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December / decembre 2008 Volume/volume 102 Number/numéro 6 [733]

Journal

The Journal of the Royal Astronomical Society of Canada

Le Journal de la Société royale d'astronomie du Canada

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Building for the International Year of Astronomy (IYA2009)

December / decembre 2008

Journal

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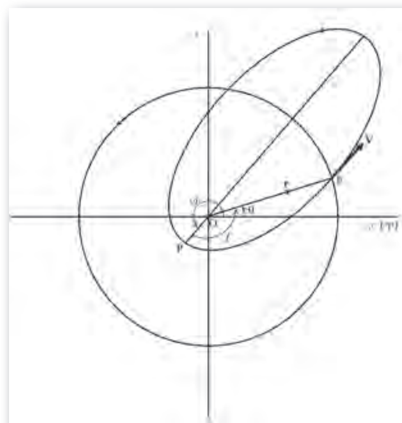

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Royal Astronomical Society of Canada   Société Royale d'Astronomie du Canada

DEPARTMENTS

Cover photo:
On the weekend of 2008 October 13 to 15, the Executive Committee of The Royal Astronomical Society of Canada gathered in Halifax, Nova Scotia, for an "Autumn Atlantic Executive Retreat." Jo Taylor, the Society's Executive Secretary, joined President Dave Lane, 1st Vice-President Mary Lou Whitehorne, 2nd Vice-President Glenn Hawley, Treasurer Mayer Tchelebon, and National Secretary James Edgar to discuss the affairs of the Society, make some plans, and try to resolve some pressing issues. The photo, taken by Jo Taylor, is outside Dave Lane's Abbey Ridge Observatory, from left to right: Mayer Tchelebon, Mary Lou Whitehorne, Dave Lane, James Edgar, and Glenn Hawley.

COLUMNS

Executive Perspectives

by Mary Lou Whitehorne, 1st Vice-President

After 20+ years of astronomy education and outreach work, the power of the stars to interest, excite, and delight never ceases to amaze me!

I recently had the opportunity to address a small rural community hall filled with people. They were retired professionals: engineers, academics, business people, and artists. None had ever really had the chance to think about the stars before. The rural skies of this seaside location are dark, and when it is neither rainy nor foggy, they are brilliant with stars.

These folks had heard vague rumours of an astronomer in their midst. They invited me to speak to their group. I presented them with an illustrated talk about stars and stellar evolution. I wanted to enable them to see the stars as dynamic and changing objects worthy of interest and publicly funded research dollars. My ploy worked. In so doing, and without planning it, I delivered my first 75 "Galileo Moments" for International Year of Astronomy, albeit a little early.

One day later, standing in a neighbour's garden, Galileo Moment #76 happened. It was the day before the autumnal equinox, and my neighbour asked about the timing of the equinox. I could see the cartoon light bulb glowing brightly over his head, when he understood that the equinox occurs at the same instant globally. He had thought that it followed the time zones and occurred progressively over a 24-hour period around the world. Potato patches are good for more than growing potatoes! Those wonderful "Aha!" Galileo Moments can happen anywhere and anytime. Be on the lookout for one lurking in your own backyard.

Officially, IYA2009 does not begin until January. However, I like the idea of getting started early with my contribution to the lofty Canadian IYA2009 goal of one million Galileo Moments. I prefer to call it good time management.

There is a small army of people in Canada gearing up for IYA2009. They include RASC members, and people from the Canadian Astronomical Society (CASCA), Fédération des Astronomes Amateurs du Québec (FAAQ), the National Research Council, the Canadian Space Agency, universities, museums, science centres, planetaria, the media, and more. RASC Centres are preparing their own outreach events, and the national Society will be supporting them with materials developed especially for IYA, such as the astronomy trading cards, the sidewalk astronomers' handbook, the star-finder project, the kids' storybook, sky quality meters for loan, and more. It is going to be a big and busy year. The RASC is ready to bring the Universe down to Earth for hundreds

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.

The *Journal of The Royal Astronomical Society of Canada* is published at an annual subscription rate of $80.00 by The Royal Astronomical Society of Canada. Membership, which includes the publications (for personal use), is open to anyone interested in astronomy. Applications for subscriptions to the *Journal* or membership in the RASC, and information on how to acquire back issues of the *Journal* can be obtained from:

The Royal Astronomical Society of Canada
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Toronto ON M5R 1V2, Canada
Internet: nationaloffice@rasc.ca
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Telephone: (416) 924-7973
Fax: (416) 924-2911

Canadian Publications Mail Registration No. 09818
Canada Post: Send address changes to 136 Dupont St, Toronto ON M5R 1V2
Canada Post Publication Agreement No. 40069313

We acknowledge the financial support of the Government of Canada, through the Publications Assistance Program (PAP), toward our mailing costs.

Canada

U.S. POSTMASTER: Send address changes to IMS of NY, PO Box 1518, Champlain NY 12919. U.S. Periodicals Registration Number 010-751.
Periodicals postage paid at Champlain NY and additional mailing offices.
The *Journal* is printed on recycled stock.

of thousands of Canadians. There will be Galileo Moments galore!

All this is not to say that 2008 has not been just as busy as 2009 promises to be. We had more than our fair share of challenges in 2008. Legislative changes to Canada's charitable tax laws have set us on the road to changes in our fee structure and many other aspects of how our Society conducts its normal business affairs. We have begun to address this issue, but the work will continue for a while yet before we can say we have all the required adjustments complete. Bonnie Bird retired after many years of stellar service. Jo Taylor, our new Executive Secretary, is working long and hard to "keep the lights on" during this period of transition. Work continues on our new business-management software and good progress is being made. All of this was complicated and slowed down by the difficulties with our upstairs tenant. That too, is being slowly resolved.

The challenges of the past year have been overwhelming at times, making it difficult for some of us on the executive to embrace the challenges of IYA2009 as joyfully as one would otherwise expect. However, I am delighted to report that the continued hard work of many RASC volunteers (you know who you are!) and our staff have successfully pushed us "over the hump." Yes, there is lots of work yet to be done, and we will do it. The RASC will emerge as a stronger and better Society for the future.

The International Year of Astronomy came along at just the right time for the RASC to shine as brightly as the stars themselves. Get out there and enjoy the glow of a million Galileo Moments!

Wanted:
Eager Beavers Who are Not Afraid to Get Creative

Your Society needs you, your energy, and your creative skills!

IYA2009 is coming fast and there's lots to do. Apart from all the fun things that will happen during IYA, we still need quick-thinking astronomers to beaver away in the background, keeping the RASC lights on and the engines ticking over.

Would you like to hone your Web skills with us? Or maybe you would enjoy tackling marketing and promotions, or helping to coordinate a group of like-minded volunteers?

Make your mark by contacting 2nd Vice-President Glenn Hawley [glennhawley@shaw.ca] or 1st Vice-President Mary Lou Whitehorne [mlwhitehorne@hfx.eastlink.ca].

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.

Early Years at the David Dunlap Observatory

by Victor Gaizauskas, Herzberg Institute of Astrophysics, National Research Council, Victor.Gaizauskas@nrc.gc.ca

Abstract The author recalls his earliest memories of the David Dunlap Observatory, the personalities of its staff and students, and its working atmosphere when the observatory was struggling to recover from the lean years following WWII.

1. Introduction

The International Year of Astronomy 2009 celebrates astronomy and its contributions to society and culture on the 400th anniversary of the first telescopic observations of celestial objects by Galileo. We are now living in a golden age for astronomy and astrophysics. A dazzling array of earthbound and space-based telescopes, each tailored to a particular range of wavelengths for maximum efficiency, has opened the entire electromagnetic spectrum to astronomers. The size and complexity of existing instruments, those under construction, and those still in the proposal stage are breathtaking. *Quo ducit Urania,* indeed!

Astronomers remain mere mortals, however: they cannot do everything they would like to. Some projects have to be abandoned, while newer, bolder, and more exciting ones are picked up. A recent victim in this process of regeneration is the David Dunlap Observatory (DDO), once near Richmond Hill, now embedded in it. The closing of DDO is bitter news to those who have lost their jobs and access to a still-useful research tool. It is also sad news for many Canadian astronomers whose road to a professional career passed through DDO. I spent two summers and one winter vacation there as a student assistant, in 1950-51. These are some of my memories of a much simpler time and of some of the people who worked there.

2. Opening Day for the DDO

Let us regress to 1935 May 31, the day DDO opened. Page 3 of *The Toronto Daily Star* for 1935 June 1 (`http://thestar.pagesofthepast.ca`) has a generous spread of photos and text about the grand opening. A thousand invited guests attended, including some of the cream of Toronto's elite as well as "luminaries," as *The Star* called them, from afar. I find several features in *The Star's* report worthy of comment.

First is the attire of the males who were the chief celebrants: black morning tailcoats, pinstripe trousers, grey vests, wing collars, and top hats in black silk or grey — the full kit. Clarence Augustus Chant is so attired and in addition wears an expression like a cat licking cream. After all, this day is his 70th birthday, his official retirement as Professor and Founding Director of DDO, and his appointment as Professor Emeritus. It was probably also his choice of eminent luminaries to witness his Day of Glory as champion of a privately endowed observatory with the largest telescope in the British Empire. One eminent participant, seated to one side of the exclusive circle of the privileged, is not similarly attired. Rt. Hon. W.L. Mackenzie King, then the Leader of the Official Opposition in Parliament, wears a natty summer suit of light hue with matching Homburg casually perched on his knee. He had just recovered from an illness and made a last-minute decision to attend. As an undergraduate at the University of Toronto (UofT) during the opening decade of the 20th century, King had attended Chant's lectures on astronomy and physics. Of all the honours bestowed on Chant that day, none could have been more heartfelt than this gesture by a former pupil who was to become the Prime Minister of Canada again in a few months.

There is a religious strain to the proceedings, as evidenced by the sub-heading to the printed text ("Scientists see Enlargement of Soul in Increase of Knowledge of Infinite") and by excerpts quoted from speeches by various dignitaries on the theme: "to Heaven via the stars." We should not be surprised: the observatory was being dedicated as a memorial to Mrs. Jessica Dunlap's late husband, who had an abiding fascination with astronomy. The tone of the proceedings and the dress code accurately reflected the solemnity and dignity of the occasion.

3. My Early Impressions of Astronomy

From the 1935 news report alone, you would never guess that the grand celebration was staged in the middle of the Great Depression. In the working-class districts of Toronto, like the one I was living in surrounding Trinity-Bellwoods Park, the news of this lavish philanthropy would have been met with indifference. Ordinary working folk had far too many worries about the here and now to think about outer space. Photographs of men garbed like plutocrats would have signalled loudly that they were already living in another world, if only a long streetcar ride away. Spending my first 14 years in a working-class environment was no preparation for a life devoted to pondering the nature of the remote Universe. I saw daily how businesses operated on a *quid pro quo* basis. Where would you find anyone crazy enough to pay you any *quid* for a wagonload of celestial *quo?*

I had so much to learn. I entered the mathematics, physics, and chemistry program at the UofT in 1947, the year with maximum enrollment by veterans of WWII. The mood on campus was businesslike, with much talk of building a better Canada. I noted the option for taking astronomy courses in upper years, but that path was shrouded in mystery. I was intent on becoming a chemist. A career in chemistry offered a way to indulge my scientific curiosity while creating new substances of benefit to society. Alas, first-year chemistry lectures were a crushing bore. The overcrowded labs for quantitative analysis proved to be an exercise in frustration. I was disillusioned and unsure where to redirect my interest in science. University physics gave me the reverse experience: a subject served up as dry as dust in high school now fed my imagination through attention-grabbing demonstrations in mechanics, dynamics, and electromagnetism.

Third year found me enrolled in the physics and astronomy option, choosing astronomy entirely out of curiosity, oblivious to any interesting career opportunities it might offer. Professor Frank S. Hogg, head of the Department of Astronomy and Director of DDO, presented the astronomy lectures; Ruth J. Northcott supervised the laboratory classes. Their roles as Editors of the *Observer's Handbook* have been described by Bishop (2008). The lectures introduced us to positional astronomy and celestial mechanics. The complementary laboratory problem sets were eye-straining exercises in interpolating seven-place logarithmic and trigonometric tables. At the time, I thought of the subject matter as old-fashioned. Less than a decade later, however, celestial mechanics was the hottest topic on Earth, as thousands vied to be first in getting the orbital elements for *Sputnik*.

I did not distinguish myself nor show more than casual interest in astronomy classes until late in the course, when we were introduced briefly to stellar spectroscopy and spectral classification of stars, which definitely caught my attention. So it came as a surprise to receive a phone call from Prof. Hogg in mid-April with an offer of a summer position as student observer and plate measurer for the princely sum of $100/month. I was momentarily speechless, as much at the low pay (out of which I would have to pay for the extra streetcar fare to DDO, and food for dinners and breakfasts when observing) as by the fact that he bothered to pick me at all. Even though three months of pay at the DDO rate would not quite cover tuition fees, I accepted what was clearly a unique offer.

4. My First Day at DDO

A sunny morning late in May 1950 saw me set off from our Leaside home around 7 a.m. to catch a radial streetcar bound for Richmond Hill. The cars on the radial lines ran on a narrow gauge track from a station of their own at the top of the southern end of Hogg's Hollow, the northern city limit. It was a straight run of 18 km up Yonge St. at a speed rarely reaching 45 km h^{-1}. Depending on stops, it took about 40 minutes to reach Observatory Lane. There, when you stepped down from the trolley, you were unmistakably in the countryside. You faced a small farmhouse on the south side of the lane with a couple of sheds behind a fenced enclosure with goats and chickens. Looking up towards DDO, there was nothing but open meadows to either side of the unpaved lane.

As I set off on the long uphill walk, I reminisced about the first time I set eyes on DDO. Around 1938, I had made my first trip north of the city limits in the company of my parents and a family friend, who was driving us to view his newly acquired property on Lake Simcoe. After the car climbed out of the ravine at Thornhill, I spied on a low ridge east of Yonge St. a collection of unusual buildings resembling many black-topped silos crowded together. As we drew nearer, the unusual size and squatness of the largest "silo," and the symmetrical placement of the smaller black "silos" on a cut-stone building of formal design gave the buildings a menacing air. Perhaps this was a monastery for an exceptionally doleful religious order? Suddenly the light dawned! Earlier, I overheard the adults speak of a place "far up Yonge St." where human corpses were taken for burning instead of burial. This place must be it. I had visions of black-cowled figures sweating over their ghoulish task, so engaged in feeding their everburning fires that they never had time to clean the soot off the domed roofs above their ovens. Creepy! A few years later, when we finally had a family car, we sometimes drove past DDO on the way to Sunday picnics at Lake Wilcox, just north of Richmond Hill. By then the Observatory had lost its sinister gloom: further oxidation had rendered the copper domes a soft shade of green.

That was still how the domes appeared that sultry May morning in 1950 as I ascended the steepening grade, past the Director's House, heading eagerly for the shade offered by the elegant stone porch at the entrance to the Administration Building. I had set a goal for arrival at 8:30 a.m. I was right on time, thirsty and drenched in sweat, only to find the front door locked. After I pushed the doorbell a couple of times, the large door finally creaked open. I was face-to-face with Mr. Mackenzie, legendary custodian of this celestial palace-on-the-hill.

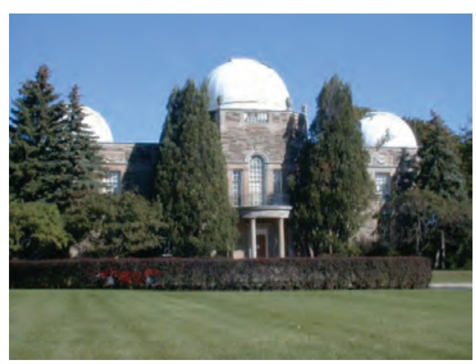

Figure 1— The western side of the administration building, the best-known view of the observatory. Image courtesy Slavek Rucinski.

"Mac," as he was universally known, was also the quintessential sentry. Woe betide those who committed an offence against the housekeeping rules, such as walking across the library's parquet floor in wet or muddy shoes, leaving an exterior door unlocked after night duty, leaving a clutter of books and papers on a library table when retiring for the night, or leaving a mess in the kitchen. They got a proper dressing down in Scots so thick that they might have recognized only every second or third word of his fiery reprimand.

When Mac ushered me into the entrance hall, I was awestruck by the architectural elegance of the interior. He suggested I sit on the stone bench against the wall facing the entrance to await the staff's arrival. That put me beneath the large multi-coloured stone tablet that commemorated the gift of the observatory to the university by the Dunlap family. Minutes ticked by and still no one appeared. The silence and the cold creeping from the stone interior into my clammy shirt reminded me of tombs and of my childhood delusion that this place was some kind of necropolis. I had to step outside from time to time to warm up. It was well after 9 a.m. before the first academic staff members arrived and my training began.

5. The Radial Velocity Program

DDO's first Director (as distinct from its Founding Director) was R.K. Young, an established authority in the measurement of the radial velocities of stars; *i.e.* the component of velocity in the line of sight. It is detected as a wavelength shift of spectral lines due to the Doppler effect. In practice, a spectrograph is used to record the spectrum of a star and, juxtaposed on the same glass photographic plate, the spectrum in the same wavelength range from a terrestrial source. Spectral lines from approaching stars are shifted to shorter (violet) wavelengths, while those from receding stars are shifted to longer (red) wavelengths relative to the terrestrial source. The single-prism spectrograph Young designed with the Adam Hilger firm in London became the sole research instrument attached to the 1.9-m telescope at its Cassegrain focus for over 20 years. It was very rugged, easy to use, and well suited for students to learn the technical arts of stellar spectroscopy.

Young took early retirement in 1946. By then he had trained two key persons who would carry on his meticulous approach to the systematic collection of data. Ruth Northcott completed her Master's degree under Dr. Young's supervision in May 1935, and was immediately appointed as a research assistant. She approached her work in measuring plates and calculating radial velocities with utmost respect for the data, with very high standards for accuracy, and with scientific rigour. She did her best to inculcate those same values in her students, politely but firmly leaving them in no doubt about what was expected at each step along the way. By nature, Ruth was orderly and self-disciplined. It was she who organized the observing records and set up the filing system and catalogues for the many thousands of plates. Each was inserted in a paper sleeve with all the facts essential for its identification written on it in a copperplate hand that revealed her natural artistic instincts. For relaxation, Ruth took up sketch pads and camera and headed for the fields around DDO or into the ravine behind her home in Hogg's Hollow. Her sketches and photographs of birds, flowers, and landscapes were the basis for larger works produced in her home studio.

The other key person appointed by Dr. Young, just months after DDO opened, was Gerry Longworth, still the only technician in 1950. He was a man with an impressive range of manual skills and an encyclopedic knowledge of all the things that went wrong during the operation of the telescope. Unlike Ruth, Gerry took a sanguinary approach to training new recruits, picked up no doubt during his service with the Royal Canadian Navy during WWII. His first words to us were about the order in which he would dismember our bodies if we brought any harm to the telescope, dome, or spectrograph. Next, he told of students who had run afoul of his instructions and why their names lived on in infamy in the private annals of DDO. He then proceeded to instruct us in the operation of the telescope and spectrograph.

