Share a Galileo Moment

April / avril 2009 Volume/volume 103 Number/numéro 2 [735]

# Journal

The Journal of The Royal Astronomical Society of Canada

Le Journal de la Société royale d'astronomie du Canada

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Exploring the Pingualuit Impact Crater · Aboriginal Sky Lore
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Celebrating the International Year of Astronomy (IYA2009)

April / avril 2009

Journal

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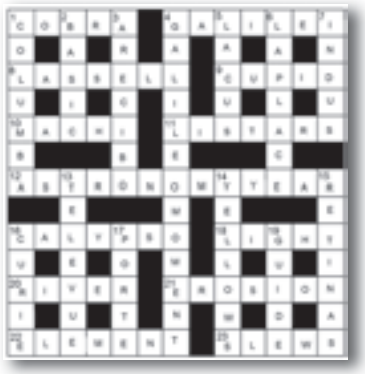

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ROYAL ASTRONOMICAL SOCIETY OF CANADA

SOCIÉTÉ ROYALE D'ASTRONOMIE DU CANADA

## DEPARTMENTS



## COLUMNS



On the Cover:
IC432, is a large, round 12th-magnitude spiral type Sc galaxy in Camelopardalis. Visually, it appears as a small fuzzy nucleus surrounded by a very large and faint hazy glow. Serge Théberge took this image on 2005 October 29 from Thornbury, Ontario. He used an SBIG ST-10XME camera with a Vixen R200SS 8" f/4.6 Newtonian reflector. Exposure was 6 x 10 minutes in each of R, G, and B filters on a Losmandy G11 mount.

# Editorial

[*From the RASCals discussion group:*
`www.rasc.ca/discussion/index.shtml.`*Ed*]

Hi All,

My name is Ralph and I am affiliated with the Winnipeg Centre of the RASC. I have been a member since 2003, and joining the club was one of the better decisions I have made. The RASC, specifically the Winnipeg Centre, has been a source of inspiration for my love of astronomy and science in general. In the last five years, I have met some really fine people from all walks of life, a lot of whom are now my very good friends.

I have been following the discussion on outreach and have now come to the point where I have to chime in and add my own two cents. A lot of us involved in the discussion have put forth comments and ideas from both sides of the fence and it has been interesting to read how varied our opinions can be on the same subject.

I personally consider outreach to be a sharing of my passion for astronomy. I will talk about astronomy to anyone who is interested or will listen, and have initiated conversations with those who seemed disinterested at first but joined in readily once they felt my passion for the subject. These conversations have exposed me to a lot of the myths about astronomy that people have come to believe in, and I have been able to set the record straight on many occasions. These people with whom I have talked are those that some of us have described as "a cross-section of the stupidity of the common folks," "idiots," and "unwashed masses." This is what has prompted me to say my piece because these comments simply reek of shallow elitism.

First of all, I am just a high-school grad who never had the opportunity or resources to attend college or university. Does that make me part of the "stupid common folk?" Am I an "idiot" because I don't have a degree? Let me tell you this, I have a lot of really good friends within the RASC who are very highly educated but do not act snobbish. They realize that there is more to life than their own expertise and that people are not "stupid idiots" because they don't share their views or interests. What makes us any different from the rest of the people out there? Are we so caught up in our own little worlds that we fail to see the big picture? Are we so egotistical as to think that science — astronomy in particular — is the only true field of endeavour and all else is superficial and sub-standard? Where exactly do we get off thinking that way?

So what if a pot-smoking, skateboard-riding, high-school dropout has no interest in looking through our telescopes and going "WOW!" That same "dreg of society" can probably build, from the ground up, an old car and fine tune it to race-ready performance. Does he think we are stupid because you and I


# Journal

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

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can't do what he can? I am sure there are some of us who have never popped the hoods of our cars and can't tell the difference between a dipstick and a tie rod.

The bottom line here is that each and every one of us has something that interests us. So what if it's not astronomy or the sciences? We all come from the same place and will eventually end up in the same place. Just because we are different does not make us better than others. What I feel should really matter is that we make the most of the time we have and try to make the world a better place, even if our efforts are insignificant in the larger scheme of things.

The mandate of the RASC in general is the promotion of astronomy and related sciences. Outreach plays a major part in achieving that goal. Whichever way it is done, it should be done. It can be advertised to attract a crowd who shares our interest...an impromptu, on-the-sidewalk, outside-a-movie-theatre event If, out of the 500 people who may walk by, only 10 percent stop out of curiosity, then the event has been worthwhile. If even one of them gains an interest, albeit only at the enthusiast level, then the event is a huge success. So, we should not argue about the best method of outreach, but use every opportunity available to us.

Most importantly, we must not allow our personal opinions, aired in a public forum, to taint the image of the RASC with the stigma of elitism. Our goal is to attract people to our interests, not turn them away from us. We are NOT more special in any way, shape, or form than our fellow human beings and that concept should be our guide when promoting the RASC and astronomy.

We have ahead of us, IYA2009. Let us make our mark.
Best wishes to all,

Ralph A. Croning
Winnipeg Centre

# Society News

# New National Office found!

On Friday, February 13, a three-year lease was signed for a new RASC National Office. Our new premises are located on the second floor of a medical and professional building, and are approximately 700 ft$^2$. By the time you read this, the Society will have taken possession on March 1.

The new National Office mailing address, effective 2009 March 16, is:

The RASC
203 - 4920 Dundas St W
Toronto ON M9A 1B7
Canada

Our telephone number remains the same (416) 924-7973

The landlord has completed some minor alterations at our request, including new carpet and paint and a storage locker.

The building is located in "Islington Village" near the Islington subway station. Visitors to National Office will find ample visitor parking available for a fully accessible building. The new National Office is significantly easier to reach from Pearson Airport.

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

# News Notes/*En manchettes*

*compiled by Andrew I. Oakes,*
*Unattached Member (copernicus1543@gmail.com)*

**U of T Professor Collects Cosmology Prize at Harvard-Smithsonian Event**

Figure 1 — Cosmologist J. Richard Bond. Photo courtesy International Astronomical Union.

Canadian cosmologist J. Richard Bond received the 2008 Cosmology Prize of the Peter and Patricia Gruber Foundation in September 2008 at a Harvard-Smithsonian Center for Astrophysics event in Cambridge, Massachusetts, USA.

The director of the Canadian Institute for Advanced Research Cosmology and Gravity Program and a professor at the University of Toronto, Bond was honoured by his international colleagues for groundbreaking theoretical work on the structure, formation, and evolution of the Universe, including the role played by dark matter. The prestigious Gruber Cosmology Prize consists of $500,000 and a gold medal, accompanied with an official citation that reads:

> *The 2008 Peter and Patricia Gruber Foundation Cosmology Prize is proudly presented to J. Richard Bond for his pioneering contributions to our understanding of the development of structures in the Universe. Professor Bond's work has provided the theoretical framework to interpret the observed inhomogeneities in the fossil radiation left over from the early stages of expansion of the Universe — the Big Bang. Professor Bond's research has helped us understand the transition from the nearly featureless early Universe to the wonderfully structured world of galaxies, stars, and planets today.*

The Gruber Cosmology Prize honours a leading cosmologist, astronomer, astrophysicist, or scientific philosopher for theoretical, analytical, or conceptual discoveries leading to fundamental advances in the field, and is awarded in collaboration with the International Astronomical Union.

Bond joins an elite group of Gruber Cosmology Prize laureates who include:

**2007:** Saul Perlmutter and Brian Schmidt and their teams: the Supernova Cosmology Project and the High-z Supernova Search Team, for independently discovering that the expansion of the Universe is accelerating

**2006:** John Mather and the Cosmic Background Explorer (COBE) Team for studies confirming that our Universe was born in a hot Big Bang

**2005:** James E. Gunn for leading the design of a silicon-based camera for the *Hubble Space Telescope* and developing the original concept for the Sloan Digital Sky Survey

**2004:** Alan Guth and Andrei Linde for their roles in developing and refining the theory of cosmic inflation

**2003:** Rashid Alievich Sunyaev for his pioneering work on the nature of the cosmic microwave background and its interaction with intervening matter

**2002:** Vera Rubin for discovering that much of the Universe is unseen black matter, through her studies of the rotation of spiral galaxies

**2001:** Martin Rees for his extraordinary intuition in unravelling the complexities of the Universe

**2000:** Allan R. Sandage and Phillip J.E. (Jim) Peebles: Sandage for pursuing the true values of the Hubble Constant, the deceleration parameter, and the age of the Universe; Peebles for advancing our understanding of how energy and matter formed the rich patterns of galaxies observed today

According to the Harvard News Office, the Gruber Foundation Prize was inspired by a conference at the Harvard-Smithsonian Center for Astrophysics attended by the founders in 1999.

## Gold Medal for Exemplary Work in Astronomy

Retired National Research Council (NCR) scientist Sidney van den Bergh received the 2008 Catherine Wolfe Bruce Gold Medal in recognition of his lifetime achievements as an astronomer.

Figure 2 — The Catherine Wolfe Bruce Gold Medal, Astronomical Society of the Pacific.

Van den Bergh is only the second Canadian recipient in the 111-year history of this prestigious award, which is presented by the Astronomical Society of the Pacific. The other Canadian medalist was John Stanley Plaskett in 1932.

Both Plaskett and van den Bergh had served as Directors of the Dominion Astrophysical Observatory (now called the National Research Council of Canada Dominion Astrophysical Observatory (NRC-DAO)) during their respective years of tenure; Plaskett as its first director beginning in 1917, and van den Bergh from 1977 to 1986.

Best known for his work on galaxies and the stars that make them up, van den Bergh has published more than 500 peer-reviewed papers covering a vast array of astronomical subjects. He has made fundamental contributions to the study of nearby galaxies, including the many small "dwarf" galaxies surrounding our own Milky Way and our twin sister, the Andromeda Galaxy, and to systems for classifying galaxies based on their visual appearance.

Other Catherine Wolfe Bruce Gold Medal recipients have included such well-known names in the world of astronomy as Simon Newcomb (1898 — the first recipient), Giovanni V. Schiaparelli (1902), William Huggins (1904), Henri Poincaré (1911), Edward E. Barnard (1917), Frank W. Dyson (1922), Arthur Stanley Eddington (1924), Edwin P. Hubble (1938), Jan H. Oort (1942), Walter Baade (1955), S. Chandrasekhar (1952), Fred Hoyle (1970), Allan Sandage (1975), Fred L. Whipple (1986), and P. James E. Peebles (1995).

On his official retirement from the NRC in 1998, van den Bergh was named an NRC Researcher Emeritus and has since remained active in research and publication.

## Canadian Component of ALMA Initiative Progresses to Next Step

A Memorandum of Understanding now specifies how Canada will be contributing to the Atacama Large Millimetre/submillimetre Array (ALMA) operations. The agreement, reached between the Herzberg Institute of Astrophysics (HIA) and National Radio Astronomy Observatory (NRAO), is to be signed once funding is in place between National Research Council of Canada (NRC) and National Science Foundation (NSF).

There will be a cash contribution toward array operations in Chile, and HIA will provide an "in-kind" contribution toward the North American ALMA Science Center in Charlottesville, Virginia. The in-kind contribution includes support scientists, maintenance of the 3-millimetre wavelength ALMA Band 3 receivers, and support for Canadian Astronomical Society/ Société Canadienne d'Astronomie software and documentation.

The Band 3 receiver project — the largest Canadian contribution — is now in its seventh year of a ten-year program. Four Band 3 production cartridges have been completed, augmenting the eight pre-production units already assembled and tested. In all, 70 receivers are to be built.

The superconducting detector technology for millimetre waves employs tiny switches about 50 times smaller than the width of a human hair. They operate at liquid helium temperatures of -269 °C with the aim of detecting and amplifying the faint whispers of radiation that reach Earth from the remotest parts of the cosmos. The HIA instrumentation laboratory in Victoria, B.C., is one of the few facilities in the world with expertise in this area.

ALMA will be an array of 64 radio antennae that will work together as one telescope to study millimetre and submillimetre wavelengths.

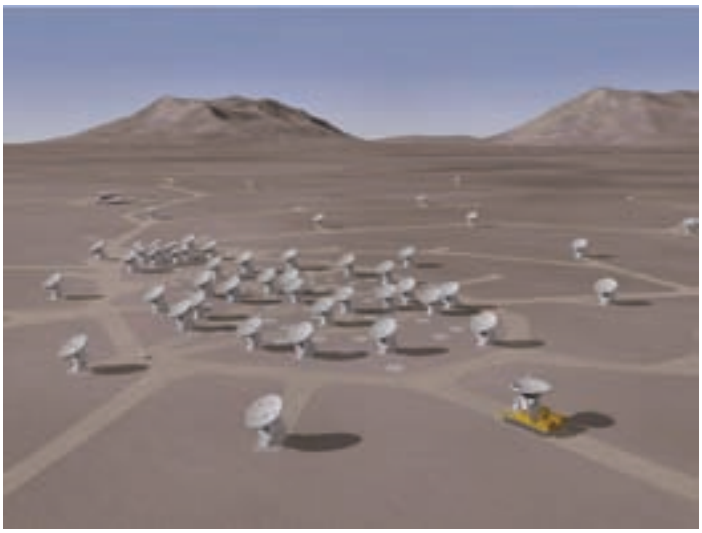

Figure 3 — An artist's conception of the layout of the central portion of the ALMA array. Image: ESA

The first ALMA production antenna was accepted by the ALMA project on 2008 December 18. Manufactured by the Mitsubishi Electric Company (Melco), under contract to the National Astronomical Observatory of Japan, it was moved by transporter on 2009 January 8 to a foundation at the Operations Support Facility (OSF) for further testing.

An international partnership between North America and Europe funds and operates ALMA. The National Research Council of Canada originally joined with the U.S. National Radio Astronomy Observatory to form the North American half of this project, which is the largest ground-based astronomy endeavour ever undertaken.

The international project promises to revolutionize humanity's understanding of the formation of planets, stars, and galaxies when it begins full science operations early in the next decade.

Chile is the host nation for ALMA and has made available the astronomical site — the 5000-m-high (16,500 feet) plateau of Chajnantor in the Atacama Desert region. Because ALMA will operate at wavelengths of 0.3 to 9.6 mm, a high, dry site for the telescope is required in order to see through the Earth's atmosphere.

The 12-metre antennae will have reconfigurable baselines ranging from 15 m to 16 km, and will be able to achieve resolutions as fine as 0.005 arcseconds at the shortest wavelengths — a factor of 10 better than the *Hubble Space Telescope.*

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

# Executive Perspectives

*by Mary Lou Whitehorne, 1st Vice-President*

The RASC is a federally registered charity.

Why? What is our purpose and function as a charity? What benefits are realized from having charitable status?

Surely, there must be more to it than the ability to issue charitable tax receipts to donors. Our publications state that the RASC is "dedicated to the advancement of astronomy and allied sciences." Because we are an organization dominated by amateur astronomers, scientific research plays a smaller role now than it once did. Essentially, it boils down to education and public outreach, on several levels.

Sharing and informing about the night sky is an important endeavour that makes a significant contribution to the fabric of Canadian society. In 1960, former RASC president, Peter M. Millman, spoke on this subject:

> *"It has been said that the cultural advancement of a country may be gauged by the support given to astronomy, and in this regard Canada has a proud tradition."*

Those words are just as true today as when they were first uttered. Astronomy offers tremendous educational and cultural benefit to its audiences. It is intrinsically interesting to all people. Everyone looks up at the night sky and wonders about the stars, the Universe, and our place in the grand scheme of things. Astronomy has deep roots in almost every culture on Earth. It has enormous power to ignite an interest in children for science, technology, and related subjects. It is a powerful springboard for the promotion of, and improvement in, science literacy among people of all ages.

Seemingly unrelated to this idea is the fact the RASC is a nationally registered charitable organization. Charitable status was granted in 1967. At first glance, we do not have the appearance of a "typical" charity. We do not raise funds to cure the sick or to feed, clothe, and house the less fortunate of the world. This makes us a little different from the commonly perceived vision of what constitutes a charity. Instead, we deal in knowledge. We strive to improve the level of knowledge and understanding among members of the Canadian public about the science of astronomy. What we do is charitable, but how so?

Mary Lou Whitehorne, author and RASC 1st Vice-President

The Letters Patent of the RASC describe the Society's objects as:

> *"(a) to stimulate interest and to promote and increase knowledge in astronomy and related sciences;*
> *(b) to acquire and maintain equipment, libraries and other property necessary for the pursuit of its aims;*
> *(c) to publish journals, books and other material containing information on the progress of astronomy and the work of the Society;*
> *(d) to receive and administer gifts, donations and bequests from members of the Society and others;*
> *(e) to make contributions and render assistance to individuals and institutions engaged in the study and advancement of astronomy."*

Many of our normal activities in pursuit of these objects qualify as charitable activity. The nature of the RASC is such that it provides access to knowledge networks on the local, national, and international levels. It enables and encourages members to learn, share, and grow to their fullest potential, should they

wish to do so. For many, this may be almost meaningless. For others it is vital. At the Society level, it is critical.

I think of our Society as an enabler. The RASC fosters the education and development of its members. It "grows" expertise and that expertise connects with expertise around the world. It raises the bar for all of us. We then share our knowledge and expertise with local, regional, national, and international communities. This "fostering from within" helps us as an organization to contribute to improved science literacy among the Canadian population and beyond. This is a significant contribution to the fabric of human society. It should not be taken lightly!

As individual members, we enjoy the benefits of belonging to one of the world's most respected national-level astronomical organizations. We may think of our activities as being "astronomy club" activities. But look closer at what we do and how it is made freely available to the public: monthly meetings, lectures, star parties, observing sessions, school visits, and information sessions at libraries, malls, and other public places. We make educational resources and other information freely available through our Web site (Yes, a Web site can be a charitable activity!). We publish the *Journal,* the *Observer's Handbook, the Observer's Calendar, Skyways, The Beginner's Observing Guide* and other informational items. We sponsor local and national science-fair awards. We educate our own members through programs like the NOVA course. Those members then become more effective ambassadors of astronomy. We support global light-pollution abatement initiatives through our own LPA committees and programs. Such activities are fundamental to the overall improvement of human society. All of this is routine.

And, we must not forget IYA2009! This will be an exceptional year, with its greatly enhanced public-education program that should leave a lasting legacy of support for, and interest in, astronomy. It is worth mentioning here that our members have contributed a generous $16,500 in support of our IYA projects. To them, and to all the many volunteers who have devoted so much time and energy toward making IYA a great success, I offer my sincerest thanks.

We may not fit the picture commonly associated with charitable organizations, but there is no doubt that what we do is of substantial and lasting benefit to the public. Yes, we are members of an astronomy club. And we also belong to a charitable organization that does a great deal of valuable work. The RASC is an organization of which we can all be justifiably proud.



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**Errata**

Last February's *Journal* incorrectly failed to give credit for the cover image. That credit properly goes to Bruce McCurdy, Edmonton Centre, for his image of Ellen Milley contemplating a fragment of the Buzzard Coulee meteorite on ice.

# The Helen Sawyer Hogg Memorial Lecture: The Art of Gentle Persuasion

*by Phil Plait, Bad Astronomy (thebadastronomer@gmail.com)*

**Introduction**

In 1985, The Royal Astronomical Society of Canada (RASC) and the Canadian Astronomical Society (CASCA) began co-sponsoring an annual lecture to celebrate the life and career of Dr. Helen Sawyer Hogg, a Past President of both Societies. Dr. Hogg was interested in increasing public awareness and appreciation of the Universe, an aim also furthered by the annual lectures. These lectures are free, open to the public, and held at the RASC or CASCA Annual Meetings in alternating years.

At the General Assembly in Toronto last summer, Dr. Phil Plait, the author of the books *Bad Astronomy* and *Death From the Skies,* gave the Helen Sawyer Hogg Memorial Lecture.

More information on the lecture can be found on the RASC Web site `www.rasc.ca/programs/lectures.shtml`

*— Randy Attwood, Mississauga Centre*

**The Art of Gentle Persuasion**

I've often wondered what would happen if we could take a census of the ideas in our heads. We could look at them one at a time and throw them into bins marked "Correct" or "Not so much."

Phil Plait, the creator of Bad Astronomy, delivered the 2008 Helen Sawyer Hogg Memorial Lecture.

Which bin do you think would overflow first?

Don't side with "correct" so quickly. For example, antioxidants are good for you, right? I see advertisements for products with antioxidants in them, news reports where they point out antioxidant-laden meal ideas, and food labels proudly displaying their level of antioxidation.

But now I'm also starting to see reports that maybe antioxidants aren't all that great. Maybe they don't do much at all, if anything.

How much of my brain is loaded with antioxidant propaganda? Well, maybe only a wayward synapse or two. But that's just one narrow topic. What other medical information have I misplaced or misfiled or been misled about? How about geology? Zoology? Movie trivia?

Or, what about — gasp — astronomy?

My brain is loaded with astronomy information. I can rattle off NGC numbers, RAs and Decs, moons, planets, supernovae dates and distances, filter bandpasses... but what's the current thinking on dark energy? How far away is the Andromeda Galaxy? Can you get out of a black hole?

