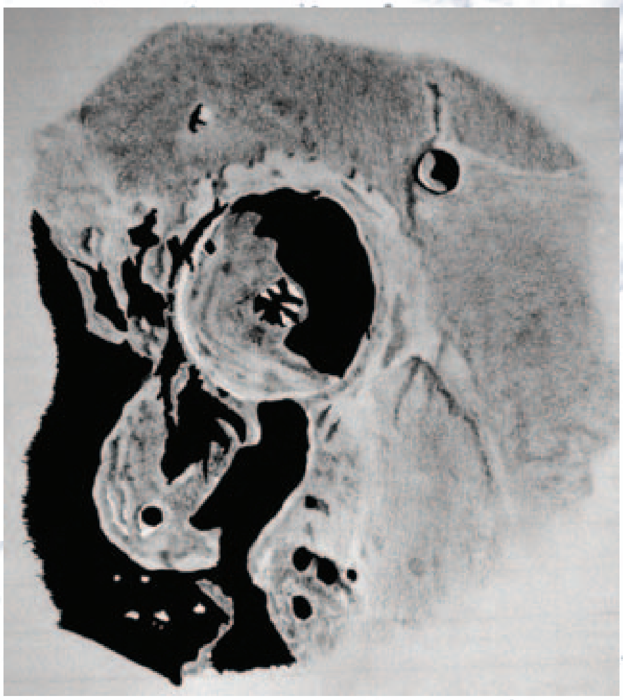
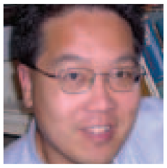


Figure 4 — The Winnipeg Centre's Gerry Smerchanski took pencil to paper to provide this drawing of the craters Cyrillus, Theophilus, and Madler (left to right) along the lunar terminator. The image was one of the finalists in the lunar and planetary category at the GA2011 photo contest.

Figure 3 — Dr. Howard Trottier took this image of NGC 4565 from his "Cabin in the Sky" Observatory under very dark skies in the South Okanagan Valley in April. He used a PlaneWave CDK17 telescope at f/4.5 equipped with an SBIG STL-4020M camera. Exposure was 6 hours in LRGB wavelengths over a three-day period. NGC 4565 is an edge-on galaxy that lies at a distance of 30-50 million light-years in Coma Berenices.

Cosmic Contemplations

How to Image Like the Pros for Under $1000



by Jim Chung, Toronto Centre
(jim_chung@sunshine.net)

From time to time, amateur astronomers experience an affliction known as aperture fever. This is not a uniquely North American phenomenon, where bigger is automatically better. As telescopes go, bigger is generally better, although it may not be practically better. Astroimagers suffer a further malady known as sensor fever, where they wish they had a bigger and more sensitive CCD sensor so as to make the most of their limited imaging time.

I do a lot of narrowband imaging from my light-infested Toronto backyard, because I don't have many opportunities to get away. Neil Fleming has made a name for himself specializing in narrowband imaging from his suburban Boston residence and his instrument of choice is the SBIG (Santa Barbara Instrument Group) STL6303E CCD. It has the APS-sized Kodak KAF6303E sensor with large 9-μm pixels and a quantum efficiency of 68 percent at the $H\alpha$ wavelength. It doesn't get much better than this combination of size and sensitivity. FLI (Finger Lakes Instrumentation) and Apogee also makes a camera with this sensor and they all sell in the $8k range.

So, when a number of KAF6303E-sensored cameras made by a microscopy imaging company called Photometrics became available on eBay for $499 apiece this past summer, a number of us jumped at the opportunity. The Quantix 6303E is an air- or liquid-cooled laboratory-grade camera with a proprietary PCI interface card and SCSI cabling. A biotechnology company had purchased approximately 250 units at $25k each in 2005 and decided to liquidate the hardware, as they deemed it too slow for their purposes. They were conducting rapid large-scale bioassays using porous micrometre-sized encoded-silicon particles that, when bonded to DNA or a protein, would alter the spectral reflectivity of the particles. Thousands of these particles would line the surface of a microscope slide, each one with distinct position; the slides would be mechanized and scanned at high speed with the camera system.

Figure 1 — Stages in the disassembly and reconstruction of the Quantix "astronomy-enabled" camera.

However, for our astrophotography use, it wasn't quite that simple. A number of modifications would have to be performed before the cameras could be adapted for recording the sky.

I don't have a permanent observatory, so I was averse to using a desktop computer to host the camera, given its rather restrictive PCI interface. Fortunately, Dell and IBM make docking stations for some of their laptops that come with a PCI interface slot and I picked up a six-year-old ThinkPad T30 and a docking station locally for only $60.

The KAF6303E sensor is a full-frame sensor as opposed to the interline-transfer sensor found in many Sony designs. The interline sensors dedicate a portion of each pixel to store the charge so that a shutter is not required to allow the accumulated charge to be downloaded. This reduces the well depth and sensitivity of each pixel. The full-frame sensor requires a shutter to stop the light signal, otherwise the last pixels to be downloaded in the sequential process would continue to collect charge, resulting in ghosting or blurring artifacts. The Quantix camera had an electronic shutter option, so there were jumper terminals on the motherboard that provided a 24-VDC signal that could be used to drive it. An appropriately sized shutter was found on eBay for $50. Some custom machining was required to make aluminum housing for the shutter and to provide T-threads to attach a 2-inch telescope nosepiece; the cost was about $250. Free software was provided with the camera, but *Maxim DL*, familiar to many readers, also speaks the PVCAM protocol used by this camera.

Did it work? Only too well. During the peak of summer heat when nights stayed above 20°C, the very effective TEC kept temperatures at –30°C, though the unit is set up for liquid cooling if necessary. The very large field of view required the use of a field flattener in order to keep stars in the periphery round. The results can be seen in Figure 3.

The other astro highlight of my summer was giving a talk and star party to a group of teenage campers at Camp P'Skapkiidaa on Manitoulin Island. Allow me to indulge in some creative travelogue writing.

It was an inauspicious start, as I found myself gridlocked on the 401 while commuters slowed down to view the spectacle of a large furniture-laden truck that had careened over concrete

Figure 2 — The camera installed on the telescope.

barriers and overturned on the embankment. This was 6 o'clock in the morning of the hottest day in history for Toronto (40°C), and I was driving my vintage car with no AC. With the windows down and my protruding elbow deflecting airflow onto my face, it wasn't bad at all as long as I kept moving down the road. Actually, better than having a convertible, because I didn't have to worry about the nonexistent melanoma on my nonexistent bald spot. It took three hours and a nauseating succession of small-town traffic lights to get to Tobermory where I caught the Chi-cheemaun car ferry to Manitoulin Island. The ship's third mate informed us that the ship's name is Ojibwa for "Big Canoe" as he handed each of us a life jacket and a paddle to help propel it past its 12-knot top speed. That's OK, I was on holiday, so I spent the next two hours eating and watching back episodes of Combat Hospital. I fondly reminisced that I haven't been on a car ferry for over 10 years. I was ravenous with hunger, so it took me a while to notice that each table has a discreetly placed crisp white paper bag; my hunger suddenly ebbed. I later decided that despite its appearance, it was not a motion sickness bag but the thoughtful means to take leftovers away.

The car was a hit with the walk-on passengers who were observing the loading process. Amid a sea of derivatively styled modern cars with their high waistlines and short overhangs, the sensually petite RX7 evoked the romance of the 1960s, until one guy hollered "Nice Trans Am!" A more knowledgeable middle-aged couple asked me what year my Mazda RX7 was, and when I responded that it was an '85, the wife just gushed about the car's beauty. It was popular with little boys as well: I overheard a pair of brothers say they liked that car, as they pointed to me while I unloaded onto the island.

This was my second time on the island. Years ago, I scouted out a practice in the town of Gore Bay, but that was in the middle of winter, and I flew in on a Twin Otter, the most unpleasant flight of my life. Even more unpleasant than flying to Cuba on a Tupolev 134, because at least I beat the odds on that one!

At the camp, there were professors and grad students giving the kids hands-on experience and some insight on the interesting career opportunities out there. I started with the basics, which also included mind-boggling concepts like space-time, time dilation, and dark matter, which they seem to accept matter of factly. I took breaks to show some of my relevant astroimages and weave in stories about Einstein's struggle to find a job, and his later pivotal letter to Roosevelt, Galileo's troubles with the Vatican, Canada's proud aerospace heritage, the James Webb telescope's birthing pains, and Nazi rocket scientists. I seemed to hold the kids interest for over an hour, and they asked plenty of questions. When I showed them the famous 2004 *Hubble* Ultra-Deep Field image containing over 10,000 galaxies stretching nearly to the beginning of the Universe some 13 billion light-years away, I told them that science doesn't have a problem with the existence of God, and that there must be other life out there. The kids asked:

"Are there monsters out there?"

"Ahh, I think that anything we don't understand or know about ends up being called a monster."

"Are the aliens friendly?"

"Good question, well the Spanish were not that friendly to the Natives. Just because someone has advanced technology it doesn't mean that they'll be kind."

"Yeah that's just like Battle Los Angeles!"

"Are there aliens in Alaska?"

"You got me! I have no idea if there are and why they would be in Alaska."

"Well because I saw it in a movie called The Fourth Kind."

"Ahhh, I see."

By 10 p.m., it was dark enough to set up my 4-inch refractor. I had liberally presaturated a pair of jeans and a long-sleeve rugby jersey with DEET, but the mosquitoes still came. If you shone a light, you could see the hungry hordes descend in clouds! We had a ring of mosquito coils around the scope and I had a Thermacell device running on the scope's tripod tray. I got bitten, but I could live with a half-dozen bites if I was spared several hundred, though they had to get me on the forehead and on my scalp, and then I felt like Quasimodo. It took quite a bit of time to parade over 30 kids through the one scope, and I warned them to be in for a bit of a visual letdown.

Figure 3 — NGC 281, the Pac-Man Nebula, after 12 hours of exposure (4 hours of Hα & OIII, each with 10-minute sub-exposures, and Hα mapped to red, with OIII mapped to both blue and green channels) with the Quantix camera on an f/5 Astrophysics Traveller.

We looked at M57, M27, M13, and M31. They wanted to see a planet and I told them that they could see Jupiter if they stayed up past 3 a.m. The 20-something counsellors stared at me aghast; they were bone weary and wanted to get the kids to bed! As I was putting my gear away, I was horrified to see over 200 dead mosquitoes lining the bottom of my tripod tray. They had apparently flown right into the heating element of my Thermacell unit in an act of self-immolation.

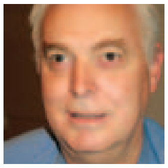
So, I slept in a tent for the first time in my life. They gave me a very nice tent with a cot and night table and LED lamp, and when it was zipped up, I was impervious to the mosquitoes. I slept very well and awoke at dawn to a refreshing, chilling breeze coming off Lake Huron. The first ferry was at 9 a.m., three hours away. Then another two-hour ride, to be followed by a boring three-hour drive. I calculated that, if I crossed the bridge at the northern part of the island and drove the long way around Georgian Bay through Sudbury and Parry Sound, I could be home by lunch.

It was a fantastic twisty drive through the rocky Canadian Shield, and I was able to keep the windows up for the first couple of hours. The turbo fed greedily on the dense cold morning air, as I passed slower traffic, urged on by my GPS, which continually updates my ETA. It was the worst temptress; if I could shave an entire hour off the projected six-hour trip, I could be home by 11! The car was really hitting its stride, as the long drive had gotten all the mechanicals properly lubricated and loose. I had gotten over the disconcerting centre free play in the steering, the wooden-feeling brake pedal, and the stunning lack of low-end torque. I learned to trust the wonderfully accurate tracking of the chassis and its nimble responsiveness and made sure that I geared down enough to keep the revs above 5000 during passing. At that sweet spot, the boost and engine responded immediately, and we zoomed past the offending (or is that unoffending) slow-poke with a shriek of exhaust followed by a resounding induction baritone as I geared up into 4th and then 5th and back into my lane at 140 kph (oops that was an indicated 140, the GPS says it was really 153 kph). The RX7 was more satisfying as a GT rather than as an out-and-out sports car. One had to work too hard to keep the engine on song, but if you kept it in 5th, you almost never had to get off the gas or reach for the brakes, because the car is so light, the handling so confident, and the miles fly by. I was home by 11:30. ✶

Jim Chung has degrees in biochemistry and dentistry and has developed a particular interest for astroimaging over the past four years. He is also an avid rider and restorer of vintage motorcycles, which conveniently parlayed into ATM projects, such as giving his Skywatcher collapsible Dobsonian a full Meade Autostar GOTO capability. His dream is to spend a month imaging in New Mexico away from the demands of work and family. Presumably he will get there in the Mazda.

On Another Wavelength

Open Clusters and Nebulous Regions in Auriga



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

If you have been searching the skies for something a little bit different, try the northern constellation Auriga. It has an interesting variety of sights, with many open clusters and nebulous regions simply because the Milky Way runs through it. Throughout antiquity, the stars in this constellation were associated with a charioteer, although many today describe it as the shape of a pentagon or house. It is one of the 48 constellations listed by Ptolemy, and is well known among the 88 modern constellations.