6. My Fellow Students

Four students had been hired that summer. A.A. (Art) Griffin and R.F. (Ron) Rodgers were my classmates in physics & astronomy. It would be difficult to find two persons of more dissimilar temperament or outlook thrust together as lab partners. Art was a mature student, married, and an Army veteran. In a very unflappable way, Art lived his life one day at a time, extracting as much of its sweetness as he could. That often meant helping others, a tendency that came naturally from growing up in a large family in small-town Ontario. His handicraft skills were well known to the staff at DDO because Art had already served the previous summer as a student observer. He was much in demand to assist Gerry Longworth with equipment and was Dr. Helen Hogg's most trusted assistant for her observations of globular clusters.

At heart, Ron was an antiquarian absorbed with astronomical sightings recorded in ancient texts or on clay tablets. He taught himself ancient languages so that he could translate from the original. Comets were his especial fascination. As a highly skilled chess player, Ron attempted at times to apply chess-like logic to ordinary life, with hilarious results. He greatly enjoyed playing the devil's advocate during heated debates on issues large or small. Ron often managed to infuriate those he worked with, because he always had a better way to approach any task.

The fourth student was Barbara Creeper, a student from R.L. (Bob) Baglow's third-year astronomy class in the general arts program at UofT. Her fun-loving disposition and her insatiable curiosity about everything under the Sun remain undimmed to this day. Free-wheeling, often hilarious, Baglow's lectures ranged far beyond astronomy; they were ideally suited to Barbara's temperament. Baglow would have recommended her to the Director because he recognized her impressive organizational skills (something Bob himself woefully lacked!) and her formidable determination to get things done. She was about to display those qualities over an issue of gender inequality.

It was an iron-clad rule in those years at DDO that unmarried women were not allowed to observe at night. Because Barbara Creeper was assigned no duties as an observer, her pay was reduced to $75/month. It was not the lesser pay that rankled with Barbara as much as being denied the excitement of setting that huge piece of machinery on a star and letting it do its work, while she admired the diamond-studded sky from the steel balcony that girdled the outside of the dome. Such are every astronomer's happiest moments. Yet she was denied fulfilling that dream because she was a woman. Her response was to show that she was better than the male students at measuring spectrograms and at reducing her measurements for radial velocities.

The process of measuring spectrograms was entirely manual and very exacting (Young 1946). With over 20 stellar spectral lines, and as many lines again to measure on the reference spectrum, our prolonged peering through a microscope was a demanding, tension-generating operation. Try as we might, neither Art Griffin nor I could measure and calculate radial velocities for more than four spectrograms per seven-hour day. Barbara consistently finished five. Thus began a game based on "anything you can do I can do better" that, with varying levels of intensity on different themes, has engaged the two of us over 58 years.

7. Academic Staff

Staff numbers were small enough to count on the fingers of both hands (Figure 1). The staff members we saw most frequently were Ruth Northcott and Dr. J.F. (Jack) Heard. They arranged on many mornings for one or the other to drive students from the south end of Hogg's Hollow to the observatory. The best part of the pickup service was the informal conversation that ensued. Prior to that summer, a university professor was for me a remote, exalted figure. Everyone who remembers Jack Heard knows he was anything but remote. He was dignified and serious when the occasion demanded but lacked any trace of pomposity. He was a perceptive observer of the smallest human frailties. He caught me once in a slip of the tongue: I referred to the goats at the bottom of Observatory Lane as having paws instead of hooves. He howled with laughter at my city-bred ignorance and ribbed me mercilessly every time we drove past the goats. Years later, he was still twitting me over my *faux pas* during casual encounters at scientific meetings, especially when there was a witness to my torment.

Figure 2 — DDO staff, visitors, and graduate students in the observatory's library, early 1953. Figure courtesy of the author and Barbara Gaizauskas.

Seated on floor: Bill Hossack (graduate student), Barbara Creeper (graduate student and Secretary-Librarian), Frank Hawker (Assistant Machinist)

Seated: Dr. Helen Hogg, Dr. Clarence Augustus Chant, Dr. Ralph Williamson, Dr. Nancy G. Roman (Visiting Astronomer)

Standing: Edwin B. Weston (Baglow's replacement), Dr. Jean K. McDonald (Visiting Astronomer; later Dr. Jean K. Petrie), Gerry Longworth (Chief Machinist), Mrs. Kathleen Longworth, Mrs. Margaret Heard, Dr. Jack Heard (Director), Ruth Northcott, Gus Bakos (graduate student), Olga Boshko (graduate student)

Jack Heard is celebrated as a master raconteur. In 1950, shaggy-dog stories were much in vogue. Some of us were treated to an uproarious competition in this genre between Jack Heard and Frank Hogg. The venue for this match was the room beneath the telescope that contained the aluminizing chamber for the 1.9-m mirror. Art Griffin and I had assisted Gerry Longworth in removing the mirror from the telescope and lowering it through the observing room floor to the room below. We removed the old coating on the mirror with cotton swabs soaked in a solution of potassium hydroxide. We were helping Gerry to position coils of pure aluminum that would be fired electrically under vacuum, when the two "profs" arrived to monitor our progress.

While seated on a bench near the entrance door, they described the "good old days" before vacuum technology arrived. Then the mirror was silvered using solutions of silver nitrate. This nasty stuff blackened anything that it contacted. Before long, Frank Hogg had launched into the Tale of Jack Heard's Wedding Day, which recounted how Jack assisted in re-silvering the 1.9-m mirror the day before his wedding. Frank had a very droll way of spinning out the yarn from that point onward, eyes twinkling as he heaped one calamity on top of another. Whether or not Jack's predicament was as serious as described did not matter. The telling of the tale was a triumph of style. Under severe pressure to outperform, Jack countered with the Tale of the Super-Achieving Immigrant Farm Labourer. He spun out his tale in agonizing detail, with plenty of pregnant pauses to build up tension and to grab the listener's attention. The match was a draw. The punch lines in both stories, which made us double up with laughter, are now deemed politically incorrect, and cannot be committed to print without risking legal action.

This camaraderie among senior staff was wonderful to behold. Alas, their happy relationship was about to end. During the two weeks of our 1950 Christmas vacation, I observed every night with the exception of Christmas. New Year's Eve was bitterly cold, but I was rejoicing in my new fleece boots and ex-RCAF flight jacket. I was nodding off while seated next to an electrical heater in a small room on the east side of the observing floor when the telephone rang to shake me fully awake around 3 a.m. Prof. Ralph Williamson gave me the shocking news that Frank Hogg had just died of a heart attack. He told me to close up immediately, to go home, and not to return until further notice.

Ralph Williamson was the only theorist on the staff. He was appointed in 1946 to take up the position vacated by R.K. Young. He was very much an ideas man and did not take easily to observing. Normally good-natured, he could be downright grouchy on matters related to the operation of the 1.9-m telescope during his watch. A brilliant early Ph.D. student of Chandrasekhar's at Chicago, Ralph was the staff member who was best attuned to recent developments in astrophysics. All four of the 1950 crop of summer students enrolled in his final-year course in astrophysics. It was probably the most stimulating lecture series I attended in all my undergraduate years. He gave us a fascinating introduction to stellar interiors and stellar atmospheres at a time when there were no student textbooks on these subjects. Lawrence Aller's *Astrophysics: The Atmospheres of the Sun and Stars* was not yet published, but Ralph distributed copies to us of chapters in the manuscript that he managed to obtain from Aller. Barbara Creeper and I were so impressed with Ralph as a teacher that, along with graduate student Gary Hanes from the physics department, we enrolled in his graduate tutorial courses for the next two academic years.

Before coming to Toronto, Williamson had been at Cornell where he was associated with Charles Seeger in sparking interest in radio astronomy. He was deeply interested in the subject and wrote papers for a lay audience that are lucid summaries of a newborn discipline (Williamson 1948, 1951). He spoke on the subject to RASC Centres in Ottawa and Toronto, and participated in several action committees advising the American and Canadian governments on the value of radio astronomy. Ralph spent seven years at the UofT Astronomy Department, but at the end there was little physical evidence that radio astronomy had arrived. Would it have had he stayed longer? The question became moot at the end of the 1953 academic year, when he abruptly resigned from the university. His personal relations had deteriorated to the point where he saw leaving Toronto as his only alternative. He joined the Los Alamos Scientific Laboratory in New Mexico, where he spent the rest of his career working on weapons design, dying in 1982. For his former students, it was a disappointing end to a promising professorial career.

In 1950, Dr. Helen Sawyer Hogg was still ranked as a Lecturer, even though she already had an impressive list of publications and had recently been recognized by the American Astronomical Society for outstanding achievement, with the Annie Jump Cannon Award. She had just passed the mid-point in a long life that would see her become a prominent figure, not just among astronomers, but among the broad Canadian public (see her obituaries by Clement & Broughton (1993) and Pipher (1993)). A proud descendant of some of the earliest families to settle in Massachusetts, she filled her life with good works. She was a gifted communicator and educator, whether in her classes at UofT, speaking to the Centres of the RASC, or in the weekly column "With the Stars" in the *Toronto Star,* which she picked up and continued for 30 years after Frank Hogg's death. All this she did in addition to being the single mother of three grown children.

Dr. Hogg was usually scheduled to use the 1.9-m telescope on moonless summer nights to photograph globular clusters. May and August nights were long enough to photograph the same cluster more than once, as many hours apart as practicable. Her goal was to measure the periods of the RR Lyrae variable stars that served as distance indicators in globular clusters. Their periods are related to their absolute luminosities. When the absolute luminosity is combined with the observed brightness measured from photographic plates, the distance to the star, and hence the cluster, readily follows.

My first session with Dr. Hogg and Art Griffin was in August 1950. She stressed many times how important it was not to lose a single minute of a clear night. She set very strict conditions against any lights inside the dome, even when re-pointing the telescope. We worked in pitch blackness to minimize background fog on her exposed plates. She needed to preserve her dark adaption while changing from one cluster to the next so that she could rapidly locate and guide on her new target. Flashlights covered in red film were used only when absolutely necessary.

Dr. Hogg was stationed on a moveable platform that allowed her to reach the eyepiece at the telescope's Newtonian focus no matter where the telescope was pointed. Art Griffin did all the telescope pointing and coarse setting until Dr. Hogg could take over the fine guiding. I retrieved plateholders with exposed plates from a large cloth handbag, which she lowered with a clothesline from her perch, and replaced it with another containing a fresh plate for the upward journey. I then retired to a small dark room built inside the north pier to put the exposed plate inside a slotted, light-tight box. A second similar box was filled with fresh plates, from which I loaded one into the recently emptied plateholder.

As the night wore on and the number of plate exchanges grew, I worried lest I confuse the two boxes. After I made a plate exchange as described and closed the boxes, I decided to turn on the dark room light momentarily so that I could relocate them in a way that would prevent mistaking one box for the other. I turned off the light before opening the door and stepped out with the freshly loaded plateholder, only to realize I had lost my dark adaption. Thinking the north side of the pier was the safer bet to avoid the telescope, I rounded it only to slam into the telescope's spectrograph at waist height. Art had made a major change in hour angle while I was inside the darkroom. A shriek reverberated around the dome: "What was THAT!?!" I offered an explanation and my apologies, expecting a thorough chewing out. I did get a stern reproach, but the emphasis was mainly on the consequences to the observations, less on my negligence, and none at all on my person. It was an important lesson in behaviour under extreme provocation.

Provocation of another kind was the daily lot of Bob and Betty Baglow. They lived with two small sons in a house on the southern fringe of Richmond Hill, within walking distance of DDO. The older boy, John, was a hyperactive child who severely tested his parents' belief that pre-school children should be left to learn by their own devices so long as they did not endanger themselves or others. One morning a haggard Bob Baglow arrived very late. He had spent hours finding and re-installing the hinge pins that four-year-old John had removed from every door in the house! Some days, John would accompany his Dad to DDO bearing his favourite toy, a spring-loaded blunderbuss that fired ping-pong balls. The firing range was the length of the second-floor corridor, and his objective seemed to be to get as many ricochets off the walls and doorways as possible. His biggest shouts of glee were reserved for the ricochets that sent his projectile pinging its way down the grand staircase to the lobby below.

Bob worked with a photoelectric photometer attached to the 0.5-m telescope in the southern dome atop the Administration Building to observe eclipsing binary stars. Under the right circumstances, the dimming of one star by its companion allows orbital parameters to be deduced from the recorded light curve. A mathematical analysis of significant complexity is required to extract the desired parameters from data that must be very precise. Bob held an M.Sc. from Cambridge University, where he had conducted related research under the direction of R.O. Redman. He was frustrated in getting enough good observations under Ontario skies but managed a trip to gather considerably better photometric data at the Steward Observatory in Tucson, Arizona. That allowed him to complete and publish an analysis sufficient to fulfill the requirements for his Ph.D.

How Bob and Betty managed to maintain their household on his meagre salary as a university lecturer remains a mystery. My recollection is that lecturers then were paid an annual stipend somewhere below $2000. Half of that may have paid their rent. Clearly, their financial outlook was dire, so it came as no surprise when Bob resigned his position in June 1952 and joined the Operational Research Directorate of the Defence Research Board (DRB) in Ottawa. There he had a distinguished career wherein he practiced his considerable mathematical skills and his talent for "thinking outside the box" to the benefit of Canada's military. He was certainly a loss to the university. Bob was a highly articulate intellectual omnivore. He could hold forth with gusto on a broad range of subjects beyond science: current affairs, literature, philosophy, psychology, religion, and music. Every conversation with him was stimulating.

There is an afterword to the Baglow story that I heard during the decade after his resignation. Bob did not defend his thesis in person before a board of examiners. A member of this board was a senior Canadian astronomer acting as the external examiner. He returned his copy of Baglow's thesis unread because the copy was unclean: some pages were smudged, while others were stuck together with jam. Bob was so incensed by this insistence on form over substance that he "binned" the thesis and resigned without taking his degree.

Fifteen years as Professor Emeritus still saw C.A. Chant putting in several hours per day in his office next to the Secretary's on the ground floor. He was still Editor of the two publications of The Royal Astronomical Society of Canada: its *Journal* and the *Observer's Handbook*. He also conducted an extensive correspondence and worked on his autobiography. Chant lived in the nearby Director's House with the McKenzies as housekeepers. He was treated with reverential respect as the Observatory's Founding Father by the academic staff. Normally formal in manner, although not unfriendly, this frail-looking gentleman spoke so quietly that one had to strain to capture his meaning. His placid existence was rudely shattered by 1950's crop of summer students.

Figure 3 — A view of the Director's House from the southeast. Image courtesy Slavek Rucinski.

DDO had a long-standing problem with unrestricted access to Observatory Lane. Unwanted nocturnal visitors would not dim the headlamps on their cars as they drove up to the dome, heedless of all the warning signs along the way. It was proposed to relocate the access road to the south side of the Dunlap property, where a gate could be installed facing what is now 16th Avenue. That was a perfect job for summer students. Jack Heard drove three of us to the proposed gateway, and dropped us off with a theodolite, a bundle of wooden stakes, and a large sledgehammer. He drove in the first stake to mark the centre of the gate. From there we were to aim the theodolite on the large brass doorknob on the main dome and drive in a line of stakes spaced about 100 m apart until we encountered the existing roadway leading to the dome. Almost as soon as he left us, there were problems sighting the doorknob. Something appeared to be obstructing it as long as we kept to the original starting point. We walked uphill through the field until we identified the offending object. It was a dead fruit tree in the garden directly behind the Director's House.

Ron Rodgers immediately attacked the barren limb that seemed to be the main culprit with the sledgehammer. After a few loud whacks, the back door of the Director's House flew open and down the steps came a very agitated Dr. Chant brandishing his walking stick over his head, shouting hoarsely to cease and desist. Ron obliged but then launched into a justification for removing at least part of a lifeless tree in order to serve a higher purpose, namely, the construction of a road that would bury most of the garden in which we were standing. This news did nothing to subdue Chant's ire. What was an obstruction to us was his favourite pear tree still blossoming and bearing fruit in his imagination. As the discussion heated up, Art Griffin slowly slid the sledgehammer out of Ron's grip and began soothing Dr. Chant with apologies and a promise to consult with the Director about the desirability of a new road. We gathered up our unused stakes, retrieved the theodolite, and retreated to the Administration Building under the resentful gaze of the fuming octogenarian. Many years later, a new access road was in fact built, but it entered the observatory's grounds from the north.

I misjudged Dr. Chant's fragility again on New Year's Day, 1951, hours after the announcement of Dr. Frank Hogg's fatal heart attack. As I walked away from the DDO that morning to catch a streetcar for Toronto, I found the ground covered everywhere by ice and iron-hard snow. The wind was howling so fiercely that I could hardly stand erect. Yet, there was frail-looking Dr. Chant, then 85 years old, cape flapping behind him, sometimes billowing around him. With walking-staff in hand, he made his way alone across that treacherous ground from the Director's House along the brow of the hill just west of the dome. He was dressed completely in black and wore a Trilby, a kind of hat I had never seen before. It was a scene worthy of a Gothic horror film!

The last time I saw Dr. Chant was during a tea break at a joint astronomy-physics colloquium held in the small auditorium of DDO sometime in 1953. Barbara Creeper and I had set out the tea paraphernalia on one of the gleaming tables in the observatory's library. Chant was the only other occupant, when in shuffled Dr. John Satterly to join us. He was well known to Chant; both had taught undergraduate courses in the McLennan Lab for many years. Satterly relished his reputation as an eccentric Englishman. His annual lectures on the properties of liquid air were notorious across UofT's campus for his outrageous antics. These included: smashing a goldfish frozen in liquid air to smithereens with a hammer fashioned from mercury, similarly frozen; drenching wads of cotton waste in liquid oxygen, ramming them into long brass tubes, igniting them and aiming the brass tubes randomly at the audience. By 1953, Satterly was a Professor Emeritus in the physics department. Seeing Chant, he rocked back on his heels in mock astonishment and exclaimed: "Great Scott, it's Chant! You're still alive? When were you born, dear boy — 1066?" Poor Dr. Chant's reply was inaudible to us, but he seemed to take the assault on his dignity in good grace.

Figure 4 — A view of the DDO's library. The portrait above the fireplace is of David Dunlap. Image courtesy Slavek Rucinski.

8. The First Canadian Ph.D. Awarded in Astronomy

By 1950, DDO had accumulated thousands of spectrograms of roughly 1000 stars of spectral classes G and later; *i.e.* stars as cool as or cooler than our Sun. This collection was a major asset for research by graduate students. As the program on radial velocities wound down, Dr. Frank Hogg proposed to use the spectrograms to classify these stars according to their spectral classes and intrinsic luminosities. Several theses were accordingly prepared on this topic in the early 1950s. The first of them was also the first Ph.D. thesis completed in astronomy at a Canadian university.