Those ideas change with time, or with better measurements. I read a lot, so I try to keep up, and I have some small experience with these ideas. You and I are familiar with a lot of these things, and I bet we can usually sniff out the wrong stuff, the misremembered, and the outright hoaxed.

But what about the public? The vast majority of people who don't live and breathe astronomy have been shown through various surveys to have only a tenuous knowledge of astronomy. In the U.S., half the population doesn't know the Earth goes around the Sun and takes a year to do it.

Getting useful knowledge out to teeming millions is already hard enough. Facing impediments of previously acquired bad astronomy makes it almost impossible.

Worse, some studies have shown that people tend to remember wrong information *even after it's been corrected.* You can explain to them patiently and scientifically just exactly how Rayleigh scattering works, but a month later they'll still think the sky is blue because the sky reflects light from the ocean.

Purely by accident — no one would do this on purpose — I've devoted my professional life to this issue. I've found that there may be ways to achieve the seemingly insurmountable goal of teaching good astronomy to the public and weeding out the bad. Ironically, I have no scientific basis for my methodology, except to keep doing what works and abandon what doesn't (which, to be fair, is a pretty good one-line synopsis of experimental science). But, happily, a lot of things *do* work: using what interests people is a good place to start. Being friendly is another. And, above all, don't forget to bring the funny.

OK, first: interesting stuff. This may shock you, but people pay more attention to things that interest them. If you

want to teach people astronomy, *good* astronomy, then you have an advantage. Astronomy is cool. People tend to like it. Even better, if someone is attending a star party or your local astronomy-club meeting, they're there because they already like astronomy. You're already a step ahead.

But then, that's not always the case. You might be at a bingo game or the grocery store, or a cocktail party, and some lout will start pontificating that NASA faked the Moon landings. What do you do then?

Let me introduce the second point: be friendly. It turns out — and I have personal experience here — that yelling, berating, and insulting someone tends to turn them off to new ideas. Using facts to beat them mercilessly doesn't help either. Worse, it will alienate the audience around you! And, they are far more important to you. After all, engaging one guy alone, even if you win, means you have converted one guy. If there are ten people listening, you can greatly increase your efficiency if you sway them as well.

That's why you need to be friendly. Don't yell, don't berate, don't beat. Smile. Be nice. Avoid insults, and don't raise your voice (as much as you really, really, really want to). Use phrases like "That turns out not to be the case," rather than "That's the stupidest damn thing I ever heard." Even when asking them for their evidence (which they very rarely will actually have), ask them "That's an interesting claim; what evidence do you have to support that?" instead of poking them in the chest and bellowing "Prove it!"

Even when short-circuiting those claims with contrary evidence, be nice. Present it carefully. Remember, that audience is listening. They want to know what's going on as well.

Which brings us to point three: use humour. If you can get a person laughing, you've made them a willing participant to your point of view.

I don't mean you have to wear a red nose or make bad puns (though I have found, on occasion, either or both have their place). What I mean here is that when you're engaging bad astronomy you should have fun. You do *enjoy* astronomy, right? It's *fun* to you? So make sure the people you're talking to see that.

When I give public talks, I always joke around. Sure, I'm serious when I need to be, but in general I have found that audiences appreciate what you're saying more when they get a chuckle out of it. They're more likely to listen if they're laughing. How much do you remember from a boring lecture?

Of course, you have to be careful when considering the venue. At a eulogy, pratfalls may be frowned upon. But I usually get good laughs when I take my belt off and blow on it to analogize the flag-waving on the Moon. Balancing eggs on end always gets peoples' attention and makes them laugh, even when they initially have no clue what I'm doing (which is debunking the old chestnut that eggs can only stand on the vernal equinox). After I explain it, they're likely to remember it better.

And once an egg is balanced, I always get a standing ovation.*

These three points (interest, politeness, humour) are necessary to make your point, but not sufficient. You also need knowledge. But, if you're reading this, you've already got a good start: you're an astronomer. And, what's better is that we now have a vast reservoir of accessible knowledge to which we can point interested people: the Internet. There are huge numbers of excellent Web sites with great discussions of topics astronomical. You probably already know of quite a few.

Of course, the Web is also full of nonsense. Hopefully, if you've primed the person, they'll know best where to look. `BadAstronomy.com`, for example.

So, the next time you find yourself confronted with someone who is completely sure the Sun will explode in 2012, or that astronomers are hiding evidence of a giant asteroid headed our way, or that Venus is actually a UFO that will come down to probe their nether regions, you know what to do.

This applies to the written word as well. Write articles, leave comments on other peoples' Web sites, or blog about all this yourself. There's plenty of room to have fun online. For example, I've found that my movie reviews are pretty popular. People sometimes love the snark, and I like to write up timely and slightly silly reviews of bad movie science when a new flick comes out. It's not always easy (I missed my chance with "The Day The Earth Stood Still," for example, which fortunately for me may have actually saved many thousands of my brain cells), but you'll find that people will be far more interested in the latest film from Hollywood than over a 14th-magnitude supernova you're trying to show them in NGC 1132.

If you have an upcoming star party or club meeting, why not focus it on a popular movie that just came out? If it's near the vernal equinox, grab some eggs. If it's near the full Moon (and why are you having a star party then?), then bend over and view it between your legs, erasing the famous Horizon Illusion.

Grab their attention, make them laugh, make them smile. That will help make them *think*. And that's the whole point, isn't it?

*Phil Plait, the creator of Bad Astronomy, is an astronomer, lecturer, and author. After ten years working on* Hubble Space Telescope *and six more working on astronomy education, he struck out on his own as a writer. He has written two books, dozens of magazine articles, and 12 bazillion blog articles. He is a skeptic, and fights misuses of science as well as praising the wonder of real science. Asteroid 2000 WG11 was renamed (165347) Philplait in his honour. Phil delivered the RASC's 2008 Helen Sawyer Hogg Memorial Lecture.*

* See? That's a pun. It's funny. Kind of.

# A New Major Observatory in Canada

*by Frank P. Roy, Elektra Observatories (frank.roy@elektraobservatories.org)*
http://elektraobservatories.org

**Abstract.** The technical details and scientific potential of a one-metre-class telescope to be situated in the Madawaska Highlands of Ontario are discussed. This area, 100 km northwest of Kingston as the crow flies, has the darkest skies in southern Canada, measured at 21.82 mag/arcsec$^2$. For maximum efficiency, it is designed exclusively for wide-field prime-focus imaging, with a highly corrected field-of-view of 5 degrees$^2$. It will employ the world's largest monolithic CCD digital sensor with some 112 megapixels. Much effort has been expended to optimize the seeing, which is expected to be better than 1.25″ mean Full Width Half Maximum. The instrument employs active optics in the prime-focus platform for active all-sky collimation and precision focus, together with the use of carbon fibre in the optical-tube assembly, dome, and parts of the mount, plus other design innovations that will produce a state-of-the-art observatory with few rivals in the world in its class. It is capable of reaching magnitude 27 in 5 hours (s/n=3, 450nm BW, Zθ = 0°, 1.25″ FWHM) with download times under 2 seconds; the telescope is capable of outperforming much larger instruments and certainly all Canadian-based imaging telescopes.

## 1. Introduction

Thirty years have passed since a major optical observatory was built in Canada. Elektra Observatories, a Canadian not-for-profit corporation is developing a high-performance wide-field one-metre telescope to be located at Mallory Hill near the town of Denbigh, Ontario. The One Metre Initiative (OMI) is breaking new grounds on several fronts. It's the first time in Canada that a major observatory will be designed, built, managed, and operated by a private concern. It will be the largest field-of-view prime-focus optical telescope in the world and will use the largest monolithic image sensor in the world. The Observatory is designed to have the best possible seeing by employing a host of advanced materials, innovations, and technologies with a deep understanding of the seeing equation. This will be the determinative factor in producing the best possible science. Several areas of research will benefit, including the search for high-Z Type Ia supernovae; near-Earth objects and Earth-sized planets orbiting red-dwarf stars are amongst the most exciting. Some of the telescope time will be devoted towards public outreach and education. This would be the only major Canadian observatory to offer such a service.

## 2. Performance Objectives

The telescope, mount, pier, dome, and site were all designed and selected for optimum image quality and maintenance of the best possible local seeing, which we believe is a more important factor to telescope performance than the more distant atmospheric seeing. Our target is 1.25″ mean FWHM at the prime focus. Extensive use of carbon fibre in the optical-tube assembly, mount, and dome will yield an extremely light and stable imaging platform. For maximum efficiency, it is configured exclusively for imaging using the ugriz filter set with the addition of a wideband-luminosity (wL) filter (420-870 nm) for quick, deep surveys (0.7 mag deeper than r´), able to reach $m_{wL}$ = 26 in under 1 hour (s/n = 3, 1.25″ FWHM, Zθ = 0°). The utilization of active optics in the form of a hexapod with 6 degrees of freedom in the prime focus assembly, a corrected wide field of view of 5 degrees$^2$, a 112-megapixel monolithic CCD image sensor with download times under 2 seconds, an exceptionally dark sky with a measured brightness of 21.82 mag/arcsec$^2$, and significant on-site computing power (~5 TFLOPS) will yield a instrument with superb capabilities.

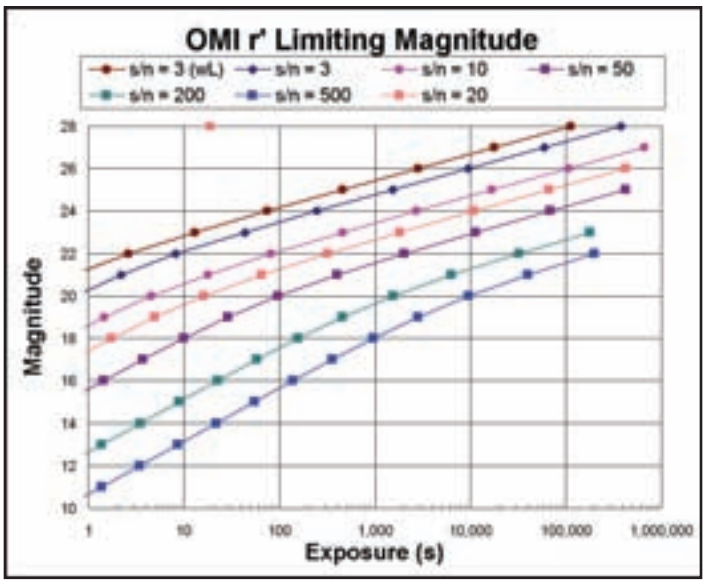


Figure 1 — OMI Limiting magnitude for varying s/n, Zθ = 0°, 1.25″ FWHM (wL = 420-870 nm)

## 3. The Site

Site selection was based on several criteria; sky darkness, altitude, and local site conditions being the most important. The sky brightness map published by Cinzano and Thiene (1998) was used for locating a potential dark site. Our objective was to get a site as far south as possible, yet still have exceptionally dark skies and a large buffer zone.

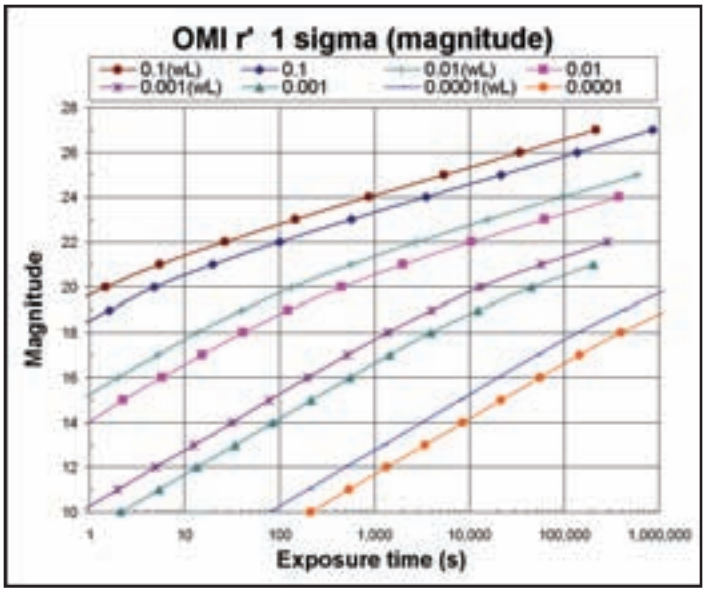


Figure 2 — OMI Photometric performance with Zθ = 0°, 1.25″ FWHM (wL = 420-870 nm)

Additionally, we wanted the highest possible elevation and a treeless area to minimize microclimates caused by a forested canopy. The ONLY area that meets all of these criteria is near the small town of Denbigh, which is located about 100 km northwest of Kingston, Ontario. Road and topographic maps were examined to locate a specific site. The chosen location is identified on topographic maps as Mallory Hill. It has an altitude of 400 metres with 80 acres of cleared land on a hilltop. The area has a good paved road running nearby and no higher elevations in the west for optimum airflow over the local terrain. Sky brightness measurements were made over several months using a Sky Quality Meter by Unihedron with readings of 21.82 mag/arcsec$^2$; no direct lights are visible from the site. There is sufficient buffer to allow for 100 years of continuing dark skies in the face of expected development. According to Environment Canada, we should expect more than 1000 nighttime cloud-free hours per annum.

| | |
|---|---|
| Latitude | N 45° 01′ 37.4″ |
| Longitude | W 77° 05′ 57.4″ |
| Altitude | 375 metres |
| Sky Brightness | 21.82 mag/arcsec$^2$ (v) (42° FWHM ) |
| Horizon Exposure | < 2° |
| Ground | 80 acres cleared land on a hilltop, 12″ top soil with a granite base |
| Clear Dark Hours per year | ~1100 (Environment Canada for Kingston) |

**Table 1. OMI site performance/characteristics**

Figure 3 — Panoramic night view at Mallory Hill, 2007 December 12/13

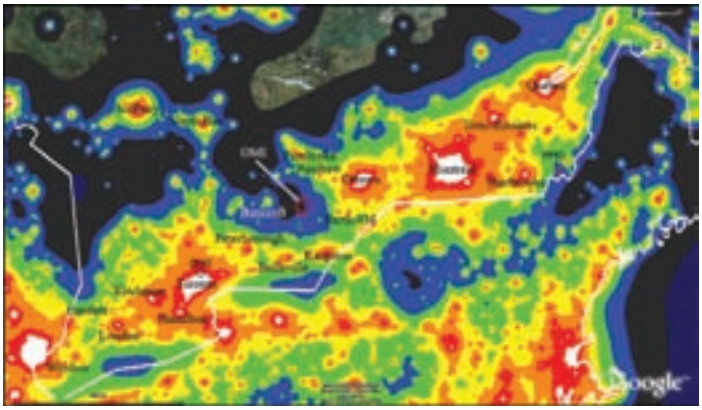

Figure 4 — Sky-brightness map of north-east North America showing the location of Mallory Hill with major Canadian observatories identified. Based on work by Cinzano and Thiene, Italy 1998

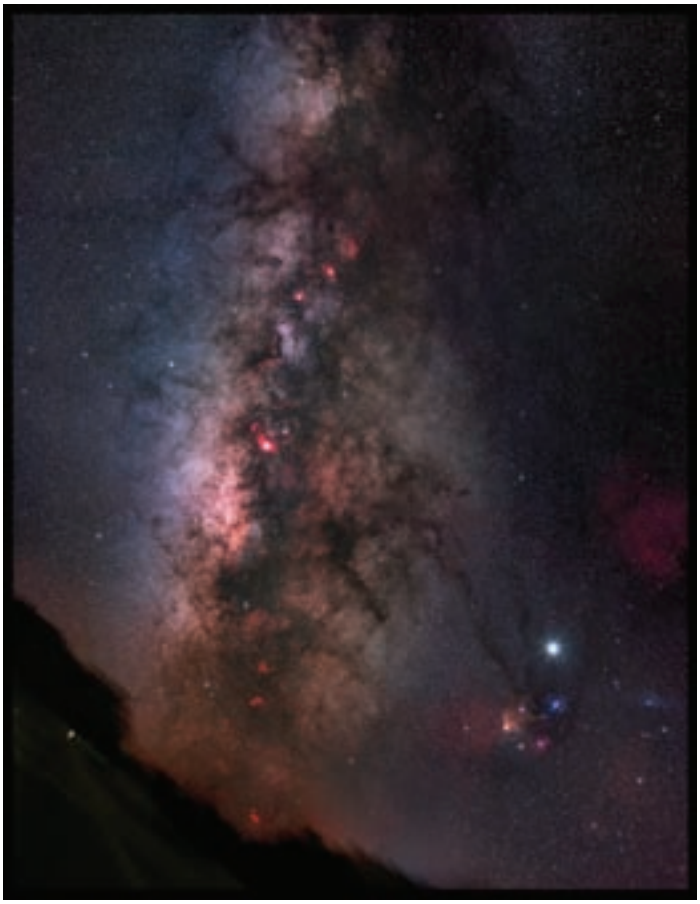

Figure 5 — The Milky Way at Mallory Hill. Mosaic of 9 images with a 50mm @ f/4, 350D, 20-minutes exp. per frame ©2007 Nathan Chamaillard

## 4. The Telescope

No effort was spared to design the best possible instrument. The telescope was designed to yield the largest possible FOV with a light, rigid frame. The OTA uses a Serrurier truss topology with Carbon Fibre Sandwich Core for a total mass of ~200 Kg. This material is also very rigid and has superb dimensional stability over temperature; the end result is a very light and stable imaging platform. The optical system is unique; according to the optician, it has the distinction of being the largest field-of-view prime-focus telescope in the world, with a FOV of some 5 degrees$^2$. The optical system uses an f/2.34 open-back cellular parabolic mirror with a mass of ~68 kg, a 4-lens field flattener/corrector of fused silica (3) + $CaF_2$ (1) with a spherical/aspherical design yielding a final f/2.4 system with 80% encircle energy of 0.4/0.7 arcsec centre/edge in the r´. The open-back structure allows for a light mirror and thin ~6-mm optical surface, thereby minimizing the mass and permitting a rapid equilibrium to ambient temperature. This is critical to eliminating the boundary effect, which can seriously degrade the seeing. The mirror has nine 90-mm low-vibration fans to accelerate the ambient temperature tracking. Mirror flaps are employed to minimize dust accumulation.

The 135-mm diameter, fully corrected field has vignetting of 6 percent. Enhanced aluminum is used with $SiO_2$/$Ta_2O_5$ over coatings with 95% reflectivity at 450-650nm and 75% from 300-1200 nm.

The u´, g´, r´, i´, z´ filter set will be used with less than 10 seconds change time between the filters. In addition, a wL filter (420-870nm) will be available reaching 0.7 magnitudes deeper than r´. A Bonn 125-mm-square high-speed shutter will be used.

| | |
|---|---|
| Aperture (clear) | 1.016 m (open back cellular), parabolic |
| Mode | Prime Focus |
| Focal Length (effective) | 2454 mm |
| f/ratio | 2.42 |
| Field of View | 5 degrees$^2$, 2.22° × 2.22° |
| Étendue | AΩ = 6 |
| Image scale | 84 arcsec/mm, 0.084arcsec/μm |
| Spatial sampling | 0.76 arcsec/pixel |
| Field Flattener/corrector | 135-mm corrected image circle, 6% vignetting |
| Field Flattener/corrector | 0.4/0.7″ (4.7/8.3 μm) 80% encircle energy in the r´ (centre/edge) |
| Field Flattener/corrector | 4-lens design, spherical/aspherical, fused silica (3) + $CaF_2$ |
| Areal Central Obstruction | <20% |
| Mirror/Optical-surface | 146 / 6 mm, Cellular Borofloat |
| Expected Image Quality | 1.25″ mean FWHM |
| Spectral Range | 350-1000 nm |
| Filters | u´, g´, r´, i´, z´ + wL, < 10 s change time |
| Active Optics (Hexapod) | +/-50 mm in x, y, +/-25 mm in z, +/-1 μm repeatable (max) |
| Active Optics motion | Lateral motion, Tip/Tilt, Rotate, Focus |
| Active Optics | All Sky Auto-Collimation and focus. Lateral x, y tracking (20Hz) |
| Mirror Accuracy | 1/16th wave P-V 550 nm |
| Mirror Roughness | ~10 nm rms |
| Coatings | Enhanced Aluminum with $SiO_2$/$Ta_2O_5$ over-coatings, >95% 450-650nm, 75% 300-1200nm |
| Shutter | Bonn 125-mm |

**Table 2. OMI Optical performance**

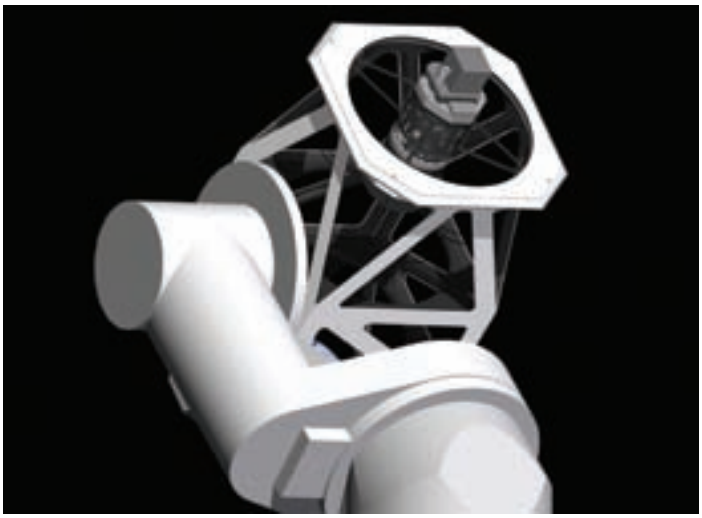

Figure 6 — 3-D model of the One Metre Initiative, provided by Dream Telescopes & Acc., Inc.