In Figure1, note the location of the nebula IC 405 and the open clusters known as M36, M37, and M38; the three clusters are south of the bright star Capella. M36 is a cluster of approximately 60 stars with an angular width of 12 arcminutes. M37 is the richest cluster in the constellation, containing over 500 stars spread across 20 arcminutes and is the brightest of the three with an apparent magnitude +5.6. M38 has approximately 100 stars and is the dimmest of the three at magnitude +6.4. All three of these clusters, which are over 4000 light-years away, can be seen with a small telescope.

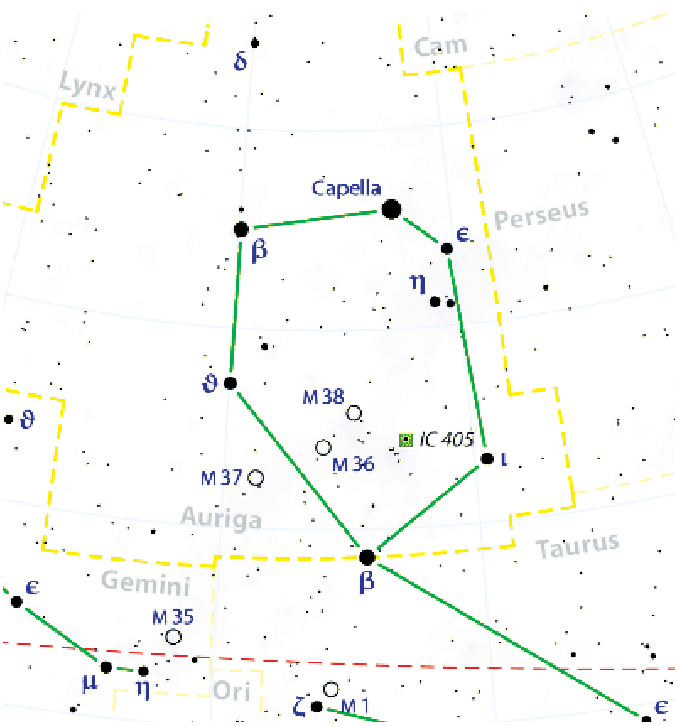


Figure 1 — A map of the constellation Auriga.

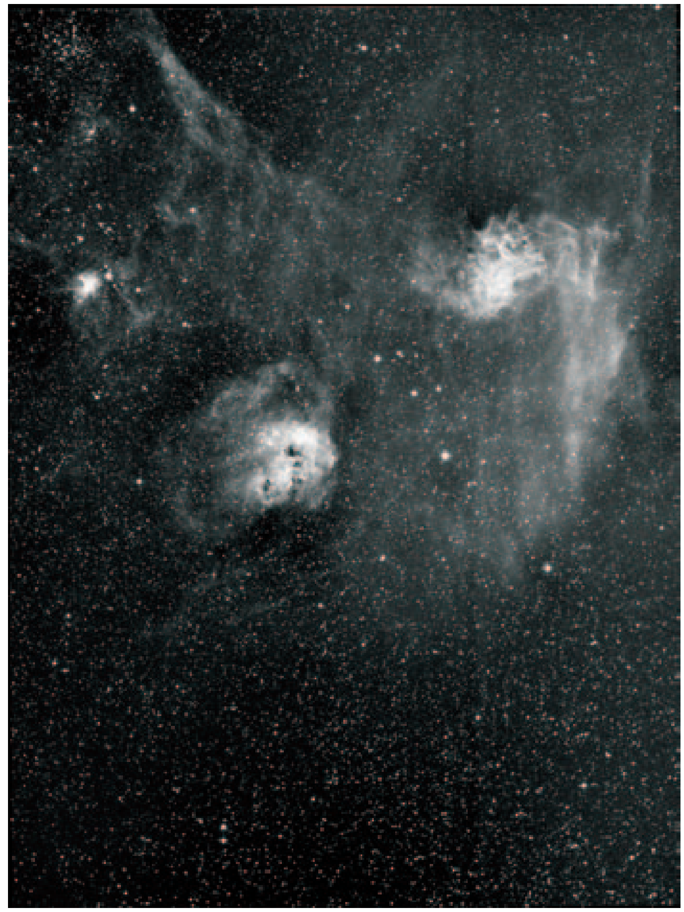


Figure 2 — Wide-field image in Auriga, courtesy of Steve Holmes, K-W Centre.

Capella (α Aur) is the brightest star in Auriga and the sixth-brightest star in the night sky. It is often described as a bright yellow giant, and lies about 45 light-years away. To the naked eye, Capella appears to be a single star, but is in fact a system of four stars in two binary pairs. The brightest pair consists of large, yellowish G-type giant stars with similar masses (approximately 2.6 $M_{\odot}$) in close orbit around each other. The other pair (often called "the kids") are small, faint, red dwarfs.

For over a hundred years, Epsilon Aurigae (ε Aur), a highly luminous F0 supergiant (absolute magnitude -8), has been one of the most observed and controversial of all the stars. Epsilon Aurigae, also known as Almaaz, is an eclipsing binary system with the longest known orbital period—27.1 years. Even more interesting than the orbital period is the duration of the eclipse—almost two years; it was last observed between 2009 and 2011. Since the non-visible eclipsing object has never been observed, astronomers a few years ago thought it might be a black hole, but now believe it is a large (10–12 solar mass), cool, opaque disk that emits practically no light. The question is, what type of object could eclipse the bright central star Epsilon Aurigae for such a long time? Furthermore, how could an object so massive be so dim? The most recent observations seem to have supplied the answer—the star is being occulted by a massive opaque dust ring.

In the wide-field image (Figure 2), you can see IC 405 on the right, IC 410 in the middle, and IC 417 on the left side. IC 405, also known as the Flaming Star Nebula, is a combined emission and reflection nebula approximately 1500 light-years away that surrounds the hot, blue star AE Aurigae. The wave-like dust and gas lanes give the Flaming Star Nebula its name. Hot blue stars such as AE Aurigae photoionize the surrounding gas, causing it to emit characteristic Hα light, while, at the same time, the dust reflects blue light from the star. As an interesting aside, AE Aurigae is believed to be a runaway star from the constellation Orion. Runaway stars typically have very high velocity that may have been caused by an earlier nearby supernova explosion.

The open cluster NGC 1893 is embedded in the nebula IC 410, a cloud of glowing hydrogen gas over 100 light-years across. By zooming in the image, you may observe a couple of dense streams of gas that appear to be trailing away from the nebula. These streamers, which are about 10 light-years long, resemble tadpoles, hence the common name for IC 410: the Tadpole Nebula. The tails of these tadpoles are a result of the radiation pressure and solar wind from the stars of NGC 1893.

IC 417, also referred to as the Spider Nebula, is another emission and reflection nebula complex that is ionized by an open cluster called Stock 8. The bright star a bit to the right of the nebula is Phi Aurigae (ϕ Aur), an orange K-type giant with an apparent magnitude of +5.08.

All in all, Auriga, with its open clusters and nebulous regions, is a very interesting constellation to visit. ✶

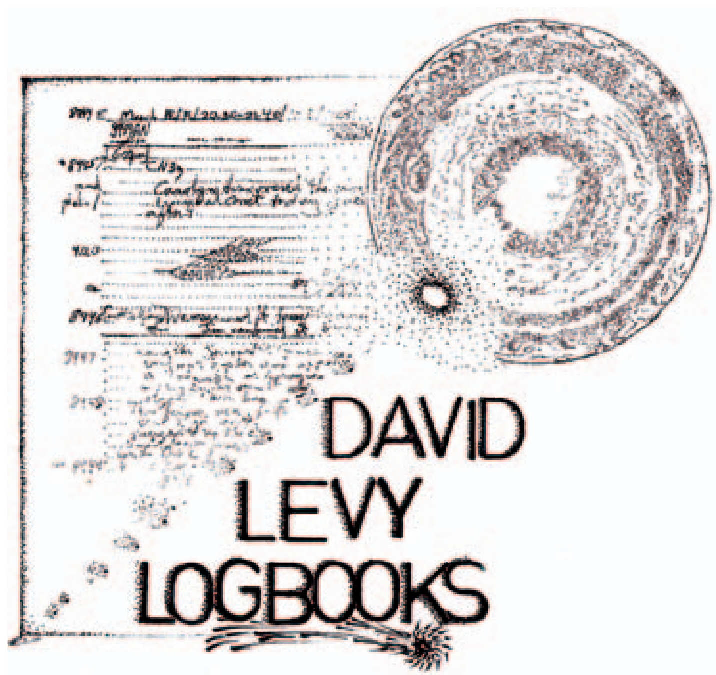
Dave Garner teaches astronomy at Conestoga College in Kitchener, Ontario and is a Past President of the K-W Centre of the RASC. He enjoys observing both deep-sky and Solar System objects and especially trying to understand their inner workings.

David Levy and his Observing Logs

by Roy Bishop, Halifax Centre (rlb@eastlink.ca)

In a characteristic act of generosity, Dr. David Levy has donated a digital facsimile of his complete personal observational archive to the RASC, to be made available to all those interested in astronomy and Dr. Levy's stellar career and achievements. A feature of the new RASC Web site will be the project's portal, featuring digital facsimiles of either individual pages for online study, or PDFs of entire logbooks for download, along with introductory resources. Dr. Roy Bishop, a longtime personal friend and mentor of Dr. Levy's, introduces this rich resource, and the RASC Archivist, R.A. Rosenfeld, places Dr. Levy's logbooks in historical context. Dr. Levy's intention is to make this resource freely available to amateur astronomers, historians of astronomy and science, and others everywhere for fair, non-commercial use. All images remain copyright Jarnac Observatory and David and Wendee Levy. For any other enquiries please contact levylogbooks@rasc.ca.

The RASC is honoured to be able to make this valuable resource available to the worldwide community. The David Levy Logbooks project is scheduled for official launch with the unveiling of the new RASC Web site. The David Levy Logbooks archive is a joint project of Jarnac Observatory (David and Wendee Levy, and Nanette Vigil) and the RASC through its History Committee (Dr. Roy Bishop and RASC Archivist R.A. Rosenfeld, with the cooperation of the RASC Webmaster, Walter MacDonald).



David Levy is the most remarkable amateur astronomer of the modern era, ever since it became possible to categorize astronomers as either amateurs or professionals in the mid-19th century. As the discoverer or co-discoverer of 23 comets, Levy's name is firmly embedded in the history of astronomy. As an author and as a public speaker, Levy is outstanding. He is also the first person to be involved in the discovery of comets by three techniques: visually (9), photographically (13), and electronically (1).

David Levy is an amateur in the best sense of that word—he pursues astronomy for the sheer love of it and shares his passion for the stars with all those he encounters. There are many others who do the same. What sets Levy apart is his dedication and talent for both astronomical discovery and communication. As the discoverer of a multitude of comets,

Figure 1 — Bishop with David Levy and his mother, Edith Levy at Acadia University on 1995 May 8, when David received an honorary Doctor of Science degree from his first alma mater. *(Photo by Linda Cann, Acadia University)*

as the author of many books, and as the spellbinding speaker at hundreds of public presentations involving audiences ranging from children to professional astronomers, Levy is unique. Moreover, it was his enthusiasm for observing, together with his participation in the research programme of Eugene and Carolyn Shoemaker, that resulted in the discovery at Palomar of Comet Shoemaker-Levy 9 in 1993. A year later that comet impacted Jupiter, one of the most dramatic and widely observed astronomical events in the history of astronomy. That comet, usually referred to as SL-9, also impacted David Levy. His adept handling of the resulting avalanche of publicity made him the most widely known amateur astronomer on our planet. Levy's participation in the Shoemakers' *Palomar Asteroid and Comet Survey* had begun four years earlier, in 1989, and lasted until that programme ended in 1996.

I first met David Levy in the autumn of 1969 when he was an undergraduate student at Acadia University in Nova Scotia, and I was on the faculty. Even then, we shared time with telescopes under the stars. Our paths have crossed many times since. A quarter of a century later, in the spring of 1995, I had the privilege of presenting him for an honorary degree at his *alma mater.* Two years after that, I introduced David and the Shoemakers when, at Acadia, they gave their last joint public presentation. My feelings about David Levy perhaps have been best summarized by the writer Timothy Ferris in the citation he prepared when Levy was awarded the 1993 Amateur Achievement Award of the Astronomical Society of the Pacific (one of many awards for which Levy was chosen *before* the discovery of SL-9). Ferris wrote: "Those who have had the pleasure of hearing Levy speak come away impressed not only by his command of astronomy but by his human qualities: warm-hearted, eloquent, generous, and fundamentally decent, he is one of the nicest guys you could hope to meet."