W.R. (Bill) Hossack's project centred on the conversion of an existing stereocomparator into a device that rapidly scanned beams of light across two adjacent spectrograms and captured the transmitted beams with a photomultiplier. Because the electrical output was displayed on an oscilloscope, the device came to be called an oscilloscopic microphotometer. With it, an operator compared two spectrograms simultaneously: one from a star that was recognized as representative of a particular class or luminosity, the other from an unclassified star. This ambitious project, intended to speed up stellar classification and make it more objective, stretched the thin resources of DDO to the utmost. In 1950, the project lay as bits and pieces in the observatory's workshop, where Gerry Longworth was rebuilding the entire optical train. Bill Hossack was designing and building the electronic circuitry. The next summer saw the comparator rebuilt to Gerry's design and most of the electronic units built but untested. I still remember the great excitement late that second summer when Bill was called to sign for a parcel in the secretary's office. There, a small group gazed in awe into a brown box that contained a 3600-rpm Bodine synchronous motor. This was a long-awaited key component that would spin a mirror to direct beams of light alternately at two spectrograms. It would also spin a slotted disc that permitted one beam at a time to enter a photomultiplier (Hossack 1953). The excitement generated over an item that might have cost about $70 indicates how cash-strapped the observatory was at that time.

Bill possessed a warm, engaging personality that had its mischievous side. Lunch hours in the crowded kitchen always presented opportunities for leg pulling. One day Bill purposely brought in an issue of *Life* magazine that contained an article that identified personalities as compulsive Type-A super-achievers or as their laid-back Type-B opposites. No one could escape the ensuing good-natured personal scrutiny using the long list of qualifiers provided by *Life*. Bill waited until the din raised by the scrutinized victims reached a satisfactory level. Then, chair tipped back and eyes shining with mischief, he set the cat among the pigeons. "The trouble with you astronomers," he exclaimed, "is that you're a bunch of escapists and you refuse to admit it!" There was a moment of stunned silence, followed by a crescendo of denials. How I wish I had kept notes that day!

Bill was awarded his Ph.D. in 1953 and remained in the department for the next academic year as a Lecturer. A multi-talented individual who excelled at whatever he tried, be it golf, playing the cello or the trumpet, he found the life of an academic too tame. Unlike Bob Baglow, he had no serious financial problems; he and his violinist wife, Mary Ann Paul, were much in demand to entertain at various functions. Bill's mockery of astronomers as escapists was made not entirely in jest. After one year as Lecturer, he joined Bob Baglow in the Operational Research Directorate at DRB in Ottawa. A couple of years later, he returned to Toronto to work as a management consultant. He was attached as an advisor to the Glassco Royal Commission on Government Organization, when he and his wife were killed in a head-on collision on Highway 17 just east of Ottawa. Their five-year-old son was the sole survivor of this terrible tragedy.

9. Night Patrol

Unlike observatories built in prosperous times following WWII, DDO had modest facilities for its night workers. Storage space for food was at a premium. If you failed to bring a stock from Toronto, you had recourse to tinned food, milk, and bread at a small general store on the west side of Yonge St. at the entrance to Richmond Hill Village. To shop there meant a return journey on foot of more than an hour along a dirt road just north of the dome.

Sleeping quarters were in a cabin about 100 m SE of the Administration Building. It was built as a guardhouse when the Canadian Army had sealed off part of the observatory's grounds during WWII for secret research. The Army left behind several iron bedsteads; we each had to provide a mattress and bedclothes. Bunking down in a meadow on a hot summer's night meant lots of field mice and spiders for company. Ron Rodgers was particularly averse to cohabiting with these creatures. One cloudy night when both of us were trying to get some sleep, Ron kept jumping out of his bed to grab a broom so that he could slam at whatever had brushed against his face. Finally, I wrested the broom from him and stuffed it under my mattress lest he poke a hole through the screening that separated us from hordes of mosquitoes.

As a city boy, I was fascinated by the bird life in the surrounding meadows. I learned that first cockcrow need not herald the dawn: roosters seemed to crow anytime not long after midnight. When there was the tiniest streak of amber on the eastern horizon and a rooster did crow, a frenzy of birdsong would start up across the fields. This "dawn chorus" might last half an hour as each species responded in its own time. At its peak, the din could keep you from falling asleep. A night spent in our no-frills bunkhouse had its compensations. If you worked the second shift on a Saturday night, you might be awakened to the sweet smell of warm meadow grass and songs from meadowlarks accompanying the church bells ringing out from Richmond Hill for Sunday morning services.

Observing alone was great fun. There was competition among us to see how quickly we could change over from one star to the next. Four minutes was considered a good average to end one exposure, replace the exposed plate with a fresh one, set the next star onto the slit of the spectrograph, focus, and start a new exposure. Setting a star's declination caused most of the delays. There was a mismatch in the coarse and fine setting speeds. One could battle for minutes with the declination's pushbutton control. A more serious problem occurred less frequently: a dome that would not budge. You then had to go down one flight to the main control panel, find the sawed-off broom handle that served as an insulating prod, and poke at the electromechanical relays until a dome motor kicked in. Worse still was the refusal of the dome shutters to close, as happened to me one night when a light shower began. Similar poking at other relays had no effect. The backup was a manually operated crank on a platform just below the shutters. The attached gear train was so seized with rust from lack of use that I could not budge the crank. In the end, I locked the telescope in a near-horizontal position, closed down the canvas windscreens between the shutters, and prayed for help to arrive before the showers turned into rain.

10. Aftermath

As much as I enjoyed the summer work and the friendly staff at DDO, I could not see myself heading there for graduate work. Few choices in advanced astronomy were offered in those years and none appealed to me. In September 1951, when I entered UofT's Graduate School, the astronomy department had four graduate students: Bill Hossack and Ian Halliday at the Ph.D. level; Barbara Creeper and Ron Rodgers at the M.A. level. By contrast, the physics department had about 30 students divided among at least 6 distinct subject areas, and those students had higher levels of support. My choice was molecular spectroscopy, with H.L. Welsh as my thesis supervisor.

By then, Barbara Creeper and I understood that we would marry once we finished our graduate work. When Barbara took on the job of Secretary-Librarian at DDO along with graduate studies, I continued to participate with her at social events with the DDO staff, like a member of an extended family. When Barbara and I did wed in 1954, the staff presented her with a silver tray. On it was engraved the main dome at DDO according to a sketch prepared by Ruth Northcott (Figure 5). Jack Heard proposed the toast to the bride. Ruth's Christmas cards came yearly, each handmade to a design of her own. When Ruth died at the early age of 56, we were invited to choose two of her paintings. Her two oils remind us daily of the long-lost rural landscape surrounding DDO.

From our perspective as students, working at DDO in its bucolic setting during the early '50s was a dream come true. In our innocence, we were oblivious to the fact that the department lay becalmed. It received slim financial support from the university. Through a series of harsh and unforeseeable circumstances, especially WWII, it had difficulty building up staff. The radial-velocity program had run its course, yet there was no bold vision for future development. Small wonder the department had difficulty attracting graduate students. It was not the glowing future forecast in the opening celebrations of 1935.

The turnaround began with the new academic year in 1953. Jack Heard, now the director, made two appointments that injected much needed vitality: D.A. (Don) MacRae as Associate Prof. replaced Williamson, and J.B. (Bev) Oke as

Figure 5 — Engraving on a silver tray of DDO according to a sketch by Ruth Northcott.

Lecturer replaced E.B. Weston (who had replaced Baglow). Both were UofT graduates who had worked at DDO as summer students; both earned Ph.D. degrees in astrophysics at prestigious universities in the U.S. The most tangible sign of a fresh wind rising was the replacement around 1957 of the prism spectrograph on the 1.9-m telescope with a grating spectrophotometer designed by Oke and MacRae. MacRae initiated a collaborative program with the Department of Electrical Engineering at UofT in 1956 to design antennae suitable for radio astronomy. His initiative soon grew into a major activity within both departments. Although Oke left for Caltech in 1958, Sidney van den Bergh arrived that year, and at once extended the department's programs to include extragalactic systems. That was also the year of *Sputnik* and the sudden awakening of public interest in all matters related to space. By 1960, the department had ten graduate students. More staff appointments further broadened the Department's offerings in courses and the scope of its research. When Heard handed over the chairmanship and directorship of DDO to MacRae in 1965, 21 graduate students were enrolled in the Department. It was finally on its way to its present status as a major national and international centre of astronomy and astrophysics.

The autumn of 1978 was the very last time I visited DDO. I stopped by on my way to a workshop at Ann Arbor, Michigan. I wanted to see how well their new microphotometer would reveal detail in my dense photographs of a very large solar flare. Since my previous visit was over a decade earlier, I had to adjust to profound changes. Direct approach via Observatory Lane was no longer possible due to residential developments. The necessary diversion took me through a small forest of pines that once were seedlings planted by the staff, including Barbara, the day before our wedding. Afterwards, as I drove downhill back to Yonge St., I groaned at the extent of development of the entire western ridge. In my mind, I blanked out row-upon-row of look-alike houses and replaced them with a moonset I

Figure 6 — An aerial view of the DDO taken by Peter Ceravolo in April 2005. Used with permission.

had witnessed at the end of an observing session one August morning in 1950.

I had been very tired but satisfied with my trouble-free night of observing and my harvest of spectrograms. The full Moon had been my silvery companion throughout the night. When I stepped out of the ground-level door, I had an unobstructed view of both western and eastern horizons. The Moon was silvery no longer — it had the colour and texture of a wheel of aged Gouda cheese. It was suspended by almost its own radius over the western horizon and so enlarged that I felt I could reach out and touch it. Such was the illumination that the Moon seemed no longer a disk but a hemispheric bulge out of the plane of the sky. Even more surprising, I felt that I was standing above the fulcrum of a gigantic teeter-totter. The western horizon was rising to cover the Moon; the eastern horizon was dipping through a bright scarlet and orange band to reveal the brilliant Sun. The sensation that the ground under my feet was tilting was so intense that I leaned back to balance myself against the dome's door. Finally, a spell that lasted perhaps 15 seconds was broken. The usual perception of Earth's rotation as celestial motion was inverted in those brief moments. I came to understand Dr. Chant's need to regard the barren trunk in his garden as a once-blossoming pear tree. I can use the memory of my own magic moment to replace present reality with a vision wherein DDO is still nestled in a pastoral landscape.

I dedicate this memoir to Barbara, without whose encouragement I might never have become a research scientist, and to our son Robert and his son Leo, both of whom need to know how intimately their lives are linked to a special place at a very special time. I am deeply indebted to Art Griffin, for it was his recommendation of me to Dr. Frank Hogg for summer employment in April 1950 that set the course of my life in astronomy.

Vic Gaizauskas was born in Toronto in 1930. He completed his Ph.D. studies in 1955 and joined the solar program at the Dominion Observatory in Ottawa the same year. Ten years later, he undertook site surveys and design studies that led to the creation of the Ottawa River Solar Observatory (ORSO) for time-lapse photography at high spatial resolution of the dynamic solar chromosphere. He is a Past President of the Canadian Astronomical Society and of Commission 10 (Solar Activity) of the International Astronomical Union. He continues as a Visiting Worker to explore the connection between the decay of solar active regions and solar prominences using the data from ORSO (1970 — 1992) archived at the Herzberg Institute of Astrophysics.

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Calculating Meteoroid Orbits

Part I: Two Dimensions

by Jeremy Tatum, Victoria, British Columbia

1. Introduction

Those who watched the British television comedy show *Yes, Minister* may remember how Sir Humphrey Appleby often used to reply to a perfectly straightforward question with the enigmatic response, "Well, yes and no." Annoying as it might be, that would probably be an accurate response to the question: "Is it easy to calculate the pre-encounter orbit of a meteoroid?"

A slightly more informative answer might be: "Yes — if we know the velocity of the meteoroid as it approaches Earth, it is exceedingly easy, and this article will show exactly how." However, it should be said at the outset that the precise determination of the velocity of an incoming fireball is a very difficult matter indeed, and is not covered in this article, so from that point of view, the answer is "No."

For our present purposes, however, we shall suppose that the velocity has been determined, and the aim of this article will be to give a short tutorial for the armchair astronomer armed with no more than a simple hand calculator on how to calculate the pre-encounter orbit of a meteoroid from its measured velocity.

The immediate quantity that can be determined — though not without a great deal of difficulty — from an observation is the angular speed of the meteor across the sky. But, in order to determine the linear speed of the meteoroid through the atmosphere, we need to know its distance from the observer, as well as its direction of motion. Again, this can be determined only with considerable difficulty; but the velocity through the atmosphere is not what we need in order to determine the orbit. What we need is the velocity of the meteoroid in space before the encounter with Earth. As the meteoroid approaches Earth, its velocity (that is, its speed and its direction of motion) is changed by the gravitational attraction of Earth. And, then, as it plunges through the atmosphere, its speed is drastically reduced. If we have managed to measure the velocity through the atmosphere, we must first allow for the drastic deceleration through the atmosphere before we can calculate the orbit. Then, we must allow for the change in velocity caused by the gravitational attraction of Earth before its final approach. Finally, we must bear in mind that, in order to calculate the orbit, we need the pre-encounter velocity relative to a Sun-centred inertial reference frame, rather than the velocity of the meteoroid relative to the moving Earth. Thus, after correction for atmospheric deceleration and gravitational attraction, we need to subtract (vectorially, of course) the velocity of Earth from the measured velocity of the meteoroid. Methods for doing this have been discussed in previous articles in this series. In any case, it will be appreciated that the accurate determination of the pre-encounter velocity of a meteoroid is not at all a trivial task.

Nevertheless, for the purpose of this tutorial article, it will be supposed that the relevant velocity has been determined, and that we are ready now for the relatively easy task of calculating from this the pre-encounter orbit of the meteoroid. I shall not be *deriving* the various formulae. Rather, I shall merely present the necessary formulae so that a reader in possession of a good scientific calculator will be able to calculate an orbit without getting too heavily bogged down in mathematical details.

In calculating the pre-encounter orbit of a meteoroid, we are not involved with high-precision celestial mechanics. At best we have available only a rough estimate of the velocity of the meteoroid, and we cannot pretend to perform calculations to a higher precision than is warranted by the relatively imprecise measurements of velocity that are usually available. For that reason, for the purposes of this article, it is assumed that Earth's orbit is a circle of radius 1 AU, even though the distance of Earth from the Sun in fact varies from 0.983 to 1.017 AU. The angular speed of Earth in its orbit is taken to be constant at 0.017 202 098 95 radians (0.985 607 668 6 degrees) per mean solar day, its orbital period being 365.256898 mean solar days. If 1 AU is taken to be $1.495\,978\,7 \times 10^8$ km, this corresponds to a speed of 29.78469 km s^{-1}.

2. Two Dimensions

We shall start with a two-dimensional version of the problem. We assume that the motion of the meteoroid is entirely in the plane of the ecliptic (the plane of Earth's orbit). We define what we mean by the *elements* of the orbit. We make clear what velocity information we are given. And, we show how to calculate the former from the latter. When we have mastered that, we move on to three dimensions.

In Figure 1, the circle represents Earth's orbit and the ellipse represents the orbit of the meteoroid, both moving counterclockwise. The origin, O, of coordinates is the Sun. The x-axis is directed towards the First Point of Aries, ♈, which the Earth passed on 2008 September 22 (UT). The point E is the position of Earth and of the meteoroid at the time of encounter. The vector **r** (of magnitude 1 AU) is the radius vector of Earth

It is often said that an astronomical unit is the average distance of Earth from the Sun. As Professor Joad [*an English philosopher and broadcasting personality - Ed.*] might have said, it all depends on what you mean by "average," and indeed also by "astronomical unit." Earth's orbit is approximately an ellipse with semi-major axis approximately 1 AU. But what is the "average" distance of Earth from the Sun? Readers of this *Journal* may recall the article by van de Kamp (1960) in which he discussed the possible meanings of "average." When applied to Earth's orbit around the Sun, van de Kamp's formulas show that the mean distance of Earth from the Sun is 0.99986 AU or 1.00014 AU depending on whether it is averaged over the true anomaly or the time. The mean of the reciprocal of Earth's distance from the Sun is 1/0.99972 AU^{-1} or 1/1.00000 AU^{-1} depending on whether it is averaged over the true anomaly or the time. Thus, it does indeed depend on what you mean by "average." Further, for precise calculations in celestial mechanics, the AU is defined without any reference to planet Earth at all. It is the distance at which a body of negligible mass would orbit the Sun in a circular orbit with an angular speed of 0.017 202 098 95 radians per mean solar day, or a period of 365.256898 mean solar days. From that point of view, one could regard it as mere coincidence that Earth's orbit happens to have a semi-major axis of length about 1 AU!

and meteoroid at encounter; it makes an angle θ with the *x*-axis. P is the perihelion of the meteoroid's orbit. The angle ω is the *argument of perihelion*. The angle *f* is the *true anomaly* of the meteoroid at the time of encounter. The symbol *ν* is often used for true anomaly, but I am using *f* (an occasionally used alternative) to avoid any possible confusion with speed. The three angles shown are related by $f = \theta - \omega$ to which 360° can be added if (as in the drawing) $\theta - \omega$ is negative. The vector **V** is the instantaneous velocity vector of the meteoroid.

The coordinates *x* and *y* are tabulated for every day in the *Astronomical Ephemeris* but not, unfortunately, in the *Observer's Handbook*. However, to the approximation, that Earth is moving in a circular orbit of radius 1 AU at a constant angular speed $\dot{\theta}$ (whose numerical value is given in Section 1), the angle θ is just given by $\theta = \dot{\theta}t$, where *t* is the time in mean solar days that has elapsed since the previous September equinox. Then $x = \cos\theta$ AU and $y = \sin\theta$ AU.

For the two dimensional problem, an *orbit* is defined by four *elements*. The first two are the *semi-major axis a* and the *eccentricity e* of the ellipse. (We assume that the meteoroid orbit is an ellipse, although there is evidence that some meteoroids arrive at Earth from outside the Solar System, in which case their orbits will be hyperbolic.) The third is ω, the *argument of perihelion,* and the fourth is *T,* the time of perihelion passage.

The two given data are the radius vector **r** and the velocity

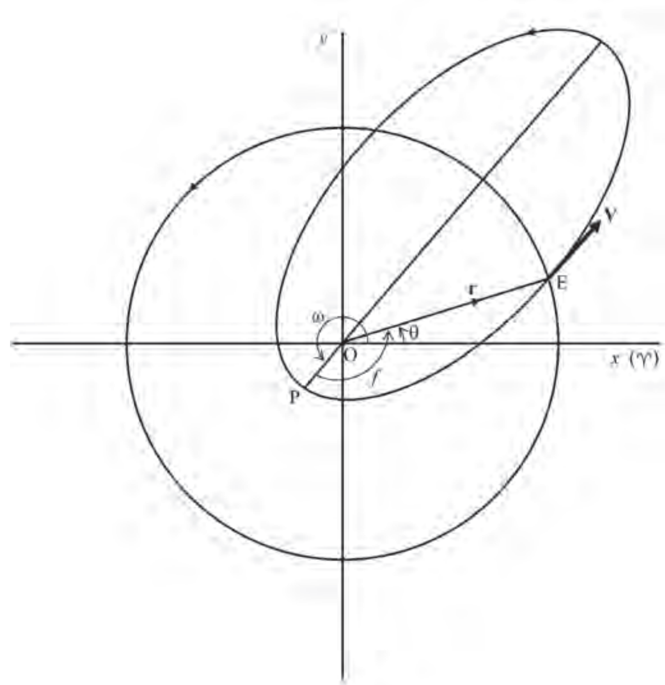

Figure 1 — Illustrating the geometry of an orbit in two dimensions.

vector **V**. Each of these has two components and so we have four presumed known quantities. Our object now is to determine the four orbital elements, given these four quantities.