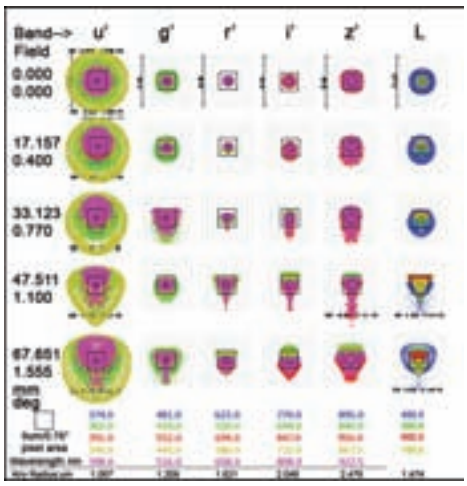


Figure 7 — Spot diagrams based on 80% encircled diameter, boxes are 25 μm in size.

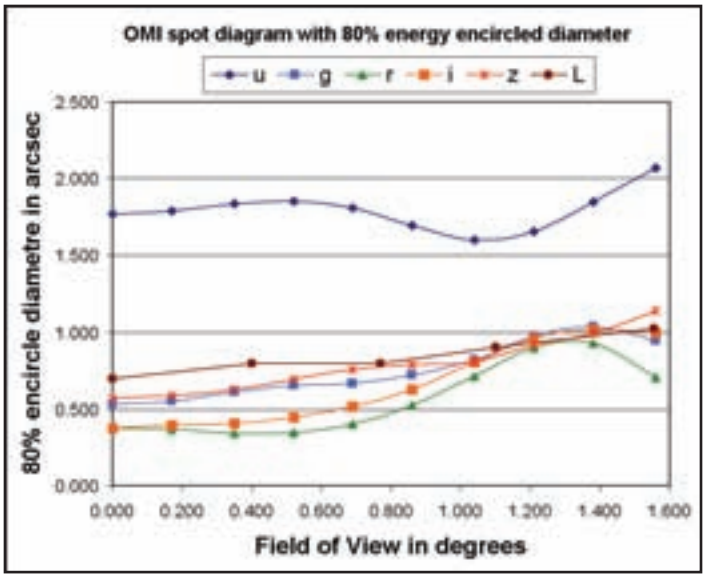


Figure 8 — OMI spot curve with 80% encircled energy, based on 9-µm pixel pitch and 0.76″/pixel

### 5. Active Optics

Integrated into the prime-focus assembly is a hexapod with 6 degrees of freedom. This allows motion in lateral, rotation, z-axis, and tip/tilt with +/-1 µm repeatability. The hexapod has the ability to respond quickly (20Hz) and may be used in the future as a form rapid x, y lateral tracking. The hexapod allows a collimation map to be applied on a continuous basis as the telescope changes position, thereby compensating for gravitational distortions and assuring sharp edge-to-edge images across the sky. In addition, the hexapod will be used for precision focus.

### 6. The Camera and Guider

The Camera will be made by Spectral Instruments and employs the largest chip ever made, a 4″ × 4″ CCD image sensor with 112 million pixels. The sensor is fabricated by Waterloo's DALSA, is manufactured at Canada's only chip factory, in Bromont, Québec. The thinned, back-illuminated, 10,580 × 10,560 pixel sensor has pixel pitch of 9.0 × 9.0 microns and a peak quantum efficiency of 94% in the r´. The entire 112-megapixel array can be downloaded in 2 seconds. This is accomplished by the use of 16 read ports. Cooled to -100 °C, the camera has effectively no dark noise (1e-/pix/hr). 16-bit quantization is used with an 80,000e- well size. The use of a monolithic sensor will improve overall efficiency of the camera by eliminating the gaps found in more traditional large-format mosaic cameras (no dithering required), and will simplify the calibration, image processing, and geometric corrections.

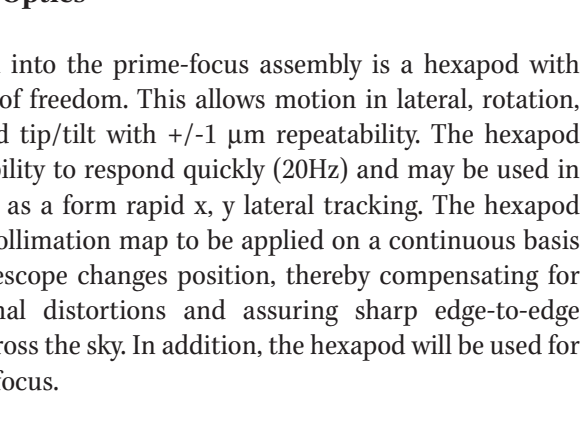

Figure 9 — STA-1600A 112-megapixel CCD

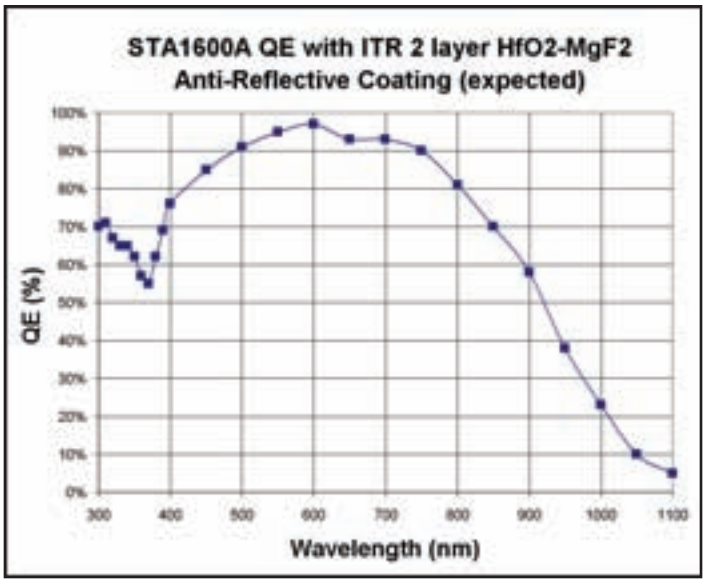


Figure 10 — QE for STA-1600A with thinned-backside illumination with a 2-layer $HfO_2$-$MgF_2$ anti-reflective coating

| Mag. r´ | #/deg² | #/Sen. | Total stars | s/n | s/n | s/n |
|---|---|---|---|---|---|---|
| Exposure ➔ | | | | 1s | 0.5s | 0.1s |
| 10.25 | 7 | 0.12 | 0 | 388 | 267 | 100 |
| 10.75 | 11 | 0.19 | 0 | 303 | 206 | 72 |
| 11.25 | 16 | 0.28 | 1 | 235 | 156 | 50 |
| 11.75 | 23 | 0.40 | 1 | 180 | 116 | 34 |
| 12.25 | 33 | 0.58 | 2 | 135 | 85 | 23 |
| 12.75 | 46 | 0.82 | 3 | 100 | 60 | 15 |
| 13.25 | 68 | 1.19 | 4 | 72 | 41 | 13 |
| 13.75 | 96 | 1.66 | 6 | 50 | 28 | 6 |
| 14.25 | 130 | 2.27 | 9 | 34 | 18 | 4 |

**Table 4. Guide-star probability at 90° galactic latitude. The s/n is based on a seeing of 1.25″ FWHM (r′). Star count is based on Bahcall and Soneira (1980).**

Four Dalsa FT-50, 1024 ×1024 pixels, 5.6-µm pitch progressive-scan frame-transfer CCDs will be used for guiding. These will

be situated at the same corrected focal plane as the main image sensor. Tracking is expected to be better than 0.1 arcsec for a s/n = 5 guide star (r´ mag. 14, 0.1s exp.). Each sensor covers an area of 0.13° × 0.13° or about 0.07 deg$^2$ total for the four sensors. This will allow a sufficiently bright star to be found even at the galactic poles. The tracking sensors are capable of >50-frame-per-second (FPS) readout and with their pixel pitch of 5.6µm offer a sampling 0.47 arcsec/pixel. This combination is suitable medium-resolution planetary imaging.


Figure 11 — The focal plane of the OMI camera showing the main sensor, guiders, corrected field, and shutter.

| | |
|---|---|
| Sensor (Main) | DALSA STA-1600A |
| Array Size | 10,580 × 10,560 pixels |
| Active Area | 95.22 × 95.22 mm, 9067 mm$^2$ |
| Spectral Range | 300-1000 nm |
| Illumination | Thinned back with enhanced UV coatings |
| Quantum Efficiency | 94% in the r´ |
| Pixel Pitch | 9.0 × 9.0 µm |
| Total Number of Pixels | 111,724,800 |
| Read Noise/Download time | <4e-/14s (full array), 12e-/2s (full array) |
| Well Size | 80,000 e- |
| Image Size | 223/670 MB (mono 16 bits/pixel, tricolor 48 bits/pixel) |
| Cooling | -100 °C +/- 0.1 °C Cryo-Tiger |
| Dark noise | 1e-/hr/pixel |
| Fill Factor | 100% |

| | |
|---|---|
| Read Ports | 16 |
| SNR | SNR 78dB @1MHz, 72.3dB@10MHZ, 65dB @25MHz |
| Non-Linearity | 1.0% |
| Sampling depth | 16 bits |
| | |
| Sensor (Guide) (X4) | DALSA FT-50 |
| Array size | 1024 × 1024 |
| Array Area | 5.73 × 5.73 mm, 33 mm$^2$ |
| Array FOV | 0.13° × 0.13°, 0.017 deg$^2$, 0.07 deg$^2$ total |
| Pixel Pitch | 5.6 × 5.6 µm |
| Spatial Sampling | 0.47″/pixel |
| Quantum Efficiency | 35% @ 525nm |
| Total # of pixels | 1,048,576 |
| Read Noise | 28e |
| Well Size | 45,000e- @30fps |
| Sampling Depth | 14 bits |
| Antiblooming | 1000X |
| Frame Rate | 94 fps (max) |
| Fill Factor | 88% |
| Shutter | Variable Electronic Full Frame Progressive |

**Table 5. OMI CCD image sensor and guide sensor performance specifications**

### 7. The Mount

Due to the low mass of the OTA, a one-tyne equatorial mount will be employed. Every effort is being used to minimize its mass, thus thermal footprint, and yet still produce a precise, accurate, and stiff design. Thus a combination of steel, aluminum, and carbon fibre will be used where appropriate, yielding a total mass of less than 200 kg. An advanced-technology dual-harmonic drive with DC servomotors will be employed, thus eliminating backlash and improving tracking and slewing. The maximum slew rate is ~4°/sec with the tracking accuracy better than 0.1 arcsec over 60s maximum error (no guiding). The mount is software programmable for added flexibility, motor currents will be monitored and limit switches will be used for a fail-safe operation.

| | |
|---|---|
| Mount Type | Equatorial One Tyne Fork |
| Drive Topology | Dual Harmonic |
| R.A./Dec. encoder/ motor resolution | <0.05 arcsec |
| Periodic Error/ Period | < 3″ P-P in RA and DEC with a 20-minute period |
| Tracking error | < 0.1″ (60 sec. no guiding), <0.1″ with long-exposure guiding |

| | |
|---|---|
| Slewing | 4 degrees/second maximum |
| Pointing Accuracy | <10 arcsec rms, zenith to +30° elevation |
| OTA Material | Carbon-Fibre Sandwich Core |
| OTA/Mount/Mirror Mass | ~200/180/68 Kg |
| Dome Type | 3/4-Sphere Calotte |
| Dome Ground Elevation | 3 metres |
| Dome Diameter/ Aperture | 6/1.3 metres |

**Table 6. OMI Mechanical Specifications**

### 8. Dome and Pier

The dome plays a critical part of the telescope/mount seeing equation. A 3/4-sphere Calotte configuration was chosen. The dome will be built of a carbon-fibre sandwich core; this material is light, stiff, and offers a very low temperature coefficient, in addition to being tough. A Calotte-type dome offers many benefits: first, it offers an improved air-flow profile, thus reducing air turbulence around the dome; second, the circular aperture will reduce wind buffeting and restrict bright off-axis star light, thereby permitting smaller light baffles in the telescope, which reduces the areal obstruction; third, it is less mechanically complex, thus improving reliability; finally, it is much more immune to snow accumulation than traditional metal-dome construction. The dome will feature a force-filtered side-input air vent to create a positive air pressure within the dome. This will minimize dust accumulation on the optics and accelerate ambient-temperature tracking. All heat-generating equipment either will be located in the control building or isolated and vented to the exterior. The pier will be a concrete cylinder with a 48″ OD and a 36″ hollow core to minimize its thermal load. The dome will be elevated by some 3 metres from the ground to improve airflow, isolate it from ground currents, and allow rapid ambient-temperature tracking. The ground has 12″ of topsoil with a granite base. This combination of topologies, materials, and designs will produce rapid ambient-temperature tracking together with excellent airflow and minimal ground turbulence, and will improve the dome seeing substantially.

### 9. Control Systems and Computational Resources

The observatory is designed to operate autonomously, and observations will be done in the queuing mode. All hardware control is via a PLC (Programmable Logic Controller) with fault detection and shutdown and with built-in redundant control computers to minimize down time. The dome aperture and rotation motors will have current monitors, and the site will feature a weather station and secondary solar power for the dome. A small super-computer will be available with 2-5 TFLOPS for on-site data analysis. A 10-20 MBps wireless link will to connect to the outside world. The observatory is solar-and wind-powered.

### 10. Science

The One Metre Initiative will have sufficient performance to benefit several key areas of research. There are many other areas where the OMI could be very productive beyond the ones mentioned here. The areas mentioned below emphasize its wide-field capabilities.

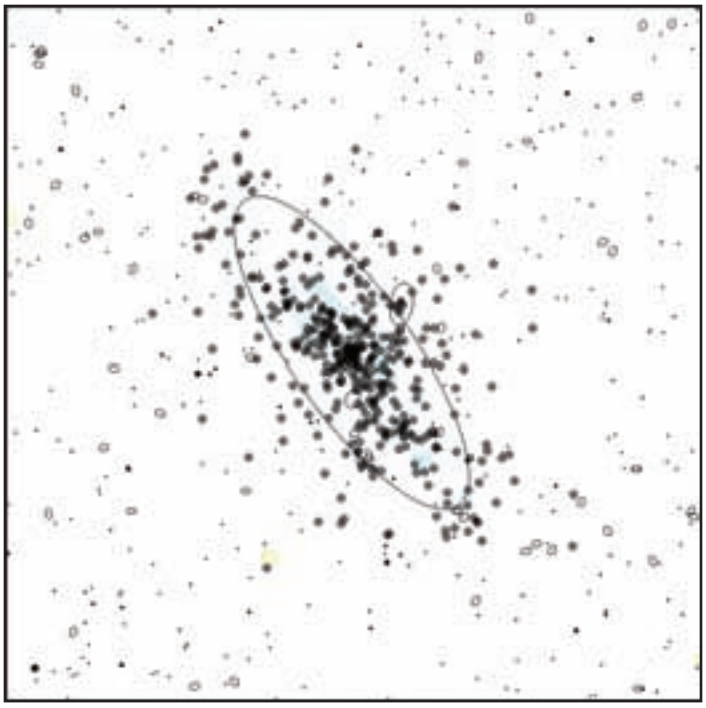

Figure 12 — This 6°x 6° FOV image centred on M31 (mosaic of nine frames) could be imaged with the OMI in under three hours to magnitude 24 (s/n=3, 1.25″, FWHM) in three colours (g′, r′, i′) with 0.3° overlapping each frame.

**Search for Earth-sized planets:** With its large 5-degrees$^2$ FOV and deep limiting magnitude, the OMI is well-suited for this task. Using the transit method, a change of 0.001 magnitude can be detected for a 17-magnitude star (r´) using a 1500-second exposure. This is the sensitivity level required to detect Earth-sized planets orbiting < M5 red-dwarf stars, which are 8-10% the diameter of the Sun and form some 80% of our galaxy's stellar population. In addition, a significant number of gas-giant planets are expected to be detected in this manner.

**NEO search:** The OMI is extremely well-suited to this task, and with its capability of searching thousands of square degrees per night, the OMI can greatly contribute to our knowledge of near-Earth objects. The large FOV, quick download time (2s), and the ability to reach magnitude 23 in under a minute should

enable the OMI to detect several hundred NEOs each year, depending on time allocation.

**Supernovae search:** Its ability to image very wide and very faint will enable the OMI to detect and follow several thousand Type Ia supernovae per OMI year (1000 hrs) to $m_{i'}$ = 24 with a s/n = 20. This type of SNe is important in confining the equation of state of dark energy, the force responsible for the accelerated expansion of the Universe.

**Galaxy clusters and Super-clusters:** Able to reach magnitude 25 (r´, s/n = 3) in less than 30 minutes with a 5-deg$^2$ FOV will allow study of the biggest galaxy clusters and super-clusters.

**Gravitational Shear, SNe light echoes, and MACHOs:** With an AΩ of 6, the OMI is a good instrument to find and study gravitational shears, SNe light echoes, and MACHOs (Massive Compact Halo Objects). All these types of objects require the search within a large FOV down to faint magnitudes.

**Rapid Variation Astronomy:** The camera is capable of full-array downloads in < 2 seconds. This opens up the possibility to search for transient phenomenon over a large FOV. GRBs, red-dwarf flares, KBOs, slowly varying pulsars, and other unusual objects are some of the possibilities.

**Surveys:** The OMI is a powerful survey tool. For example, a survey to magnitude 24 in 3 colours, down to -25° DEC could be accomplished in 6 years with 225 hours per year devoted towards the task.

## 11. OMI and CFHT Comparison

The OMI with its large AΩ compares favourably to the CFHT (Canada-France-Hawaii Telescope) in terms of survey work. For magnitude 23.5 (r´) and brighter, the OMI can actually outperform the CFHT. Due to the CFHT's very long download times, short exposures are very inefficient.

## 12. Outreach and Education

A certain percentage of the telescope time will be devoted towards outreach and education. This will be the only major observatory in Canada to offer this service. Amateur astronomers, educators, teachers, students, schools, colleges, and the public will be able to book queuing time on the telescope. With its enormous capabilities, the OMI offers huge science possibilities across almost all areas of astronomy and astrophysics. To give the imaging capabilities of the OMI a reference point, have a look at POSS II images produced by the Palomar 48″ Schmidt telescope. The OMI will have higher sampling (0.76″ vs. 1″) and go some 4 magnitudes deeper for the same field size.

In terms of esthetic beauty, the OMI images will be amongst the best in the world and should not disappoint any astrophotographer.

The purpose of the outreach and education is to promote science, engineering, and an appreciation of the natural beauty of the night sky. We hope that by exposing young Canadians to such a facility, some will go on to develop careers in science and technology. Canada needs more people in these fields to remain competitive on the global stage.

## 13. Conclusion

The OMI was designed to take advantage of the latest technological and design innovations together with new high-performance materials and an understanding of the seeing equation to design a modest-cost (~$2 million) facility with performance unmatched by any one-metre class telescope in the world. Situating the observatory in southern Ontario has drawbacks in terms of climate, but the low capital and low long-term operational cost, together with a high-yield imaging throughput, more than compensate. In addition, the proximity to several universities with astronomy departments in Ontario and Québec is a significant benefit. In terms of outreach and education, the OMI will offer tremendous imaging possibilities not found anywhere else in the world. The establishment of the One Metre Initiative will become a valuable asset to Canadian astronomers. The Mallory Hill site has much potential for optical astronomy for it has darker skies than the major observatories in Arizona and California.

**Notes:**

1. All calculations are based on work by Bradley E. Schaefer, 1998 (ccdlimit.bas). The tool in an enhanced form is available on our Web site, which can be used to verify the data.
2. Detailed engineering and 3-D CAD drawings provided by Dream Telescopes and Acc., Inc.
3. Special recognition to Jonathan Buchanan for providing a high-resolution a 3-D CAD rendering of the telescope and 3-D animations of the entire facility.