David and his wife, Wendee, live in Vail, Arizona. Nevertheless, The Royal Astronomical Society of Canada is honoured to call David Levy one of its own. Levy was born in Montreal in 1948, has been a member of the RASC Montreal Centre for nearly half a century, and currently is the Honorary President of both the Montreal and Kingston Centres of the Society. In 1980, at its annual meeting in Halifax, the RASC awarded him the Society's Chant Medal for his work on variable stars and for promoting astronomy for children, in particular. In 1988, the International Astronomical Union named asteroid 3673 "Levy" in his honour. In 2002 in Montreal, he received the Society's Simon Newcomb Award for his literary talent. Levy's invitations have ranged from elementary school classes to the White House. He holds degrees from Acadia University in Nova Scotia (B.A.), Queen's University in Ontario (M.A.), and the Hebrew University of Jerusalem in Israel (Ph.D.), plus honorary degrees from five universities. Dr. Levy contributes the article *Observing Comets* and his list *Deep-Sky Gems* to the annual *Observer's Handbook* of the RASC, as well as the columns *Nightfall* for the popular Canadian astronomy magazine *SkyNews*, and *Evening Stars* for *Astronomy* magazine.

Levy's deep love for the night sky and boundless enthusiasm for experiencing it pervade his life. In 2010, he gave a copy of his observing logs to the RASC. Thanks to Walter MacDonald, those files are now accessible on the RASC Web site. The logs cover over half a century, beginning with memories of sky events from his childhood. Levy's main focus has been a search for comets that began on 1965 December 17, although his records cover everything in the sky—Moon, planets, eclipses, variable stars, meteors, sun pillars, occultations, constellations, sunspots, lightning, zodiacal light, green flash, rainbows, clouds, etc.!

Over the years, Levy organized his observing sessions by numbering them in sequence, beginning with the solar eclipse of 1959 October 2. However, those numbered sessions were preceded by three childhood memories of an observation of the Big Dipper and a meteor, and of inventing his own constellations composed "of stars resembling friendly beacons in a lonely night."

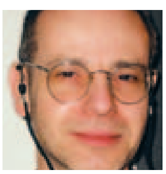
Each page of his observing logs, in Levy's distinctive handwriting, typically contains records of half a dozen sessions. The record for each session begins with the session number, an indication of whether the session took place in daylight or dark (and if in dark, the portion of the night), the date (occasionally the month is indicated, but seldom the year), the clock times when the session began and ended, an indication of sky conditions, the location, telescope(s) used, other people present, and observations. Levy developed a concise code for the basic information such that many of the session reports occupy no more than two or three lines. Asterisks precede observing sessions of particular significance, with up to three asterisks for those that were extraordinary. Among the latter is observing session #6684, involving the discovery of his first comet on 1984 November 13, after 19 years of searching! Over eight years later, session #8949 records the night that the discovery films of SL-9 were taken. By 2011 August 15, he was at observing session #16,328 for an average of more than 300 sessions per year for over half a century. Aside from Levy's remarkable dedication, those figures were made possible by his decision to live in Arizona, both for the clear skies and for his health.

Several of the session records are sprinkled with personal comments by Levy and "guest book" comments by numerous friends and acquaintances who shared evenings under the stars with him. Other names occur from time to time, including *Lima Bean* and *Bounder*, Levy's cats, and *The Beagle*, the dog that Levy shares with Wendee. More frequent are *Miranda*, *Minerva*, *Echo*, *Pegasus*, and others—Levy's names for his various telescopes. *Miranda* is a 41-cm Newtonian with which he made the majority of his visual comet discoveries. *Minerva* is his cherished, 44-year-old, portable, 15-cm Newtonian. *Echo* is a 9-cm Newtonian that Levy has had since his childhood. *Jarnac*, the name of his observatory, is the name of his paternal grandfather's cottage in the Laurentian mountains of Québec where Levy made some of his earliest observations of the night sky.

In his notes for session #12,572 late in 2001, 36 years after the start of his programme of searching for comets, Levy wrote, "The primary goal [has been] not the discovery of comets but the *search* for comets. The primary aim was and is: To become *very* familiar with the sky through searching for comets and/or novae." Few people know the night sky as well as David Levy, and *very* few can match his talent both for discovery and for inspiring others about the wonders of astronomy. ✶

Dr. Roy Bishop, a Past President of the RASC, served as Editor of the Observer's Handbook for a Saros cycle. Like David Levy, he is a recipient of the Society's Chant Medal, and asteroid 6901 Roybishop orbits with 3673 Levy in the main asteroid belt. Currently, Roy is Emeritus Professor of Physics at Acadia University, and Honorary President of the RASC Halifax Centre."

Astronomical Art & Artifact



David Levy's Logbooks in Context

by R.A. Rosenfeld, RASC Archivist
(randall.rosenfeld@utoronto.ca)

> "Truly, the very art [of astronomy] is incomprehensible from the beginning unless through experience"

– Mose Sefardi *fl.* AD 1106-1120 (Millás Vallicrosa 1943, 99)[1]

> "Recorded observation consists of two distinctive parts: 1st, an exact notice of the thing observed, and all the particulars… and 2dly, a true and faithful record of them…"

– Sir John Herschel (1832, 120)[2]

David Levy's generous gift of his digital logbook archive to the RASC, and the world, provides a unique historical resource. In exploring the archive, one can obtain insights into an individual's dedication to the night sky, encounter a contemporary example of a long-lived literary form, and have the vicarious experience of observing by the author's side—tasting the quality of the nights, the excitement of discovery, and the enduring bonds of astronomical friendships (if the reader has not done so already, he or she should read Roy Bishop's introduction to David, his logbooks, and his role in contemporary astronomy). Astronomy is a viscerally visual experience in which memory plays a vital role. Records of what has been observed are vital cultural components of what we can remember. Created in the present to store data and experiences, records chronicle the astronomical and human past, and serve to fashion future research agendae through the tally of what was seen, what was not seen, and what might yet be seen.

Astronomers' logbooks are by definition the field notebooks and lab notebooks of those who look at the nocturnal—and diurnal—sky. They have traditionally been the formal material space for astronomical data "hot off the eyepiece," and the surface where the raw stuff of disciplined encounters with astronomical phenomena is set down, the place for the initial expression in endurable, recoverable, and communicable symbols of what was seen, measured, and described, before the processes of reduction, application, or publication. (This does not mean that logbooks are zones devoid of hypotheses and conjectures—far from it). They possess high probative and juridical value in precedence cases, and contain the basic evidence for reconstructing experiments or observational procedures when results are reassessed, irrespective of the brevity of their entries. Besides being physical things, logbooks comprise a literary genre with a history and conventions, and intriguingly and paradoxically, are personal documents reflecting the research style of those who created them, however much they may be institutionally mandated, formulated, and owned. The value of primary observational records is arguably greater than that of the apparatus with which they were created. There would be no science of astronomy as we know it without logbooks.

The creation and curation of astronomical records, so quintessentially a part of modernity's scientific enterprise, is a cultural practice of considerable temporal depth. The intention to record data in a retrievable form is seemingly a constant, whether one employs a radio-telescope antenna and a computerized recorder, or the human eye with a sketchpad and pencil. When the young David Levy was keeping his first logbooks and hoping to discover a new comet, his thoughts doubtless turned to the company he wished to join, that of Charles Messier, Jean-Louis Pons, and Leslie Peltier, and to their methods of seeing, thinking, and inscribing. In the still of the night, under the dome of heaven, it is possible to experience a quiet quickening in the marrow knowing that such archetypal watchers of the sky observed and recorded in a fashion not altogether foreign to the contemporary amateur experience—or so one imagines.

How old is the discipline of astronomical note taking? What is the place of David's logbooks in that tradition?

The search for origins powerfully motivates inquiry, possesses an endless fascination, and perennially disappoints those who crave immutable answers. The late Alexander Marshack argued forcefully that "time-factored, relational" marks on mobilary Upper-Palaeolithic artifacts constitute evidence of the systematic recording of astronomical observations. Central to his discussion were engravings on the abri Blanchard bone, dating to the Aurignacian period (*ca.* 32,000 BP (has precise chronometrical import (derived from the convention of C14 calibration with BP=1950) which BC lacks.), and those on several La Placard bone "batons," dating to the Magdalenian III era (*ca.* 13,000 BP), which he read as graphical records of lunar phases (Marshack 1972/1991). Archaeoastronomers are willing to grant consideration to the hypothesis and merit to the methodology, although neither are above just criticism (Ruggles 2005, 5-7; Bahn *et al.* 2010; Kelley & Milone 2011, 157-158). The hypothesis remains unproven but not implausible. It offers the possibility of a very long chronology for our habit of astronomical note taking—in fact, an ocean of time in terms of human culture. Even if Marshack's hypothesis receives robust confirmation, it does not necessarily mean that David's—and our—ancestors shared our motivations for recording the night sky (in Babylonian and subsequent eras, observation often served astrological purposes, a technical application few of us would now seriously contemplate). Heaven only knows what a Pleistocene observer would have made of the apparition of a bright naked-eye comet; no glyph or graph has yet been seriously proposed as a Palaeothic record of such an observation.[3] If one should accept the Marshack hypothesis, then at the most basic level, three connections can be posited between David's logbooks and Stone Age astronomical records; both are products of the hands of hominids of the same genus, both employ symbolic notations, and both must meet contextually set standards of accuracy.

It appears that the civilizations of the Tigris and Euphrates have bequeathed us the oldest unequivocally identifiable observational records surviving in what may be their original state.[4] It is a region that would not have been unknown to David's ancestors. The prime surviving records of observations, the Babylonian Astronomical Diaries, are in the Akkadian language in cuneiform script, on clay tablets, and the earliest surviving example dates from 652 BC (*Astronomical Diaries*; Hunger & Pingree, 1999, 139-158). A concern with contextual accuracy and the recoverability of astronomical data is evident in these most adamantine of records, aspects we like to think characterize our logbooks as well, although paradoxically the medium of clay tablets can offer on the one hand superior longevity to paper, and yet on the other a potentially greater frangibility (David's logbooks don't shatter when dropped). The medium of the Astronomical diaries raises an interesting recurrent question that can and should be asked of any class of observational document; are these the fundamental first-generation material record of the data they transmit? Are the surviving artifacts the actual physical logs created on the nights of observation, or are they second- or third-generation copies? Clay tablet technology could have been used under the

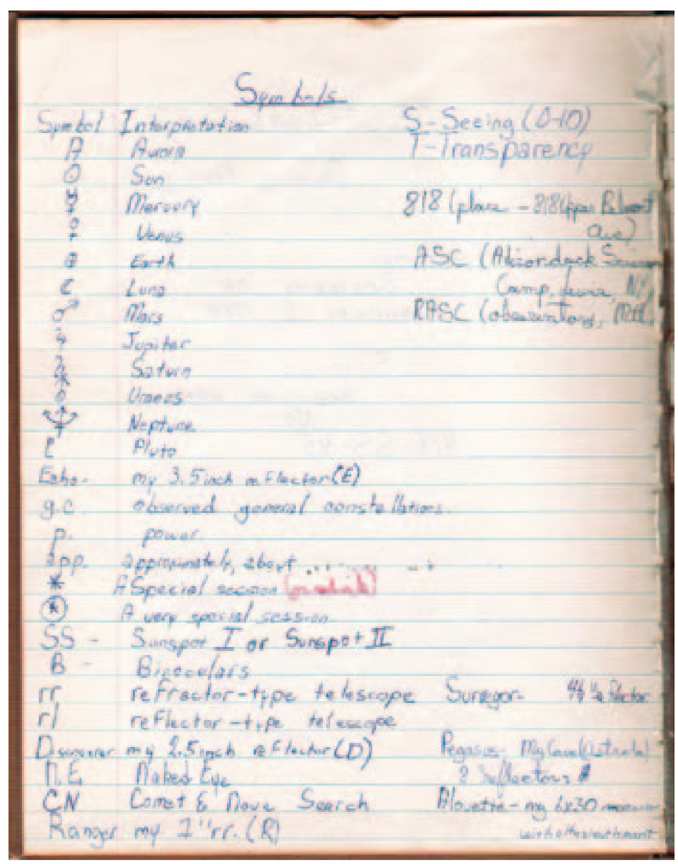


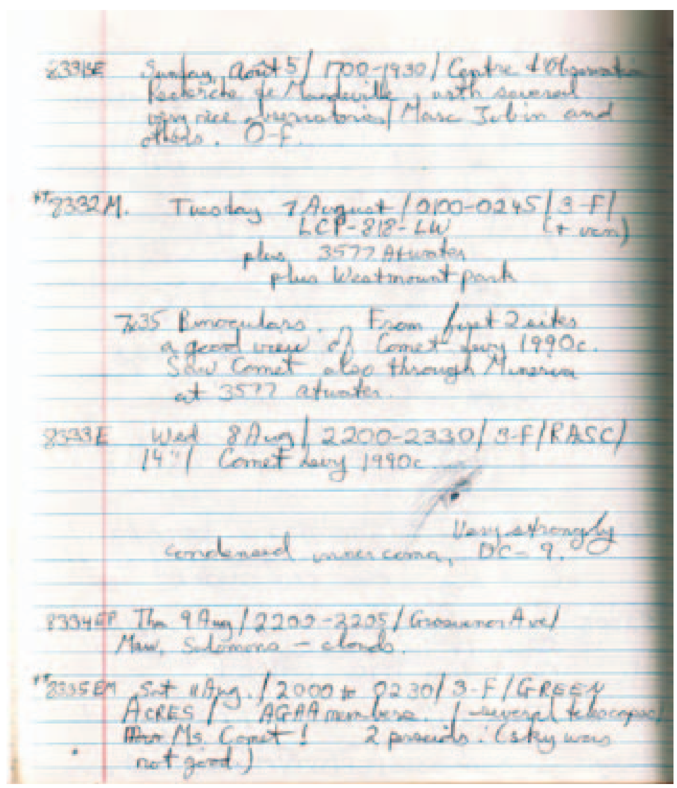
Figure 1 — LOG2-02. Early system of abbreviations developed by David in 1965

night sky, but would it always have been convenient to do so? Were less-permanent, easily correctible media employed instead, such as wax tablets? This is a question to which we shall return. When looking through David's logs, what evidence can you find that they are in fact first-generation observational records? What of your own logs?