The easiest element to calculate is the semi-major axis *a,* which is given simply by

$$a = \frac{1}{2 - V^2}. \qquad (1)$$

Here *a* is the semi-major axis, in AU, of the meteoroid's orbit, and *V* is the magnitude of its velocity **V** at encounter relative to the Sun-fixed coordinates of Figure 1, in units of 29.78469 km s^{-1}.

When you have found *a,* it is easy to calculate the *period P,* which is given by

$$P^2 = a^3, \qquad (2)$$

where *P* is the period in sidereal years, and *a* is the semi-major axis in AU. Because of this simple relationship, the period is not regarded as an independent orbital element, because, if you know *a,* you automatically know *P*.

It will be noted from equation (1) that if $V = \sqrt{2}$ which corresponds to a speed of 42.1 km s^{-1}, *a* becomes infinite. Speeds faster than this correspond to hyperbolic orbits and hence to interstellar meteoroids that have arrived from outside the Solar System.

A little bit of calculus is always good for the brain, and it is instructive to differentiate equation (1) to obtain

$$\frac{da}{dV} = \frac{2V}{(2-V^2)^2} = \sqrt{4a^3(2a-1)} \qquad (3)$$

What this equation tells us is how large an uncertainty there is in the semi-major axis as a result of an uncertainty in the speed *V*. For example, the following table gives, as a function of the measured *V* and computed *a,* the uncertainty in *a* corresponding to an uncertainty of 1 km s^{-1} in *V*.

Measured *V* km s^{-1} AU	Computed *a* AU	Uncertainty in *a*
26	0.81	0.04
28	0.91	0.05
30	1.01	0.07
32	1.18	0.10
34	1.43	0.16
36	1.85	0.28
38	2.67	0.61
39	3.48	1.06
40	5.04	2.29
41	9.34	8.05
42	73.51	511.18

The table shows that, for speeds less than about 33 km s^{-1}, the calculated semi-major axis will have an uncertainty of less than about 10 percent. For larger speeds, corresponding to meteoroids originating in the main asteroid belt, the uncertainty is much more serious. For speeds that would correspond to orbits larger than the main asteroid belt, we really have *no idea whatever* what the pre-encounter size of the meteoroid's orbit was. And, from equation (2), we perceive that the uncertainty in the deduced period is 50 percent greater than the uncertainty in *a*. These figures should be borne in mind when assessing assertions, not all of which are believable, that are pronounced distressingly often about the origins of fireballs observed by eyewitnesses, or indeed measured by instruments unless measured with high precision.

The next element to yield is the eccentricity, *e*. To obtain this, I have redrawn Figure 1 as Figure 2, stripping away everything except the axes and the position and velocity vectors, and I have added a couple of angles. Since we are assuming that **r** and **V** are known, this implies that we know the angles that they make with the *x*-axis (θ and ψ respectively) and of course then we also know the angle α, which is ψ − θ.

From the dynamical theory of an elliptic orbit, the angular momentum per unit mass of the meteoroid is $\sqrt{G\mathrm{M}a(1-e^2)}$. Geometrically, this must equal the moment of momentum per unit mass with respect to the Sun, which is $rV\sin\alpha$. Here *G* is the universal gravitational constant, and M is the mass of the Sun. If we equate these two expressions, and express distances

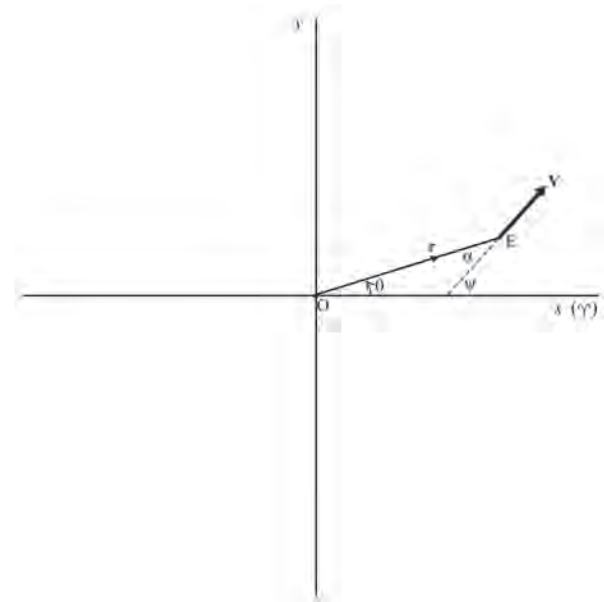

Figure 2 — Illustrating the angles ψ and α.

in AU and speed in units of $\sqrt{G\mathrm{M}/a}$, which is the speed of Earth in its orbit around the Sun, (29.8 km s^{-1}), we obtain

$$V^2 \sin^2\alpha = a(1-e^2). \qquad (4)$$

If we combine this with equation (1), we obtain

$$e^2 = 1-(2-V^2)V^2\sin^2\alpha. \qquad (5)$$

and so we have calculated the eccentricity.

In Figure 3, I draw graphs of *e* versus *V* for various values of α. These graphs illustrate that small uncertainties either in *V,* the speed, or in α, the direction, can give rise to large uncertainties in the deduced eccentricity, particularly where the slopes or the separations of these graphs are steep. For example, if α = 90°, a 10 percent uncertainty in *V* gives rise to a 20 percent uncertainty in *e*. To this must be added the additional uncertainty in *e* arising from the likely considerable imprecision in the direction α.

The equation to an ellipse in polar coordinates is

$$r = \frac{a(1-e^2)}{1+e\cos(\theta-\omega)}. \qquad (6)$$

At Earth encounter, *r* = 1, so ω is now determined, except for a quadrant ambiguity, which we shall discuss during the course of the numerical example that follows.

The last element to be determined is the time of perihelion passage, *T.* To do this, we first calculate a series of angles,

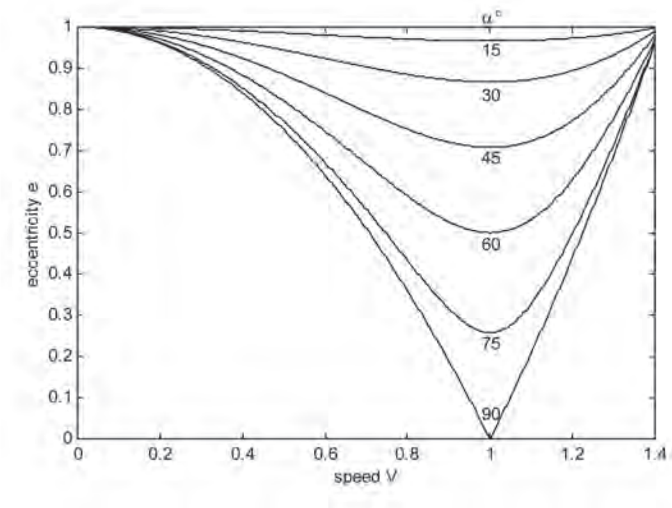

Figure 3 — The relation between the measured orbital speed and the deduced eccentricity. Where the graphs are steep or widely spaced, small uncertainties in V or in α translate into large uncertainties in the deduced eccentricity.

denoted by *f, E,* and *M,* called respectively the true, eccentric, and mean anomalies, and which are given by the following series of equations:

$$f = \theta - \omega, \tag{7}$$

$$\cos E = \frac{e + \cos f}{1 + e \cos f} \tag{8}$$

and

$$M = E - e \sin E \tag{9}$$

At last, we can calculate the time(s) of perihelion passage from

$$T = t - \frac{MP}{360} \pm nP. \tag{10}$$

Here M is the mean anomaly in degrees, n is any integer (which might conveniently be taken to be zero), and t is the instant of encounter of the meteoroid with Earth. It is important, of course, that T, t, and P all be expressed in the same units (for example sidereal days and decimals of a day).

A numerical example is surely in order. In 2008, Earth is on the x-axis at the time of the September equinox, which is at 2008 September 22.6556 UT = day 266.6556. Let us suppose that a fireball is seen at 2008 October 7.9000 = day 281.9000, which is 15.2444 days after the equinox. Earth is assumed to move in its orbit at 0.985 607 668 6 degrees per day, so at the time of the meteoroid encounter, $\theta = 15°.0250$.

Let us further suppose that we have determined that the velocity of the meteoroid is 38.0 km s^{-1} (so that $V = 1.276$) at an angle of $\psi = 75°$ to the x-axis.

From equation (1) we immediately obtain

$$a = 2.686 \text{ AU}. \tag{11}$$

(Note that if the speed were actually 39.0 km s^{-1} rather than 38.0 km s^{-1}, the semi-major axis would be 3.503 AU — which illustrates, even at this rather modest speed, how very sensitive the calculation of a is to small uncertainties in the speed. Note also that, in order to obtain satisfactory results, all decimal places of intermediate calculations should be retained and not rounded off prematurely.)

Equation (2) tells us that

$$P = 4.403 \text{ sidereal years} = 1608.1 \text{ days}. \tag{12}$$

Now, $\alpha = \psi - \theta$, so that $\alpha = 59°.975$. Equation (5) tells us that

$$e = 0.739. \tag{13}$$

Next we go to equation (6), which we can invert and set $r = 1$ to give

$$\cos(\theta - \omega) = \cos f = \frac{a(1 - e^2) - 1}{e} = 0.2980. \tag{14}$$

Now comes the quadrant ambiguity referred to earlier, for this equation has two solutions, namely

$$\theta - \omega = f = 72°.6601 \text{ or } 287°.3399\,, \tag{15}$$

corresponding to $\omega = 302°.3649$ or $87°.6851$. (16)

The two possible ellipses, as seen from the north ecliptic pole, are shown in Figure 4, in which Earth's orbit is the circle. The encounter is at the point where both ellipses and the circle intersect. We do not immediately know in which ellipse the meteoroid is moving, or indeed, whether it is moving clockwise or counterclockwise. However, inspection of the velocity vector **V**, which makes an angle 75° with the x-axis, immediately shows us that the orbit is the upper ellipse (with $\omega = 302°$ and $f = 72°.7$), and that the motion is counterclockwise.

In preparation for the calculation of the time of perihelion passage, we calculate the eccentric and mean anomalies from equations (8) and (9), recalling that we already know $\cos f$ from equation (14). Attention should be given to a possible quadrant ambiguity in determining E from equation (8): E and f are not always necessarily in the same quadrant. We obtain

$$E = 31°.8202 \text{ and } M = 9°.5028. \tag{17}$$

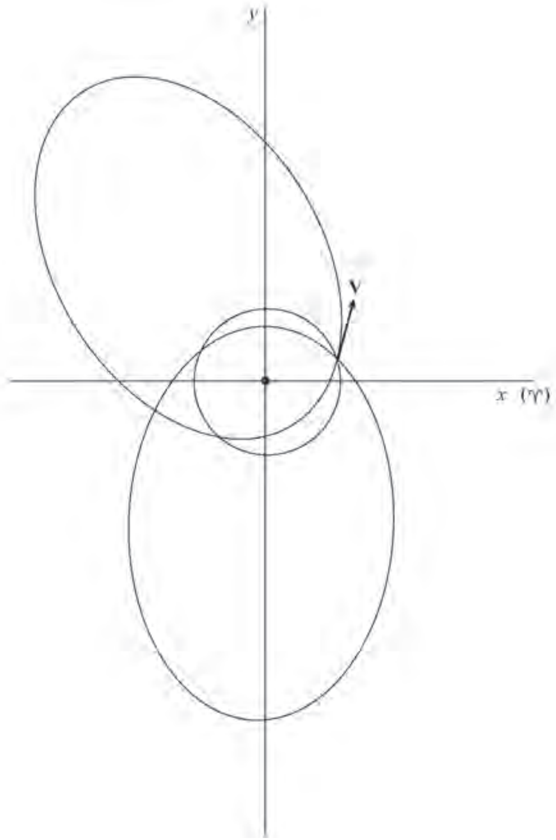

Figure 4 — A quadrant ambiguity in the solution of the equations gives rise to two possible ellipses. The ambiguity is immediately resolved by inspection of the velocity vector.

Previously, we had calculated that the period P is 1608.1 days, so that $MP/360 = 42.4$ days.

The time of the encounter was 2008 October 7.9000, so that the time of perihelion passage was 44.4 days before this, which was

$$T = 2008 \text{ August } 26.5, \qquad (18)$$

and the calculation is complete.

The following table summarizes the above discussion and gives three additional data sets for practice.

Time of event (day of year)	Speed km s^{-1}	ψ deg	*a* AU	*e*	ω deg	*T* (day of year)
281.9	38.0	75	2.686	0.739	302.4	239.5
302.6	24.0	186	0.740	0.888	197.2	259.6
329.1	19.2	205	0.631	0.876	228.4	281.0
304.5	31.2	142	1.108	0.264	121.7	240.1

The reader may notice that, in each case, we have been able to determine the four elements, *a, e,* ω, and *T* from apparently only three data, namely the velocity (speed *V* and direction ψ) and date of the occurrence. But, in fact, a fourth datum is given, namely the distance from the Sun, which was 1 AU.

Next time, in the second part of this article, we shall try the calculation in three dimensions.

Reference

Van de Kamp, P. 1960, JRASC, 54, 167

Daniel Knode Winder (1828-97) the First President of the Toronto Astronomical Club

by Peter Broughton, Toronto Centre (pbroughton@3web.net)

Abstract D.K. Winder was born and died in the U.S.A., but he lived in Canada for about fifteen years. During his time here, he became the first president of the Toronto Astronomical Club (1868) and a founder of the Toronto Entomological Association (1877). He wrote many religious articles and books and a booklet on mushrooms in which he identified a new species. Two letters to *Scientific American* in 1869 show he was a pioneer in studying the spectrum of the aurora. He was also an early "sidewalk astronomer," taking his telescope to the people.

Introduction

The Toronto Astronomical Club, the first of its kind in Canada, is just one year younger than our nation. After a period of doubtful existence and a number of name changes, the club evolved into the society we know today as the RASC. With the passage of 140 years, few records of the club's beginnings remain, and references to its first president, Daniel Knode Winder, are widely scattered. No obituary of him ever appeared in the publications of the Society — just a brief sentence about his passing. An obituary was published in a Detroit newspaper, together with his likeness (Figure 1).

Nearly everything that has been written of the earliest days of the Toronto Astronomical Club, or Society as it became in 1869, originates with Andrew Elvins (1823-1918). He was the driving force behind its creation and knew Winder well. It may seem strange that Elvins, always considered the energizer of the astronomical society, was not the first president. In fact, he never held that office. His deference to Winder, whom he considered to have a better education, was mirrored at the time of the Society's incorporation in 1890, when he demurred in favour of Charles Carpmael, the director of the Toronto Observatory.

Figure 1 — This line engraving is reproduced from a microfilm copy of Winder's obituary in The *Evening News* (Detroit) 1897 November 1, 2.

By the early years of the twentieth century, the Society was well established and some members began to realize even then that its history was in danger of slipping away. Perhaps on his own initiative, Elvins dictated some recollections, first in 1904 to L.H. Graham, and then in 1913 to C.A. Chant. They both took down in shorthand, and then transcribed, what Elvins told them. In 1917, A.D. Watson added his own comments in his presidential address published in the *Journal,* claiming that Winder was "a former lecturer on Astronomy in a United States College," and that he was "a kindly and sanguine person and very popular." In 1919, Chant clearly used the dictated notes in writing Elvins' obituary for the *Journal*. Here is a quote from that obituary that refers to Winder:

> *During the American civil war, [Elvins] came in contact with Daniel K. Winder, who was an enthusiastic student of science. He had been a professor in an Ohio college (at or near Cleveland), but was a pacifist, being opposed to war under all circumstances, and also holding the view that the Bible tolerated slavery. Consequently, he found it very uncomfortable in Ohio and so came to Toronto, where he settled and obtained a living as a printer. He also preached for the Disciples [of Christ], but as there were very few of that religious view in Canada, they could not employ a regular preacher. Mr. Winder was a good botanist, and while on pleasant walks he made Mr. Elvins acquainted with the various species of trees, and also introduced him to the use of mushrooms. Mr. Winder was the author of a book on the mushrooms of Canada. Besides this, he was well informed in astronomy and possessed a two-inch telescope. Mr. Elvins was allowed to use this and spent many pleasant hours with it.*

Though nothing in that passage contradicts anything that Elvins said, the original transcriptions suggest that Winder had a hard time making ends meet. Elvins says the Disciples would have provided the necessities of life for Winder and gives his opinion that Mrs. Winder was a better printer than her husband. Some corroboration that his printing business was not a great success may be found in the 1876 city directory where his occupation is no longer printer but pianoforte dealer.

Recent Biographical Research on Winder

In recent years, online genealogical records and other databases (especially `www.ancestry.com`) have allowed a fuller picture of Winder to emerge. Daniel Knode Winder was born in Hagerstown, Maryland, in 1828, the son of Daniel Winder, a clergyman, and Catherine Knode. His ancestors had come to the United States from England in the early 1700s. He may have moved to the American Midwest with his parents; the 1840 census for Cambridge Township, Wayne, Indiana, lists a Daniel Winder as the head of a household with six children under the age of 15. Certainly, by the time he was in his teens, Daniel K. Winder was in New Paris, Ohio, where he published a small religious monthly, the *Reformer,* from 1843 to 1845. After marrying Mary Jane Miller in Champaign County, Ohio in 1848, they had three children — two girls, Ida May and Jennie, and a boy. Champaign County seems to have been a centre of settlement for a number of branches of the Winder family. The 1850 US Census shows Daniel K. Winder in Campbell, Kentucky; his father was in nearby Jefferson Township. By 1853, and for the next five years, he is listed as a printer in Cincinnati city directories. At about the same time, he took out six US patents, mainly for improvements to printing, but one was for a bed-bottom and another for a method to raise water. The 1860 Census puts him in Cuyahoga, Ohio, his parents now in Millcreek Township, Ohio, where they ended their days. In 1861-62, he was pastor of Franklin Circle Christian Church in Cleveland. His son Daniel Carey was born in 1863 near Urbana, Ohio.

In an article about this son in *Landmarks of Detroit,* his middle name is spelled Cory, and it is stated there that the family moved to Toronto in 1864. Otherwise, the first indication of the Winders' presence in Toronto dates to 1866 when Daniel K. Winder printed a pamphlet and appears in the city directory.