**REFERENCES**

1. Roy, Frank P. & Wiegert, Paul 2008, Cassiopeia, No. 139, Winter solstice 2008.

# Exploring the Pingualuit Impact Crater

*by Charles O'Dale, Ottawa Centre (codale0806@rogers.com)*

## Introduction

The Pingualuit Impact Crater, located in northern Quebec at N 61° 16′ W 73° 40′, was the first structure in Canada for which an impact origin was proposed. The structure is classified as a simple crater, 2.8 km in diameter and 400 m deep. It is slightly larger than the smallest crater on the Moon that is observable from our planet (Meen 1951). The inner slope of the 3.4-km-diameter rim averages 30° and the outer slope averages 10°. The rim extends to a diameter of ~4.6 km and continues gradually outward to merge with the surrounding terrain at ~6.6 km. The peak of the rim is ~160 m above the inner lake level and 120 - 150 m above the regional terrain. The lake within the crater, with a depth of over 250 m, is one of the deepest in North America. It is also one of the clearest in the world with a transparency of over 35 m. Dating using the isotope ratio $^{40}$Ar-$^{39}$Ar (Grieve 2006) gives the impact structure an age of 1.4 ± 0.1 Ma.

The Pingualuit Impact Crater was formerly named New Quebec Crater and, previous to that, Chubb Crater.

## Field Investigations of the Pingualuit Crater

Pingualuit Impact Crater was first photographed in 1943 by a U.S. Army Air Force aircraft and three years later by the Royal Canadian Air Force (Figure 1). Y.O. Fortier compared the RCAF photograph with a picture of the Barringer Crater in Arizona and proposed a meteoritic origin for the structure. A prospector, Frederick Chubb, knowing that diamonds are sometimes associated with craters in South Africa, proposed that the structure might be a surface expression of a diamond pipe (Marvin, Kring 1992). He approached V. Meen of the Royal Ontario Museum and, together, in 1950 and 1951, they made the first expeditions to the crater (Figure 2). Dr. Meen (1950) named the crater after Chubb.

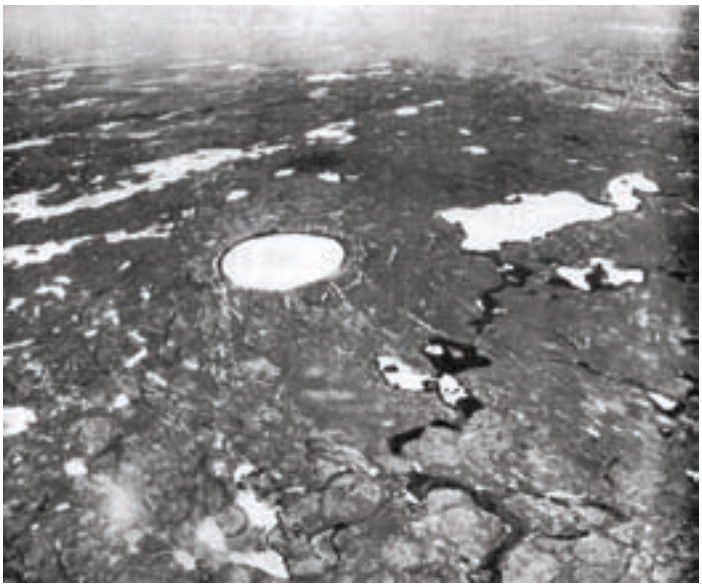

Figure 1 — This aerial photograph from 20,000 feet (6100 m) of the Pingualuit Impact Crater and Lake Laflamme was taken by the Royal Canadian Air Force in 1946 (Meen 1950). Pingualuit Impact Crater and Lake Laflamme were formerly named Chubb Crater and Museum Lake, respectively.

Meen confirmed that his expeditions did not find any traces of diamonds, volcanic rock, or meteoritic materials at the site of the structure. However, based on his observations, he proposed an explosive event to explain the creation of the structure (Meen 1952). He later stated "We can conclude, therefore, that Chubb Crater is an explosion crater and because of its tremendous size, is due to extra-terrestrial forces. The only such force so far proven to be capable of producing such craters is the impact and explosion of a meteor. No evidence of any sort has been observed that supports a theory of any other origin" (Meen 1957).

Figure 2—The aerial routes I followed from Ottawa to the crater on both of my expeditions were almost the same as the aerial route of the first expedition by Dr. Meen (1950). Fort Chimo and Wakeham Bay are now called Kuujjuaq and Kangiqsujuaq, respectively.

J.M. Harrison of the Geological Survey of Canada re-examined the crater in 1954. He collected evidence that glaciations had scoured that entire region of the Canadian Shield and deposited erratic boulders on the crater rim and surrounding countryside. Harrison agreed with Meen, stating that "no other process seemed adequate to account for this unique, circular, rimmed bowl in polished granite in a Precambrian shield area with no vestige of recent volcanism" (Harrison 1954).

E.M. Shoemaker explored the area in 1961, and in his view, there remained little doubt of a meteoritic origin. He stated that obtaining critical evidence probably would require drilling through the crater floor (Shoemaker 1962).

The impact origin of the Pingualuit Impact Crater was finally confirmed in 1986 with the discovery of impactite in the vicinity of the structure. J. Boulger found a rounded vesicular pebble 1.75 cm across that was totally unlike any of the country

rocks. The sample was sent to the Harvard-Smithsonian Centre for Astrophysics for petrographic examination. A thin section proved to be rich in quartz grains with multiple sets of planar features (Marvin, Kring, and Boulger 1988). Planar deformation features in quartz confirm an impact event (Grieve 2006).

**From a Dream to Reality**

I first became aware of the Pingualuit Impact Crater in the 1950s while watching Dr. Meen on our old black-and-white television. He was giving an interview describing his expeditions to the crater, and I think that was when the desire to explore that crater for myself first began. It was over 40 years before I could make this dream come true. During those 40 years, I explored many other impact structures in North America from the ground and from the air with my airplane (see `http://ottawa-rasc.ca/wiki/index.php?title=Odale-Articles`).

My first expedition to the Pingualuit Impact Crater was in 2001 with an overflight of the structure. I shared this exploration flight with Terry Peters, a flight instructor and friend. A flight to that remote area of the Quebec Arctic is not a trivial expedition. Our route to the crater approximated the route followed by Meen (Figure 2). The flight from Ottawa to Kuujjuaq (formerly Fort Chimo) was routine, with fuel stops at Chibougamau and Schefferville. The distance to the crater from Kuujjuaq, our only reliable source of fuel in that area, demanded that I make exact calculations of fuel burn, fuel load, and payload to ensure a safe flight between available airports. The weather also has to be factored into the planning to ensure a safe flight. Only by carrying extra fuel on board were we able to spend less than 20 minutes orbiting the Pingualuit Impact Crater and still safely make it to one of the remote airports (Figure 3). At that point, I thought my dreams had come true — as true as practicality demanded, at least.

Eric Kujala, a fellow RASC member, contacted me after he had read the results of my flight to the Pingualuit Impact Crater. That article was also posted on the Ottawa Centre RASC Web site (above). At our first meeting, we agreed to an informal "crater exploration" partnership; our primary desire was to expedite a ground-exploration project to the Pingualuit Crater. We investigated many avenues for access to the crater, even including walking the 90 km from Kangiqsujuaq (formerly Wakeham Bay). In the meantime, we explored many other impact craters on the ground, using Eric's canoe, and from the air, using my airplane.

All our planning efforts changed with the November 2007 opening of the Parc national des Pingualuit (`http://www.nunavikparks.ca/en/parks/pingualuit/index.htm`). An airstrip was constructed at the crater, which meant that we could make it to the crater by simply chartering an airplane from Kuujjuaq. I could not use my airplane for the final leg of this trip due to the weight and fuel constraints caused by the extra bulk of our camping gear, and because general aviation aircraft are not allowed to land in the park. Finally, in August 2008, we arrived at Pingualuit Crater to spend four days living our dream.

**An Amateur Investigation of the Pingualuit Impact Crater**

Our first day in the crater area was spent setting up our campsite and doing a reconnaissance of the local terrain. It was too late in the day for a productive trip up to the crater. From the campsite (Figure 3), the rim of the crater looked like a small hill in the distance. The temperatures here in August ranged from a pleasant 20 °C during the day to the freezing point at night. The water in my canteen contained ice crystals in the mornings.

Figure 3 — This was my home for our four-day expedition to the Pingualuit Impact Crater. The rim of the crater is the "small" hill in the far background. You can see the rock field that we had to navigate through to make it to the crater.

Figure 4 — The outer rim of the crater is covered with these granite blocks making it a challenge to climb safely up the 100-m, 10° slope. This rock field surrounded the crater to a distance of over 5 km. Lac Laflamme is in the distance.

Figure 5 — The lake within the crater became visible as we climbed over the flat peak of the rim. The far rim is 3 km in the distance, a challenging hike!

Figure 6 — The 30° inner slope of the rim is an unstable talus slope. I did not attempt to climb down to the water at this point.

Figure 7 — There were numerous gullies that we had to transit during our trip around the crater. The image also gives you a good distance perspective. The people leading the hike are just visible on the rim in the distance.

Figure 8 — Though the depth of the water in this image was over 2 m, the clarity of the water was a sight to behold! At this location, there was a small ledge in the water before the bottom dropped off at the 30° angle of the inner slope. The temperature of the water was just above the freezing level.

Early in the morning of the second day, we proceeded up to the crater rim. The walking was extremely difficult, as the ground in the area is covered with large fragments of rock. The rim rose continuously in the 2.5-km walk from Lac Laflamme (formerly Museum Lake) to the crater. We had to climb over two ridges before reaching the steep slope of the rim itself. The outside rim is composed of a jumbled heap of fragments of granite that cover the surrounding ground for a distance of nearly 5 km (Figure 4).

After a climb of 100 m up a 10° slope, we made it to the top. The rim is so broad that at its peak we could not see the lake inside the crater nor the immediate surrounding terrain (Figure 5). As we walked toward the centre of the crater, we came to a steep 30° descending talus slope. The boulders on the slope were very unstable, making it unsafe for a descent to the lake at that point (Figure 6).

From where we stood, it was over 3-km across to the opposite side of the rim. The rim is highest and widest at its northeast position, giving the crater a lopsided cup shape. It was perfectly silent; we could hear the waves breaking on the inner rim 150 m below us. The distance to the water is very deceptive. It looked so close that it seemed you could easily throw a rock into the lake from where we stood. I tried and didn't even come close to hitting the water!

Our hike around the crater took most of the day and

Figure 9 — This is one of the few *in situ* samples of bedrock that I had found around the crater. This example was completely shattered by the impact over 6 km away. The rim of the crater is the small hill on the horizon.

Figure 10 — This is a 2-m example of the type of impactite that Boulger (1988) had discovered on his expedition in 1986. The 1.4 ±0.1 Ma age of the Pingualuit Impact Crater was determined by $^{40}$Ar-$^{39}$Ar analysis of impactite (Grieve 2006). I placed the caribou antler on the rock for scale.

I have to say it was not one of the easiest hikes that I have experienced. There were frequent and deep gullies along the lip of the rim that we had to transit (Figure 7). Our Inuit guides were extremely helpful in showing us the various unique geological features of the crater, and led us to the only safe descent to the shoreline. The clarity of the lake was amazing to see firsthand (Figure 8). The water temperature was just above freezing. We even found wild blueberries on the inner slope. Being an amateur rock hound, I kept searching, unsuccessfully, for any rock fragments on the crater rim that would have been created by the impact.

I made two trips to the crater during our four-day visit. On the other two days, I explored outside the rim, documenting the effects of the impact on the local geology. The example of shattered bedrock that I found was most compelling. It is difficult to comprehend the magnitude of the impact forces originating more than 6 km distant that caused this rock to shatter so thoroughly (Figure 9). About 5 km east of the crater, I was fortunate to find a large example of impactite (Figure 10). I also experienced a close encounter with a few caribou and found an old Inuit campsite. Unfortunately, I did not find any shatter cones.

Having had Arctic survival training with the military, and now again, experiencing this type of desolate terrain, I stated to our Inuit guides how respectful I am toward their ancestors who could successfully support and feed a family up here. I also have the utmost respect for Dr. Meen's exploration team, who, day after day for a month, climbed to the crater rim from their base camp for their research. The two trips I made to the crater rim totally exhausted me! My exploration of the Pingualuit Impact Crater and local area was very rewarding, an experience I will treasure the rest of my life.

*Charles O'Dale is a retired electronic technologist who specialized in semiconductor failure analysis. He has combined his engineering skills with his hobbies of astronomy, geology, and flying to document his explorations of impact structures on this planet. Charles is a member of the Ottawa Centre of the RASC where he served as Chairperson, President, and is currently Ottawa's Past President.*

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# Aboriginal Sky Lore of the Constellation Orion in North America

*by Frank Dempsey, Toronto Centre (frank.dempsey@sympatico.ca)*

## Introduction

The brilliant stars of midwinter shine brightly, and the constellation known in contemporary astronomy as Orion is one of the best-known and familiar groups of stars. The brightness and uniqueness of the easily recognized line of three stars forming the traditional belt of Orion contribute to the familiarity with and easy recognition of this star group. For North American aboriginal cultures, this prominent constellation was used for seasonal and nightly time keeping and calendar functions, such as the Navajo method of planting when the constellation was setting at dusk (early May). Legends are one method of utilizing cosmic phenomena to teach concepts that are difficult to understand; to teach structured behaviour and tribal ethics, morals, and beliefs; and to promote ways of living that would be in sustainable harmony and order with the Universe. An examination of the mythology of the constellation in various aboriginal cultures across North America shows numerous variations and several main interpretations. In this note, several interpretations have been selected, including an assortment of hunting characters and animals, the Navajo hero figure, a person's hand, and the conflict between the warm Chinook and the cold winds.

Figure 1 — Orion, in all its glorious colours and brilliance, attracts more notice than just about any other constellation. This image was provided by Stuart Heggie, who used a Nikon F2, 50-mm f/2.8 lens, Supra 400 film, and 20 minutes of his life in February 2003 to get it.

## Various Hunters and Animals

An assortment of legends associated with the stars most often described the three Orion belt stars as a prominent star group. One example is the mythology of the Cree natives of the central subarctic regions of Canada, in which the three bright stars were known as a group whose name (Nictotcima uts) translated to "The Three Chiefs" (Miller 1997). In the Arctic, the Inuit natives had several myths associated with the stars of Orion. The two bright stars commonly called Betelgeuse and Bellatrix were known as the star group Akuttujuuk and were associated with the very important occasion of the returning daylight (MacDonald 1998). This pair of stars is visible in the southern sky at the time of year when the evening twilight begins to lengthen. The three belt stars were seen as Ullaktut, three runners or hunters, while the fainter stars below were the hunters' children, carrying clothes for their fathers. The fuzzy star (Orion Nebula) was seen as a fur being carried by one of the children. A legend about the star Rigel explained that the star was Kingulliq, meaning "the one behind." He was seen as a hunter who dropped behind his three brothers (Ullaktut) in order to recover a dropped mitten. Another Inuit legend told of three hunters pursuing a bear with a sledge, off the edge of an ice floe, and into the sky. The sledge is represented by the Orion sword stars (below the belt stars), the three hunters are the three bright belt stars, and the bear is represented by the bright star Betelgeuse. In another Inuit legend, the three belt stars represented a great stretcher for drying and stretching rawhide.

In many other aboriginal cultures, animals local to the particular region were represented by the belt stars. In the southern coast of California, the Ipai natives saw the Orion group as a hunter with an arrow, and the "shield stars" represent the horns of a mountain sheep, while a slightly different version from the nearby and closely related Tipai natives saw Orion's belt stars as mountain sheep. To the Cahuilla natives of the southeastern California region, the belt stars were also three mountain sheep. The sword stars represented an arrow, and the star Rigel was a hunter who shot the arrow. For the Maricopa natives of the southwestern regions along the Colorado River, most of the entire constellation Orion was a mountain sheep, and they saw the three belt stars as an antelope, a mountain sheep, and a deer. The sword stars represent an arrow, and the three stars (Betelgeuse, gamma, and lambda) above the belt stars represent the head of the arrow. The star Sirius was the

mountain-sheep hunter who has shot the mountain sheep with the arrow. In another southwestern variation, the Seri natives of the desert region near the Gulf of California saw the belt stars as the mountain sheep, the sword stars as an arrow, the star Betelgeuse as an antelope, and the star Sirius as a dog that follows the mountain sheep. Several of the Pueblo tribes saw the belt stars as fawns.

In the San Joachim Valley of California, the Yokut natives saw the stars as the Crane family. The legend described the violent demise of Crane's husband, Wolf (Miller 1997), but the result is Crane followed by her two sons in the sky as the Orion belt stars. For the Pawnee natives of the Great Plains, the belt stars were seen as three deer. The Pawnee were a Caddoan-language speaking tribe. The three deer were significant in the creation legend of Caddoan-language natives. In the creation legend of the Wichita, another Caddoan-speaking tribe on the central Great Plains, the first man and woman appeared on Earth with only corn, arrows, and a bow. The Earth was in total darkness until they shot three deer, and then there was light and the stars appeared (followed eventually by animals and villages). The Osage, also on the Great Plains, were a Siouan language-speaking tribe and they also saw the belt stars as three deer. The Osage constellation of Stars-Strung-Together consisted of the two main stars of the sword of Orion connected by the hazy nebula. The Omaha were closely related to the Osage, both speaking the Siouan language, and for the Omaha, the Orion belt stars represented a large foot of a goose.

**Celestial Canoes**

In the mythology of the Kwakiutl peoples of the Pacific coast near the north end of Vancouver Island, the Orion stars represented a hunter called Harpooner-of-Heaven, who paddles a canoe and has a box that releases the fog when he opens it. An otter that Harpooner-of-Heaven hunted escaped to the sky and became the stars of the Pleiades. Another group further south along the Pacific coast, the Snohomish tribe of the Salish (located along the coast of Washington state), saw the Orion belt and sword stars as two canoes and a salmon. A more detailed description of the representation of the Orion belt and sword stars as two canoes and a salmon was provided by the nearby Wasco natives (in the region of the Columbia River in the state of Oregon). In the Wasco legend, the three belt stars are the canoe of the Cold Wind brothers, and they are in a race against the canoe of the Chinook, or warm-wind, brothers, represented by the Orion sword stars. Both canoes are in a race to get a salmon, which is represented in the constellation by a fainter star just north of the Chinook Wind brothers' canoe and just south of the easternmost star of the Cold Wind brothers' canoe. More details of the conflict between the Cold Wind and Chinook Wind (actually a wrestling match) can be found in several similar versions (described in Bastian and Mitchell 2004 and in Monroe and Williamson 1987), but a curious observational detail about the stars of the constellation that some find interesting may be that the stars representing the Cold Wind canoe are bright (as might be expected during a cold wind from the north when the skies are clear) while the stars representing the Chinook Wind canoe are fainter and hazy (with the nebula), as might be expected during a warm Chinook wind when clear skies may be hazier than the skies accompanying a cold northerly wind.

**The Hand Stars**

An interesting interpretation of the stars of Orion was the Hand constellation, as seen by the Crow, Hidatsa, and Lakota, all Siouan language-speaking tribes of the northern Great Plains in the states of Montana and the Dakotas, and possibly in southern regions of Saskatchewan. In this constellation, the Orion belt stars were the wrist, and the lower half of the common constellation of Orion was the Hand, seen as a hand with fingers outstretched (southward), and with the Orion sword stars seen as the thumb. A brief summary of the legend involves a pair of twin boys whose mother was killed by an evil trickster named Red Woman. The boys then grew up together and gained hunting skills, which they used to slay some of the evil creatures that harmed humans, such as bears, cougars, and a knife-edged beaver that killed and ate many people. Eventually they decided to search for and take on Red Woman, who had killed their mother. As the boys pursued and overtook Red Woman, she reached into the sky as a final desperate attempt to escape, and the twins cut off her hand at the wrist before destroying her. Several similar variations of the legend have been described (McCleary 1997), but the result is that the constellation of the Hand is a prominent marker of the final attempt of an evil creature to escape destruction, and a visible reminder of the eventual triumph of good over evil so that humans could live on the Earth. The details of the legend also include the father's efforts and strength to hold his family together, and so this prominent constellation is also a reminder (especially during verbal storytelling while the constellation is visible in the sky) of the importance of family togetherness for survival.

**Long Sash**

In the southwestern desert and pueblo region, the Navajo legend of First Slim One (or Long Slim One, or First Slender One), or the equivalent legend of Long Sash for the nearby Tewi language-speaking tribes, is a striking legend of a hero who leads his people on a long and difficult journey along an endless trail from the troubled land where they emerged into the world, to a distant new land where they could live in peace. Along the way, he teaches living skills to his people, stops at a "place of decision" where he asks his weary people if they really want to continue, stops again at a "place of doubt" to consider if he has

the strength and direction to continue the journey, and finally reaches the new land where the people have lived in peace and harmony to this day. More specific details of the legend (Miller 1997) indicate that the endless trail is represented by the Milky Way and that the "place of decision" is represented by the bright stars known as Castor and Pollux. First Slim One was one of the eight primary Navajo constellations and represented planning and consideration. He was represented by all of the major bright stars of the modern constellation Orion; in one version of the legend, he had a curved walking stick in front of him (Miller 1997) and in another version (Williamson 1984) the curved line of stars in front was a digging stick for planting, while a circle of stars above (north of) the stick was a basket of corn seeds.