There may very well have been serious stargazing with some sort of "logbook" practice in pre-Ptolemaic Egypt, as in the pre-Hellenistic Greek sphere, but, if so, neither culture has bequeathed much artifactual evidence in the form of first-generation observational records (Evans 1998, 21-22; North 2008, 31, 95, 98).[5] Secondary evidence for the existence (or earnest institution) of first-generation data records picks up with figures such as Hipparchus (*fl.* 150-125 BC) and Claudius Ptolemy (*ca.* AD 100-170), the two greatest figures of Hellenistic astronomy. Both made use of the Babylonian corpus of observations, and made their own as well (Pedersen & Jones 2010, 408-421). There are, alas, no logbook survivals from this impressive epoch for mathematical astronomy. In their ultimate physical form, observational data may have been distinguished by entry in reed pen and ink on papyrus rolls, a type of book quite different from the codex form of David's logbooks (roll=sheets attached end-to-end to form one continuous writing surface, requiring unrolling and rolling to access; codex=sheets folded down the middle and nested one within the other, usually sewn together through the folds, and given protective covers). The actual books in which Hipparchus or Ptolemy would have entered their observations would probably have been wax tablets—square or rectangular panels of ivory, bone, or wood with hollowed-out planed surfaces covered with a mixture of wax and hardening agents, and written on with styli of metal (silver, copper-alloy, or iron), bone, or ivory. [6] Very cursive, informal scripts were frequently employed, and some abbreviations used—not unlike David's observational entries in some respects (abbreviations: LOG 01, verso of front cover; LOG 02-02). Wax tablets were often found in codex form, and thus would approximate the physical appearance of David's logbooks.

The Hellenistic astronomical texts, with their observational data both contemporary and retrospective, survive thanks to the efforts of medieval scribes active in the Byzantine, Islamic, and western-Christian cultural spheres. Contrary to misconceptions still popularly held by many astronomers both amateur and professional, there was much scientific enterprise in the period from the "fall" of Rome to the time of Copernicus—it is the "Dark Ages" themselves that are a myth. This period saw considerable and variegated astronomical activity, as McCluskey (1998), North (2008), and Park (2011), among others, have so ably established. One can encounter the words "*experimentum*" and "*observatio*" frequently enough in the sources, although their complex lexical meanings may at times possess a different colour from strictly modern usage. Astronomical observation and the recording of observations are certainly to be found, particularly from the late 11th century forward, with figures such as Prior Walcher of Malvern (*fl.* 1091-1135), William of St. Cloud (*fl.* 1285-1312), and Jean de Murs (*ca.* 1290-*post* 1357; Park 2011, 24-33). The tradition continues through Geoffrey Chaucer (*ca.* 1340-1400), Georg Peurbach (1423-1461), Regiomontanus (1436-1476), and Bernhard Walther (1430-1504), which brings us into the midst of the early modern period (North 1988; Park 2011, 32-37). A concern with improving the precision of observation can be discerned in the activity of some of these figures, and most were at pains to improve the fit between theory and observation. The modern harvesting of observational data by amateurs for professional use serves similar ends (*e.g.* AAVSO), and some of David's mentors, such as Leslie Peltier, played notable parts in that activity, as has David (see Roy Bishop's comments on David's collaboration with Gene and Carolyn Shoemaker). David continues his advocacy of this important amateur activity to this day.

It is from the later Middle Ages that what appear to be first-generation observational records begin to survive in modest number, perhaps for the first time since the creation of the Babylonian diaries. While there are similarities with David's logbooks, there is one physical form of medieval observational record that seems utterly alien to current practice. It is the entry of observational data in the free spaces around a pre-existing physical text, literally writing in a published book! It is as if David were to take Fred Whipple's dirty-snowball paper from the *Astrophysical Journal* (1950) and


8331E Sunday, August 5 / 1700-1930 / Centre d'Observation ... with several ... Marc Jobin and others. O-F.

8332M. Tuesday 7 August / 0100-0245 / 3-F / LCP-818-LW (+ ven) plus 3577 Atwater plus Westmount park

7x35 Binoculars. From first 2 sites a good view of Comet Levy 1990c. Saw Comet also through ... at 3577 Atwater.

8333E Wed 8 Aug / 2200-2330 / 3-F / RASC / 14" / Comet Levy 1990c

Very strongly condensed inner coma, DC-9.

8334 Th 9 Aug / 2200-2205 / Grosvenor Ave / Mau, Solomons - clouds.

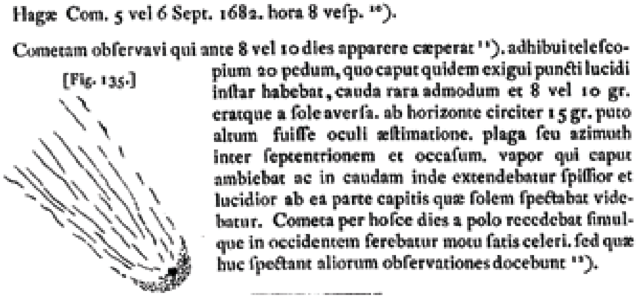
8335EM Sat 11 Aug. / 2000 + 0230 / 3-F / GREEN ACRES / AGAA members / several telescopes ... Ms. Comet! 2 passed. (sky was not good.)

Figure 2 — LOG16-084. David's observation of the spectacular comet Levy C/1990 K1

write his comet and other observations in the margins, or better yet, try to do the same on the sheets of Antonín Becvár's (1969) comet-hunting atlas, or on the pages in volumes of Gary Kronk's *Cometography* (1999-)! Past human uses of seemingly familiar technologies can strike us as both familiar and foreign at the same time. (Doubtless the reverse is also true—our astronomical ancestors would see aspects of our art of observation as both customary, and alien).

The rate of survival of what may be actual physical logs created on the nights of observation, or at least second-generation records, increases notably as the "renaissance" spawns the "scientific revolution," contributing in time to the Enlightenment (all fraught words—only the last was coined in its day!). With greater temporal proximity comes greater familiarity. Even a cursory comparison of David's logbooks with Galileo's, Christian Huygens', or William and Caroline Herschel's notebooks, reveals much more in common than not. Not only are the physical aspects of the books functionally indistinguishable, but the information fields are frequently comparable, and the types of page layout (*mise-en-page*) are at times closely analogous. Christian Huygens' logbook entry for 1682 September 5/6 specifies the date, time, and place of observation, the instrument used, object observed and its position, and includes a description and drawing; on 1990 August 8 David provided the same type of information for the same type of celestial object in his logbook (Huygens 1925, 131; LOG 16-084), only the media and language differ (Latin text in pen and ink on non-acidic hand-made paper in one case, and English text in biro on mass-produced acidic paper in the other). Even before a close reading of their respective contents, it is the immediate visual impression of consonance between the pages of David Levy's and Christian Huygens' respective logbooks that instantaneously makes the case for obvious cultural affiliation.[7]

One very attractive feature of David's logbooks is that they serve as a record of astronomical friendship down the years. It is not just that David entered the names of those with whom he observed on specific nights, but that he frequently had them add their own signed entries. This recalls another type of book familiar to astronomers as members of the republic of letters, from Shakespeare's day, past Halley's, to the evening



Hagæ Com. 5 vel 6 Sept. 1682. hora 8 veſp. [10]).

Cometam obſervavi qui ante 8 vel 10 dies apparere cæperat [11]). adhibui teleſcopium 20 pedum, quo caput quidem exigui puncti lucidi inſtar habebat, cauda rara admodum et 8 vel 10 gr. eratque a ſole averſa. ab horizonte circiter 15 gr. puto altum fuiſſe oculi æſtimatione. plaga ſeu azimuth inter ſeptentrionem et occaſum. vapor qui caput ambiebat ac in caudam inde extendebatur ſpiſſior et lucidior ab ea parte capitis quæ ſolem ſpectabat videbatur. Cometa per hoſce dies a polo recedebat ſimulque in occidentem ferebatur motu ſatis celeri. ſed quæ huc ſpectant aliorum obſervationes docebunt [12]).

[Fig. 135.]

Figure 3 — Huygens' logbook entry for 1682 September 5/6. Compare to David's LOG16–084

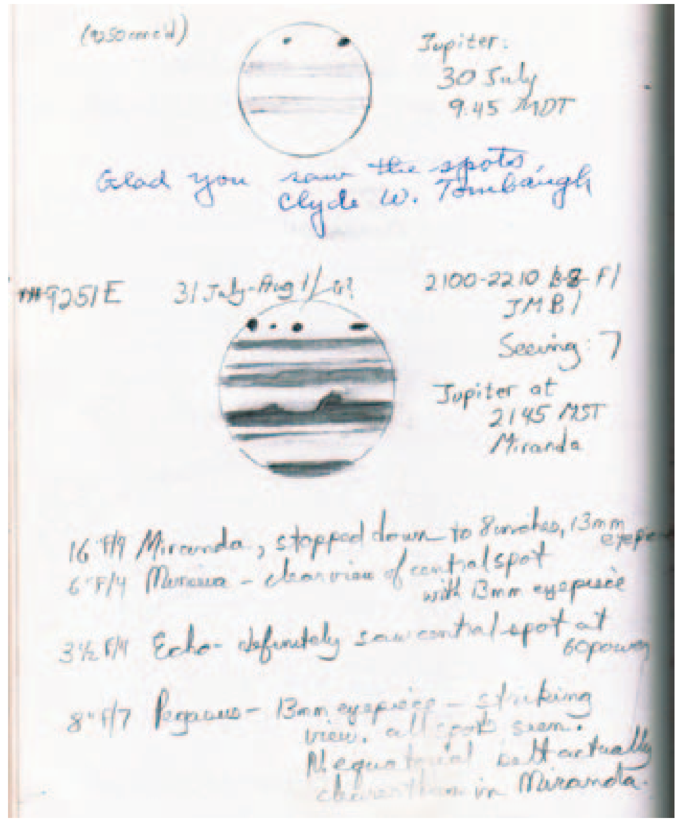


Figure 4 — LOG17-103. David's observations and drawings of the impact of comet Shoemaker-Levy 9 (D/1993 F2), and Clyde Tombaugh's autograph comment

of Herschel's life; the *Liber amicorum*, or the *Album amicorum*, that is, the "Friendship Book" (Ortelius 1969; Stammbücher 1989; Mauelshagen 2003). The friends of the owner of a *Liber amicorum* would indicate their friendship, esteem, and respect for the owner by making the owner the gift of a poetic epigram, or an ode or encomium, a pictorial emblem, a drawing, or a print or woodcut, and their signature, all of which would be entered in the book. (Wealthy friends could hire professional poets and artists to design and execute their entries for them!). This delightful feature of David's observational records produced some memorable entries. It also points to another feature of astronomical records of which we are not always conscious; logbooks are static representations of dynamic interactions. There is an oral element to observing with other people, and logbook entries can in reality be the product of mixed modes of communication, orality and writing, an aspect that can be difficult to capture from the surviving static texts. (It is possible in some periods that observations were not given written form immediately, but were transmitted orally, and retained in multiple living memories for extended periods, something quite different from our modes of data preservation).