Another conscientious objector who came north during the Civil War was John Muir (1838-1914). He spent two formative years in Meaford, Ontario, from 1864 to 1866, where he joined the Disciples church. After the war ended, he moved to California, where he became a renowned conservationist. Though there is no evidence that Winder and Muir knew one another, it is not difficult to think of them as kindred spirits, seeing God's grandeur in nature and the cosmos.

Winder's Astronomical and Technological Achievements in Toronto

As mentioned above, Winder's connections with Elvins and the astronomical society began in 1868 or perhaps earlier. There is little note by Elvins (1868) in the *Astronomical Register,* an English periodical for amateur observers that had started up in 1863. In it, Elvins alludes to observations he and Winder made jointly of a sunspot that June. They were convinced that it was rotating — just an illusion no doubt, but indicative of the care they took in examining the detailed appearance of the spot.

For RASC members, Winder's two letters on the spectrum of the aurora in *Scientific American* of 1869 are probably his most striking contribution, since they were written when scientists were just beginning to grapple with the physical properties of the aurora. To put Winder's observations in context, note that Anders Ångström, professor of physics at the University of Uppsala in Sweden, was apparently the first person to study the auroral spectrum, when he observed a faint display of the northern lights during the winter of 1867-68. As part of his famous work *Recherches sur le spectre Solaire* published in 1868, Ångström wrote that the auroral light was almost monochromatic with a wavelength in the green part of the spectrum at $\lambda = 5567$ [556.7 nm]. On widening the slit on his spectroscope, he found three feeble bands in the spectrum near Fraunhofer's F line [486 nm]. Ångström found it remarkable that he had observed this same auroral green line in the spectrum of zodiacal light and of sky-glow the previous year, yet it did not coincide with that of any gas, simple or compound, that he had studied. He concluded his article with a look to the future: "It follows from what I have said, that an intense auroral display ... will probably give a more complicated spectrum than the one I have observed. Supposing that to be true, there will be some hope of explaining more easily the origin of the rays found and the nature of the phenomenon itself [my approximate translation]."

Winder may not have read Ångström's own words, but he was aware of his research from reading an account of a meeting of the RAS, as reported in the *Astronomical Register* for May 1869. J.J. Plummer of Durham presented a paper based on his own observations of the auroral spectrum, and in the ensuing discussion led by William Huggins, G.B. Airy, and Warren De La Rue, Ångström's work was alluded to. Observers like Ångström, who used a grating to disperse the light into its spectrum, calculated the wavelengths of spectral lines they saw with their spectroscopes. Those using a prism, like Plummer and presumably Winder, measured the relative position of the lines, and inferred the wavelengths in relation to known lines, such as the ubiquitous D lines of sodium near 589 nm and other Fraunhofer lines.

Winder, in his first letter to *Scientific American,* published 1869 October 9, described the aurora he had seen on September 3 in terms that remind us that city residents in those days had very little light pollution to dim their fine views of the night sky. "[The] aurora borealis hung over us, waving like luminous canvas floating in the breeze, and forming a brilliant corona near the star Scheat, in Pegasus." He reported, "On this occasion I submitted the aurora to a careful spectrum analysis," a surprising accomplishment for an amateur just two years after Anders Ångström had examined the spectrum of the aurora for the first time. Winder went on to say, "I succeeded in obtaining a distinct spectrum, consisting of one very bright line in the yellow and one faint line in the green. The bright line was close to the sodium line D, and coincident with an air line in the solar spectrum. The dim line in the green I could not identify as belonging to any known substance."

It may be that Winder even built his own spectroscope. His obituary in the Detroit *Evening News* of 1897 November 1 credits him with building "the first spectroscope in the Dominion." While that priority is probably unverifiable, it is known that in 1869 Winder spoke on "The construction and application of the spectrograph to celestial chemistry" to the Astronomical Club and to the Canadian Institute.

The same obituary also states that he built the first Edison phonograph and the first Bell telephone in the Dominion. Though these claims are dubious, it is not unreasonable that he built such devices. Instructions on how to build a telephone, for instance, appeared in *Scientific American* for September 1878. The earliest reference to the phonograph in Toronto newspapers seems to be 1878 May 11, the year before Winder left to return to the States.

By the time Winder wrote his second letter to *Scientific American,* dated 1869 November 15, and published December 25, he had studied more auroral spectra and was more confident. "The bright line seen by myself, I found to be very nearly 557 [nm]" he wrote, and went so far as to attribute it to oxygen. He based his conclusion on telluric absorption lines seen in the solar spectrum when the Sun was near the horizon. His attribution was not that surprising, considering that nitrogen and oxygen make up 99% of the Earth's atmosphere, but it is an interesting coincidence that someone in Toronto should associate the green line with oxygen, perhaps for the first time, many decades before its firm identification with that gas was established in 1925 by University of Toronto professor J.C. McLennan and his graduate student Gordon Shrum. The spectral line at wavelength 557.7 nm comes from an electron transition in oxygen that requires about 0.4 seconds to occur. Normally such a transition cannot take place, since collisions will de-excite the atom much faster, but in the rarefied upper atmosphere (100 km or higher), the transition does occur. Of course, no one in Winder's time knew anything about atomic structure and would not have understood what McLennan and Shrum proved, but his scientific contemporaries did find his letters interesting.

P.H. Vander Weyde, Chair of Industrial Science at Girard College, Philadelphia, responded to Winder's first article with a somewhat critical letter in *Scientific American* (1869 November 20). Winder's second letter, partly in reply to Vander Weyde's, was reproduced in *Scientific Opinion,* an English periodical that advertised itself as "a weekly record of scientific progress at home and abroad."

Winder the Naturalist and Life in Canada

Sometime after 1869, Winder must have briefly returned to the States, for passenger lists show his arrival in Canada from

Cleveland in 1871, the same year that he wrote a 23-page booklet *Mushrooms in Canada*. He carefully described the various species of mushroom he had seen in his adopted land, identifying which he had eaten, and introducing the reader to a new species, *Lactarius Canadensis.* He clearly had a deep interest in the natural world and was a friend of the well-known Toronto botanist, William Brodie (1831-1909). Dentistry provides evidence of their acquaintance at this time, for Brodie became a member of the Royal College of Dental Surgeons in 1870 and Winder was a special lecturer to the Ontario Dental College 1871-2. Later, in 1877, they were founding members of the Toronto Entomological Association. Brodie was President and Winder was first Vice-President. Winder collected the society's first specimen — a larva of the common Tiger moth, *Arctia isabella*.

During the years 1872-79, Winder served as assistant chaplain of the provincial lunatic asylum in Toronto. The city directories show he lived on McGill Street (or Magill as it was spelled then) and that he was also working as a printer. He is known to have printed a 64-page sermon by the Reverend Thomas Rattray in 1878, when Winder's son, after an apprenticeship, entered the trade with him.

Later Years in Detroit

The family moved in 1879 to Detroit, where Winder's name appears in directories as a printer. He was well known in that city as an amateur astronomer, showing the transit of Venus to throngs of people in 1882, and setting up his telescope on pleasant evenings on the city's Campus Martius (Figure 2). He would charge spectators 5 cents for a look at the Moon and planets, along with a lecture. After his wife's death in 1891, he wrote and printed three religious books between 1893 and the time of his death in 1897. Two were on the subject of *Positive Proofs of a Future Life*.

Some of these facts come from Winder's obituary in the Detroit *Evening News* of 1897 November 1, which refers to him as Professor Winder, and the "Campus Martius Astronomer." It states that he was formerly a professor of music at Hygun College, Cincinnati, but this is likely a misprint for Hygeia Female Athenaeum, part of a mid-century Utopian community near Cincinnati. No record of Hygun College, and no record of Winder at Hygeia, could be found.

In addition to his booklet on mushrooms and his letters on the aurora, Winder wrote several religious articles. There is indirect evidence that he wrote on other topics. Janet Brodie, in her book *Contraception and Abortion in Nineteenth-Century America,* mentions a pamphlet by Daniel Winder entitled *A Rational or Private Marriage Chart: For the Use of All Who Wish to Prevent an Increase of Family* (1858) and the *History of Detroit and Michigan* (1884). She states that he was the author of "a work on The Aurora Borealis." Presumably, this was not just the letters in *Scientific American,* though no trace has been found of anything more comprehensive.

Figure 2 — Daniel K. Winder with his telescope on Detroit's Campus Martius (date unknown). The sign attached to the brace on the tripod says "Sunspots Today." (Courtesy of the Burton Historical Collection, Detroit Public Library)

Winder was survived by his three children, Mrs. A.J. Roberts of Chicago, D.C. Winder and Mrs. A.W. Carkeek, of Detroit. He was buried in Woodmere Cemetery, Detroit.

Conclusion

Winder's frequent moves and many occupations reinforce the notion that he struggled throughout his life to make ends meet. He had an active interest in the latest technological and scientific advances of his age and a commitment to popularizing astronomy. At a time when astronomy was seen by many as a part of natural theology, his deeply held religious beliefs and strong principles made him well-suited to be the first president of our Society 140 years ago.

Notes and Acknowledgements

Rather than giving an extensive list of references, I have identified many sources within the article. Further details can be found in the "Winder" file of the RASC Archives, where I will deposit my research notes.

I am grateful to Ian Halliday, Don Lafontaine, and Hans Rollman for some expert advice. Members of the Winder family, Elna and Jay Thompson, as well as many archivists and librarians helped facilitate my research, most notably Ra Dajkovich-Graham of the Toronto Public Library.

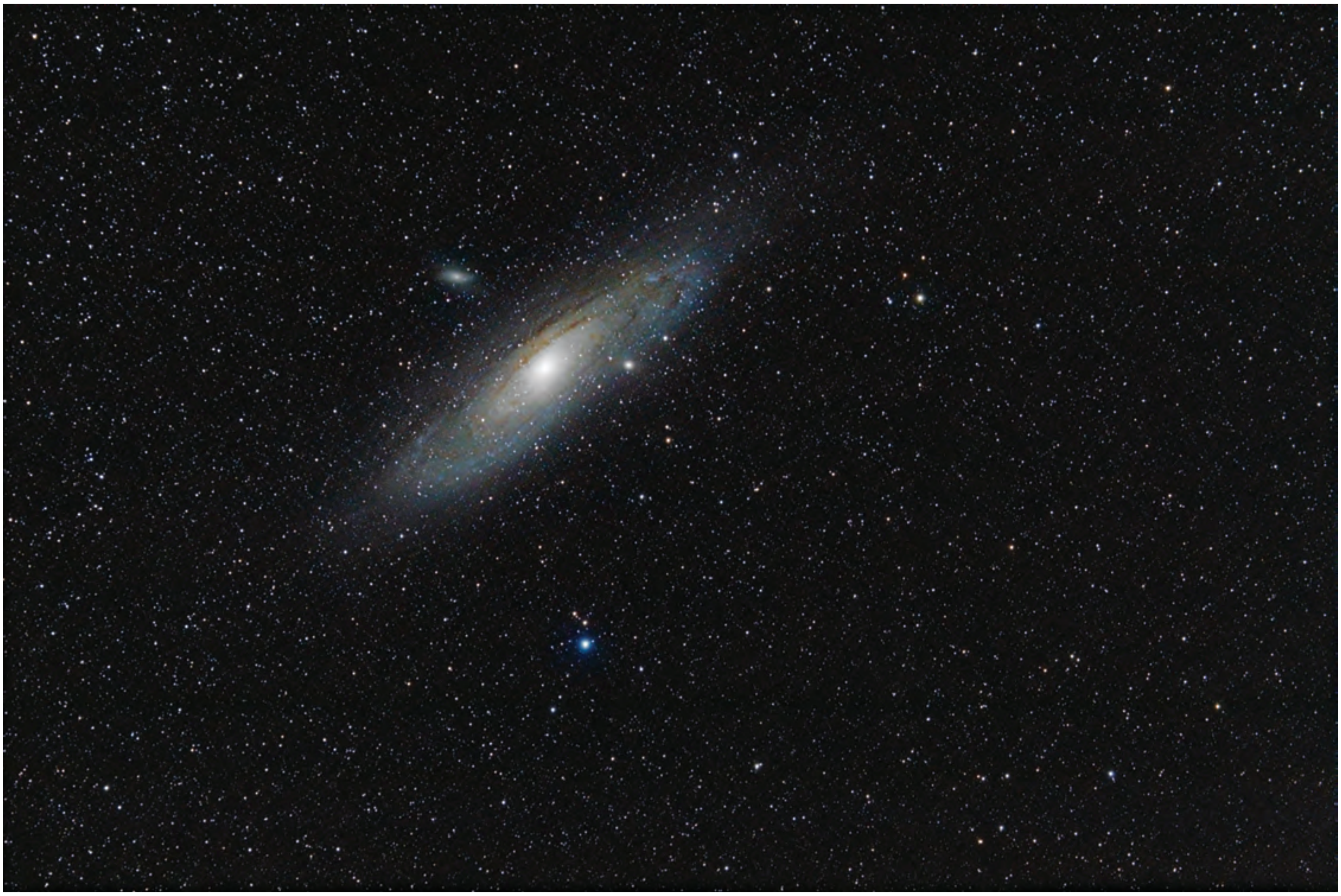

Figure 1 — This exquisite wide-angle shot of the Andromeda Galaxy was captured by Kerry-Ann Lecky Hepburn of Grimsby, Ontario, using a 100-400-mm lens at 200 mm on a Canon 40D. The image is a composite of 14 3-minute frames, taken at Starfest 2008.

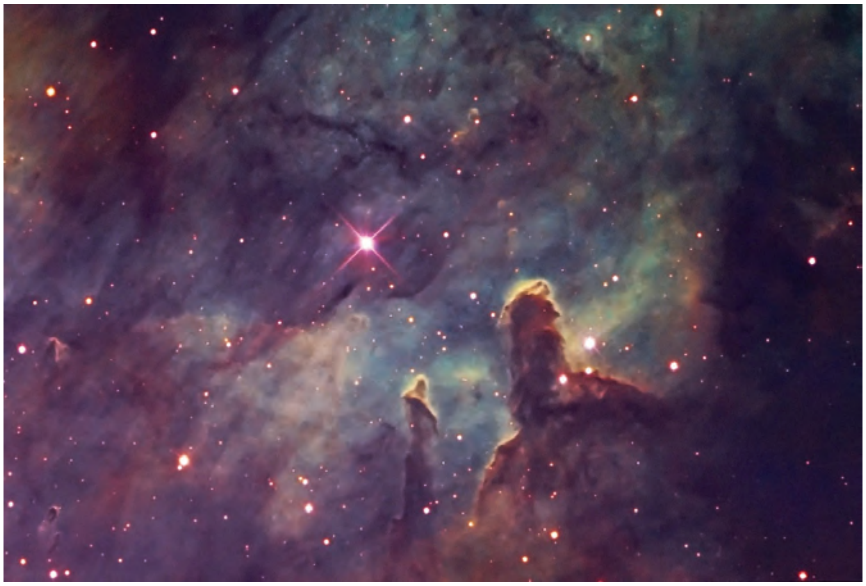

Figure 2 — Stef Cancelli is out of action until his dec motor can be fixed, so when he found this image of CeD 214 in his archives, he decided to have a go at a difficult processing challenge. The photo was acquired by Paul Mortfield using a 16-inch Ritchey-Chrétien telescope and narrowband filters in hydrogen, oxygen, and sulphur. The colours selected for each passband are those known as the "Hubble Palette." CeD 214 is an emission nebula in Cepheus.

Figure 3 — Eric Benson collected light for over 26 hours in May and June 2007 and 2008 to construct this photo of the Tadpole Galaxy (Arp 188). Eric used a Celestron 11 LXT, two SBIG cameras, a Losmandy G11, and a lot of patience. The tail of Arp 188, over 300,000 ly in extent, was caused by tidal interactions with another galaxy about 150 million years ago.

Figure 4 — Winnipeg Centre's outgoing President, Ron Berard, describes this as "...a straight-forward 15-minute exposure with the Nikon D70 and a 14-mm Sigma lens set at f/2.8. The shot is taken at Brereton Lake in the Whiteshell Provincial Park, east of Winnipeg."

Filters and the Visual Astronomer

by Carl Roussell, Hamilton Centre (newton15cm@yahoo.com)

Introduction

The RASC has started a new mailing list for astrosketchers, where various drawing media and techniques are the topics of the day. This article discusses the use of coloured filters for planetary observing. Optical filters add to the visual-observing experience by uncovering detail that would remain hidden by white-light (integrated) observing. An optical filter is usually a piece of coloured glass that is threaded in the barrel of an eyepiece. Alphanumeric codes — Wratten numbers — are used to define the colour and bandpass (range of light frequencies the filter passes) for a particular filter.

Filter Characteristics

The following table provides data on some of the more common filters used by amateurs.

Number	Colour	% Transmission	Peak Trans.	Characteristics
W25	Red	14	6150	strongly blocks blue and green
W23A	Red-Orange	25	6030	enhances red and orange, blocks blue and green. W21, W15, W12 similar but with less contrast
W21	Orange	46	5890	
W15	Deep Yellow	66	5790	
W12	Yellow	74	5760	
W8	Light Yellow	83	5720	enhances red and orange
W58	Yellow-Green	24	5400	strongly rejects red and blue
W82	Light Blue	81	4770	increases contrast with little light loss
W80A	Blue		improves red-blue contrast	
W38A	Blue	17	4790	strongly rejects orange and red
W47	Blue	23	4638	strongly rejects red, yellow, green

What to Look For and Which Filter to Use

Mercury

Mercury has no discernible atmosphere, so when you observe this planet, you see its surface. There are dark and light patches and streaks, and small bright spots. The dark markings are best seen with the denser W25 (red) or W23A (red-orange) filters. The light areas show best with the lighter filter W21 (orange). Some observers have had success seeing detail with yellow filters (W15, W12). Because it is an inferior planet, you can watch Mercury as it goes through phases like the Moon. Use the W25 to look for irregularities in either the terminator (such as bumps or indents) or the cusps (which at times may appear blunted).

Venus

Venus has a thick atmosphere, so any time you spend here will be dedicated to recording cloud patterns. As with Mercury, Venus is an inferior planet that goes through phases. The same W25 filter used for Mercury can be applied to Venus terminator and cusp studies. At times, observers have reported seeing the cusps of Venus extend far past 180 degrees. This effect is caused by sunlight reflecting off the atmosphere, earthwards, when Venus is near inferior conjunction. Using the W25, W58 (green), and W47 (deep blue) will help make the cloud structure more apparent. For smaller aperture telescopes, try replacing the W25 with a W23, and W47 with a less dense blue (W38A). Whatever the telescope you use, Venus is one of the most difficult objects on which to detect detail.

Mars

Mars appeals because you can see both surface and atmospheric detail. For surface features, W25 provides the greatest contrast, while W21 and W23A give good contrast between light and dark areas. For smaller instruments, the W25 may be too dense and one of the less dense orange filters will be needed. Any of the yellow filters will brighten the desert areas, while at the same time making blue and brown markings appear darker. Green filters are useful for seeing frost and ice fog, and for polar studies. The blue filters W38A and W80A will brighten blue and white clouds and limb hazes. W47 will brighten high altitude clouds, equatorial cloud bands, and polar hazes. This latter filter is very dark and will not show much except on larger instruments.