**Summary**

In summary, the various legends for the constellation Orion fit into interpretations of local and regional variations in climate (particularly in the Kwakiutl conflict between the Cold Wind and the Chinook Wind) and the significant animals of importance for sustenance. The prominent and bright belt stars of Orion were seen in many of the legends as hunter figures, representing the prominence of the hunter in native North American societies. The legend of the creation of the Hand Stars was a legend that promoted the importance of family unity, and is an example of the common theme of the destruction of ancient evil beings in order to make the world safe for humans, as well as an example of the dominance of good over evil. The hero figure was fully represented by the Navajo figure First Slim One (or Long Sash), and in this example of Navajo constellation mythology, the theme of a long journey to a new world was featured. Many of the legends were also parts of the larger cosmogony that attempted to explain the structure and order of the known Universe.

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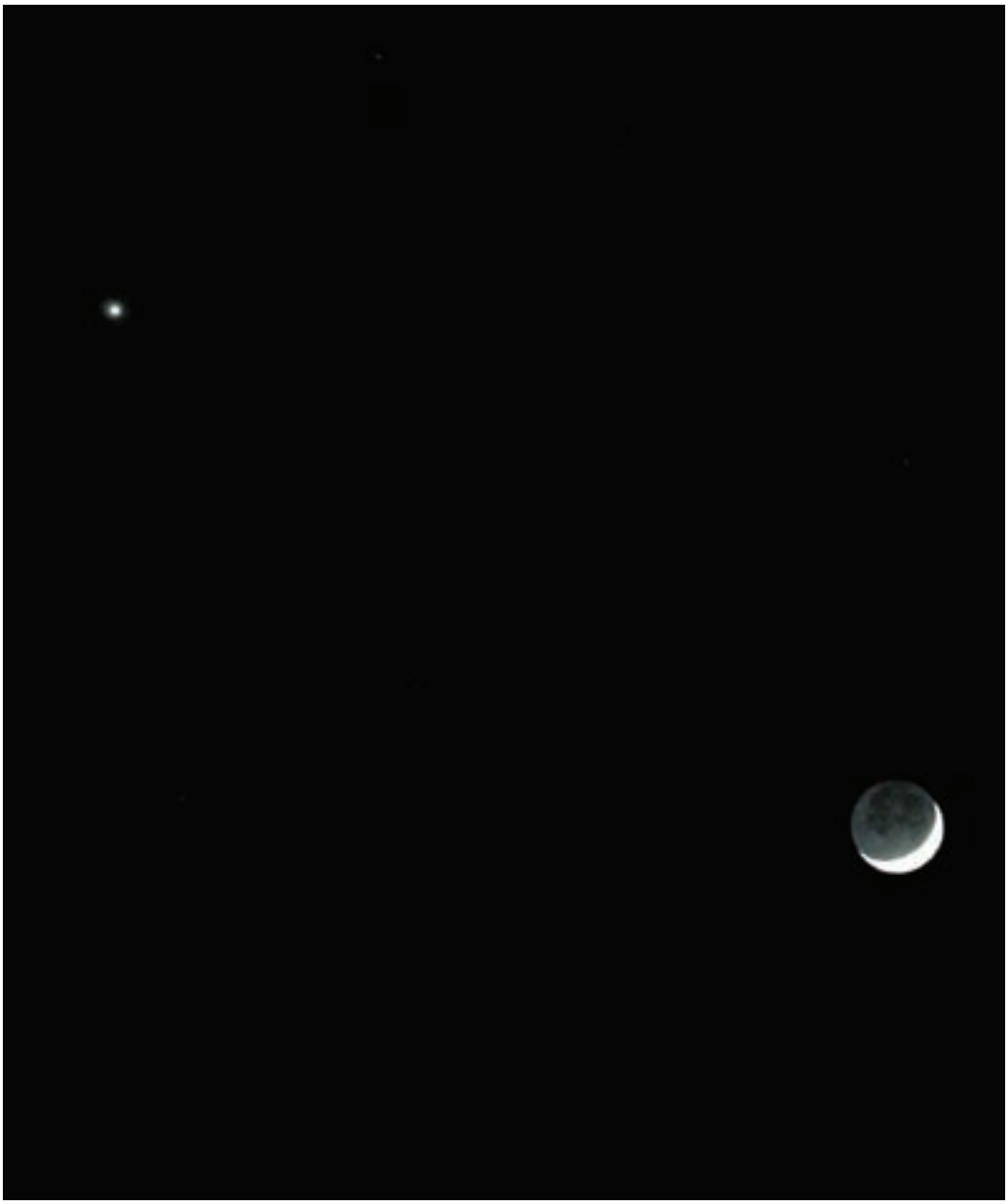
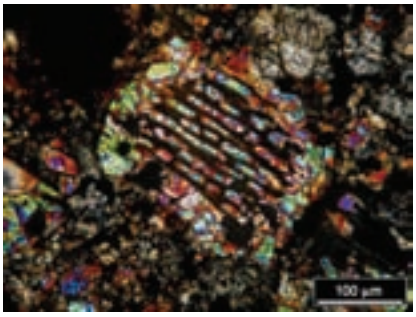
# Pen & Pixel



Winnipeg Centre's Ralph Croning used the transparency of crisp prairie January skies to record the close approach of Venus and the cresent Moon on the 29th of the month. Ralph used a Nikon D70 at 135 mm and f/3.5 for this 1/3rd-second exposure. The extensive snow cover across the Northern Hemisphere makes the Earthshine particularly prominent at this time of year.



Under the microscope and in cross-polarized light, a thin slice of a Buzzard Coulee meteorite specimen reveals spectacular structural detail. One of the larger features at ~250 microns (1/4 mm) is a chondrule of barred olivine. See Orbital Oddities on p. 79. Copyright Department of Earth and Atmospheric Sciences, University of Alberta. Used with permission.

Mark Burnell of the Winnipeg Centre took advantage of a rest break on a long drive to grab this lovely shot of the Moon. In Mark's words "During one of our bi-weekly trips to Ontario, the boys and I stopped at our usual leg-stretching stop, Clearwater Bay. As we were getting back into the car, we noticed the Moon was peeking between a couple of trees. Never going anywhere without my camera, I mounted it on my monopod and took a few pictures. Here is what I think is the best one, taken 2009 January 9 with a Canon 50D 70-200-mm f/2.8 at 200 mm, ISO 100, f5, 1/200s exposure. I made some minor adjustments in *Photoshop CS4* and a slight noise reduction and sharpening using *Neat Image,* along with a major crop."

In the days of film, an adventurous astrophotographer could defocus the camera in a series of steps as an image was being recorded. The final result brings out the colouring in the stars very dramatically, as this photo from John Mirtle shows. "Haven't seen anyone pull that type of shot off yet with a DSLR... :o)" says John. Is that a challenge to our digital photographers? This photo is a piggy-back exposure of Orion, gradually defocussed at one-minute intervals. Notice how the colours of the stars gradually appear as the overexposed star images give way to the decrease in light intensity as the image spreads out.

# A Handwritten Copy of a Report by William Wales and Joseph Dymond of Observations Taken of the 1769 Transit of Venus at Prince of Wales Fort, Hudson's Bay, Canada, Attributed to William Wales

*by Rita Griffin-Short (rgshort@spectranet.ca)*

## The Transit of Venus in 1769

The David Dunlap Observatory (DDO) Library of the University of Toronto holds a handwritten copy of a report of the 1769 observations of the transit of Venus carried out at Fort Prince of Wales, Hudson's Bay, recorded by astronomers William Wales and Joseph Dymond[1]. They were one of four British teams, sent worldwide by the Royal Society of London, who would view this astronomical phenomenon. Their objective was to time the ingress and egress of the transit; the data collected from all the teams would be used to determine the Astronomical Unit (AU), i.e. the mean distance between Earth and the Sun. This, and the need to find a reliable method of determining longitude at sea, were the driving scientific challenges of the 18th century. The other teams were: James Cook and Charles Green, sent to Tahiti; Charles Mason to Caven, Ireland, and Jeremiah Dixon and William Bayley, who travelled together, assigned to Northern Scandinavia; Dixon to Hammersfost Island and Bayley to North Cape.[2]

## Lost and Found

Pages 16 and 18 from an unnumbered, handwritten, 21-page manuscript (MS) attributed to William Wales were reproduced in an article by J. Donald Fernie in 1998. They came to my attention while browsing through back issues of *American Scientist* (AS), where I found the article "Transits, Travels and Tribulations."[3] This article was one of a series of five about the transit that were designed to alert readers to the returning event in 2004. The pages reproduced in the article consist of astronomical and meteorological data, and include the first four and part of five of seven concluding remarks made by the team in their record of adjustments and general observations. Dr. Fernie cites The Thomas Fisher Rare Book Library (Fisher), University of Toronto, as the manuscript's repository: "William Wales's handwritten observations on the 1769 Transit of Venus, together with his comments, taken from his *Astronomical Observations By Order of the Royal Society*."[4] However, Fernie


Figure 1 — Canada Post recognized William Wales primarily as a meteorologist in this 1968 First Day Cover.

doesn't discuss the MS or the published report, nor include a publishing reference in his bibliography. Rather, he reproduces material from Wales' later *Journal of a Voyage, made by Order of the Royal Society, to Churchill River, on the North-west Coast of Hudson's Bay,* citing an article by Dr. Helen Hogg in which she refers to a previous article where the seven remarks from the published report are included.[5]

In 1976, Dr. Fernie published *The Whisper and the Vision, Voyages of the Astronomers.* He reproduced the same MS pages in their entirety, citing, "William Wales' handwritten observations on the 1769 Transit of Venus, together with his comments, taken from his *Astronomical Observations By Order of the Royal Society...* (reproduction from the original MS by courtesy of the David Dunlap Observatory, University of Toronto)." The book, which postdates Dr. Hogg's articles, came to my attention later as I was searching for the MS. The book and AS articles relied on secondary sources, particularly on Dr. Hogg's articles, themselves based almost exclusively on secondary sources.[6]

Where was the MS, in the Fisher or the Dunlap Library? How did it come to Canada? Is it in Wales' hand or might it be in Dymond's? Both Dr. Hogg and Dr. Fernie used the pages as window dressing; neither expressed any interest in the MS itself. Were they not curious? Finding it became a bit of an obsession!

[1] 1769, Philosophical Transactions of the Royal Society (PTRS) Vol. 59 467-488

[2] Ibid, 1771 Vol. 61 397-432; 1770 Vol. 60 454-496; 1769 Vol. 59 253-272

[3] 1998, AS, Part iv, September-October 423 (422-425)

[4] Ibid 423

[5] 1948, Hogg, JRASC, Vol. 42 May-June 153-159 and July-August 189-193; Wales` Journal 1770 PTRS Vol. 60 100-136; 1947, JRASC, Vol. 41 November 323-324

[6] 1976, *The Whisper & the Vision the Voyages of the Astronomers,* Clarke, Irwin & Company Limited, 22-23; Dr. Hogg had a copy of the observations volume which she mines selectively for Wales, Samuel Holland, and Thomas Wright (324-326)

After several emails back and forth to the Fisher Library, it reported that the MS wasn't in its collection; the Dunlap Library didn't reply. I wrote to Dr. Fernie, though he couldn't recall why the citations were different, he said it should be at DDO. He sent me the name and email address of its librarian, Lee Robbins. She replied almost immediately saying she would look for the MS and if located would copy and send it to me. This she did a few weeks later. I wanted to examine the MS itself to see on what kind of paper it was written, but was unable to do so.[7] Though I've had to make do with a photocopy, I'm grateful to Ms Robbins and Dr. Fernie for their help in securing it.

In 1946, Dr. Hogg began a series called "Out of Old Books," for the *Journal of the Royal Astronomical Society of Canada (JRASC).* Her objective was to make accessible earlier articles about astronomical and related events to new readers. Her series about the 18th-century British transits of Venus observations appeared in *JRASC* in 1947 and 1948. Those articles are a bit of a muddle. She mentions that she "borrowed from McGill University," Volume 59, 1769, of the *Philosophical Transactions of the Royal Society,* that "contains twenty-eight papers on the transit signed by many famous names." She names ten American and French observers, adding, "the most noteworthy of the Canadian observations is by Wales and Dymond."[8] She includes their remarks and the note that appears at the beginning of their report that "the floor of the observatory might be above 50 feet above the level of the sea at low-water mark."[9] She doesn't discuss the observation results, only wonders, quoting a later writer, David Gill, whom she mentions earlier in her article, why there is no mention of their experiences as they "journeyed...to that desolate coast."[10]

The first mention of the MS, in print, comes from Dr. Hogg in 1950. She announces the donation by Dr. J.B. (Joseph Burr) Tyrrell (1858-1957), to the DDO, of "an original manuscript copy of an article on the first purely astronomical observations ever made in the Canadian arctic." She writes that Dr. Tyrrell was, in 1950, ninety-two years old, and a geologist "of great note," who had explored much of northern Canada. "Dr. Tyrrell bought this manuscript, inscribed in the hand-writing of William Wales, from a bookshop in London, England, in 1928, believing that an item of such note in Canadian history should repose in Canada. The manuscript is in an excellent state of preservation. The records were beautifully written, and carefully and systematically entered." She notes that, when she was writing her 1947-1948 articles, she "had no notion that the original copy... was located right in Toronto."[11] There is no attempt to discuss what must have come as a surprise. My browse through later journals found no further mention of it. Nor have I found any mention in later publications. Both Dr. Hogg and Dr. Fernie assume the MS is in Wales' handwriting though they provide no supporting evidence. But is it?

Figure 2 — Prince of Wales Fort by Samuel Hearne.

**Provenance**

There are problems with the manuscript's provenance. The date of purchase, 1928, is questionable, as neither its origins nor author are satisfactorily ascertained. Heather Robertson, in *Measuring Mother Earth: How Joe the Kid Became Tyrrell of the North,* writes that Tyrrell suffered a severe heart attack in April 1928, and was confined to his home for the rest of the year.[12] Alex Inglis also mentions "a massive heart attack in 1928."[13]

Tyrrell made twenty visits to Britain in his lifetime, the last in 1926.[14] He regularly delivered papers to the Geological Society of London, receiving its Murchison Medal in 1918.[15] As agent for the London based Anglo-French Exploration Company, he was obliged to cross the Atlantic yearly to report to its Board of Directors, even during the First World War. While waiting to present his report, he often had to "cool his heels" for weeks. He used the time to research David Thompson's early life, as well as Samuel Hearne and Philip Turnor, using the HBC archives, amongst others.[16]

Why did Tyrrell wait so long before donating the MS, if, as Dr. Hogg notes, he thought it was important enough to "repose" in Canada? Why choose 1950 to do so? I suggest he may have been reminded of his acquisition when he either

[7] Does the paper date to the period? The astronomers would have been supplied with paper and writing supplies, therefore the paper is important to secure the originality of the MS.

[8] 1947, Hogg, JRASC, Vol. 41 November 319-326

[9] Ibid, 323-324

[10] Ibid, 323; Sir David Gill (1843-1914), Scottish astronomer, viewed the 1874 transit on the Island of Mauritius. In 1877, he spent six months on the Island of Ascension observing Mars hoping to find a better method to measure the Sun's distance. His wife, Isobel Gill, who accompanied him to Ascension, wrote, *Six Months in Ascension*, for which Gill wrote the introduction from which Dr. Hogg quotes

[11] 1950, Hogg, JRASC, Vol. 44 123

[12] 2007, McClelland & Stewart: Toronto, 296

[13] 1978, Inglis, *Northern Vagabond The Life and Career of J.B. Tyrrell,* M&S, 1978, 239

[14] Ibid, 236

[15] Robertson, 296; Sir Roderick Impey Murchison (1792-1871) a Scottish geologist; Joe received the medal for his research on Ice-Age glaciers

[16] Ibid, 283-285, 301; Tyrrell edited the Thompson, Hearne, and Turnor journals for the Champlain Society.

read Dr. Hogg's articles about the transits or someone told him about them. He would have noticed that Dr. Hogg wasn't aware of the MS because she had to borrow the report from McGill University's library. By then the date of acquisition had slipped his mind. Did Tyrrell himself present the MS to DDO or someone acting for him? Did it come with more information than Dr. Hogg imparts to her readers?

My interest in the MS comes from a deeply ingrained curiosity about the past, a need to try to get it right. How could such a MS have been forgotten? Did no reader of Dr. Hogg's articles ask about the MS? Did she discover it while researching the Company's archives? Or was it truly serendipity? Why did she think it was Wales' and not Dymond's, as the report clearly names them both? Did she know the real story behind it? Does either the Hudson's Bay Company or the Royal Society know anything about it? My aim is to try to unravel some of its mysteries and make sure the MS is securely archived and available for future research.

**Whose Manuscript is it?**

The handwriting is uniform throughout the MS, indicating one hand. The writing is small, but perfectly legible, written with a fine pen in a business-like way, the numbers are neatly drawn within the columns of mathematical data. Daily meteorological and astronomical readings were recorded, each astronomer initialling his own observation results. Errata on the MS are noted and corrected in the formal report for the Royal Society.

From previous research about the transits, I have two documents that appear to be in their hand. [17] One is a "thank you" note, the other a list of instruments and the two stoves to be returned to London. The men were asked to write and sign a statement thanking the Company for its hospitality over the 13 months they spent at the Fort. The note is written in a formal, even, hand, slanting to the right. The lower case "d" is written throughout as a Greek delta that is formed in one stroke of the pen circling upwards to the left ending in a curl. One "d" is exaggerated with a dot placed within the curve. This style is typical of 18th-century writing by those with a classical education and has an elegant touch. In the case of a past tense, the "e" is often elided with a dot placed just between and slightly above the two last consonants. The writing tends toward florid, perhaps for effect. It is dated Sept. 2(?) 1769. Wales signed first, in large, plain, slightly slanted to the right, business-like, letters, with a light touch of the pen. The "d" with dot is similar to many such "d"s in the MS. The upper case "H," "W," and "T" are similar to those in the MS as are the numbers "7" and "9." The writer likely was Wales.

The second document's handwriting is smaller, heavier, with overly long "ss" that were written as an "f" in the 18th century. The writing matches Dymond's signature on the note but not the note's writing. His signature is very different from the note's writing. It is written in smaller letters with a heavy, more dramatic touch. The first and last "d"s are written with an emphatic flourish. The upper case "D" curves up and to the left ending in a small curl. The final "d" is written in one stroke moving upward, curling around to the left and carried back down under the entire word. To emphasize finality, Dymond employs several strokes of the pen to create a 2-3-mm-thick line of dark ink. The initial of his name, "J," is also overly long as are the "ss" in the list. The "d"s in the list are similar to the final "d" of his name. The "b"s in the list do not match those in the note, nor do the numbers "7" and "9." The handwriting in the MS does not show any similarities with the list's handwriting except in the writing of the "d" which was common in 18th-century writing.

I have tried, unsuccessfully, to secure further examples of their writing from the Royal Society and the National Maritime Museum at Greenwich. Acknowledgement of my recent email to the HBC Archives informs me of a two to three months wait for query replies. Until further examples are obtained, identification cannot be absolute, but I feel reasonably certain of my assessment.

**The Astronomers**

Who were these two men, pioneers for the benefit of science in a new venture of cooperation between the HBC and the Royal Society? This would be a first for the Company — a Company that guarded its trading activities carefully. The men were accorded the privilege of eating at the Governor's table at the Fort and at the Captain's while at sea. The Company asked that the men comply with two conditions: they should have no access to Company business, nor discuss or write about it, and must attend daily Divine service. [18] While Wales kept a formal journal of their voyage, where he noted important astronomical events, the physical and animal world, and the native peoples who lived in it,[19] none has been found from Dymond.