The "modern" logbook tradition established in the 17th-18th centuries, which had formed out of earlier traditions of observational record, continued into the Victorian, Edwardian, and subsequent eras with various experiments, refinements, and adaptations to new technologies of communication and data entry and storage, but with no breaks.[8] David received that tradition in the second half of the 20th century from his mentors, such as Isobel Williamson, Roy Bishop, and others in the RASC and elsewhere, who still cultivated an art of observational record, which, in its essentials, was little different from that of observers before the invention of achromatic OTAs, and large Herschelian reflectors. Contextually, this is the place occupied by David's logbooks in the tradition of astronomical record making. It is a tradition that is ongoing, and a disciplined practice that serves amateurs well—David and all of us (Markov 2011). In some respects, the logbook tradition has an intriguingly—and perhaps disconcertingly—long pedigree. Perhaps this is another wonder to add to those experienced under a clear night sky. ✶

Appendix: *Scriptura Davidica Jarnacensis*

David's logbook scripts are amenable to several classificatory treatments. They can be analyzed as one would the scripts current when the Bard of Avon wrote of astronomy—an author in whom David has a more than passing interest (Levy 2011, 27-50, 97-98). To use formal palaeographic nomenclature, David's logbooks are written in a bimodal Italic hand, ranging from a formal (set) Italic to a cursive (rapid) Italic, with few Secretary elements, characterized by letter forms nearly shorn of serifs, inessential descenders, ascenders, and ligatures, and displaying a sparing use of abbreviations. The chief difference between his formal and cursive Italic modes is that the one is more carefully produced, and the latter features letters joined by regular connecting strokes (the practical implications are that cursive hands can be written more rapidly than formal hands—but this is not invariable). Or, if one wishes to forego historical resonance and surrender analytical capacity, one can follow modern educational theory and speak of "slanted print scripts" (="formal Italic hands") and "cursive scripts" (="cursive Italic scripts"). David's formal (set) Italic predominates in the earliest logbooks 1962-1965 (LOG 01-02), and thereafter his cursive (rapid) Italic predominates (LOG 03-23), but it is never absolute, and both can be found on some pages (LOG 14-007). Occasionally mechanical writing technologies are employed, such as a date stamp throughout 1967 (LOG 04), and typewriter for much of 1968 (LOG 05-018-026). Different coloured inks are occasionally used, usually one colour per dated entry (it seems to have been a matter of using whatever writing implement was at hand). The letter forms of both *Scripturae Davidicae Jarnacenses* show remarkable stability over the better part of half a century, as do the modules of the scripts (module=ratio of letter height to width, and the ratio of both to the interlinear space). And, when the logbooks function as *libri amicorum*, there are other hands present in the logbooks besides David's. The text support is relatively thin, commercially pre-lined wood-derived paper stock of high acidic content, typical of school notebooks of the second half of the 20th century. In summary, *Scripturae Davidicae Jarnacenses* are highly utilitarian, making up for what they may lack in formal elegance through the virtues of clarity and readability. David would always be able to decipher the morning after what he had written the night before with a minimum of effort, and he and we can still do so decades later. The manuscript technology of his logbooks, now digitized, has stood the test of time.

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(Endnotes)

1 The quote continues "and, likewise, no one can recognize a master of that art without experience" ("*Ars etenim ipsa non nisi per experimentum primum potuit comprehendi et magistrum artis similiter sine experimento nemo potest cognoscere*").

2 Sir John (1832, 130) also remarks: "With respect to the record of our observations, it should be not only circumstantial but *faithful*; by which we mean, that it should contain all we did *observe*, and nothing else." That is, the observer's moral integrity as an observer *must* be manifest in his or her records. The approval of circumstantial detail allows considerable freedom of choice as to style, and content—tastes will vary.

3 Kronk starts with 674 BC; Kronk 1999, x, 1.

4 They enjoy temporal precedence over the far-eastern material. I will not refer further to Chinese—or for that matter to Indian or Arabic—material in this discussion, for several reasons. That there were borrowings and adaptations of astronomical data, techniques, and equipment between cultures is undeniable. The world of far-eastern astronomical practice was, however, rather remote from the western cultural traditions to which David is heir (one can make a better case for the influence of the Indian and Arabic worlds). Those who are interested in the far-eastern material can turn to Xu *et al.* 2000, and Pankenier *et al.* 2008. Needless to say, I find the Needhamite case overdrawn.

5 The pre-Ptolemaic (and some of the Ptolemaic) Egyptian heritage can be sampled through the pages of Clagett 1995.

6 For further details, see Rosenfeld 2002 and Rosenfeld 2003.

7 David has written evocatively on his encounter with some original logbooks of this period; O'Meara 1998, vii. Nicolas Leste-Lasserre (2002, 2004) has written some important unpublished studies of this material.

8 For an interesting episode of one formative stage, see Nasim 2010. I wish to thank Professor Nasim for generously sharing his study with me.

Second Light

Pluto's Twin?

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The dwarf planet Eris (originally 2003 UB313) was discovered in 2005. It was estimated to have a radius similar to that of Pluto (though rather uncertain), and as it has a satellite, its mass was determined to be somewhat greater than Pluto's (1.27+/-0.02 for those who want the precise number). It is in an eccentric and highly inclined orbit typical of a scattered Kuiper Belt object, currently near its aphelion and about 96 AU from Earth. Bruno Sicardy of the Observatoire de Paris and an international team of astronomers have now determined, using a stellar occultation, that Eris' radius is 1163+/-6 km (see the October 27 issue of *Nature*). Pluto's radius remains uncertain, but is in the range of 1150 to 1200 km, so it remains unclear which body is bigger. Sicardy and his team calculate a geometric albedo of 0.96, making Eris one of the most reflective bodies in the Solar System.

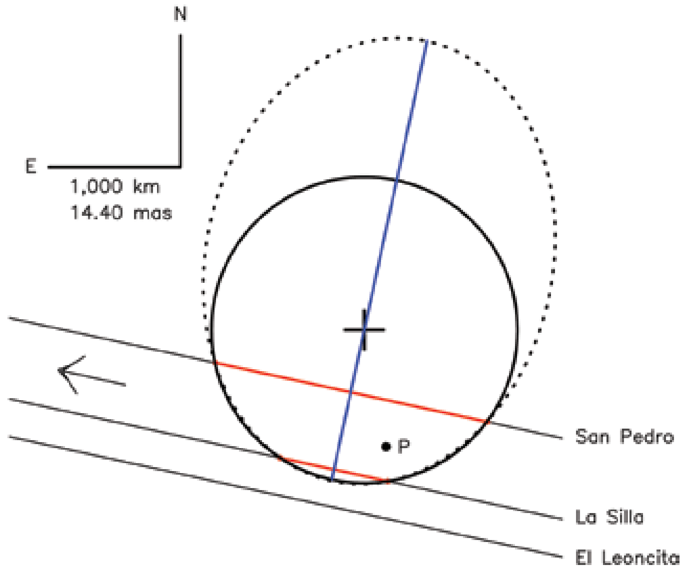


Figure 1 — The three lines show the trajectory of Eris from three locations as it occulted the star. The two telescopes at San Pedro de Atacama were separated by just 20 m, which is indistinguishable on this scale. Courtesy of Bruno Sicardy and Nature.

The discovery of Kuiper Belt objects (KBOs) over the last 18 years rather rapidly led to the realization that Pluto's odd—for a planet—orbital properties are naturally explained if it is simply one more KBO. A number of years ago this led to the (contentious) creation of the category of "dwarf planet." To me, this was an entirely silly debate—Pluto was recognized as a KBO, and there was no need to create a new category. But, I digress.

In 2006, Eris' radius was estimated to be ~1200 km, based upon observations with the *Hubble Space Telescope*, but the size on the sky—just 34 milliarcseconds—made the measurement very challenging, and the uncertainty was relatively large. The best way to measure the sizes of small, distant objects is through stellar occultations, where the body blocks the light of a star. Using several telescopes at different locations, the size and (sometimes) the shape of the body can be calculated. One of the big challenges for these measurements is determining what stars will be occulted at what times, given that the orbits of distant KBOs are not known as precisely as main-belt asteroids, or even Pluto, because they have not been tracked for much time.

In order to maximize the chances of catching an occultation, large collaborations with access to telescopes around the world have been established. Three out of 26 telescopes mobilized by Sicardy caught the occultation, 10 were clouded out, and the rest did not see it. Two telescopes at San Pedro de Atacama, in Chile, one at the European Southern Observatory at La Silla (also in Chile), and a fourth at Complejo Astronomico El Leoncita in Argentina contributed to the result. Although the telescope in Argentina did not see the occultation, the data helped constrain Eris' size (Figure 1).

As Eris' mass was already known—based upon the orbit of its satellite—the calculated radius of 1163 km leads to a density of 2.5 g/cm^3. Pluto's density is 2.0 g/cm^3, and two other KBOs have densities of 1.0 and 1.6 g/cm^3, which Sicardy suggests indicates diverse origins for the bodies, or different evolutionary tracks.

There is no evidence for an atmosphere above a pressure of a few nanobars on Eris. It is ~97 AU from the Sun, near its aphelion, where the peak temperature from solar irradiation (the "sub-solar" point) is at best 35 K. In this way, it is quite different from Pluto, which does have a tenuous atmosphere of several microbars (a thousand times more than the limit for Eris). It is the presence of that atmosphere that is the biggest contributor to the uncertainty in Pluto's radius. As Pluto moves rapidly away from the Sun (its perihelion was in 1989), its atmosphere is expected to freeze out onto the surface sometime in the next decade or two, as its atmosphere is mostly nitrogen, with traces of methane and carbon monoxide.

Sicardy speculates that Eris' atmosphere has frozen out, and as it approaches perihelion at 38 AU about 300 years from now, the frozen gases will sublimate and produce an atmosphere like that presently on Pluto.

In the meantime, Eris is one of the most reflective bodies in the Solar System, reflecting 96 percent of the sunlight that falls on it. This high reflectivity is very suggestive of periodic resurfacing, as would happen with atmospheric collapse and later sublimation.

The three telescopes that captured the light curve of the occultation were 40, 50, and 60 cm. There is still a lot of interesting science that can be done with modest-sized telescopes—something to bear in mind as astronomers try to figure out how to build (and pay for) ones that are 30 m or more in diameter. ✶

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

Jim Low

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

I never thought I'd be writing Jim Low's obituary; I fully expected that he'd be writing mine 20 years hence.

I first met Jim at a meeting of the Montreal Centre in the late 1950s. He was a tall, quiet young man about a year older than I was. He was even shyer than I was, and I didn't get to know him well, though I respected his intelligence and competence. Shortly after we met, he left for a stint in Great Whale River as a meteorological technician, so I saw little more of him.

We next met in the early 1980s when we were both members of LOGIC, the Toronto Apple Computer users group. Still shy, he introduced himself and asked if I was the same Geoff Gaherty that he had known in Montreal. I was the sysop (system operator) of the LOGIC BBS (bulletin board system), an early ancestor of the Internet, and soon asked Jim to become my assistant. This was the first time Jim displayed to me his uncanny knack to do exactly the wrong thing with computer software. Within minutes of being granted sysop access, he had managed to delete me as a user! Jim combined his interests in computers and genealogy by becoming a beta tester and software support person for genealogy software. The developer knew he could rely on Jim to find any bugs in his software.

Shortly after, I became president of LOGIC, and a year or two later Jim joined the Board of Directors. At his first Director's meeting, we sent Jim out for doughnuts and, while he was gone, elected him President of the club. His greatest moment as LOGIC's president was when a irascible member called him a petty tin-pot dictator! His wife Eleanor nearly died laughing!

At this time in my life, I was no longer actively involved in astronomy, but Jim quietly encouraged me with gifts of an *Observer's Handbook* and a copy of *Looking Up*. In 1997, I rekindled my interest in astronomy and once again started

Figure 1 — Jim Low (in front) on a field trip to the Springhill Meteor Observatory at the 1964 Spring Meeting of the AAVSO in Ottawa. Like many of us in those days, he proudly wears his RASC blazer.

seeing Jim regularly at Toronto Centre meetings. While Jim was proud of his role as an armchair astronomer, he decided to buy a new telescope and sought my advice. On my suggestion, he bought a 10-inch Dobsonian and resumed observing Mars.

I often thought of Jim as a "retiring personality," because he retired more often than anyone I've ever known. First, he took early retirement from the Meteorological Service because he could no longer stand the office politics. He soon was working as an Apple technician for a local computer store. Eventually he retired from that job. Shortly after, I received two emails within a day or two of each other. One was from Jim saying he was applying for a job at Starry Night software, and was wondering whether I thought he could get along with Pedro Braganca, who would be his boss there. The second email was from Pedro, an old friend of mine, wondering whether Jim would be a good working for him. I said yes to both emails, and this began yet another career for Jim. Starry Night also found they could rely on Jim to find new and creative ways to crash their software.