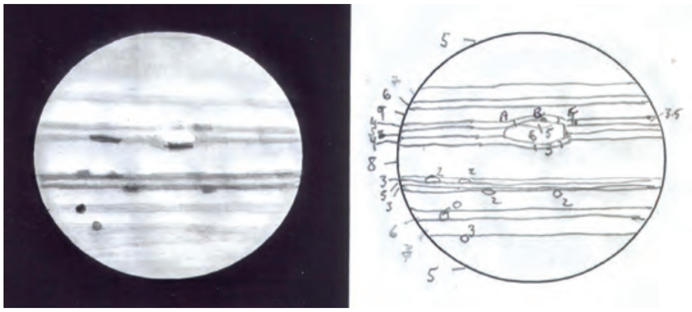

Figure 1 — Jupiter, 2008 August 05, 0500 UTC: final drawing with intensity estimates. Ganymede is transiting at the lower left of the planet's disk.

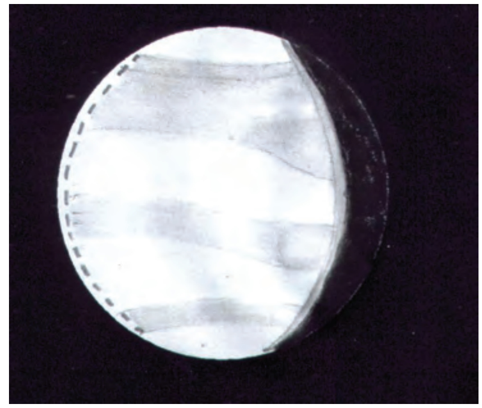

Figure 2 — Venus, 2008 September 23, 2226 UTC: RGB drawing of suspected albedo markings using visible, W25, W58, and W47 filters.

Jupiter

Jupiter is a treasure to observe. Changes are always happening in its atmosphere, the only aspect we can see. The dark belts and polar regions show up best in W80A, W56, and W23A filters. Light zones are best viewed with yellow or green filters. The Great Red Spot reacts well to either a W80A or W38A, but use a W25 to observe satellite transits. Basically, there is so much to see on Jupiter that, no matter which filter you try, at least one feature will improve in appearance.

Saturn

Saturn is one of the most beautiful objects to observe. The rings are better seen with red (W25 and W23A) and blue (W47 and W38A) filters. Belts offer subdued detail but are well worth examination, so try using W23A, W15, W58, and W38A filters. For bright zones between each belt, try W23A, W58, and W12 filters. At times, Saturn develops bright spots (storms) near the temperate and equatorial regions; light yellow or blue filters (W8, W12, W82A) may help these spots stand out against the rest of the visible disk.

Uranus and Neptune

These very distant worlds show only small visible disks in the telescope, so detection of any features at all will be a challenge, even for larger instruments. As with Jupiter and Saturn, you are seeing only the upper reaches of the atmosphere. Both planets might present some limb darkening, caused by a reduction in the sunlight reflected back towards the Earth. Patient and disciplined amateur observers have reported polar brightening, polar collars, and even discrete clouds on Uranus, but little on Neptune. For moderate-sized telescopes, try using W23, W15, and W82A filters. If you have a smaller scope, you might have to use a W21 or W12 in addition to the W82A. If aperture is not a problem, try using the W25 and W58 filters.

Tricolour Drawings

Astroimagers often achieve their best results by stacking individual red, green, and blue (RGB) frames to construct the final image. Astrosketchers can use the same process when completing their drawings. The first step is to draw what you see in integrated (white) light onto your observing form. Record the brightness intensity for each feature at this point. Now continue the observation using the red, green, and blue filters. Draw what you see with these filters onto the same form. When you are done with the shading, you will have drawing with more detail — colour detail — than if no filters had been used.

Learning the characteristics of each filter will add to the thrill of drawing. For example, since red and blue are at opposite end of the spectrum, what is bright in one filter may appear dim in the other. In addition, if when observing Mars you see a bright spot, you can identify its nature by its appearance in different filters. If brighter in red light, the feature is likely dust, but if brighter in blue light, it is probably a cloud.

There can be quite a learning curve to using coloured filters, but the rewards will be well worth the efforts.

Clear skies to you.

Carl Roussell has been a member of the Hamilton Centre since 2005, and the ALPO since 2003. He is drawing his way towards the RASC Messier Certificate.

John Goldie's Paraselene Drawing

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

"MOCK MOONS...a somewhat rare phenomenon, which however, I suspect, if it were carefully looked for, would be found of more frequent occurrence than may have been supposed."

— T.W. Webb 1871

Paraselenae (Moon dogs - the counterpart of Sun dogs, or parhelia), together with their associated ice halos, are atmospheric effects caused by the refraction of moonlight by hexagonal ice crystals. Generally occurring at or near full Moon, when that luminary travels low in the sky and the temperature is brisk, paraselenae and halos were thought surprising, intriguing, and memorable enough to merit reporting in the 19th-century literature of science. They are most frequently encountered, however, not in the astronomical journals of the period, but in the first-hand narratives of Arctic and northern exploration. The commonest term to express the subjective response of the observers to the phenomena is "beautiful;" one has the impression that the repeated choice of that word in these scientific contexts was not frivolous.

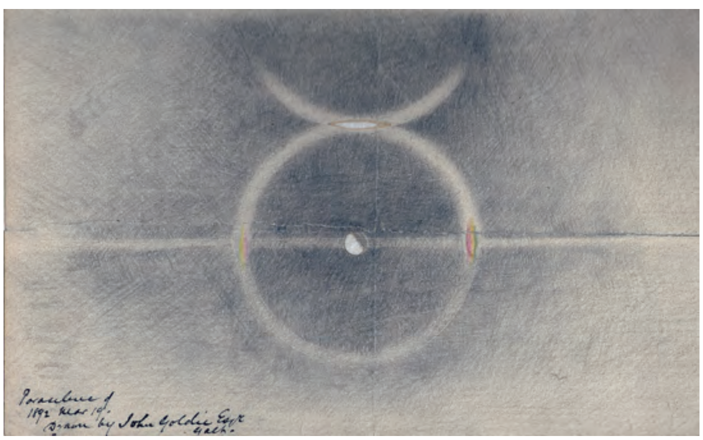

Figure 1 — John Goldie, Paraselene, 1892 March 19, Galt, 18.42 x 27.3cm. This is one of the most accomplished drawings in the RASC Archive's A&P Album. Goldie was a first-rate astronomical draughtsman. The present RASC Archivist hopes one day to see and draw his own paraselene observation.

John Goldie's (1822-1896) paraselene image is arguably the most accomplished drawing in the *Album of the Astronomical and Physical Society* (see Rosenfeld 2008, 203), and the most scientifically significant (Figure 1). In Goldie's drawing one can see a circumzenithal arc, a 22° halo, a paraselenic circle, and paraselenae. The detection of colour by the eye during these phenomena, as in the paraselenae here, is unusual, though not unheard of. Goldie first constructed the main geometrical features with a pair of compasses and a straightedge on thick paper. He then did the elaborate shading with a graphite pencil, using his considerable skill in cross-hatching to create local variations in the darkness of the sky (varying the density and layering of cross-hatching with a single grade of pencil is an alternative to creating variations of tone by employing pencils of varying grades). He finished the drawing by adding the colours in crayon, and the inscription in pen and ink: "Paraselene of/ 1892 Mar 19./ Drawn by John Goldie Esqr/ Galt."

We are fortunate to know something more about Goldie's observation and its graphic record, for while this drawing was never published in his lifetime, the circumstance that called it forth did appear in print. At an 1892 March 22 meeting of the Astronomical and Physical Society (A&P), A.F. Miller (1851-1947) of the Society's council read a report from Goldie detailing his observation:

> *At 2.20 a.m. March 19, I saw a fine instance of this phenomenon. The moon was South-east by South, and its altitude about 23°. At about a radius of 27°[sic], there was a very bright semi-circular halo or arch over the moon, each end of this arch resting upon a 'mock moon,' having the same elevation as the true moon, and shining brightly, more especially the Western one [- this is clearly visible in the drawing]. Underneath the moon, the halo was continued so as to form the complete circle, but the lower part was so dim as to be only just visible. Immediately above the moon was an inverted arch, and the point of intersection was very bright, as if the light of both arches was added together. The upper arch faded from view about 30° on each side of the point of contact. A light streak passing through the true and mock moons extended to the North-west, where it faded away. Another streak passed upwards nearly to the zenith [this feature, a moon pillar, is not shown on the drawing]. The phenomenon continued to increase in brightness, and at 2.30 a.m. the mock moons shone with brilliant rainbow tints, the Western one being specially conspicuous. So bright were they that had the moon been obscured the false images would have cast well-defined shadows. The atmosphere at the time, though not quite clear, was transparent enough to reveal the brighter stars quite perfectly; nor was there any other condition of the air different in appearance from what is general at this season of the year."...Mr. Harvey [1834-1905, another A&P councillor] being anxious to see diagrams of*

the phenomenon, Mr. Miller said he would ask Mr. Goldie for a sketch [TA&P 1892, 24].

The drawing Goldie executed for Harvey, and by extension the Society, is doubtless the drawing reproduced here. Even though it is retrospective, there is no reason to doubt its general accuracy (beyond the omission of the moon pillar), for it was based on the written description sent as a communication to the A&P, which Goldie likely extracted from his observation log (if this survives, it remains to be identified); a sketch may even have formed part of the log. Additionally, the practice of observation may have honed his memory skills, particularly for the details of such a striking phenomenon. The practice of executing a finished astronomical drawing from a log-book entry sometime after the observation was quite common at the time. A notable exponent of the practice was the superb astronomical draughtsman Charles Piazzi Smyth (1819-1900), the Astronomer Royal of Scotland, whose finished drawings done the morning after an observing session could show detail absent from his sketches, but fresh in his excellent memory (Warner 1983, 111). Antonie Pannekoek (1873-1960) also placed great reliance on his memory when doing his superb and superbly accurate drawings of the Milky Way (Ashbrook 1984, 375-378). Many astronomical artists of the present day use this technique, drawing the finished sketch the day after the observation from whatever mixture of memory and record they find reliable.

Goldie (Figure 2) was a highly respected member of the A&P, who gave considerable material support to the Society, as well as social standing (TA&P 1896, obit; A&P minute 1896 March 31, engrossed). The son of a noted Scottish-Canadian field naturalist who made his mark in botany, the younger John Goldie was a major industrialist in the Galt region. His economic position and avocation made him a Canadian counterpart to the Victorian "Grand Amateur" astronomers of Great Britain recently chronicled by Allan Chapman (1998). The part John Goldie and his social peers played in the development of Canadian astronomy has yet to be fully recounted.

Figure 2 — John Goldie outside his observatory in Galt. His equatorially mounted refractor is visible through the open door and dome. The structure is typical of small 19th-century observatories, although the woodwork and finish appear to be quite superior. The design, known as the "Romsey Observatory," is the Victorian equivalent of the SkyShed POD. It was developed by the Rev'd Edward Lyon Berthon (1813-1899), and was meant to be a solid, adaptable, low-cost alternative to other structures. The design would probably work as well today as in the days of Queen Victoria (Berthon 1864). The Romsey Observatory would have been a familiar sight on the 19th- and early 20th-century Canadian astronomical landscape; have any survived?

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Abbreviations

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The Formation and Evolution of Galaxies

by Leslie J. Sage (l.sage@naturedc.com)

For about the last 20 years, it has been more-or-less accepted that the galaxies in the present-day Universe formed largely through mergers, as small clumps of gas gradually built up larger galaxies. This notion worked nicely with numerical simulations of the evolution of large-scale structure (clusters of galaxies, and streams of clusters), done within a framework where gravity is dominated by cold, dark matter. The so-called "hierarchical formation" model, however, is coming under some stress from work performed by Daniel Stark of Caltech and colleagues, and separately by Mike Disney of Cardiff University and his colleagues (see the October 9 and October 23 issues, respectively, of *Nature*).

When I started graduate school in 1983, galaxies were thought to have formed from large clouds of gas in the early Universe (the "monolithic" approach). The amount of angular momentum in any particular cloud determined whether it became an elliptical galaxy (low) or spiral (high). My thesis was on the effects of interactions on the gas (and star formation) in galaxies, and at the end of the oral defense of my thesis proposal (a major step at Stony Brook before formally embarking on the thesis work), one of the committee members said "But it's obvious galaxies don't interact — just take the number of galaxies and divide by the volume." But with the release of data from the orbiting *Infrared Astronomical Satellite (IRAS),* that view rapidly changed between 1984 and 1987, by which time it was obvious that not only do interactions and mergers between galaxies happen, but these interactions lead to very interesting consequences — in particular, bursts of star formation where, in extreme cases, much of the inner kiloparsec of a galaxy can be forming stars more rapidly than the Orion Nebula. Of course, galaxy interactions weren't new - work by Chip Arp in the 1960s with his *Catalogue of Peculiar Galaxies,* by the Toomres in the early 1970s, and Beatrice Tinsley in the mid-1970s, had a minority appeal — but they weren't mainstream astronomy in the early 1980s.

Dan Stark has used gravitational lensing of a galaxy at a redshift of 3.075 (just 2.1 billion years after the Big Bang) to get a closer look than would otherwise be possible. The major axis of the galaxy has been expanded by about a factor of 8, allowing him to achieve a linear resolution of just 120 parsecs — 5 times better than previously achieved! What he finds is a medium-sized galaxy in regular rotation, although there are significant random motions as well. The gas in the galaxy seems to be in a general "medium," not in smaller clouds that are bound together by their own gravity,

The bright edge-on lenticular galaxy, NGC 5866, (a.k.a. the Spindle Galaxy). Located in Draco, it has a magnitude of 9.9 and dimensions of 5.2 x 2.3 arc-minutes. NGC 5866 has been proposed as a candidate for the disputed Messier 102.

with the implication that it was acquired through accretion of surrounding material, rather than through successive mergers. This suggests that he is seeing the gradual assembly of a spiral disk via accretion into a central-bulge component.

Mike Disney and his colleagues took a different approach. They reasoned that because galaxies are complex systems, the global properties such as half-light radius, luminosity, mass, and colour should depend upon numerous different independent parameters such as angular momentum, age, the fraction of the total mass supplied by baryons (some galaxies seem to be more dominated by dark matter than others), on top of which there should be the effects of random mergers and interactions. Using a sample of galaxies found in a blind survey looking for atomic hydrogen in galaxies (to avoid the selection effects of an optically selected sample, though the HI survey has its own selection effects), they found — surprisingly — that the global properties are all correlated with each other. In other words, by specifying any one property, *e.g.* mass, the others are easily predicted with considerable accuracy. The one property that doesn't quite follow this is the colour. There seems to be both a "systematic" component that is correlated with the other properties, and an additional "rogue" component that is not correlated with anything, which probably reflects the relatively recent history of bursts of star formation.

It is hard to see how galaxies could be assembled more or less randomly, and still have this unity of properties. Perhaps a variation on the old monolithic formation scheme might work better, at least for spiral galaxies (Disney's sample will be dominated by spirals, because they tend to have more atomic hydrogen than ellipticals). It might be that the spherical bulges are what are left over from the various merger events, while the spiral disk is gas acquired from the surrounding medium. If that were the case, then perhaps the histories of galaxies weren't so divergent after all, and mass really is the unifying parameter that determines the evolutionary path a galaxy follows.

Gary Welch of Saint Mary's University in Halifax and I have been struggling for the last ten years to understand the odd properties of the gas in lenticular and elliptical galaxies, going back and forth on whether the monolithic or hierarchical models worked better. Maybe the Universe has been fooling us, and it's really a hybrid in almost all cases. That would make life a lot more complicated, but that's what keeps astronomy interesting!

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.*

Deep-Sky Contemplations

A Final Column...

by Doug Hube (jdhube@telus.net) and Warren Finlay (warren.finlay@interbahn.com), Edmonton Centre

In this series of articles, we have tried to encourage observers to "see" more than the visual images that appear in their telescopes. The shapes, the variations in surface intensity, and the colours of astronomical objects are just the visually detectable superficial manifestations of something more fundamental. The visible features of every astronomical object are the products of more-or-less complex internal physical processes including, but not limited to, gravitational interactions, thermal processes, nuclear reactions, and other energy transformations. It is those physical processes that lead ultimately to the images that delight and challenge the eye. To view the images without considering the processes is, in our opinion, equivalent to reading the conclusion to a story without having been introduced to the main characters.

The ways in which we, in the early years of the 21st century, are able to look at deep-sky objects are fundamentally different from those available to our predecessors of even a few decades ago and certainly to those of a century or more, earlier. Astronomers have many more electromagnetic windows through which to look. As hobby astronomers, we have technically advanced tools at hand that would be the envy of professionals even a few decades earlier. We have benefitted from discoveries and advances in the fundamental sciences that were inconceivable a century ago: we can now *understand why* deep-sky objects appear the way that they do.

Fifty years ago, there was but one *really* large telescope, the 5-m instrument on Mount Palomar. Most astronomical research was conducted with 2-m diameter telescopes, such as those at the Dominion Astrophysical Observatory, Victoria, B.C. and at the David Dunlap Observatory north of Toronto. The detector of choice — well, no choice, actually — was the photographic plate. Those telescopes, giants in their time, are comparable in size to the *secondary cages* on the current largest telescopes. Size is not the only thing that counts, of course, and the telescopes at the DAO and at the DDO (until its ignominious closure earlier this year) have continued to be scientifically very productive.

The first draft of this column is being written on the day that CERN is officially turning on the Large Hadron Collider (LHC), an "instrument" (is that the appropriate term for something costing billions of dollars and with dimensions measured in tens of kilometres?) that may open a new window into the ultramicroscopic quantum world, a world that no one a century ago could have imagined. Will the LHC lead to the discovery of the "Higgs particle"? Will it provide clues to the nature of dark matter and, thereby, answer one of the most pressing riddles of cosmology? The next few years may well tell.

"Deep sky" has changed in meaning in step with progress in understanding the structure and evolution of the physical Universe. In the introduction to her book *Problems in Astrophysics,* published in 1903, Agnes M. Clerke stated, "Queries, in the coming years, will be put to the skies very different from those here propounded; and answers of a surprising kind will doubtless be afforded to our present interrogatory." Would anyone dare to deny that the same statement is as valid today as it was more than a century ago?

We encourage you to dig deeply as you continue your exploration of the deep sky.

Doug Hube is a professional astronomer actively retired from the University of Alberta and Associate Editor of this Journal.

Warren Finlay is a Professor of Mechanical Engineering at the University of Alberta, a keen explorer of the night sky, and the award-winning author of Concise Catalog of Deep-Sky Objects.

This is the final column in Deep-Sky Contemplations. We express our appreciation, not only for the time and effort put in by Doug Hube and Warren Finlay over the past three years, but also for the insights provided from the new way of looking at the Universe. — Ed.