William Wales (1734-1798), a Yorkshireman, was, at age 34, an experienced mathematician and astronomer. His early life and education remains a mystery, but he was educated, having a knowledge of Latin and Greek, as his distinguished publishing record shows. He began early in the 1760s with the writing of mathematical problems for the *Ladies Diary,* then moved on to translating an early Greek mathematical treatise and editing Charles Green's observations of the Tahiti transit. [20] He was teaching in London when he was introduced to Nevil Maskelyne, the Astronomer Royal, by his brother-in-law, Charles Green (Cook's astronomer on the first voyage). Maskelyne hired

[17] 1769, HBC Archives, August 29, Reel 139 A11/14

[18] 1768, January 20, HBC Minutes of the Governor's Committee, Microfilm Reel 5 A1/43; 1768, August 30, Fort Prince of Wales Log, Reel 139, A11/14 #28 p90

[19] Wales, PTRS, Vol. 60 1770 100-136

[20] 2001, Bibliography compiled by Jenny Elliston, Wendy Wales and Wendy Whelen for *Cook's Log,* Vol. 23, No.2, p1839; Charles Green died on Cook's first voyage


Figure 3 — New Hebrides recognized Wales' contribution to Cook's voyages

him in 1756 to begin computing for the Nautical Almanac and then chose him for The Bay.[21]

Wales is described as "humane," a man "quite austerely devoted to a fine sense of duty." Samuel Taylor Coleridge, who as a student at Christ's Hospital School became fascinated with atmospheric phenomena, "as wonder and mystery of the universe," admired Wales, "his old mathematics master, a man of uncommonly clear head." [22] Gregarious by nature, intelligent and resourceful, he accommodated himself to Fort life, imparting his skills to interested staff, making and keeping professional contacts that would last all his life. Besides maintaining his journal, he attempted to carve a sundial using local stone. [23] His work at The Bay was the beginning of what would become an illustrious career. He was chosen to be James Cook's astronomer on Cook's second voyage, and upon his return to London was appointed mathematical master at Christ's Hospital School.[24]

Joseph Dymond (1746-1796), also a Yorkshireman, born in Brierley, a small village adjacent to Warmfield where Wales was born, remains an enigma. [25] Though he was a young man in 1768, he was not inexperienced. He had been computing for the Astronomer Royal, replacing Green as Maskelyne's assistant at Greenwich Observatory. [26] He must have been competent to have been chosen for The Bay. Unlike his congenial colleague, he seems to have lacked social skills, a loner perhaps, and certainly not happy at The Bay. He often skipped meals and

[21] 1989, Derek Howse, *Nevil Maskelyne The Seaman's Astronomer,* Cambridge, 86

[22] Michael E. Hoare, "Two Centuries' Perceptions of James Cook: George Forster to Beaglehole," in *Captain James Cook and His Times,* Eds. Robin Fisher & Hugh Johnston, Douglas & McIntyre, 1979, 222; Rita Griffin-Short, "The Ancient Mariner and the transit of Venus," *Endeavour,* December, 2003, 175-179

[23] This sundial was first mentioned by Douglas Leechman in *The Beaver,* Spring 1966, "A Primitive Computer," the research was taken up by Parks Canada historians, Lester A. Ross, "Stone Sundial from Fort Prince of Wales," Parks Canada Research Bulletin No. 193, June 1983 and John D. Light, "The octagonal Stone Sundial from Fort Prince of Wales," Parks Canada Research Bulletin No. 249, September, 1986 and "Research Note on William Wales' Stone Sundial from Fort Prince of Wales," *Journal of the American Scientific Instrument Enterprise,* Vol. 13, No. 2, 1999, 107-114. Mr. Light, a colleague and friend, died, May 2001

[24] 1998, Wayne Orchiston and Derek Howse, "From Transit of Venus to Teaching Navigation: The Work of William Wales," *Astronomy and Geophysics,* Vol. 39, 21-25

[25] 2004, Wendy Wales, *Cook's Log,* Vol. 27 No. 1 "William Wales' First Voyage," 29 (27-32)

[26] Howse, 100, 102

Figure 4: William Wales

Divine service while at sea and at the Fort. This was considered an affront and was noted in both the Fort's and Captain Richard's logs. [27] Such behaviour would not have amused either the Company or the Royal Society. Had it not been for the compensating professionalism of his colleague, the Company might have refused to cooperate in future scientific endeavours of mutual interest.

Was Dymond a religious dissenter? To a Yorkshiremen, the cold winter would not have been unusual. Did the isolated nature of the environment lead to a kind of ennui? We don't know if he had a drinking problem, a possibility. Perhaps he was simply shy. Was Maskelyne aware of his uncongenial character and paired him with the senior, stable, Wales? Upon their return to London, Dymond paid the Company five pounds, twelve shillings, three pence "for necessities supplied him at the fort." [28] What they were is not mentioned, though they would have been recorded in the Fort's log where everything was accounted. I didn't find anything more when I was doing my research. There is a great silence about this man's behaviour. Only from the Company records do we know something was amiss. Wales doesn't mention it in his journal. Whatever the reason, it precluded his continuing in the Astronomer Royal's employ. The record is silent between 1769 and 1796, when he died in Blyth, a seaport town on Northumberland's east coast, where he appears to have migrated to begin a new life.[29]

Dymond would have been the likely suspect for disposing of his copy of the MS in a moment of pique. But, since it was found in London, he might have sold or given it away before returning north. Or, it might have been left with the Royal Society. Dr. Hogg notes that the MS was in good condition, which suggests that it was gently used and didn't change hands often.

It isn't likely that Wales would wish to dispose of his copy. His career was just beginning; it would become part of his teaching materials. However, Wales left a will, and it provides a clue to the possibility that the MS was sold after his death. Wales directed that all his books and instruments, including the observatory clock from the Mathematical School and the watch that he customarily wore, "together with all such other effects as not immediately necessary for the use of my wife," be

[27] See note 19

[28] See note 19, Reel 5 1A/43, Wednesday, 1769 November 22

[29] See note 26, 29

sold.[30] Perhaps the Company or the Royal Society, or colleagues, bought the MS. One wonders if his library was also sold; he read widely and mentions, as an example of a more obscure text, Crantz's *A History of Greenland.*[31]

William Trollope, Wales' grandson, born the year Wales died, in his *A History of the Royal Foundation of Christ's Hospital,* wrote, that after Wales' death, the observatory was stripped of its instruments and thereafter was used only for basic instruction. [32] This represented a decided downturn in navigation instruction at the school at a time when those skills were much needed. Wales, using his own state-of-the-art instruments and practical experience, had raised the bar to a high standard of instruction that those who followed him were unable to meet. Given his contribution to his field, it is fitting that we consider the manuscript his, at least until new evidence proves otherwise. Wales, one of the many unsung heroes of 18th-century astronomy, mathematics, and navigation science, was overshadowed by the career of James Cook. The manuscript remains a unique example of the meticulous care accorded to science by a disciplined practitioner.

*Rita Griffin-Short has an Honours B.A. in Ancient History and Classical Archaeology from Brock University and an M.A. in Classical Studies from McMaster University. She has taught at Brock and McMaster in her field and has worked in Cyprus, Greece, Italy, and Yugoslavia, and in New Hampshire for Boston University. She was introduced to historical archaeology in 1974 when she was asked to rescue a small redware pottery that whetted her interest in this field. To sharpen her skills, she worked on a 1790s glassworks in Temple, New Hampshire. She was licenced in Ontario in 1979 and has conducted historical archaeology projects for the Ontario Heritage Foundation, including the Marmora Ironworks. Now retired, she is writing about the 18th-century transits of Venus, and the development of the reflecting telescope.*

[30] 2001, Wales, Wendy. "William Wales' Will," Cook's Log, Vol. 27 No. 3 1851
[31] 1770, PTRS Vol. 60 106
[32] 1834, William Trollope, London , 200 "`...sundry telescopes, a transit and other instruments, which were then in constant use, have been long removed...and the practical information which the King's Boys now receive is necessarily limited to...sextant and quadrant...indeed there is now no observatory."

# Edmonton Centre Observers Measure Asteroid 111 Ate

*by Alister Ling, Edmonton Centre (aling@telus.net)*

**Marcus Antonius:**
And Caesar's spirit, raging for revenge,
With Ate by his side come hot from hell,
Shall in these confines with a monarch's voice
Cry "Havoc!" and let slip the dogs of war,
That this foul deed shall smell above the earth
With carrion men, groaning for burial.

*Julius Caesar Act 3, scene 1,* 270-275 William Shakespeare.

It's not often you can say you've outdone the *Hubble Space Telescope.* Nevertheless, we did just that, thanks to a wonderful team effort from a handful of our members. We successfully measured the size and approximate shape of main-belt asteroid 111 Ate.

Back in the spring of 2008, Paul Maley told me he was flying to Edmonton from his home in Texas specifically to record this occultation! Paul is the Executive Vice-President of IOTA (International Occultation Timing Association). This encouraged us to organize as many locals as possible to ensure a good coverage. Apart from the fact that this was the best event of the year for Edmonton, it fell on a Saturday evening in August. Luckily, it was not on a star-party weekend!

Until they are actually measured, asteroids are given a size based on their infrared and visible-light properties. Most of you have seen pictures of Ceres and Vesta taken by the *Hubble Space Telescope* — the nearly round objects of 900 km and 500 km are a couple of dozen pixels across. Before August 24, Ate's approximate size was listed at 135km.

So how can a bunch of amateurs do better? Only the shadow knows!

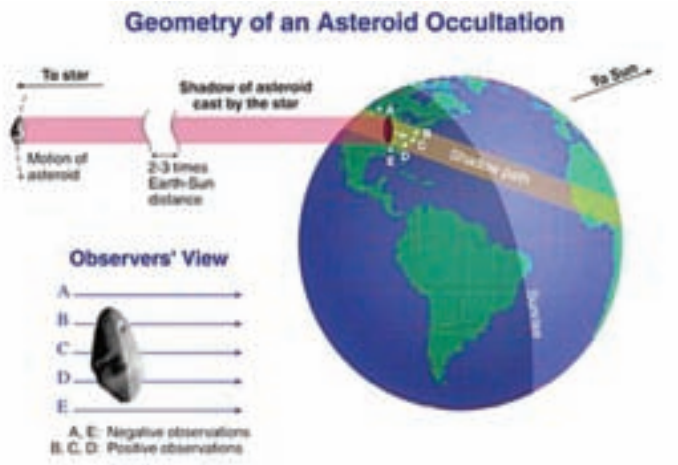



Figure 1 — Geometry of an asteroid occultation: the asteroid eclipses the star and its shadow is projected onto the Earth's surface. Observers B, C, D on Earth see the asteroid block or "occult" the star for several seconds, while observers A and E are outside the shadow path and do not observe it; the event is then termed a "miss." From the IOTA *Occultation Observer's Manual.*

On the ground, we set up a "picket fence" and record how long the background star disappears from view. A software algorithm then analyzes the results to convert our duration and position measurements into the asteroid's size and shape. When we work as a team, those reporting a miss (A and E in Figure 1) make a significant contribution, because if we all got a "hit," we still would not know the size of the asteroid. By design, we send observers to the miss zone. In practice, the path of the asteroid is not perfectly predicted due to uncertainty in the asteroid's orbit and in the position and proper motion of the background star (yes, it moves too!). It often happens, and it did this time, that the path shifts, so that the observer at A records an event, while D gets a miss.

The spacing of the chords, or pickets, in the fence depends on the size of the asteroid and number of observers on the team. Reality increases the challenge by throwing in topography (accessibility), driving distance, time of night, day of the week, mobility of the observers, and of course, weather. In the end, it's better to have two closely spaced chords than only one result. Finally, you never know until afterward who looked at the wrong star, didn't get set up in time, or had some form of equipment failure — and it's a long list of things that Murphy can nail you with!

Before summer began, Barton Satchwill volunteered to take Paul Maley to the predicted centre line and loan him his 8-inch SCT. I knew that Massimo Torri and Ross Sinclair were going to take the anchor point at the TWoSE (Telus World of Science Edmonton) observing deck using the Mallincam; on watch was Observatory "Captain" Bruce McCurdy. Since I already had recorded a few successful occultations, I volunteered to do the "sacrificial drive" to the predicted limit at Slave Lake Provincial Park potentially to record a miss. Wayne Sanders from the Prince George Centre, although *en route* to Cypress Hills, left instructions back home for observers in case the path shifted north to cover them. With a week to go, Mike Noble said he would take a spot near Pigeon Lake (where he would be doing CCD imaging afterwards), while Mike Hoskinson was going to watch it from his Hastings Lake observatory.

I organized a Friday suppertime meeting at Boston Pizza the night before the event to confirm which observers were going where. In the growing enthusiasm, we picked up Paul and Sherry Campbell, Sharon Tansey, Murray Paulson, Sherrilyn Jahrig, Larry Wood, and Stephen Bedingfield, who was *en route* to Cypress Hills from Yellowknife (Stephen was the one who made the connection to Shakespeare). And, why not have a Saturday lunchtime barbecue as well? The gatherings were great opportunities for people to learn more about chasing, including the stalking of occultation's crown jewel, the total solar eclipse. Paul Maley's prime hobby is being the lead organizer for Ring of Fire eclipse expeditions.

Although Prince George was clouded out, the Alberta side enjoyed near-perfect weather. Both Mikes endured equipment failures, which is why you don't see their results on the final chart. In the rising panic of technological problems, we sometimes forget that it is better to get an audio timing on a voice recorder than nothing at all. Lesson (hopefully) learned.

At the deck, Bruce watched through a telescope, while a small crowd gathered around the TV monitor that Massimo and Ross had set up to display the output from the Centre's Mallincam. This gizmo has the capability of integrating, or stacking, exposures on board, and releasing the output a second later, so Bruce had the interesting experience of watching the star's light disappear a whole second before the crowd nearby burst out in a cheer!

Thanks to the determined mathematical effort of Mike Hoskinson and Massimo Torri, they extracted good event times from the output — the camera was not supposed to be in integration mode, and could have resulted in a much lower precision than what a visual observer is capable of! Speaking of which, with all the excitement, Bruce forgot to bring his recorder and no one had set up the WWV time audio signal. If Murphy had hit hard and taken out the Mallincam, we would have achieved the notoriety of greatest number of observers witnessing an event with no data to show for it. But, even if that had happened, the thrill and fun of the experience would have still been worthwhile.

Over the next few days, we analyzed our recordings and sent the data in to IOTA's Brad Timerson, who used Dave Herald's *Occult* software to produce the cross-section of 111 Ate.

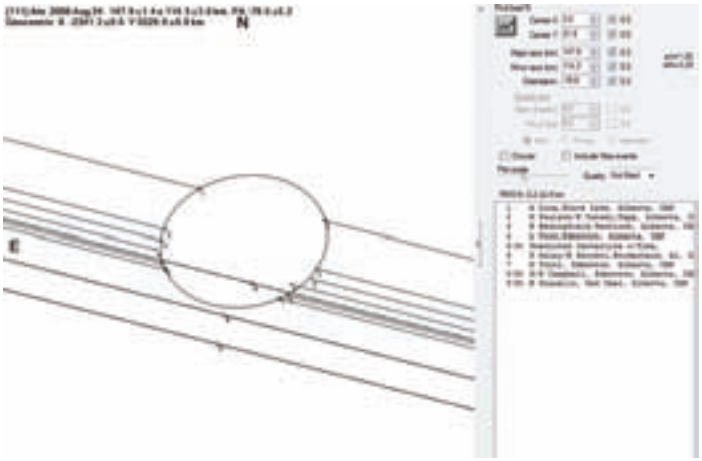


Figure 2 — The preliminary results of our efforts. Not only do we understand the shape of the asteroid in some detail, but also its orbital path was determined to a higher precision.

Although Barton himself did not have a second scope to watch the event live, he said it was quite illuminating watching a "pro" at work. Paul had a single-minded focus on observing the event with a plan B and plan C ready in case there was any equipment problem, all the while cycling through the checklist again and again.

An unexpected bonus from this event was making contact

with an observer from Red Deer, Bob Gosselin. When the opportunity presents itself, he said he would take the southern limit, saving us from a longer drive and of course providing another chord.

You may be wondering, "Doesn't the asteroid rotate as it moves?" Yes, but most of these events take only a few minutes to cross the face of the Earth, so it typically does not matter. But, an extraordinarily well-observed event spanning continents could reveal a change in shape, though this has yet to be done.

This was a really fun way to do science — we are eagerly awaiting more asteroid occultations.

*Alister Ling enjoys all aspects of visual astronomy since discovering Jupiter with a 4.5-inch Tasco in the mid-1970s. Slowly but surely, he is adding impartial scientific measurement to the mix; the challenge is to do it unattended so he can keep the eye at the eyepiece when it's clear!*

## On Another Wavelength

# M81/M82 & Arp's Loop

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

The M81 Group of galaxies, containing M81 and M82 along with several smaller associates, is located 12 million light-years away in the constellation Ursa Major. M81, also known as NGC 3031 and Bode's Galaxy, is a beautiful type Sb spiral galaxy. It appears to have an active galactic nucleus that is very luminous across the entire electromagnetic spectrum. This extraordinary luminosity at the core of M81 may be caused by hot gas spiralling into a supermassive black hole lurking at its centre. As gas falls into such a black hole, it can be heated to millions of degrees and emit extremely intense radiation.

M81 is found at right ascension 09h 55m 33.2s, declination +69° 3′ 55″, and has an apparent magnitude of 7.89, which is beyond the naked-eye limit for most of us. The way to find M81 by starhopping is to look for the Big Dipper, start at the bottom-inside star (Phad) of the bucket, go diagonally up and across to the top of the bucket (Dubhe). This line points almost directly at M81, which is about the same distance again as your diagonal line.

In Figure 1, M82, an irregular galaxy (a.k.a. the Cigar Galaxy), can be seen somewhat edge-wise near the top, to the left of M81. Both galaxies can be viewed with binoculars, but you will need at least an 8-inch telescope to see any structure.

M81 and M82 have been tugging on each other gravitationally for the past billion years and now appear to be orbiting around each other with a period of about 100 million years. M82 seems to have suffered recently from a close encounter with M81, causing it to form several dark lanes throughout its structure. As a result of the interaction, density waves of gas have created many star-forming areas characterized by bright blue stars in both galaxies. These are found in M81's spiral arms and scattered around M82's outer areas. Gravitational interactions have also caused in-

Figure 1 — M81 and M82 image courtesy of Ron Brecher, Kitchener-Waterloo Centre. Exposure: 51 x 90-sec unguided exposures using a modified Canon Digital Rebel XT, 105-mm f/6 refractor, and Hutech LPS filter. Acquired and processed with *Images Plus*.

falling gas to create many hot blue stars in the centres of the galaxies. Today, M82 is usually described as a starburst-type galaxy with stars forming at a rate fifty to a hundred times faster than a normal galaxy of its size.

Since massive stars generally have short lifespans, a star in M82 explodes on average about every ten years. These violent explosions heat the surrounding gas, blasting it out of the galaxy and creating filamentary structures with a characteristic red (Hα) colour that extend perpendicularly outward from the galaxy core. Because all the hot new stars in M82 radiate and heat up any nearby dust clouds, M82 is also the brightest infrared galaxy in the sky.

Recently, researchers (deMello *et al.* 2008), using data from the *Galaxy Evolution Explorer (GALEX)* satellite and the

*Hubble Space Telescope,* discovered "blue blobs" in a structure called Arp's Loop, a wispy bridge of neutral hydrogen gas that stretches between M81 and M82. These "blue blobs" were interpreted as small clusters of O and B stars recently condensed from the gas that was tidally stripped from M81 and M82. In effect, they are orphaned clusters of blue stars that may be as young as 10 million years and that do not appear to belong to either galaxy. The next time you look through your telescope at M81 and M82, just try to imagine Arp's Loop and the "blue blobs" between them.

**Reference**

deMello, D.F., Smith, L.J., Sabbi, E., Gallagher, J.S., Mountain, M., and Harbeck, D.R. 2008, AJ, 135, February, 548

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

## Through My Eyepiece

# Perception and Reality

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

Now that the International Year of Astronomy is upon us, we all probably find ourselves talking to the public more about astronomy. Sometimes this communication fails because what we, experienced astronomers, see in the sky is quite different from what someone who rarely looks at the sky will see. I spend a fair bit of time these days answering questions in the Astronomy & Space category of *Yahoo!Answers* (`http://ca.answers.yahoo.com`). Most of the people asking questions know little about astronomy, so this gives me a good sense of the difficulties people have in understanding what they see in the sky. Here is a good example:

**Did anyone notice the overly huge star next to the Moon last night? I saw it around 7-ish p.m. (Central time). I don't know if it was just a planet getting close to earth, UFO, or just a big-*** comet about to crash into our planet.**

This refers to the conjunction of the Moon and Venus on 2009 January 29 [see Ralph Croning's photo in Pen & Pixel - Ed]. You will notice that *Y!A* has a "profanity filter" which coyly hides words it considers to be offensive with asterisks; this makes it particularly hard to discuss human evolution when our species always comes out as "**** *sapiens*"!

The first problem is that Venus is described as an "overly huge star." I'm not surprised at people confusing stars and planets; I expect that. What concerns me is the highly inaccurate "overly huge." This person is clearly confusing size and brightness. On this night, Venus was 29 arcseconds in diameter: to anyone with normal vision, this is a point source of light. It's certainly very bright (magnitude -4.5), but not huge. I see this mistake again and again, people describing bright objects as being large in size.

The other distressing issue in this question is the person's readiness to jump from a factual description to a far-fetched interpretation. To the inexperienced observer, most objects in the sky are UFOs, in its true meaning: Unidentified Flying Objects. After all, they wouldn't be asking what this was if they could identify it. Unfortunately, for most people on *Y!A,* UFO means "alien spacecraft." To an advanced astronomer, the interpretation of Venus as a comet may seem strange, but I still remember my first night as an amateur astronomer, trying to figure out whether the bright object I saw in Leo was a comet or not; it turned out to be Jupiter. What does bother me is the leap from a comet to its being about to crash into our planet!