In time, Jim wanted to spend more time with his beloved grandchildren, and so decided to retire from Starry Night. He

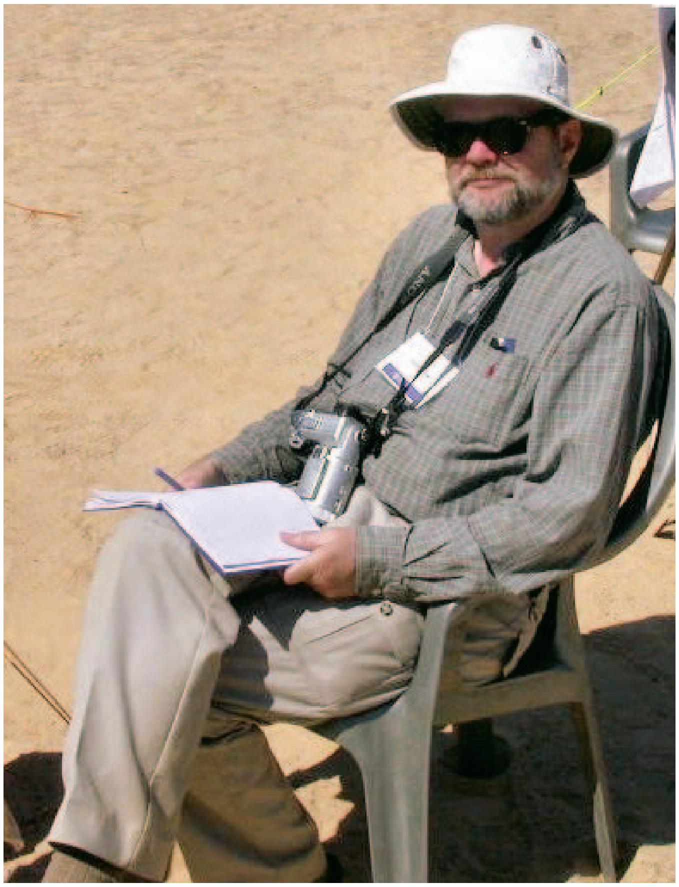


Figure 2 — Jim Low at the solar eclipse in Jalu, Libya, in 2006. Here Jim is wearing his Tilley wardrobe, which he favoured because of its lifetime guarantee. Many of us wore our Tilley hats in his honour at his memorial service overlooking Rice Lake on September 18.

recommended me as his successor there, and I've been working there ever since!

Some of my happiest memories of Jim are of the many lunches we had together over the years, mostly at Fran's on St. Clair. There we really got to know each other, sharing stories of our equally dysfunctional families. Jim rebounded from his horrible family history by becoming a wonderful father of four great kids and an even better grandfather to their kids. Every year he would chronicle his travel adventures and the travails of grandparenthood in his annual Christmas letters.

Although Jim was proud of being an armchair astronomer, he escaped from that armchair at regular intervals to travel around the world to view solar eclipses. My wife and I especially enjoyed travelling with Jim to the eclipse on 2006 March 29 in Jalu, Libya, followed by a tour of Italy.

It was a great shock a couple of weeks ago to learn of Jim's sudden and unexpected death. I had had an email a few days before, commenting on my most recent JRASC column, and another, the morning of his death, talking about his plans for upcoming trips and eclipses. Here are some of Jim's final words, always optimistic and cheerful:

I'm enjoying my armchair. I even attended a meeting in the neighbouring Port Hope Library a few months ago where Terry Dickinson was speaking. I don't go to observing sessions such as StarFest, but I haven't missed a GA in over ten years! The GA is 'Armchair Astronomer's Heaven.' My 10-inch telescope is stored at Carrie's place here in Cobourg (because they have a clear view of the sky, unlike my house). But I've pulled it out only a couple of times since I moved here. The GA is in Edmonton next June 28–July 1. Handy. My sister lives there and has room for me. Hmmm… Transit of Venus mostly visible from western Canada on June 5. Might as well go for that and stay at my sister's place for the GA. Hmmm, some more. Annular Eclipse of the Sun from western USA a bit earlier on May 20. Why not head west a little earlier? I could observe the eclipse from southern Utah, then spend some time in Salt Lake City at the big genealogy library there, then head for the transit… I just might get more observing done next year than I have in a number of years. But my daughters won't be pleased to be without 'Grandpa Daycare' for a couple of months.

"My family historical pictures and documents (some go back before 1850) are getting scanned and stored electronically. Cupboards full of old pictures are being scanned and will fit on a few DVDs. Those pictures overflow Ikea cupboards filling a wall of my room, 10′ long, 8′ high and 3′ deep with overflow boxes piled on the floor 4′ x 4′ x 4′ and wonder if I should destroy the originals once scanned. I almost did until someone told me years ago 'keep the original home movies, as they will last longer than the VHS tape you copied them to,' He was right. They are now recopied to DVD—from the original films. I'd better keep the originals.

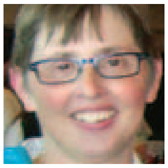
"Heck, why bother? When I go, the dumpster will appear on my lawn."

Not so. At his memorial service, his kids told me of the gold mine they have found on his computer. He's been shooting videos of their kids while babysitting them over the last ten years, movies they never knew existed. Best of all are the videos of him singing to his grandchildren: none of us ever knew Jim could sing.

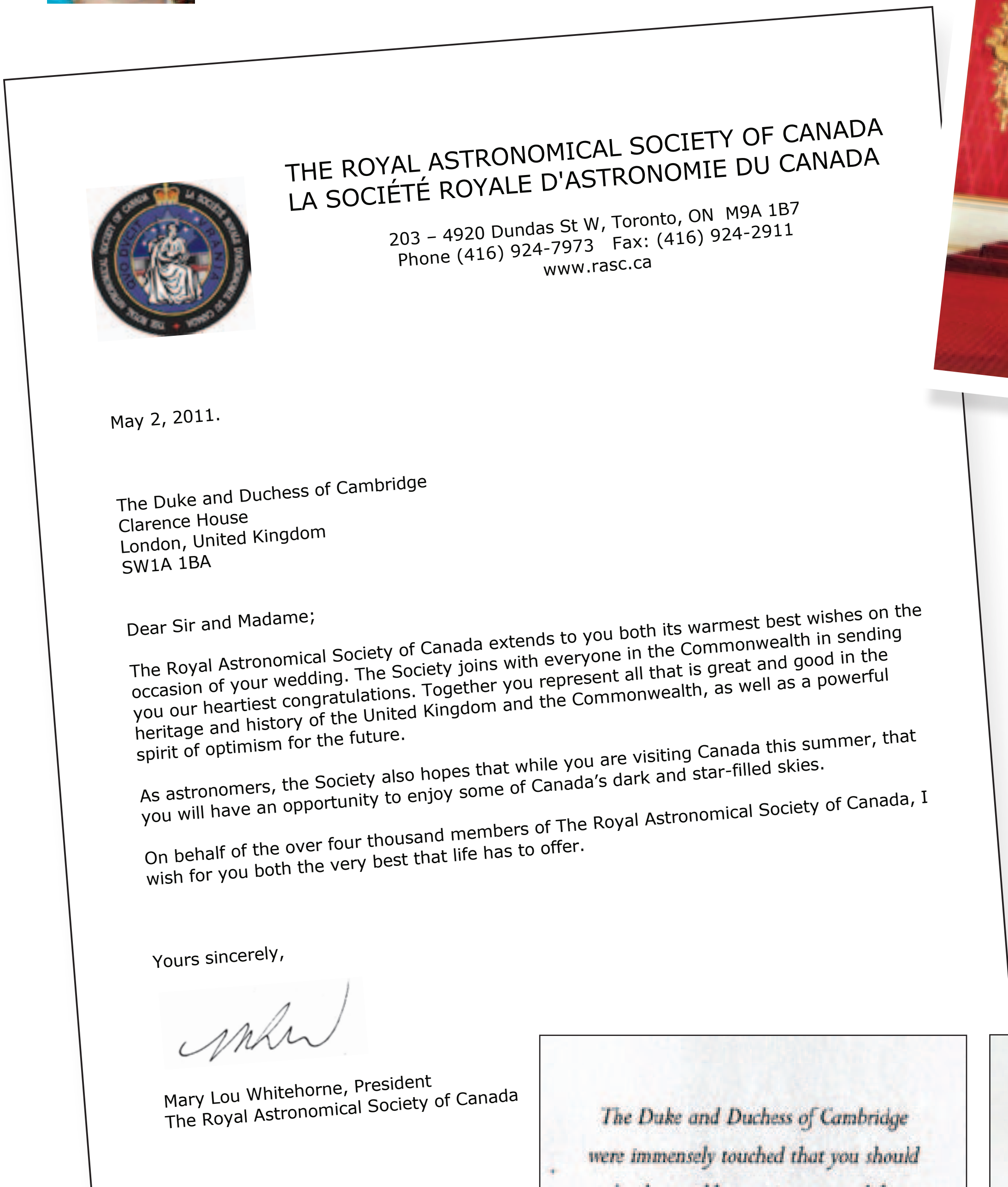
[The thumbnail of Geoff Gaherty, at the start of this column was taken by Jim Low at Milan airport on their way to the total solar eclipse in Jalu, Libya, in 2006.] ✶

Geoff Gaherty 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 contributes regularly to the* Starry Night Times *and writes a weekly article on the Space.com Web site.*

Royal Correspondence



Mary Lou Whitehorne
President, RASC



THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
LA SOCIÉTÉ ROYALE D'ASTRONOMIE DU CANADA

203 – 4920 Dundas St W, Toronto, ON M9A 1B7
Phone (416) 924-7973 Fax: (416) 924-2911
www.rasc.ca

May 2, 2011.

The Duke and Duchess of Cambridge
Clarence House
London, United Kingdom
SW1A 1BA

Dear Sir and Madame;

The Royal Astronomical Society of Canada extends to you both its warmest best wishes on the occasion of your wedding. The Society joins with everyone in the Commonwealth in sending you our heartiest congratulations. Together you represent all that is great and good in the heritage and history of the United Kingdom and the Commonwealth, as well as a powerful spirit of optimism for the future.

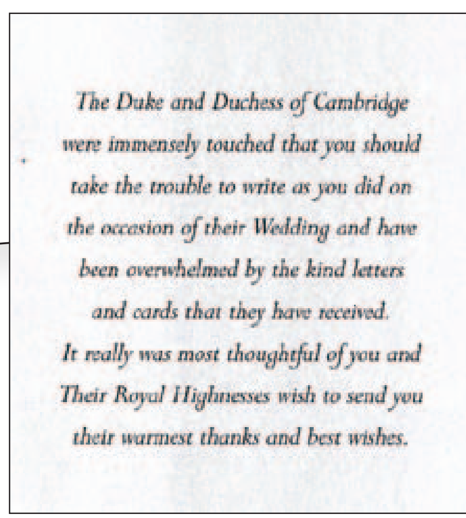
As astronomers, the Society also hopes that while you are visiting Canada this summer, that you will have an opportunity to enjoy some of Canada's dark and star-filled skies.

On behalf of the over four thousand members of The Royal Astronomical Society of Canada, I wish for you both the very best that life has to offer.

Yours sincerely,

Mary Lou Whitehorne, President
The Royal Astronomical Society of Canada

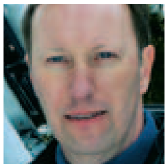
President Mary Lou Whitehorne wrote a congratulatory message to the newlyweds on behalf of the Society, and this is the response from the Royal couple—the photo and "Thank You" on the reverse.



The Duke and Duchess of Cambridge were immensely touched that you should take the trouble to write as you did on the occasion of their Wedding and have been overwhelmed by the kind letters and cards that they have received. It really was most thoughtful of you and Their Royal Highnesses wish to send you their warmest thanks and best wishes.

Imager's Corner

SMI Processing



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

This edition continues a group of Imager's Corner articles that will focus on a few techniques that are useful in processing astrophotos. Over the next several editions of the *Journal*, I'll attempt to give a guide to image stretching, background correction, SMI processing, and other techniques that I happen to find useful. All the techniques discussed will be useable with nothing more than a standard image processor that supports layers and masks. No special astroimage software is required.

This month, we will deal with SMI processing. SMI is "screen combine with an inverted mask" and is a way of greatly enhancing faint detail. It can be used iteratively to increase its effect. SMI processing works best on emission nebulae where the data slowly fades into the background. The technique was originally developed by Jerry Lodriguss and is detailed in his excellent series of image-processing CDs.

Let's start with the M8 image in Figure 1. There is a lot of faint detail not yet visible in this image, so we will use several iterations of SMI processing to make it appear.

Figure 1
Start by duplicating the image on a new layer. Blur this duplicate using a Gaussian filter with a radius of one or two pixels. Then place a mask over the blurred layer made from the inverse of the luminance of the blurred layer. The mask is shown in Figure 2.

Figure 2
The mask and blurred layer are then screen-combined with the original image using the layer stack shown in Figure 3.

Figure 3
The resulting image after the layer stack is merged or flattened shows enhanced dim detail.

Figure 4
Repeating the process twice and adding a levels adjustment layer to darken the background produces the image in Figure 5.

Figure 5
As you can see from the above images, not only has the nebula been enhanced but the faint emission surrounding the nebula is now visible. The levels adjustment and the histogram of the

Figure 1.

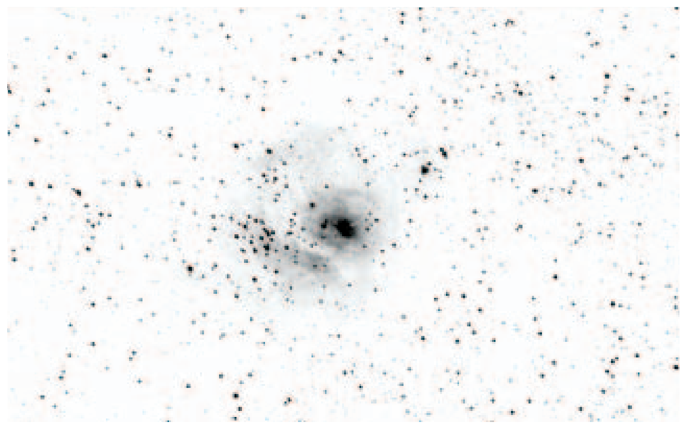


Figure 2.