Through My Eyepiece

Eyepieces

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

Since my column is called "Through My Eyepiece," I thought it might be of interest to actually talk a bit about eyepieces. Eyepieces are the powerful magnifiers that allow us to examine in detail the images formed by our telescopes.

The original eyepieces were simple single lenses: concave in Galileo's telescope, convex in Kepler's. Telescope makers learned that they could improve the quality of their telescopes' images by improving the quality of their eyepieces, so they gradually developed an ever-more-complex set of designs that now bear their designers' names: Huygens in the 17th century; Kellner and Plössl in the 19th century; and Nagler in the 20th and 21st centuries, to name a few.

Back in the 1950s and '60s, when I first got into astronomy, the terminology used for eyepieces was a bit vague. My first telescope came with two eyepieces: a 28-mm "Kellner" and a 12.5-mm "Ramsden." I later upgraded by buying three Brandon "orthoscopic" eyepieces. As a teenager, I disassembled everything I got my hands on, and was mildly surprised that few of these eyepieces actually resembled the diagrams in books. When I got back into astronomy in the '90s, "Plössl" eyepieces were all the rage, a design totally unheard of back in the '60s. Somehow, something looked familiar — it turned out that both my Edmund Scientific 28-mm "Kellner" and my Brandon "orthoscopic" eyepieces were, in actual fact, Plössls. All four were symmetrical designs made up of pairs of cemented achromats. So I'd actually had a set of Plössl eyepieces without knowing it!

The most striking development in recent years in eyepieces has been the ever-widening apparent field of view of modern designs. For most of the telescope's history, eyepieces were in the 40° to 50° range, typified by Kellner and Plössl designs. Some wide-field designs were developed, mostly for military purposes, that were then adopted by amateur astronomers when they came on the war-surplus market; the Erfle design is a good example of a military eyepiece put to civilian astronomical use. Towards the end of the 20th century, computerized optical-design programs and exotic types of glass became available, and we saw a sudden quantum leap in the eyepieces available to amateurs, both in field of view and dollar cost!

Modern eyepieces can now be grouped by their apparent fields of view. What I'll call "normal" are around 50°, usually based on the Plössl design. "Wide angle" eyepieces are in the range of 65 to 70°. "Ultra wide angle" range from 82° up to 100°.

A second way of looking at modern eyepieces is in terms of their eye relief: how far above the eyepiece's lens you must place your eye in order to see the whole field of view. With traditional designs like the Plössl, eye relief was a little bit less than the focal length of the eyepiece. This was quite comfortable with longer focal lengths, 20-mm and higher, but increasingly uncomfortable as the eyepiece's focal length became shorter. A 4-mm eyepiece required cramming one's eyeball right up against the eyepiece's lens, downright dangerous in sub-freezing temperatures. Amateur astronomers learned to use a Barlow lens to increase magnification without decreasing eye relief, and eyepiece designers learned to build a Barlow lens into some designs so that all eyepieces in a series would have the same comfortable eye relief.

Many beginners make the mistake of believing that they need to own a large number of eyepieces, and the manufacturers cater to this by selling eyepiece kits that include a number of different focal-length eyepieces plus a variety of filters. I recommend avoiding these kits — the eyepieces are often of poor quality and include some of limited usefulness, such as 40-mm eyepieces in 1.25″ barrels, which are like looking down a soda straw, and 4-mm Plössls with absolutely no eye relief whatsoever. You will do better to buy one or two quality eyepieces, carefully chosen for the sort of observation that you do.

I discovered after I'd been observing variable stars for a while with my 280-mm Newtonian, that I was doing 99% of my observing with just two eyepieces. These were a 22-mm Tele Vue Nagler (63×, 1° 18′ field of view) and an 8.8-mm Meade Ultra Wide (157×, 32′ field of view). When I switched to doing most of my variable-star work with a 280-mm Schmidt Cassegrain with more than twice the focal length, I again gravitated to two eyepieces: a 40-mm University Optics MK-70 (70×, 1° field of view) and a 16-mm Tele Vue Nagler (175×, 28′ field of view). These same pairs of eyepieces also work well for observing deep-sky objects on these scopes.

The only objects that require more eyepieces are the Moon and planets. In fact, I find it useful to have several eyepieces with relatively slight differences in focal length for the Moon and planets because atmospheric seeing requires close matching of magnification to seeing conditions. On my Newtonian, for example, I have eyepieces for my binoviewer yielding magnifications of 190×, 240×, 300×, and 400×, and find myself using all of these quite frequently. Most of the time the 240× eyepieces are slightly favoured. If the seeing is too poor to use 240×, it is usually too poor to bother observing at all. The powers above 240× are reserved for nights with very stable air. Fortunately, such nights are common enough to make it worth having these eyepieces handy.

When I observe with any of my smaller telescopes, I find myself using roughly the same magnifications that I use on my 280-mm scopes. The only exception is when I take advantage of the smaller scopes' shorter focal lengths to take in a wider field of view. With the dark skies I enjoy here in Coldwater, I can really take advantage of wide fields of view to observe the largest objects, such as M31 and its companions, the Small Sagittarius Star Cloud (M24), and the Veil Nebula. I never really appreciated these huge objects until I left the city for darker skies.

Geoff Gaherty is the recipient of the Society's Chant Medal for 2008. 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. Though technically retired as a computer consultant, he is now getting paid to do astronomy, providing content and technical support for Starry Night software.

Gizmos

Coming In From the Cold

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

How do you tell the difference between a professional astro imager and a Canadian amateur?

It's obvious when you think about it. The amateur is the one with hypothermia. That's because the one feature that big professional observatories all seem to have is a well-lit observer's room with heat. There is a row of computers on a long desk against one wall, and the astronomers are in chairs, a little bit sleepy, comfortable, and warm.

Think about that the next time you are waiting out an exposure in your back yard or even in your roll-off observatory, stamping your feet and swinging your arms, and wishing you had taken up stamp collecting.

What you need is an observer's room with a computer and a comfortable chair and, while you're at it, a fridge full of snack food and the ball game on the tube.

Fantasy?

You may already have it.

You need *XP Pro* on your home computer, and both it and your telescope laptop should be logged on to a wireless router.

Set up your scope, camera, and laptop — everything ready to start imaging. Go to your observer's room (the one the kids call the living room) with the computer and the comfortable

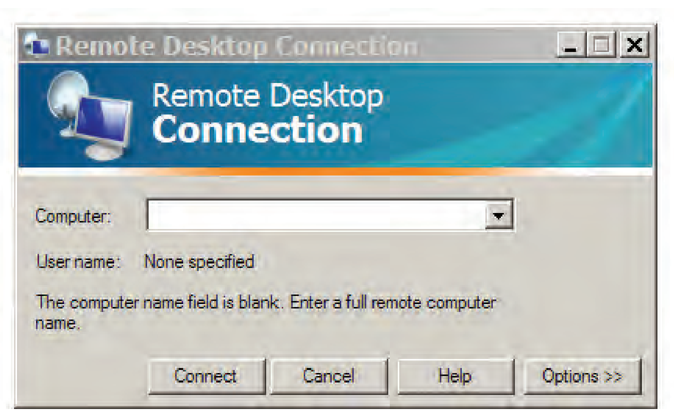


Figure 1 — A screen capture of the Remote Desktop set-up window.

chair and the fridge full of snack food and the ball game on the tube, and boot your computer.

Go to the Start Menu, Programs, Accessories, Communications, Remote Desktop Connection.

Fill in the computer name of the laptop. Fill in your user name on the laptop. Fill in the laptop's password.

Bingo.

What you see (I hope) is the same thing that you would see if you were outside in the cold. All the programs running on your laptop appear to be running on your home computer, and they can be controlled from your home computer's keyboard exactly as they can from outside. You can aim your telescope, operate your camera, and view the downloaded images from your living room.

And, you can stay warm.

Of course, it's not likely to be that easy. Computers can be fussy, and, if everything works out to be as simple as I have described it, we will both be surprised. Use the help files and work your way through it or Google "Get started using Remote Desktop with Windows XP Professional." If that fails, get help from a friend.

But, stay with it because it beats hypothermia.

Don Van Akker and his observing partner, Elizabeth, focus on the stars from Salt Spring Island, B.C. Don will help with this or any other Gizmos project if you email don@knappett.com.

Gerry's Meanderings

Old or New? How Do Modern Beginners' Scopes Compare to Those of Our Memories?

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

Most of the readers of this august journal are no longer interested in beginners' telescopes, but most can recall, with great detail, their first telescope, and the views that it gave them. Today, people are still getting their first telescope and getting those same wonderful memories. However, memories can be misleading, and they do fade into nostalgic mists wherein one might wonder just how good or bad were those beginner's scopes?

For many of us, the first scope owned would have been the notorious department-store 60-mm refractor. Much has been said about these scopes, good and bad. Many of us lobbied our parents hard for such a telescope, which promised the treasures of the Universe for a sum that made our parents nervous but not dismiss the purchase outright. In addition, each of us who went through that experience might also remember that the old Eaton's or Sears catalogues usually listed a model above what we thought we could convince our parents to buy for us. This was usually some larger refractor on a gangly equatorial mount instead of the alt/az mount that we settled for. We, being properly conditioned consumers, realized that these larger, more expensive flagships were probably more than we would need, and we knew to be content with our middling 60-mm dreams.

These days, there is much more variety when it comes to beginners' telescopes. Not only is there a vast range of styles, but the size of scopes for beginners has expanded. In addition, something in our consumer conditioning has been drastically altered that now allows us to consider all sorts of telescopes for our first instrument. Nevertheless, I keep thinking about that bigger, more expensive scope on the same well-worn page of the catalogue that featured my first scope and kept my attention for so long. Were they any better than my first scope of the time and do they still "make 'em the way they used to?"

Figure 1 — Meade 395 mounted on top, with its modern equivalent, the Sky-Watcher 90, beneath.

As an all-too-brief attempt to answer this question, I compared an almost 20-year-old Meade 395 90-mm f/11 achromat with a new Sky-Watcher 90-mm f/10 achromat. The venerable Meade 395 comes very close to that flagship from my memories; the new Sky-Watcher is in many ways its modern equivalent. Both are 90-mm achromats with simple rack-and-pinion focusers in the "serious" 1.25-inch format. The Meade's focal length is 1000 mm while the Sky-Watcher is 910 mm. The older, stouter Meade weighs in at 3.2 kg and the Sky-Watcher comes in at 2.7 kg.

Mechanical Performance

The two scopes look and feel very similar. The newer Sky-Watcher focuser has a smoother feel and does not have the slight free play of the old 395. The free play could be dialled out with a little adjustment, but the rougher feel of it would take a lot more work. The old-style solid rings of the Meade 395, with their contra-piston friction blocks to tighten up the scope, are not as convenient as the hinged compression rings on the Sky-Watcher. The Sky-Watcher rings also leave open the top mounting bosses so that other accessories can be attached. The lighter weight of the Sky-Watcher would also be appreciated by anyone wanting to use the scope for guiding.

Figure 2 — The hinged rings of the newer scope are much more convenient and versatile.

Optical Performance

I would have expected the performance of these two scopes to be as close as the appearance and specifications. At low powers of 30 to 50×, the views in the two scopes are quite similar. Images in the newer scope seem slightly brighter, and there is slightly less flare on bright objects. However, it was at higher powers, on the demanding target of Jupiter, where the differences became obvious. At around 100× (10-mm Speers-Waler), the views of Jupiter were starting to max out in the Meade. Any more magnification would have degraded the image. The view at 100× (9-mm TMB planetary) in the Sky-Watcher held up quite well in excellent conditions. Details in Jovian cloud belts could barely be discerned and Io's shadow was quite prominent, just off the north equatorial band. These details were visible in the Meade but there was a definite improvement in clarity and contrast in the newer scope. It also showed less lateral colour on the planet's disc. Views of deep-space objects such as nebulae and star clusters showed the two scopes to be more similar. It was mainly in the high power where the two differed.

Under star testing, the two scopes looked surprisingly similar. Except for a bit more colour when out of focus in the Meade, the diffraction rings looked very close. Perhaps the better optical performance can be attributed to better modern glass, and the better contrast due to superior modern coatings? The older Meade has the familiar blue tinge of magnesium-fluoride coatings, while the new Sky-Watcher has the modern green-and-purple multi-coatings.

Figure 3 — The purple and green of modern coatings might allow brighter images than the older bluer coatings.

With such a small sample size, no generalizations are warranted, but anecdotal experiences do have some impact in dispelling misty-eyed memories. So, somewhat surprisingly, the new telescope shows itself to be the superior instrument — especially when higher powers are concerned. When one considers the relative bargain that new telescopes represent compared to those old scopes, with almost two decades of inflation in between, one can only conclude that these are good times to be beginning the adventure in astronomy. Those starting their observations these days should carry memories into the future of images that can be sharper, if not sweeter, than those of yesterday can.

Acknowledgements: I would like to thank John Hleck of Side Line Distribution for generously providing some equipment used in the article.

Gerry Smerchanski's interest in astronomy extends at least as far back as his second spoken word, which was "Moon," but it took a leap forward when he obtained his first department store telescope in 1969. Gerry is a scope-aholic and suffers from "ocularosis," which is defined as the inability to ignore eyepieces and other optical equipment.

Orbital Oddities

Perseid Pursuit

by Bruce McCurdy, Edmonton Centre (bmccurdy@telusplanet.net)

Into the distance, a ribbon of black
Stretched to the point of no turning back
A flight of fancy on a windswept field
Standing alone my senses reel
A fatal attraction is holding me fast
How can I escape this irresistible grasp?
Can't keep my eyes from the circling sky
Tongue-tied and twisted, just an earth-bound misfit, I

Above the planet on a wing and a prayer,
My grubby halo, a vapour trail in the empty air,
Across the clouds I see my shadow fly
Out of the corner of my watering eye
A dream unthreatened by the morning light
Could blow this soul right through the roof of the night
There's no sensation to compare with this
Suspended animation, a state of bliss
Can't keep my mind from the circling sky
Tongue-tied and twisted, just an earth-bound misfit, I

— Pink Floyd, *Learning to Fly*

David Gilmour's song re-visions the flight of fantasy of the mythical Icarus, but, as great art so often does, conveys multiple meanings that resonate sympathetic strings within the experiences and desires of each audience member. To this earth-bound misfit, the poem by the third-generation lyricist of the ever-astral Pink Floyd evokes a different, more achievable flight from daily life: the road trip in pursuit of dark skies. Some of the passages in the latter stanza summon images of my own fatal attraction, meteors.

I have always thrilled to the sight of a shooting star, which appeals to my interests in dynamic astronomy and natural beauty. It is fun to consider the circumstances that cause the orbits of planet and meteoroid to intersect, resulting in the fiery destruction of one and a pleasant diversion on the other.

The meteor calendar is heavily lopsided, with the huge majority of the annual activity occurring within about five months, starting with the south delta Aquariids (SDA) in late July. I had had only a couple of low-yield meteor sessions since the Quadrantids in early January, so I was chomping at the bit to get out to a dark site. SDA peak night on July 28-29 featured clear skies, so after my (city) observatory shift I headed out to Edmonton Centre's Blackfoot site in Beaver Hills Dark Sky Preserve. Pulling into an otherwise empty parking lot just after midnight, I was greeted with a superb view of a long-lost friend: the Milky Way. After 12 long weeks of perpetual twilight, not to mention much longer than that of perpetual light pollution, what a joy to be under a dark sky again!

My rustiness showed in a few ways as Mr. Murphy struck again and again without mercy. The Sky Quality Meter didn't work, presumably due to battery malfunction; unfortunately I couldn't figure out how to open the darn thing in the darkness that persisted due to *both* of my red flashlights also malfunctioning. The one of those I could open in the dark needed the wrong size batteries. Oh well, I didn't really need those flashlights to read the Limiting Magnitude Field Locator charts I had forgotten at home. So I had to resort to old-fashioned estimating of the LM. Fortunately my talking watch and microcassette — the two devices I actually tested before leaving home — worked fine, so the enumeration proceeded without further glitches. In a satisfying three-hour session, I observed nearly 50 meteors from various radiants.

The Perseids were already strongly in evidence fully two weeks before their peak, as I saw more of them (12) than meteors from any other radiant. That distribution was unique among various reports on the Global Meteor Observing Forum that week, surely a product of my northerly latitude. My relatively modest counts of 10 Aquariids and 7 Capricornids during the three hours were both "personal bests" from these southern sources, and I considered myself fortunate to have seen a single example of a Piscis Austrinid, whose radiant reaches just 6° above my southern horizon at best. The one PAU I did spot was actually *dropping* to the lower left of Fomalhaut, and right into the treetops on the southern horizon.

The Moon cleared the trees around 2:30 local time. It was a compelling sight, just three days from new and the impending Total Solar Eclipse that some of my pals subsequently observed from the Canadian Arctic. The waning crescent replete with earthshine towered above the most northerly portion of the ecliptic, hanging just below Auriga like a temporary pendant for the pentagon. Given that the SDA's peak was occurring exactly a fortnight ahead of the Perseids, it was easy to visualize the exact opposite conditions applying with respect to both phase and declination on Perseid peak night: a fat waxing gibbous Moon hovering far below the most southerly part of the ecliptic. Indeed, in the morning hours of August 12 the Moon would be at about -28° declination, setting around local midnight despite its fairly advanced 11-day-old phase. (A similar opposite-Moon relationship exists between the Lyrids and eta Aquariids; the Orionids and the (peak of the) south

Taurids; and, imperfectly, the Ursids and Quadrantids, meaning that every year one of each pair should be relatively Moon-free, the other more problematic.)

In 2008, the lunar phase was set up perfectly, with the Moon diving southward and under the ecliptic throughout the fortnight building up to the Perseid max. An early setting Moon waxed throughout early August, allowing an ideal opportunity to monitor the gradual rise of activity in the overnight hours until the Perseids' sudden surge to maximum on the night of August 11-12.

Fifteen years ago, individual meteor counts were sent via "snail mail" to the International Meteor Organization, whose newsletter would dutifully report the results 6 or 9 months later. Nowadays a simple on-line report can be filled out on IMO's Web site (www.imo.net), with results instantly uploaded to a "live ZHR graph" nearly in real time. To assure something approaching continuous coverage it is critical to have observers from different stations across the globe; for example, observations from Western Canada take place long after sunrise has occurred in Europe, where the greatest numbers of reporting observers are located. The huge land mass of Canada is lightly represented; meteor observers, especially of major showers like the Perseids, Geminids, and Quadrantids, are encouraged to report your results (see Figures 1 and 2).

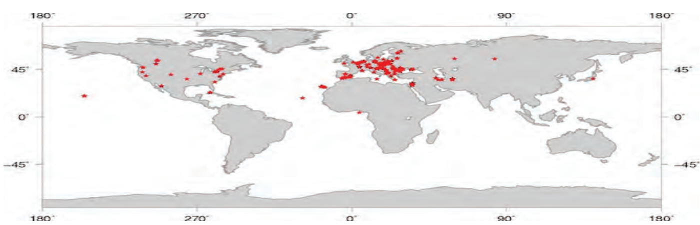


Figure 1 — Global distribution map shows a great concentration of reporting observers in Europe and far fewer in North America. Asia was very poorly represented in 2008, as the Olympic Games seemingly wiped normally productive Chinese observers off the map. In all, IMO reported 228 observers in 33 different countries contributed to the global effort. All figures courtesy IMO and reproduced with permission.