**What's going on with the Moon? I live in Illinois and the Moon is acting weird. It is on the completely opposite side of the sky it is usually on, looks twice as big. Here's the weirdest part. It is crescent, but the visible crescent is on the bottom, not sideways.**

Non-astronomers have a lot of trouble with the Moon's phases. A very large number of the people on *Y!A* are convinced the phases are caused by the shadow of the Earth falling on the Moon; this is by far the most common astronomical error people make. They are baffled when they notice that a gibbous Moon's terminator is convex. Related to this is the belief that the Moon can only be seen at night; they are greatly surprised when they see the Moon in a daylight sky. They also seem to believe that the Moon is always in the same location in the sky. These three beliefs are all mutually exclusive and are all contrary to Kepler's Laws, but somehow some people manage to believe all three simultaneously. It is amazing what you can believe if you don't think — are these the same people who deny the Apollo Moon landings?

Many people believe that the crescent Moon's cusps are always oriented pointing either east or west, which of course only occurs when the ecliptic is nearly parallel with the horizon. This gets them totally confused when, as in this case, the ecliptic is nearly perpendicular to the horizon, so that the cusps of the waxing crescent Moon are pointing straight up.

**If you watch the Earth from the Moon, is it possible that Earth is illuminated at the top? The Moon for Jan 18, 2009 is illuminated left part, sometimes the right part is illuminated. When will the Moon be illuminated only at the top (or bottom)? That means the Sun is up and I should be receiving all light from Sun, right? How the photo of Earth from Moon is top illuminated?**

This one really had me baffled until I realized that he was talking about the famous Apollo 8 image of the Earth from the Moon.

The Apollo 8 vehicle was in a near-equatorial orbit of the Moon. The astronaut taking the picture held the camera so that the lunar horizon was more or less vertical, or running north to south[1]. Therefore, the Earth in the iconic picture has been oriented so that north is to the right and south is to the left. It was actually very close to Northern Hemisphere's winter solstice, so the southern part of the Earth is more illuminated than the northern half. All this is pretty obvious to a serious astronomer, but anyone else looking at the picture assumes the Moon's limb is horizontal and the Earth is being lit from "above."

Another area where astronomers and non-astronomers may miscommunicate is when talking about directions. As astronomers, we automatically orient ourselves to the cardinal directions given us by the stars: Polaris is north, and all else follows. The public tends to base their directions on the local street grid, which can be very deceptive. Most astronomers living in Toronto, say, soon learn that the street grid is tilted about 15° relative to true north. Astronomers in Montréal have a much worse time of it: in the central city, the grid is rotated about 75°. Sherbrooke Street is an extreme case: from Peel to Pie IX it runs almost due north-south, despite being named Sherbrooke East and West!

All of which we need to keep mind when we're talking with people during the IYA. It's very easy to forget the difficulties we all had when we first started talking astronomy.

*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.*

[1] From the Apollo history http://history.nasa.gov/ap08fj/14day4_orbits456.htm: "We have presented this photograph in an unconventional orientation with the Moon's horizon vertical. On Earth, the convention for a sunrise or moonrise shot is to have the horizon running left to right. Bill Anders has said that this is how he sees this image. They were orbiting around the Moon's equator and with north being to the top, Earth came out from behind a vertical horizon."

# Buzzard Bolide

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

*There's something solid forming in the air,*
*The wall of death is lowered in Times Square.*
*No-one seems to care,*
*They carry on as if nothing was there.*
*The wind is blowing harder now,*
*Blowing dust into my eyes.*
*The dust settles on my skin,*
*Making a crust I cannot move in*

*And I'm hovering like a fly,*
*waiting for the windshield on the freeway.*

— Genesis, "Fly on a Windshield"

The singer, a young Peter Gabriel at his most vulnerable, pauses as he awaits the inevitable. The tension builds for a moment as his voice trails off, then simultaneously the spotlights flash, the cymbals crash, and the music explodes in a strange and wonderful new direction. A dense instrumental fantasia sets the stage as Rael, the protagonist of Genesis' 1974 masterpiece *The Lamb Lies Down on Broadway,* embarks on an unforgettable journey.

I used to think this song was about my life; recently, however, I concluded it could just as easily describe meteorites, in their final encounter with Windshield Earth. This column is about both of those things.

The spotlight flash that signalled the end of the road for the Buzzard Coulee meteorites marked the beginning of an unforgettable personal road trip. I was sitting in my living room working on my laptop computer when it caught my eye out the picture window. I looked up and saw a second, brighter flash, then a couple more in rapid succession just above the eastern horizon, about 95-100° azimuth, dropping to only 5-10° above the horizon at that point (luckily for me, as the sky view from my couch is restricted from azimuth 90-120, and only about 25° altitude). It was an intense orange colour reminiscent of flickering firelight, easily brighter than the full Moon. There was broken cloud on the distant horizon that the fireball had clearly dropped behind, suggesting a distance in the order of hundreds of kilometres. After all the road trips chasing meteors, the best one I've ever seen came to me.

The bolide was observed by thousands, with reports ranging from Fort McMurray to Montana to Manitoba providing a first rough triangulation of what was surely a fall zone. In Alberta's Capital Region it occurred an hour after sunset with commuter traffic at its peak. Just within the RASC population, Edmonton Centre members Yves Lamarre, Tim Dixon, Geoff Robertson, Greg Scratchley, and Dave Cleary all sent first-person accounts. Alister Ling did us all one better by capturing the event on his all-sky camera, and his video was already being shown on the six o'clock news, one of several updates provided within the news hour.

Figure 1 — Ellen Milley of the University of Calgary discovered more than just meteorites in a fish pond near Lone Rock, Sask. She also found herself something of a media darling, in a fish bowl of publicity. Here photographers compete for the best close-up.

Meanwhile, reports poured in from all over, with switchboards lighting up at universities, science centres, media outlets, even 911. Over 400 reports were filed at the Web site of the Meteorites and Impacts Advisory Committee (MIAC), an "unprecedented" response in the long and distinguished experience of Dr. Alan Hildebrand, Coordinator of the Canadian Fireball Reporting Centre and, it turned out, exactly the right person to receive and interpret those reports.

I happened to be instructing an adult astronomy course at Telus World of Science Edmonton (TWoSE) that very evening. The phones were ringing off the hook as I arrived, still vibrating, about an hour after the fireball. Before giving my own first-hand account, I polled the class, and, sure enough, one member had seen the fireball proper and a couple of others the bright flash that lit up the entire sky. A local TV station had sent a camera, so we two gave our own eyewitness accounts; later I heard from an old friend who had seen my interview on CNN!

And then, silence. There was talk of an ongoing search by Dr. Hildebrand and his crack team from the University of Calgary, but no reports of a find and no appeals to the amateur community for help in the search. By Wednesday of the following week, Frank Florian, TWoSE's Director of Space Sciences, amateur meteorite aficionado and personal friend, decided to conduct his own field trip in the general area. Frank invited me to ride shotgun on a two- or three-day journey, in a volunteer capacity, but with expenses paid. How could I refuse?

The plan was to interview some of the many eyewitnesses who had phoned in to the science centre and collect some video footage of their descriptions of the event for a possible future

public exhibit. If we happened to get a hot tip, well...

We left on Thursday morning, November 27, and toured some of the fine agricultural communities of eastern Alberta. Everywhere we walked into a town hall or general store or post office there was somebody who had experienced the fireball, and those who hadn't knew somebody who had. Fireball stories graced the front pages of small-town weeklies like the *Provost News* and *Macklin Mirror.*

One memorable interview occurred with Jim Pugh, a farmer on the banks of the Battle River north of Edgerton, Alberta. Jim saw the fireball from within his shed, and emerged to hear the "pop-pop-pop" of what were surely fragmenting meteorites some 30 seconds later, due east of his location.

On Friday morning, we awoke to the news that meteorite fragments had actually been recovered by the U. of C. search team and a media event was planned right at the recovery site. Trouble was, nobody knew where that was or how to find it. Through science centre contacts, Frank learned that the plan was to have interested media show up at noon in Arby's in Lloydminster and wait for instructions. We decided it was a nice day for a Great Canadian, and "happened" to drop in to Arby's around the appointed time.

It was quite the scene, as 35 media people descended on the restaurant. Some of them were known to Frank and me, and we blended in easily. Eventually some 20 vehicles — and CHED's traffic helicopter! — joined a convoy for a 20-minute drive to Buzzard Coulee, the site where meteorites had been located by Ellen Milley, a member of Dr. Hildebrand's search team. The media throng scrummed around the two scientists, who patiently conducted interviews and posed for photographs. Soon enough the story would be all over the news, local, national, even international.

I kept my eyes peeled around the site but didn't stumble upon a meteorite on dry land as one lucky reporter did. I conducted a binocular search of a neighbouring pond and noted a likely looking black suspect projecting from the ice, which, after a brief debate with temptation, I dutifully reported to the search team. I was pleased to later discover it was a valuable specimen of the subset known as oriented meteorites.

Figure 2 — Bruce McCurdy can barely believe his good fortune in holding the largest specimen recovered to date from the Buzzard Coulee fall. The 13-kg monster was found by the father-and-son team of Les and Tom Johnson of the Drayton Valley, Alta., area, who flank Bruce in this image. Any seeming affiliation with a local sports team is entirely circumstantial. (When in Saskatchewan...)

After the media horde dispersed, Frank and I roamed the area hoping to find a meteorite or two that may have fallen on crown land. No such luck, but we did encounter another fellow with an astronomy interest and magnets on his shoes who suggested we go to the Marsden Hotel pub about 20 km to the south. We walked in the door to an extraordinary sight — lying on a bar table was a 13-kilogram meteorite that had been recovered by an enterprising rock hound. The monster was somewhat larger than a human head! Frank quickly confirmed its extraterrestrial origin, as did Dr. Hildebrand, who arrived a couple of hours later.

Figure 3 — Frank Florian of Telus World of Science - Edmonton proudly displays his first-ever meteorite find.

The massive rock was a huge hit at the pub where the locals were passing it around and examining it carefully, in between rounds of "meteorite shooters" — Sambuca, Kahlua, and Grand Marnier — that some generous soul was providing on the house. Given it had already been handled rather excessively, there was no point in passing up the opportunity to pick up and hold this object, which was simultaneously one of the newest and one of the oldest rocks on Earth. What a thrill!

After spending the night at the Marsden Hotel, Frank and I continued our expedition on Saturday. We prowled the area by car, getting out to explore a few small ponds, and examined various suspect rocks by the side of the road and in the ditches. Eventually we approached the farm where the original finds had been made. The farmer, Ian Mitchell, was hanging out at the entrance, restricting access to just Dr. Hildebrand and his research crew from University of Calgary. Ian recognized us from the previous day, and, realizing we were serious in our pursuit, directed us towards a remote group of beaver ponds in a corner of his property, well-away from other searchers.

We headed in that direction, took a wrong turn and spent quite a little time on dry land exploring a cart path and a stubble field, still without success. There were many "meteor-wrongs," including terrestrial rocks, clods of dirt, vegetative matter such as wood chips, and animal droppings.

Eventually we scrambled and slid down a steep and slippery embankment into the coulee, where we located the beaver ponds. A preliminary scan turned up nothing, but on our second trip to the biggest pond Frank found a meteorite roughly 2-3 cm in all dimensions embedded in the ice. A few minutes later, I found one of similar size — what a thrill that was! After a further search I came across a larger, 151-g specimen that we had to chip free of the ice. Finally, Frank found a very small meteorite of about 1 cubic centimetre. We were running out of light, so scrambled back up the embankment with our

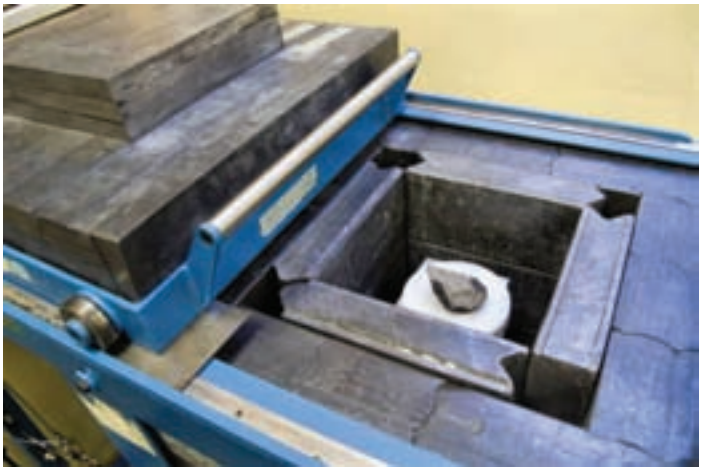


Figure 4 — The largest specimen recovered by Bruce and Frank was some 7 cm along its longest axis, just right to comfortably fit within this 15-cm "lead cave" at the SLOWPOKE nuclear reactor at the University of Alberta where its isotopes were counted for seven days. ©Department of Earth and Atmospheric Sciences, University of Alberta. Used with permission

finds safely wrapped and stored. We returned to Ian Mitchell, who recorded our finds for Dr. Hildebrand but, as I had hoped, told us to keep the meteorites we had found. We promised to put them to good use.

Tired and happy from our successful expedition, Frank and I returned to Edmonton late that night, our meteorites, images, and memories safely in tow. Frank immediately turned the four specimens over to Dr. Chris Herd, Associate Professor of the University of Alberta's Department of Earth and Atmospheric Sciences and Chair of the Astromaterials Discipline Working Group. Chris and his team quickly set to work analyzing them. The largest specimen was placed in a "lead cave" at the SLOWPOKE nuclear reactor, where its isotopes were counted for seven days.

Elsewhere, lab technical staff cut an extremely thin slice of one of the golf-ball-sized meteorites and shaved it down to 30 microns (.03 mm, or about 1/1000 of an inch) thickness. I was invited by Dr. Erin Walton to come have a look. Accustomed as I am to sights of astonishing beauty through a telescope, I was wholly unprepared for the delights of examining an astronomical object through a high-quality microscope. Cross-polarized light shining through the slice revealed tiny chondrules, fossilized grains of the solar nebula with remarkable structure and spectacular colours reminiscent of stained glass. (See the colour photo in the centre spread of this issue of *JRASC*.)

The results of this and other research were submitted to the 40th Lunar and Planetary Science Conference in an abstract with the impressive title of "Mineralogy, petrology and cosmogenic radionuclide chemistry of the Buzzard Coulee H4 Chondrite" by Drs. Erin Walton, Chris Herd, and John Duke. A photograph of "my" 151-g meteorite adorns the first page (see `www.lpi.usra.edu/meetings/lpsc2009/pdf/2072.pdf`).

Interest in meteorites extended far beyond the halls of academia, however. Enthusiastic response to my field-trip reports on the Global Meteor Observing Forum prompted me to display some of the images Frank and I had obtained. With the help of my friend, Stephen Bedingfield (RASC Unattached), we established a Web site at `http://skyriver.ca/astro/bruce/meteorite.htm`. In its first few weeks, the site attracted over 20,000 visitors from all 13 Canadian provinces and territories, 49 of the 50 American states, and some 90 countries all over the globe! My images were copied — with and without permission, but I didn't care — on Web sites and blogs in many different languages, and popular science sites like *Discover Magazine, The Universe Today,* and the *Society for Popular Astronomy.* Besides making the cover of the February *JRASC,* my photos were published in three foreign-language publications: the French *Astronomie,* the Slovenian *Spika,* and the Finnish *"Tähdet ja avaruus" (Stars and Space)*. In asking for my permission, each asked my "conditions"; ever the amateur, I simply requested a hard copy of each publication for my personal archives. It was quite surreal to see my name embedded in these articles, making high-sounding quotes in (presumably) perfect Finnish!

Locally, once the 151-g specimen completed its stay in the lead cave, it was returned to its discoverers for public education purposes. Just before Christmas I had the pleasure of displaying it to an ultra-enthusiastic group of Grade 6 students in Brentwood School in Sherwood Park, many of whom had seen the fireball for themselves and were thrilled to see a piece of what had caused it. Later, it was a feature attraction at the January10kick-offevent for the International Year of Astronomy, an event that drew about 1000 visitors to Telus World of Science. Throughout the school and public-education aspect of this event, an important part of the story is not just what the meteorite tells us, but the very process of how we find out. Young researchers like Ellen Milley and Erin Walton, who feature prominently in the story, serve double duty as role models for our scientists of the future.

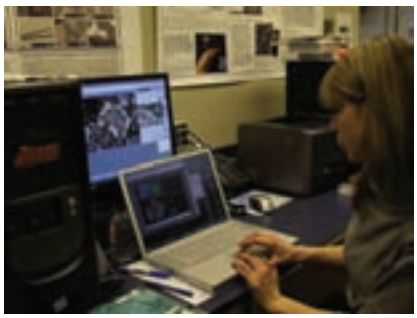


Figure 5 — Dr. Erin Walton of the University of Alberta's Earth and Atmospheric Sciences Department analyzes thin slice images (see the colour spread at the centre of this issue for an image of the slice itself).

It's difficult to imagine a more exciting astronomical adventure than the Buzzard Coulee meteorite fall. For me it has delivered something for virtually every one of my demonstrated

interests: observing meteors, contemplating Solar System dynamics, amateur contribution to science, public outreach, interaction with the global community of astronomers and other engaged people everywhere, and connection to the cosmos in which we live.

*Bruce McCurdy hopes to join the search for more fragments of the Buzzard Coulee meteorite after the snow recedes.*

**Acknowledgements:** Thanks to Frank Florian, George Smith, Ian Mitchell, Alex Mitchell, Ellen Milley, Dr. Alan Hildebrand, Alister Ling, Franklin Loehde, Murray Paulson, Dr. Christopher Herd, Dr. Erin Walton, Stephen Bedingfield, and Dr. Douglas Hube.

# Carpe Umbram

# Amazing Tools for Planning Your Occultations

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

*I went to Kansas City on a Friday*
*By Saturday I learned a thing or two*
*But up till then I didn't have an idea*
*Of what the mod'rn world was comin' to....*
*Everything's up to date in Kansas City...*

"EVERYTHING'S UP TO DATE IN KANSAS CITY"
From the stage show "Oklahoma"
© (Richard Rodgers / Oscar Hammerstein II)

I can't really speak to the state of modernity in the State of Missouri since I've never been there. I can, however, speak to the contents of my computer, and I'm happy to say that, while not everything is up to date therein, there is more up-to-date stuff now than ever before.

Specifically, I have finally installed a couple of programs that make the planning of my occultation events much simpler and more integrated with those of other observers. Many of you are probably 'way ahead of me in this regard, since I'm a bit of a Luddite. Nevertheless, "I learned a thing or two" and encourage all occultationists to do likewise, if they haven't already done so.

The first program is *Occult v. 4.0.5* by Australian David Herald (`www.lunar-occultations.com/iota/occult4.htm`). This version replaces all versions formerly known as *winOccult*. The name change indicates that it is designed to function on any platform that supports *Net V2* framework — not just *Windows*.

To quote its author: "*Occult* is a program dedicated to the prediction and analysis of occultations of astronomical objects, including lunar occultations, occultations by asteroids and planets, eclipses of the Sun and Moon, and mutual eclipses and occultations of satellites of planets." Among other things, *Occult* is used to generate predictions of asteroidal occultations, and then analyzes the results in both tabular and graphic formats. In *Occult,* you can look up an asteroid, check to see if and when it has been observed occulting a star, what size and shape was deduced, and who contributed the data. Sort by observer, plot profiles, list double-star discoveries, and much, much more. For instance, a search of the asteroid (25) Phocaea reveals that observations were made of seven different occultations between 1998 and 2008. The number of observers varied from 1 (2002 September 8) to 19 (2006 October 3), and major and minor axes obtained varied from 98 km × 55 km (1998) to 86 km × 72 km (2006). *Occult* is the program that drives IOTA these days. It has become indispensible for all its operations.

And then there's *Occult Watcher* (`www.hristopavlov.net/OccultWatcher/OccultWatcher.html`).

Developed by Hristo Pavlov, another Auzzie, *Occult Watcher* (*OW* for short) babysits *Occult* for you. By defining your personal parameters, such as your latitude and longitude, how far you are willing to travel, the limiting magnitude of your telescope, the minimum change in magnitude you are willing to tolerate, and other specifics, *OW* will alert you to occultations coming to a place near you. It also generates *Google* maps of the predicted path, allows you to mark your observing site ("station"), shows you other declared observers' stations, plots your relative separations across the occultation path, and generally makes it really easy to plan an efficient "attack," while minimizing the chances of duplicating chords. In short, it does for you what the list at the end of this article does for all of Canada, only in far greater detail and with your parameters in mind.

Here's a case in point. I check *OW* and see that there is a good occultation coming up on a Friday night involving the asteroid (95) Arethusa (Fig. 1). It's a high-rank event (meaning that the degree of confidence in the prediction is very good), it falls within the limit of my travel distance, the target star is relatively bright (magnitude 9.6), and the drop in brightness will be easy to spot. The only negative is that the nearly full Moon

Figure 1

will be 52 degrees away. By clicking on the <Show online map with stations> link in the lower-left corner, I learn that the path edge nearest to my home in Toronto cuts across southwestern Ontario from Port Stanley on Lake Erie to Sarnia on Lake Huron. There is a note that tells me "(t)here are currently 2 announced stations for this event" and that none of them is mine. I decide to give it a try. I mark my probable observing site on the map and a telescope icon pops up marking my station. It also amends the note to three stations and adds that one is mine (Figure 2).