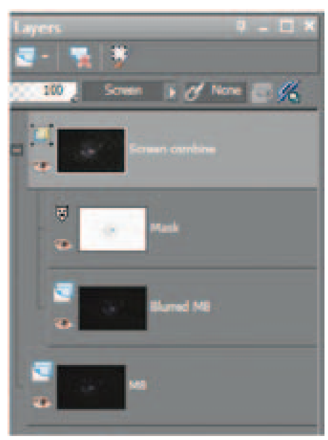


Figure 3. (left)

Figure 4. (below)

SMI-processed image are shown in Figure 6; this display is used to set the black point for the image.

Figure 6
SMI processing will enhance faint background detail and increase the SNR (signal-to-noise ratio) of the faint detail because of the blurring. There is some minor loss of detail in the faint areas, but the results are worth it. A "levels adjustment" is required as a last step because SMI processing will make the final image look a little washed out.

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

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

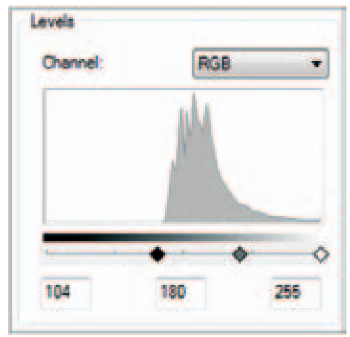
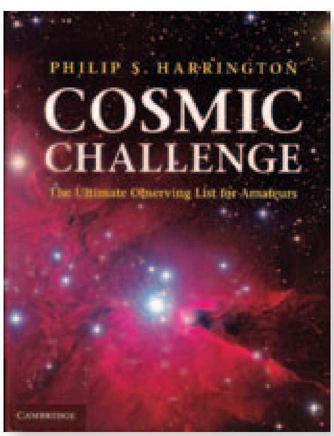


Figure 5. (above)

Figure 6. (left)

Reviews / Critiques

Cosmic Challenge, by Phillip S. Harrington, pages 467, 15 cm × 23 cm, Cambridge University Press, 2010. Price $35 softcover (ISBN: 978-0-521-89936-9).



In 1997, when I purchased a 4-inch Schmidt-Cassegrain telescope and used it from my back porch in London, Ontario, one of my best early observing sessions was in spring with a copy of Guy Consolmagno's *Turn Left at Orion* guidebook for small telescopes, borrowed from the local public library. *Turn Left at Orion* was a compendium of 100 targets for small telescopes, including bright Messier objects, open clusters, stellar associations, and double stars. Many introductory astronomy books do not indicate what is realistic to see in a telescope, opting instead for colourful (and often unrealistic) photographs. *Turn Left at Orion* did not make that mistake, instead including descriptions of what could be seen, along with finder charts and realistic drawings for every object as they appear in the eyepiece. *Turn Left at Orion* taught beginners how to use "averted imagination" to place an object in context as part of our galaxy or beyond.

Cosmic Challenge is Phil Harrington's latest work and a variation on the guidebook theme. The book joins other recent entries into the genre including Stephen O'Meara's *Deep-Sky Companion* series (including *Messier*, *Caldwell*, and *Hershel 400* books), W.H. Finlay's *Concise Catalog of Deep-Sky Objects* and Mark Bratton's *Complete Guide to the Herschel Objects*.

Phil Harrington is probably best known for his *Star Ware* books (four editions to date), where he provides a complete overview of astronomical equipment, along with guidance on what items to choose for specific applications. He has been an observer for over 35 years and has written other guidebooks in the past, so he is well qualified to prepare a book such as *Cosmic Challenge*.

Harrington has structured the book differently from the other guidebooks with which I am familiar. First, he has dispensed with the "telescope talk" that starts off many astronomical texts. *Cosmic Challenge* assumes that you are an astronomer and that you already know the difference between a refractor and a reflector. Second, the introductory text focusses on making the most of what you have, in terms of dark adaptation, understanding magnification/field of view, and other concepts that are critical when observing difficult objects. While the writing is a bit technical, good information is provided and I learned a few things in perusing it.

The sections are organized according to optics needed, proceeding from the unaided eye, to binoculars and 3- to 4-inch telescopes, to medium apertures (6-8-inch), large apertures (8-12-inch), and very large apertures (12-inch and beyond). Each section includes a mixture of features and objects drawn from all aspects of visual astronomy (Solar System, deep-sky, double stars, and so on), and each object has been chosen to represent a "cosmic challenge" of one kind or another, for example: lunar features at a specific phase; Martian features requiring strong magnification and favourable observing conditions; double stars (just) visible to the unaided eye; faint deep-sky objects; and the use of smaller optics to detect something usually viewed with a larger optical system.

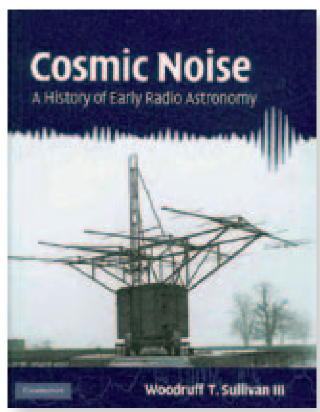
Each page includes a four-star rating, description of the object, astrophysical background information, and a detailed finder chart and hand-sketched eyepiece diagram to give you an impression of what to expect in the eyepiece of your telescope. It is very much a personal list from an experienced observer (in much the same way that David Levy's recent book *Deep Sky Objects: The Best and Brightest from Four Decades of Comet Chasing* is also a very personal list), and it is clear that the author has enjoyed using the "cosmic challenge" concept to bring together a very eclectic list of objects that are certain to contain some that most of us would not have thought of observing before (*e.g.* try to observe M81 from a dark-sky site with the unaided eye).

If there is a weakness with the book, it is that completing the "cosmic challenge" as a whole would appear to be more or less impossible, particularly from a light-polluted environment. It might make a good project for someone at an excellent site, but it contains too many rare objects for the average backyard astronomer to tackle. On the other hand, one does not purchase a book such as *Cosmic Challenge* in order to observe everything, but more for the enjoyment of finding something interesting to observe not seen previously. The organization of *Cosmic Challenge* (by season and aperture) makes it simple enough to identify an observing challenge for the next observing run. The lengthy descriptions provided by Harrington provide a wealth of context—historical and astrophysical—to enhance one's enjoyment of each object. Finally, the helpful finder charts and eyepiece diagrams are very useful for finding objects. In particular, information on obvious star-hops and nearby reference stars can help, particularly with binocular challenges.

In all, *Cosmic Challenge* is an enjoyable read, and works both as an armchair astronomy book and as a field guide, something that very few books do effectively. The quality of the editing and presentation by Cambridge University Press are excellent, and the author writes in an engaging manner aimed at the experienced amateur.

Denis Grey

Denis Grey is a past president of the Toronto Centre and finds observing from downtown Toronto challenging at the best of times.



Cosmic Noise: A History of Early Radio Astronomy, by Woodruff T. Sullivan, III, pages 574, 19 cm × 25 cm, Cambridge University Press, 2009. Price $130 hardcover (ISBN: 978-0-521-76524-4).

Is there such as thing as a young science? *Cosmic Noise: A History of Early Radio Astronomy* takes the reader on a multi-national adventure spanning the serendipitous discovery of galactic radio emission in 1932 through to the establishment and recognition of radio astronomy as a separate discipline in the early 1950s. In less than 80 years, radio astronomy has helped us discover and understand the radio universe of black holes, pulsars, and solar emission.

Although *Cosmic Noise* was published in late 2009 by Cambridge University Press, author Sullivan began gathering interviews, notes, and key papers in 1971, shortly after completing a Ph.D. in astronomy. *Cosmic Noise* is a mammoth work, combining research, technical information, historical studies, and subtle social commentary into an interesting guide to the entire field of radio astronomy, with a focus on post-World War II advancements in the USA, England, Australia, Canada, Japan, the former USSR, and the Netherlands. It will appeal to astronomers, engineers, historians, and curious individuals who, like their predecessors Karl Jansky and Grote Reber, wished to understand the sky at radio wavelengths.

Sullivan starts close to home and takes us out into our galaxy and beyond. Early efforts to detect solar Hertzian waves, the effect of sunspots and solar prominences, and the challenge of monitoring solar bursts began with early explorers like Charles Nordmann, a graduate student, who attempted to observe the Sun at radio wavelengths from the French Alps. Sullivan notes how there was a shocking 40-year gap before anyone accidentally or purposefully discovered the Sun's radio emission with Stanley Hey's work in 1942. Next, we move outward, to Karl Jansky, trying to eliminate shortwave radio static noise at Bell Labs in 1928, a scant 17 years after Marconi first succeeded in sending radio signals across the Atlantic. Jansky discovered galactic emission, and today the non-SI unit of flux density carries his name (Jy = 10^{26} W m^{-2} Hz^{-1}).

Backyard science began with young Grote Reber, an amateur radio enthusiast (call sign W9GFZ), who eventually built a 160-MHz parabolic dish, about 31 feet in diameter, behind his home in Wheaton, Illinois, during the World War II era. He obtained very sensitive vacuum tubes through contacts at RCA and GE, and proceeded to engage in a radio survey of the night sky. His work revolutionized interest in the field, and he was one of the first people to convert his data to astronomical co-ordinates (right ascension and declination). A recurrent theme of *Cosmic Noise* is that many of the early researchers, even into the early 1950s, knew little to nothing of traditional astronomy (what we now call optical astronomy), and had to educate themselves on the basics in order to interact with their colleagues. Previously, because they could not make themselves understood, their work was often ignored.

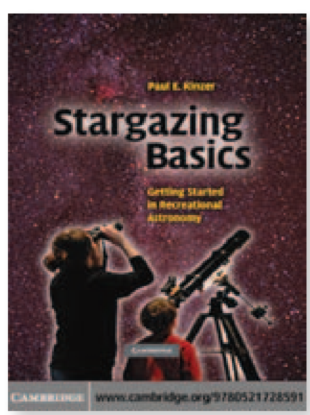
The outline of research at Cambridge, Manchester, Jodrell Bank, and Australia makes excellent reading, especially tales of erecting antennae in farm fields and the early struggles of pioneers like Ruby Payne-Scott, who made fundamental discoveries with her Australian colleagues, but was effectively forced to retire from the field once she married and had children. Work on the various big-dish projects is well documented, and early work on the 21-cm hydrogen line is presented with clarity. Toward the end of the work, we hear how John Bolton did a 1950 tour of major European observatories, helping them to understand the new science of radio astronomy. We also get a hint that Allan Sandage did not mention the optical identification of radio sources by his senior colleagues Walter Baade and Rudolph Minkowski in key research papers related to the 200-inch optical telescope at Palomar.

Two minor items came to my attention. First, the reader might be better served by a rework of the first chapter, as it attempts to organize the story by bringing together essential background and history with an explanation of the author's structure for the narrative. Separating the two topics into separate chapters would help the reader engage more quickly with the excellent material that is in 1.2.3 and then follows in chapter 2. It may be wise to read the two sections and then return to 1.3 later. The second is an incorrect spelling for the David Dunlap Observatory in Toronto, spelled "Dunlop" in two places, and correctly in another. Otherwise, there is excellent coverage of the subject matter, including Arthur Covington and Peter Millman's work in Canada, and details of groups around the world. Sadly, Woody Sullivan only takes us to about 1953, and so the rest of the story is yet to be written. We miss the stories that will hopefully come of Canada's Algonquin Radio Observatory, the SETI Institute's Allen Telescope Array, and the Atacama Large Millimetre Array in Chile.

Two of the gems of Sullivan's work are hidden in Appendices A & B. The first is a primer for the physics and techniques behind early radio astronomy. It contains everything you need to know in a nutshell about the basics, including an excellent tutorial on key concepts, and clear explanations at a high level of how radio equipment works. The second is an explanation of how the author did the oral history, recordings, and interviews that were essential to the book. The second appendix would have served well as part of the introductory chapter. The rich quotations, plentiful photographs, and excellent narrative make *Cosmic Noise* a most enjoyable, compelling, and authoritative read, and is highly recommended.

Colin Haig

Colin Haig, M.Sc., is 2nd Vice-President of the RASC, a former employee of a Lucent New Venture company (a Bell Labs successor), and holder of a Certificate of Proficiency in Amateur Radio with the Advanced Qualification, allowing him to legally build radio equipment to listen and transmit to extra-terrestrial and terrestrial entities.



Stargazing Basics: Getting Started In Recreational Astronomy, by Paul E. Kinzer, pages 160, 18 cm × 25 cm, Cambridge University Press, 2008. Price $20 softcover (ISBN: 978-0-521-76559-1).

Stargazing Basics delivers exactly what the title promises, the very basics of stargazing for the beginner, from using unaided eyes for viewing, to purchasing and observing with a telescope. It provides anyone with an interest in astronomy a helpful and relatable guide to get past the problems and frustrations a beginner faces.