Having literally put Canada on the map in 2008 with my first report of Perseids, I decided to make a project of it and spend some time under the sky every possible night. I couldn't afford the investment of time and gas money to make an all-nighter of it each time, so decided to observe from my light-polluted front yard for an hour or two as often as possible, with a few targeted road trips. In the end, I got eight nights of observing this Perseid season, four urban and four rural. I figured that hour in the front yard was a heck of a lot better than no hour at all.

But was it scientifically useful? I decided to make a test case of my own results. Those lost two magnitudes theoretically suppressed the number of Perseids seen by a factor of 4 or 5, and the lower counts would surely introduce significant scatter

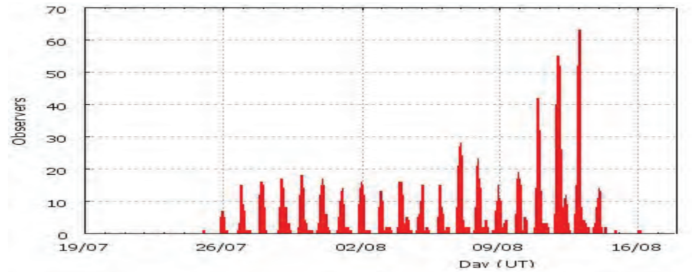


Figure 2 — Temporal distribution graph shows daily peaks during dark hours in Europe, with North American coverage characterized by the much smaller secondary peaks to their right.

in the data points. Would there be enough signal left to be of value? (See Figure 3 for results and conclusions.)

A major weather system moved into north-central Alberta 36 hours prior to the shower maximum, projected to occur around 11h UT on August 12. After the long campaign observing the shower build-up, I wasn't about to let a little thing like bad weather get in the way. Fortunately, I have the perfect observing partner in Alister Ling, a wonderful friend who not only shares my interest in meteors but is a meteorologist, and a fine one, by profession. Al's sterling record of correctly predicting where the holes might appear for dynamic events like eclipses, transits, occultations, and meteor-shower peaks is second to none, and once again he came through in spades.

On the big day, Alister advised that we would have to drive a long way south for the clear skies we craved. Superimposing

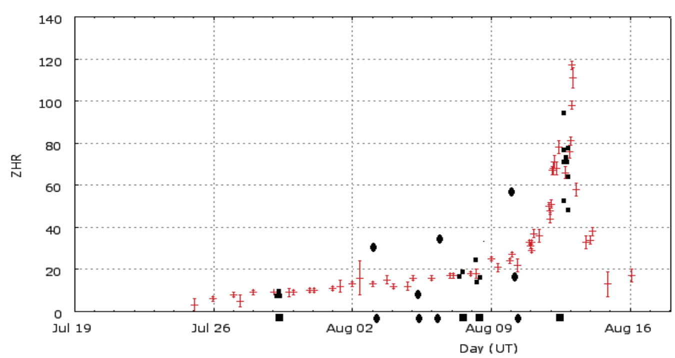


Figure 3 — The writer's personal observations are plotted against the IMO's "Live ZHR graph." Observing sessions of July 29 and August 3, 5, 6, 7, 8, 10, and 12 are marked at bottom, with hourly (half-hourly on peak night) results plotted directly above. Ovals represent observations from an urban station, squares designate rural sites. Note how the rural observations place very close to the curve representing international results, whereas urban observations tend to fall far outside. Error bars (not shown) are roughly ± 15 percent on peak night with high meteor counts, ± 30 percent on low-yield nights under rural skies, and ± 50-100 percent from within the city. This latter range of possible values suggests that short-duration individual data points from urban stations may not be statistically significant, although averages taken over several hours and/or among several observers might refine the results.

Fiure 4 — A bright meteor flashes in northwestern Perseus, near the radiant in this image captured by Ross Sinclair of the RASC Edmonton Centre.

a satellite-imagery model, a road map, and a light-pollution map, Alister picked out a spot 15 km SW of Nanton, Alberta, some 400 km south of Edmonton.

Just after suppertime, Ross Sinclair and I piled into Alister's Subaru. There's room for three when telescopes are not required! As we hit the open highway, the ribbon of black that stretched into the distance carried the promise of a memorable observing session. After a long drive through solid overcast, the clouds finally began to yield near Calgary, and eventually we emerged into clear skies. We found an appropriate side road exactly at the targeted destination, with zero vehicular traffic and clear, transparent skies. The area is in the foothills of the Rocky Mountains, where the altitude is about double the ~700 metres it is around Edmonton. The fact that we were over 3° south of our normal sites meant we had to wait a little longer for the Moon to set, but once it did we got a solid three hours of magnitude 6.7 skies before the start of morning twilight.

Alister and Ross set up their cameras for a little meteor photography, while I settled in immediately to begin the count. Over the next 4.5 hours, I observed 256 meteors, including 229 Perseids; not quite the spike of activity that was reported from Europe the following morning, but an impressive show nonetheless. There were plenty of bright ones in the mix, including 20 of negative magnitude and another 20 of magnitude 0. The best was a gorgeous emerald-green fireball of mag -6 with a persistent train that lasted some 25 seconds to the naked eye. Fortunately, this beauty occurred within the field of view of all three of us, and both cameras (see photo). While the vapour trail in the empty air was slowly dissipating, another -1 Perseid with a 1.5-second train blazed a short distance away.

I and at least one other observer witnessed three more fireball-class Perseids; one white -5 with a 15-second train, an orange -5 with a 6-second train, and a coppery -4 with a briefer 2-second train. In all I noted persistent trains on over one-quarter (~60) of observed Perseids. I'm sure this fraction is on the low end, as there were times when my taped notes were insufficiently descriptive due to clumping of meteors; at one point in my tape I was trying to record details of five different meteors that I had seen within six or eight seconds, and there were several other bursts of three or four in a similarly short interval. My observing partners also experienced such clumps, and there were at least two occasions when Ross or Alister saw four or five in succession, where I saw just one or none. The best burst came around 10:00 UT when we probably saw 10 different meteors among the three of us in no more than 10 or 12 seconds. They were going off all over the place, and so were we.

As advertised, the rise to peak was dramatic. After 13 hours of counts from various locations where I averaged 5 Perseids and never topped 10 within a single hour, peak rates were around 1 per minute. Expressed in half-hour intervals, my counts were surprisingly smooth and consistent as the radiant rose during the dark hours between moonset and morning twilight:

30-minute bin	PER	LM	ZHR	Comments
0630-0700	11	6.0	53	
0701-0730	26	6.3	94	Moonset during interval
0731-0805*	28	6.6	75	*5-min break
0806-0835	30	6.6	76	
0836-0905	32	6.7	71	
0906-0935	34	6.7	72	
0936-1005	35	6.7	71	
1006-1035	20	6.4	48	LM reducing in twilight
1036-1105	13	5.4	64	" " " "

All too soon, the dream was threatened by the morning light. As always, I strained to see that last fireball as the stars gradually faded into the breaking day, reluctantly tearing my eyes from the circling sky once Alister and Ross had their gear packed. Three tired but content observers shared driving duties during the long ride home.

The next night, skies over Edmonton cleared off unexpectedly, and I set up in my front yard for one more hour of post-peak Perseids. Almost immediately, I saw a -2-magnitude beauty rip the fabric of the sky, my 300th Perseid of a highly satisfying campaign. Almost as quickly, however, exhaustion overcame me, and I succumbed without resistance to a long and refreshing sleep in the cool night air.

Bruce McCurdy has observed the Perseids every August since 1988.

Quick Picks for Observing

by Kim Hay, Kingston Centre (cdnspooky@persona.ca)

March 2009	Event
Wednesday, Mar. 4 7:26 UT	First-quarter Moon
Saturday, Mar. 4 15:08 UT	Moon at perigee *(367,019 km)
Sunday, Mar. 8 2:00 a.m.	Daylight Saving Time begins
Tuesday, Mar. 10 2:38 UT	Full Moon
Wednesday, Mar. 18 17:47 UT	Third-quarter Moon
Thursday, Mar. 19 13:17 UT	Moon at apogee* (404,301 km)
Friday, Mar. 20 11:44 UT	Vernal Equinox**
Thursday, Mar. 26 16:06 UT	New Moon
Saturday, Mar. 28 8:30 pm	Earth Hour `www.earthhour.org`

April 2009	Event
Wednesday, Apr. 2 2:32 UT	Moon at perigee* (370,013 km)
Thursday, Apr. 3 14:34 UT	First-quarter Moon
Tuesday, Apr. 7	Saturn — Moon conjunction
Thursday, Apr. 9 14:56 UT	Full Moon
Thursday, Apr. 16 9:17 UT	Moon at apogee* (404,231 km)
Thursday, Apr. 17 13:36 UT	Third-quarter Moon
Wednesday, Apr. 22	Earth Day Peak of the Lyrids (LYR) - 18 meteors per ZHR, variable up to 90. Meteor shower from Apr. 16-25
Friday, Apr. 24 15:23 UT	New Moon
Tuesday, Apr. 28 6:28 UT	Moon at perigee* (366,041 km)
Apr. 29 - May 3	International Astronomy Week

Meteor Showers for March-May:
`www.imo.net/calendar/2009`
***Perigee** - the point in the orbit of the Moon that is closest to the Earth
***Apogee** - the point in the orbit of the Moon that is farthest from the Earth. For more dates on perigee/apogee of the Moon, new and full Moon dates visit:
`www.fourmilab.ch/earthview/pacalc.html`
****Vernal Equinox** - The sun passes from south to north at the northern vernal equinox (spring)
Δ **ZHR** - zenithal hourly rate — hypothetical rate observing with a clear sky and at limiting magnitude of 6.5, if the radiant were at the zenith

May 2009	Event
Friday, May 1 20:44 UT	First-quarter Moon
Saturday, May 2	International Astronomy Day. For more information see `www.rasc.ca/astroday`
Sunday, May 3	Saturn — Moon conjunction
Wednesday, May 6	Peak of the η-Aquariids (ETA) 85 meteors per ZHR Δ variable rate with 45-85
Sunday, May 17 7:26 UT	Third-quarter Moon
Thursday, May 21	Moon–Mars–Venus conjunction: look before sunrise for the triangle in the east.
Sunday, May 24 12:11 UT	New Moon
Monday, May 25 15:45 UT	Moon at perigee* (361,154 km)

(Setting in the SW in early April)

CANIS MAJOR
The great Overdog,
That heavenly beast
With a star in one eye,
Gives a leap in the east

He dances upright
All the way to the west,
And never once drops
On his forefeet to rest.

I'm a poor underdog,
But to-night I will bark
With the great
Overdog
That romps through the
dark.

— Robert Frost, 1928

2009 International Year of Astronomy

This is a global celebration of astronomy. Since the first view that Galileo looked through the telescope and discovered the moons of Jupiter, to the cutting-edge missions to space, we can all be a part of knowing and learning about astronomy. Be a part of the excitement of 2009 with celebrations across the world and Canada as we bring astronomy to the young and old.

The International Group has Cornerstone Projects such as 100 hours of Astronomy, Dark-Sky Awareness, and the Galileo Telescope. Go to `www.astronomy2009.org` for more information. The Canadian node of the IYA has many projects such as the "Galileo Moment," Canadian First Nations and Inuit Peoples historical knowledge of the heavens, and many more. Visit `www.astronomy2009.ca` for more information, or to volunteer.

Visit your local Centre's Web site for updated information on what your Centre is doing for IYA2009. It's never too late to help volunteer for an event or just to offer a spare pair of hands. Come be part of the excitement in 2009

Society News

by James Edgar, National Secretary (jamesedgar@sasktel.net)

Last month, we devoted Society News to Bonnie Bird's retirement — she flew the coop! So, the question that may present itself is, "Who's minding the store now?" The short answer is, "Jo Taylor is now the Executive Secretary." So, you might ask, "Who is this Jo Taylor?" She joined as our part-time employee a few years ago, working as the Membership and Publications Clerk. It was (and still is) her job to process membership renewals, to fulfill orders from the eStore, and to mail out the many orders for *Observer's Handbooks, Observer's Calendars, The Beginner's Observing Guide,* and *Skyways/Explorons.* In addition to all that, she now has the role of Executive Secretary. Our By-Law #1 says, "the Executive Secretary shall supervise and operate the national office of the Society, and shall discharge such other duties as may be prescribed by the Council." Pretty broad strokes, wouldn't you say? She's capable, cheerful, hard working, dedicated, has a great sense of humour, and she can suck it up with the best of them! Jo runs her own small business, working out of her home, where she creates stained-glass works, jewellery, quilting, sandblast etching, and beadwork. You can see her site at `www.forbiddencolors.ca`.

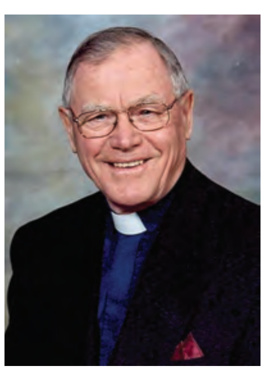
Some of the people on National Council and a few others living close to the Metro Toronto area have met Jo, either in person or in a phone conversation, but most don't even know what she looks like. I'll cure that ill right now — here is a snapshot of the better side of Jo Taylor.

The next time you get near to 136 Dupont Street, drop in, give her a hug, and say "Hello!"

Obituary/Nécrologie

Reverend Father Firmin Michiels
1930 May 7 - 2008 March 2

Father Firmin Michiels of Holland, MB, a long-standing member of the Winnipeg Centre, passed away on 2008 March 2, at the Brandon General Hospital at the age of 77 years.



Firmin joined the Winnipeg Centre in 1978, and shortly after purchased a Celestron C-11 telescope. He loved the heavens and excelled in his deep-sky and solar-eclipse photography. Many of his shots of the February 1979 Winnipeg solar eclipse were included in the slide package sold by the Centre to raise funds for a new telescope and dome at Glenlea. I will always remember fondly our late-night discussions about creation and the Universe. No matter what either of us thought or believed, we always came back to the fact that it was spectacular in its beauty.

— Guy Wescott, Winnipeg Centre

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Astrocryptic

The answers to last issue's puzzle

1 B	R	2 A	D	3 L	E	4 Y		5 T	H	6 E	B	7 E
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8 U	R	S	A	M	I	N	O	R		9 A	R	A
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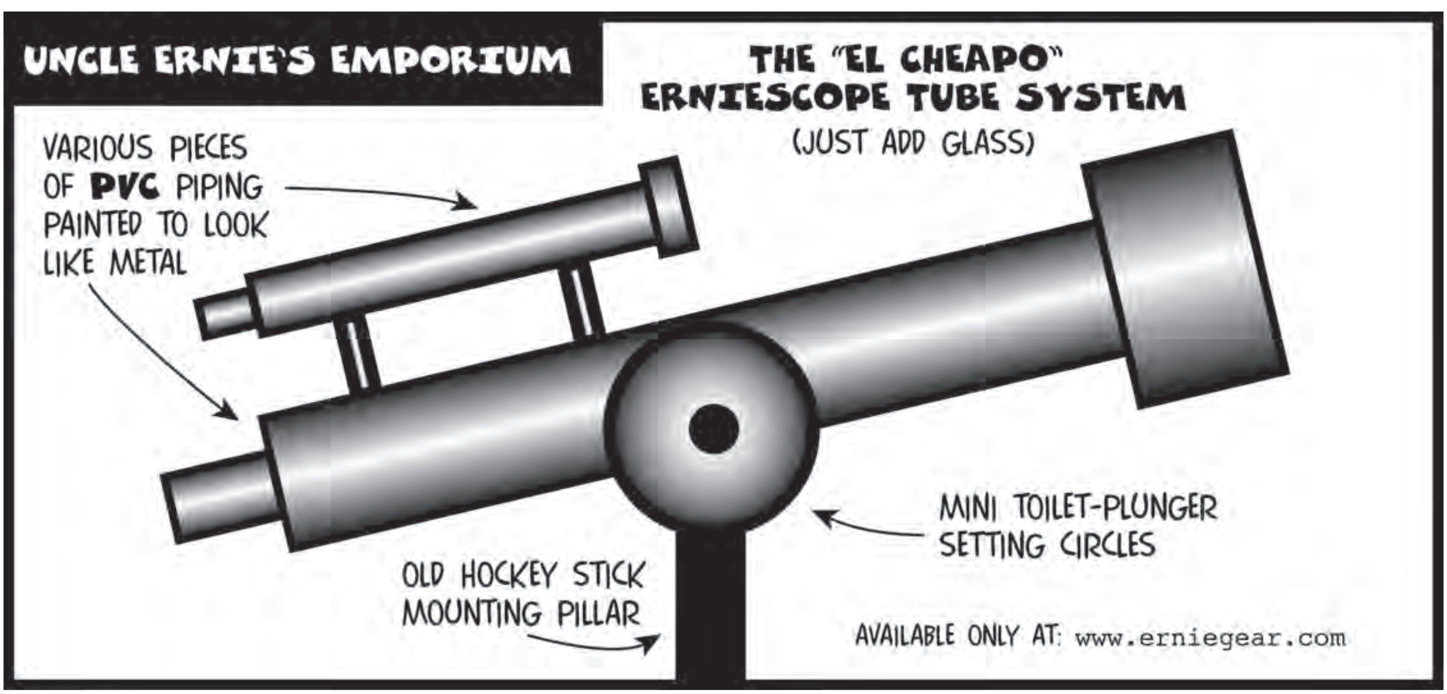
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Great Images

M20, the Trifid Nebula, is a favourite summer and fall target for astronomers. Its three-part shape, though not its colours, are readily seen in even the smallest telescopes. In this image, the blue reflection and red emission portions of the gas cloud dramatically illustrates the physical processes going on in the nebula. Messier described and numbered only the star cluster at the centre of the gas cloud, leaving the cataloging of the nebula to Herschel. The image is a 30-minute exposure with a Starlight Express SXV-M25 camera using a Takahashi FS-102 telescope at 816 mm.

Photo: Jay Anderson

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

NATIONAL OFFICERS AND COUNCIL FOR 2008/CONSEIL ET ADMINISTRATEURS NATIONAUX

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

Montréal Centre
18455 Meloche St, Pierrefonds QC H9K 1N6

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

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

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

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

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

Québec Centre
2000 Boul Montmorency, Québec QC G1J 5E7

Regina Centre
PO Box 20014, Regina SK S4P 4J7

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

Sarnia Centre
c/o Paul Bessonette, 160 George St, Sarnia ON N7T 7V4

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

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

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

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

Vancouver Centre
1100 Chestnut St, Vancouver BC V6J 3J9

Victoria Centre
3046 Jackson St, Victoria BC V8T 3Z8

Windsor Centre
2831 Alexandra Ave, Windsor ON N9E 2J8

Winnipeg Centre
PO Box 2694, Winnipeg MB R3C 4B3