Stargazing Basics is written in relaxed, friendly, first-person prose. Author Paul Kinzer owns and runs *Seeing Stars: Portable Planetarium and Star Parties*, and has been a professional educator for 12 years. He keeps things light, almost never getting technical. Even when technical, the explanations are clear and concise, and continue to keep things interesting and understandable for the reader.

The book opens with an inviting introduction that answers the basic question commonly asked by those with an interest in astronomy, but with few resources: Where do I go from here? It also provides an accurate explanation of what to expect in the book. The style is engaging from the start. It is divided into three parts: Part I about equipment (including naked-eye), purchasing and using binoculars and a telescope, Part II providing beginners with some objects to find using whatever method selected, and Part III provides a glossary with terms highlighted in bold print.

Although the book has three parts, only the first two are intended to be read; the glossary serves as a reference. *Stargazing Basics* provides good tips for observing naked-eye and makes an excellent case for buying binoculars first and a telescope later. For the former, the author lays out all of the options and accessories with their pros and cons, before making a personal recommendation for those who are still unsure. The initial explanations and descriptions are unbiased. A brief introduction to astrophotography is included.

At the end of most chapters is a handy list of resources, including books, star charts, software, Web sites, magazines, dealers, reviews, and astronomy clubs. They are excellent additions to the book. Each topic is touched on briefly. Should readers find a certain subject interesting, such as astrophotography or deep-sky objects, they are provided with a way to find out more about the particular topic.

One thing that was somewhat distressing was the lack of warning about the dangers of not using proper filters when observing the Sun, although obvious to even a beginner. Necessary warnings were not stressed enough when talking about solar observing through binoculars or a telescope. Mentioned in passing on page 24, the dangers of observing the Sun without a filter are not properly explained until page 79.

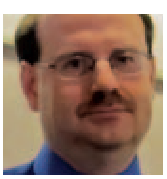
Near the end, *Stargazing Basics* becomes more technical and at times almost boring. Pages describing the properties of Mars or globular star clusters make the end of the book seem to drag relative to the easy-to-read earlier chapters. Though necessary to truly teach beginners all they need to know, portions will slip over the heads of some.

Stargazing Basics does more than just talk about the Solar System or telescopes. It covers some of the most common problems and frustrations faced by those beginning in astronomy. It guides readers through problems such as the department-store telescope or the fancy, but complicated, features a beginner does not need. People can become frustrated by such problems and lose interest in astronomy altogether. The book takes readers around such problems and helps them get straight to the good stuff: observing!

Holly Ayles

Holly Ayles is a Grade 9 member of the New Brunswick Centre, with a long-standing interest in astronomy and science, which she shares with her father James. Holly's work on light-pollution EPO has won numerous awards, the latest being first prize (younger age division) in the International Statistical Literacy Poster Competition at the 58th ISI World Statistics Congress in Dublin for "La Pollution Lumineuse" in collaboration with her friend and colleague Emily Baxter.

New Qilak Award for Astronomy Outreach and Communication



Dave Lane
Awards Committee Chair, RASC

The Awards Committee formally announces and calls for the first nominations for the new **Qilak Award** for Astronomy Outreach and Communication. This award was developed jointly and is sponsored by the RASC, the Canadian Astronomical Society, and la Fédération des Astronomes Amateurs du Québec and results directly from the partnership formed for International Year of Astronomy. Each organization may select only one award recipient each year.

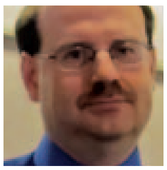
The Qilak Award is intended to recognize individual Canadian residents, or teams of residents, who have made an outstanding contribution, during a particular time period, either to the public understanding and appreciation of astronomy in Canada, or to informal astronomy education in Canada, and to promote such activities among the members of the sponsoring organizations. The awards do not recognize achievement in formal astronomy education or achievement by a person or team of persons in the performance of their regular duties in their job or profession.

To be eligible for the RASC-sponsored award, a nominee or a team of nominees must be a RASC member(s). Nominees must have made the contributions being recognized while working in Canada.

Nominations are solicited from anyone familiar with, or knowledgeable of, the nominee's or nominees' achievements. A letter of nomination should highlight how the nominee or team of nominees have distinguished themselves in this endeavour and/or cite exceptional achievement. Nominations received but not awarded for the current year's competition will remain under consideration for the following year.

For more details about the award and how to make a nomination, see www.rasc.ca/awards (click on Qilak Award in the menu). The deadline for nominations is 2011 December 31. ✶

Call for Nominations for RASC National Awards



Dave Lane
Awards Committee Chair, RASC

The RASC sponsors several annual national awards that recognize achievement or service by our members. These awards include:

- the **Chant Medal** is awarded, not more than once a year, to an amateur astronomer resident in Canada on the basis of the value of the work carried out in astronomy and closely allied fields of the original investigation and specifically not for the services of the Society, worthy though these may be.
- the **Ken Chilton Prize** is awarded annually to an amateur astronomer resident in Canada, in recognition of a significant piece of astronomical work carried out or published recently.
- the new **Qilak Award** for Astronomy Outreach and Communication recognizes individual Canadian residents, or teams of residents, who have made an outstanding contribution, during a particular time period, either to the public understanding and appreciation of astronomy in Canada, or to informal astronomy education in Canada, and to promote such activities among the members of the sponsoring organizations.
- the **Service Award** is given to members in recognition of outstanding service, rendered over an extended period of time, where such service has had a major impact on the work of the Society and/or of a Centre of the Society.
- the **Simon Newcomb Award** is intended to encourage members to write on the topic of astronomy for the Society or the general public, and to recognize the best published works through an annual award.

More detail, including eligibility and nomination requirements for each award can be found at www.rasc.ca/awards.

The deadline for nominations is **2011 December 31**. Send the nominations or questions about the awards programme to Dave Lane, Awards Committee Chair at dave@davelane.ca. ✶

Astrocryptic Answers

by Curt Nason

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23 K	L	I	N	E	■	24 C	I	R	C	L	E	T

It's not all Sirius—Cartoon

by Ted Dunphy

Society News

by James Edgar
(jamesedgar@sasktel.net)

I write this while on board Air Canada 857 Heathrow to Toronto, having spent nearly four weeks in the UK. I even managed to do some observing there, as we enjoyed clear skies, a daytime Moon, and even a hint of aurora! In mid-September, I was honoured to be in the observatory of one Nigel Ball (www.nigelaball.com). You may even see an article from him in this *Journal* one day.

By the time you read this, National Council meeting #4 of 2011 (NC114) will likely be over, and we Councillors will be thinking about setting the 2012 budget for March at NC121. In the running of a large business, there are always decisions to be made, and this one is no exception. We are extremely fortunate to have a competent Executive Director at National Office who now has the responsibility to make those decisions in consultation with the Executive Committee. Of course, National Council is the Board of Directors, so are involved in the approval of overall planning—that's what the meetings are for.

Our publications are on an even keel and production is on time or ahead of time—all good news.

Our influence in the area of light-pollution abatement continues at the pinnacle of success—we have more Dark-Sky Preserves to our credit, and the most hectares, of any other country in the world. We are currently in the process of trade marking that term (in both official languages), an operation taking about two years and costing over $1000.

As winter approaches, but dark skies abound early in the evening, take some time to get the telescope or binoculars out and observe. Clear skies! ✶

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Executive committee and appointed officers for 2011/Comité exécutif et membres attitrés pour 2011

Honorary President	Jim Hesser, Ph.D., Victoria
President	Mary Lou Whitehorne, Halifax
1st Vice-President	Glenn Hawley, B.Sc., B.Ed., Calgary
2nd Vice-President	Colin Haig, B.Sc., M.Sc., Hamilton
Secretary/Recorder	James Edgar, Regina
Treasurer	Mayer Tchelebon, MBA, CMA, Toronto
Past Presidents	Dave Lane, Halifax and Scott Young, B.Sc., Winnipeg
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Editor of Observer's Handbook	David M.F. Chapman, M.Sc., Halifax
Editor of The Beginner's Observing Guide	Mary Lou Whitehorne, Halifax
Editor of Observer's Calendar	Dave Lane, Halifax
Executive Director	Deborah Thompson, CAE, Toronto

Centre addresses/Adresses des centres

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

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Niagara Falls ON L2E 6A2

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Vancouver Centre
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Victoria BC V8T 3Z8

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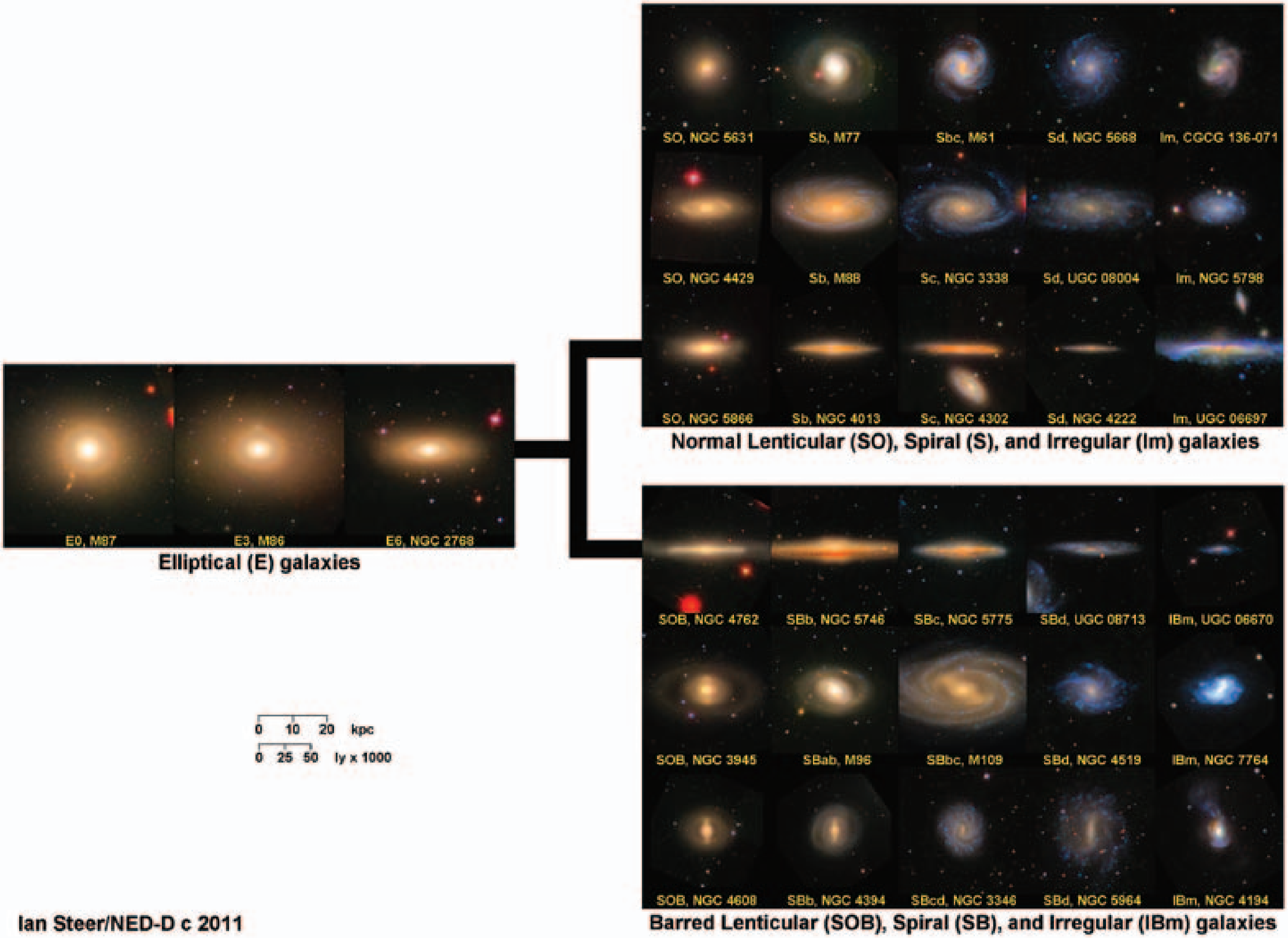

Journal

Great Images

HUBBLE TUNING FORK SHOWN TO SCALE USING NED-D: Hubble's galaxy evolution sequence suggests ellipticals evolve into both normal and barred forms of lenticular, spiral, and irregular galaxies. It has been largely supplanted by Toomre's sequence, which suggests spirals collide, merge, and evolve into ellipticals. Shown here are the largest examples of each Hubble type found from among eight thousand galaxies in the NASA/IPAC Extragalactic Database of galaxy Distances (NED-D) that have both redshift-independent distance estimates and published Hubble types. NED-D's sample is large enough to provide three-views for all types following ellipticals, including examples seen edge-on, face-on, and at intermediate angles. NED-D's mean distance estimates allow examples to be shown with absolute diameters set to a common scale, rather than apparent diameters as usual. All images are from the Sloan Digital Sky Survey, except for IBm, NGC 7764 from the SIMBAD database.