Figure 2

I click on the link to show station sorts and get a list of all announced stations, arranged by their relationship to the path

Figure 3

centreline, path edges, and 1-sigma lines (Figure 3). My station is good with respect to the other observers. With a few weeks to go, I expect that other occultationists will also sign in, so we should get a good sampling of this occultation. Now if we could just get the weather to cooperate...

These are only two of the free programs available through the Web site of the International Occultation Timing Association. I highly recommend that you try them. I'm sure you'll like them and will agree that everything is up to date at IOTA, if not Kansas City.

Here is a list of possible occultations over populated parts of Canada in April and May 2009. For more information on events in your area, visit the IOTA Web site `www.asteroidoccultation.com`. Please let me know (email address above) the events in which you plan to participate, so we can coordinate all observers in the most efficient fashion.

| DATE (UT) 2009 | ASTEROID # | NAME | STAR MAG | Δ-MAG | MAX DUR (Secs) | PATH |
|---|---|---|---|---|---|---|
| Apr. 5 | 5029 | Ireland | 8.7 | 7.8 | 1.6 | sON, swBC |
| Apr. 8 | 570 | Kythera | 10.2 | 4.9 | 3.8 | NL - QC |
| Apr. 8 | 3617 | Eicher | 9.5 | 6.6 | 2.0 | nON - nQC |
| Apr. 8 | 6002 | 1988 RO | 11.5 | 6.4 | 4.0 | MB |
| Apr. 10 | 1512 | Oulu | 11.9 | 3.3 | 7.1 | sBC |
| Apr. 15 | 169 | Zelia | 11.9 | 1.3 | 2.8 | NS - nMB |
| Apr. 15 | 366 | Vincentina | 11.6 | 2.9 | 6.0 | MB |
| Apr. 16 | 336 | Lacadiera | 10.3 | 3.5 | 11.7 | swON |
| Apr. 22 | 186 | Celuta | 9.8 | 2.6 | 5.1 | sBC |
| Apr. 24 | 13 | Egeria | 12.0 | 0.4 | 17.0 | SK |
| Apr. 27 | 1353 | Maartje | 11.4 | 3.1 | 2.6 | sAB - nBC |
| Apr. 28 | 543 | Charlotte | 11.9 | 2.7 | 2.3 | NS - QC |
| Apr. 30 | 780 | Armenia | 12.4 | 1.9 | 6.8 | swON - nAB |
| May 5 | 1614 | Goldschmidt | 8.4 | 6.8 | 5.8 | sON - nSK |
| May 5 | 781 | Kartvelia | 12.5 | 2.0 | 16.9 | AB |
| May 10 | 467 | Laura | 10.4 | 5.3 | 6.3 | sQC |
| May 11 | 566 | Stereoskopia | 10.9 | 3.6 | 9.2 | NL |
| May 14 | 2382 | Nonie | 10.7 | 3.8 | 1.7 | nwON |
| May 17 | 1786 | Raahe | 8.9 | 7.9 | 3.6 | NL - cON |

# 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<br>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<br>Peak of the Lyrids (LYR) - 18 meteors per ZHR, variable up to 90.<br>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

# A Moment With…

# Dr. Christian Marois

*by Phil Mozel, Toronto and Mississauga Centres (phil.mozel@sympatico.com)*

*Then felt I like some watcher of the skies when a new planet swims into his ken...*

— Keats

There haven't been too many planets swimming into the ken of astronomers these days. At least, not since the discovery of Uranus and Neptune. Back then, astronomers could actually see their quarry. Now, new (extrasolar) planets don't so much swim into view as reveal themselves through their gravitational influence on their parent star, either by shifting spectral lines or by blocking some of a star's light during a transit. However, seeing is believing, and wouldn't it be nice actually to lay eyes on one of these far-off worlds? Given their great distances, it is not an easy task! Small wonder, then, that the first planet beyond the Solar System was glimpsed unambiguously only recently. This was accomplished by a team led by Dr. Christian Marois.

Dr. Marois started young. As a child, he was curious about the world, always asking questions. When he was four or five years old, his mother showed him a solar eclipse using a pinhole viewer. Naturally, he wondered what caused it. Naturally, he went on to find out.

Later, while working on his M.Sc., Dr. Marois spent two years studying the problems of taking direct images of extrasolar planets. During his Ph.D. work at the Université de Montréal, he designed, with his supervisors Drs. Rene Racine, Rene Doyon, and Daniel Nadeau, instruments capable of hunting down extrasolar planets, later building and using them to good advantage. He additionally developed planet-hunting observational strategies and software that allowed faint planetary light to be teased from the glow of a primary star. (For his thesis, he was awarded the Plaskett Medal, presented annually to the Ph.D. graduate from a Canadian university who is judged to have submitted the most outstanding thesis in astronomy or astrophysics in the preceding two years). Dr. Marois went on to do post-doctoral work at the Lawrence Livermore Laboratory in California. Dr. Marois worked as a team member on the Gemini Deep Planet Survey, which used the 8-m Gemini North telescope in Hawaii to try to obtain images of giant Jupiter-like planets. The survey of 80 roughly solar-mass stars indicated that such worlds, at least around our kind of star, are relatively rare.

At this time Dr. Marois realized that more-massive stars (such as A-types) would be worth imaging because, while bright, they might have more massive planets orbiting farther away that would be easier to find. At that point, the International Deep Planet Survey started in September 2007, using Gemini North, the 10-m Keck 2, and the European Southern Observatory's 8.2-m Very Large Telescope. The project quickly focused on HR 8799, a sixth-magnitude star in Pegasus. A dust disk around the star indicated its youth (about 60 million years old), which meant that any associated planets would likely be glowing in the infrared. The star's proximity to Earth, 130 light-years, makes it relatively easy to study.

Dr. Christian Marois

But, did planets actually orbit this star? To find out, Dr. Marois, now at the National Research Council's Herzberg Institute of Astrophysics (HIA), and his team used an infrared

camera, occulting disk, and adaptive optics on both Gemini North, and later, the Keck telescope, to subtract the light of the parent star. They also applied Dr. Marois's *angular differential imaging* technique. In this procedure, a sequence of images centred on the star were collected and, since the telescopes were on alt-azimuth mounts, the star remained centred while any associated planets revealed themselves through a change of position due to image rotation (generally considered a problem in amateur circles but used to excellent advantage here!).

The actual discovery of a planetary system (with not one or two but *three* planets!) came in March 2008 while using the Gemini North images acquired with the Altair adaptive-optics system (built at HIA to correct for the image blur induced by Earth's atmosphere). The planets were confirmed in July 2008 during the reduction of data obtained the previous year with the Keck telescope. At the time of his discovery, Dr. Marois was not at the eyepiece or in the lab, but in an airplane flying back to Hawaii to use the Keck scope again. And there they were, on his laptop! "It was really, really exciting! . . . everything was too good to be true; it was like being in a movie," Dr. Marois admits. Some people thought he was way off base, especially for claiming multiple planets. Yet the images produced by Dr. Marois' team are now generally accepted as the first unambiguous images of extrasolar planets. (Previous claims had been made but are generally tenuous and sometimes beg the question "What *is* a planet?" or even "What is a star?"). Subsequent analysis also found the planets in older data, thereby providing four years of orbital motion. Dr. Marois confesses that it was amazing to see the planets in motion around the parent star.

What's next in studies of this new planetary system? Getting values that are more accurate for the planets' masses for one thing. (Each is currently estimated to tip the scales at between 5 and 13 Jupiters). Characterizing the planets' orbit and the length of each planet's year are others. With orbital periods lasting from 100 to 500 years, Dr. Marois admits "this will take some time."

And, what are these planets like? What are they made of? This is a job for spectroscopy, specifically, the Gemini Planet Imager (GPI), an international collaboration involving many partners including the Herzberg Institute of Astrophysics and the Université de Montréal. To be mounted on the Gemini South telescope in 2011, the GPI will consist of an adaptive-optics system, a coronagraph (to remove most of a star's light), and a near-infrared spectrograph. The system will provide high-contrast imaging and allow determination of a planet's atmospheric composition.

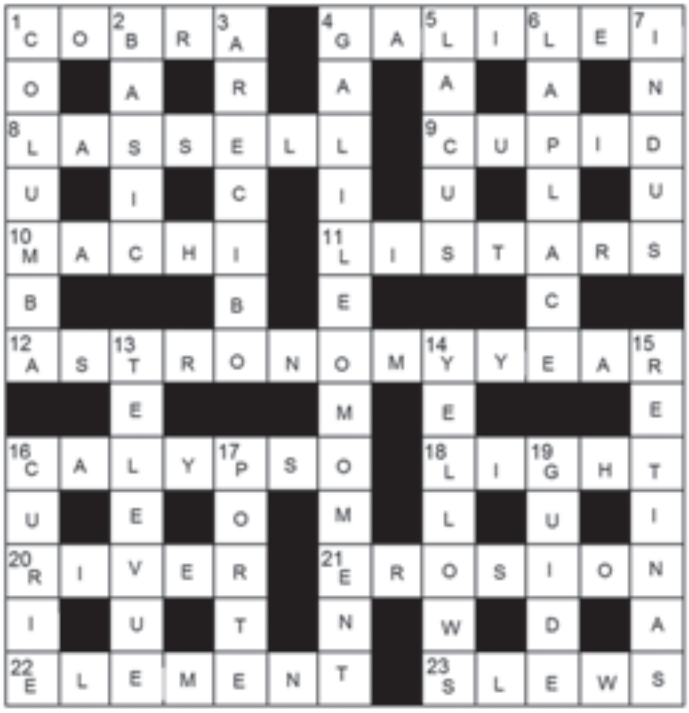
What about Earth-size planets? Dr. Marois feels that one will be discovered within five years using indirect means, perhaps even in the HR 8799 system. However, direct imaging, and characterizing the planet spectroscopically, may take decades. Nonetheless, the detection of planets orbiting HR 8799 was a crucial step toward that eventual discovery.

I've taken a peek at HR 8799 from my back yard. While the planets are invisible, it was neat to know they are there. Any way you look at it, this star is a star worth keeping an eye on.

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

# Astrocryptic

The solution to last issue's puzzle



# Springwater Observatory

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

Almost everyone who gets really serious about this hobby at one time or another gets to thinking about owning an observatory. Certainly for imaging, an observatory is wonderful. Being able to simply close the roof and go to bed is a dream come true for anyone who has ever had to put away their equipment while almost too tired and bleary eyed to function.

Springwater Observatory came about for that reason and I will use the next few columns to describe it and how it was built with a view to helping you to decide what your observatory might look like.

Saltspring Island is one of the Gulf islands situated between Victoria and Vancouver and, although it does not have a big light-pollution problem of its own, it is well served by the generosity of its neighbours. So straight up is good, and everywhere else has sky glow all around.

It does not matter so much then that our site is a small meadow surrounded by high trees. The hidden horizon is suffused with sky glow anyway. To maximize the view we located the observatory against the trees at the north end of the meadow at a place where you can just still see Polaris. That gives us maximum sky to the south. Everything to the north eventually comes around if you wait, and the trees close behind dramatically decrease the dew.

Our observatory is for both of us and for that reason it had to house a large Dob, as well as an equatorial mount. That meant it had to be large enough to give us both space and, as well, that the south-facing wall had to be low enough to accommodate the Dob at its maximum depression for our site.

The pictures show what we came up with; a small wood-frame building with a metal roof, solar panels that come to life when the switch is turned, and the top half rolls away.

The south wall is barely 30 inches high, low enough to get the Dob down. The north wall is over seven feet tall. It hides only trees, but as a big bonus cuts out almost all wind. The run-out rails are a bit longer than those of most roll-offs, to get the roof far enough away to get out of the field of view of the Dob. The wooden floor is raised above the ground, and allows cooling air to circulate in through floor vents and out through vents in the gables. The front wall has shutters that open for air and light, and close to keep out the heat of the day. The roof is of deep corrugated metal that circulates air to keep out the heat, and is sloped to maximize the efficiency of the solar panels that provide the only power.

It's a great observatory for us, and, by describing it now and in the next few issues, I hope I can help you visualize the best observatory for you. So, next issue, the pier.

*Don Van Akker observes with his wife Elizabeth from their observatory on Salt Spring Island. He's looking for ideas for future columns and would like to hear about yours.*

# DISCOVER SASKATCHEWAN'S LIVING SKIES!

Enjoy the magic of Cypress Hills Interprovincial Park (CHIPP) and Dark-Sky Preserve in August 2009 and do something never done before at an RASC General Assembly: be armchair astronomers during the day and real astronomers at night! We are delighted that the 2009 RASC GA has been awarded to the Saskatoon Centre of the RASC. The GA will be held in conjunction with the Saskatchewan Summer Star Party (SSSP). 2009 is also the International Year of Astronomy and a GA will be held, for the first time, at a dark-sky site. It is our goal to provide an affordable, memorable GA where participants can observe under some of the darkest skies in Canada and still enjoy the traditional social & business activities of a GA.

**Featured Events**

- **Special Pre-GA/SSSP Tour of the Canadian Light Source (Synchrotron)** - For attendees who can arrive in Saskatoon on Tuesday, August 11, we have arranged a special evening tour of Canada's premier scientific facility.

- **BBQ** - A traditional SSSP event held Thursday evening before the Ruth Northcott Lecture

- **Ruth Northcott Lecture** - Presented by Alan Dyer. Alan is a planetarium show producer, co-author with Terence Dickinson of *The Backyard Astronomer's Guide,* and a contributing editor to *SkyNews* and *Sky and Telescope.*

- **RASC National Awards and Friday Supper Social** - Awards ceremony followed by a reception and informal meal featuring a menu of beef brochettes, free-range chicken skewers, canapés, and refreshments.

- **Fr. Lucien Kemble Lecture** - Presented by Dr. Carolyn Shoemaker, best known for her comet discoveries and her extensive studies of asteroid impact sites all over the world.

- **Saturday Banquet** - Our banquet features Saskatchewan delicacies: Lake Diefenbaker Steel Head Trout, Saskatoon Berry Stuffed Pork Loin, Saskatchewan Wild Rice Pilaf, and wine from the Maple Creek Winery.

- **Tour of Fort Walsh and the Maple Creek Winery** - On Sunday afternoon, join us for a tour of Fort Walsh and the Maple Creek Winery, finishing with supper at the Star Café in Maple Creek.


**GA/SSSP 2009 Tentative Schedule of Events**

**Thursday, August 13:**
- National Council Meeting
- Sod Turning for Dark-Sky Campground and Observatory
- BBQ
- Song Contest and Sing-along
- Ruth Northcott Lecture
- Observing

**Friday, August 14:**
- Paper Sessions
- Solar Observing
- First Nations Storytelling in the Park
- RASC Awards Presentations
- Supper Social
- Park Public Presentations - Astro Interpretive Program
- Observing Clinic 1
- Observing

**Saturday, August 15:**
- Swap Meet
- Light Pollution Panel/Workshop
- Fr. Lucien Kemble Lecture
- Invitation to GA 2010
- SSSP Awards and Door Prizes
- Group Photo
- Banquet
- Walk-about Social in the Meadows
- Observing Clinic 2
- Observing

**Sunday, August 16:**
- Annual General Meeting
- National Council Meeting
- Tour of Fort Walsh and Maple Creek Winery
- Potluck Supper for those not on the Tour
- Observing

**Registration**
Visit our Web site for information on registration costs and to download the printable registration form. Mail-in payments by cheque only; payments by credit card will not be accepted.

**Transportation**
CHIPP is located in the southwestern corner of Saskatchewan, 30 km south of Maple Creek on Hwy 21. We strongly suggest that fly-in delegates who will be attending the National Council Meeting on Thursday, August 13, fly into Saskatoon on Tuesday so that we can transport you to the Park on Wednesday, August 12. We will arrange transportation back to Saskatoon for Monday, August 17.

**Accommodations**
To book accommodations in the Cypress Hills Resort Inn, contact them directly at (306) 662-4477. We also have the entire Meadows Campground reserved for those who wish to camp at the observing site. There is a mix of powered and non-powered sites. All campsites in Meadows are rush: first come, first served, except for 15 powered Reserve-a-Site spots. When you arrive at the park, register at the Camping Office and tell the staff that you are with the star party and that you want to camp in the Meadows Campground. Pay the appropriate camping fees. Additional information is available at `www.tpcs.gov.sk.ca/CypressHills`.

**Call for Papers**
We will have two sessions of scientific talks and a poster session where delegates can share their astronomical experiences, data, and insights. To participate please submit a proposal by e-mail to Gord Sarty and in that proposal please include:

- Author list - with the speaker as first author
- Title
- Preference for a talk or poster
- One paragraph abstract, limit 150 words
- One image, jpeg format (optional - large images will be reduced in size)

Except for the image, please submit all material in the body of the email, no other attachments please. Deadline for the submission of proposals is June 1, 2009. Late proposals can only be considered for posters and only if there is room. Detailed instructions will be emailed to the submitters of accepted proposals.

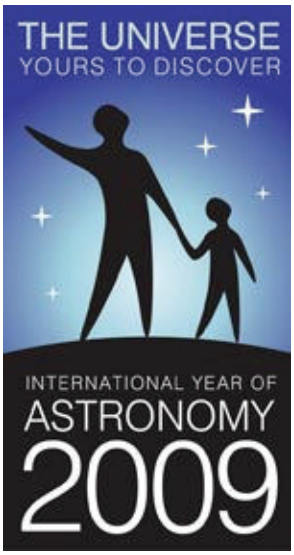
**Astrophoto Display and Contest**
The Astrophoto contest will accept film or digital photos taken by the exhibitor in the following categories: Prime Focus - Solar System; Prime Focus - Deep Sky; Piggy-back; Tripod. Contact Al Hartridge for details.

**Astronomical Sketch Display and Contest**
This year we are holding a contest to promote a dying art: sketching astronomical objects at the eyepiece. Contact Al Hartridge for details.

**"Starry, Starry Night": Art, Quilt, and Poetry Exhibition**
This astronomy-themed art exhibition is open to kids (4-12 years), youths (13-17), and adults. Art created by the exhibitor is welcome in the following categories: quilt, hand-work, poetry, drawing, painting, collage, and any photograph not in the photography contest. Contact Kathleen Houston for details.

**Contact Us**
- Primary e-mail for information, registration, and art exhibition: sssp.sk@sasktel.net
- Scientific program: Gord Sarty at gordon.sarty@usask.ca
- Astrophoto and Sketching contest: Al Hartridge at ahartrid@sasktel.net
- Phone: Barb Wright (Chair) at (306) 249-1091 or Rick Huziak and Kathleen Houston (Registrars) at (306) 665-3392

The most up-to-date information about GA/SSSP 2009 will be found on our Web page at: `homepage.usask.ca/~ges125/rasc/sssp2009.html`. We will also be placing announcements on the RASC eNews Web page, with links to our Web site.




# Obituary

**Jim McLeod, Winnipeg Centre**

Jim McLeod, a much-respected member of the Winnipeg Centre, died suddenly on 2009 January 13. Though relatively new to the Centre, Jim quickly became a friend and valued member of the extended RASC family in Winnipeg. He had a great enthusiasm for astronomy, and a respectful and warm demeanour, hidden in a feigned sense of formality with those he knew well. His sense of camaraderie and devotion to people he cared about made him welcome at every star party. Jim was the proverbial back-yard astronomer with a list of favourite objects that he was always willing to share; his observing reports were a continuing source of information and encouragement to those less enthusiastic about going out into the night sky, especially during Manitoba's infamous winters. Jim was always one of the last to pack up and was never discouraged, no matter what the observing conditions were — fog, dew, or minus-30-degree temperatures.

Winnipeg Centre members will sorely miss his contributions to the nighttime sessions under the stars.

# Where is This Telescope?

*by Edward Majden, Victoria Centre (epmajden@shaw.ca)*

The late John V. Hodges of the Regina Astronomical Society built this telescope in the late 1940s - 1950s. It is a compound 12-inch Newt-Cass-Greg, f-5, f-20, f-30. I was told that the primary mirror was made from the same melt as the Palomar 200 inch. One of the unique features is the selsyn telescope position indicators seen at the base of the pier. Not as accurate as today's digital systems but an interesting addition. Hodges sadly passed away in 1983. I recently contacted his son Gerry about the location of the telescope and he said it was given to someone but he could not recall the name. The present members of the RAS now the Regina Centre of the RASC have no idea of its location either. So far, I have been unable to track it down. Sad, if it is not being used for its intended purpose and is rusting away somewhere. This was a state-of-the-art amateur-built telescope from that era that should be used or at least displayed in a museum. Can anyone help locating it?

# Over 55 Percent of 2008 Donations Support the International Year of Astronomy

*by Denis Grey, Toronto Centre*

The Society received nearly $30,000 in donations from over 400 donors in 2008, of which more than 55 percent was directed to the Society's efforts for the International Year of Astronomy.

The additional funds directed to the International Year of Astronomy have allowed the Society to significantly expand the print runs for the many IYA resources that have been co-sponsored or spearheaded by the RASC. This, in turn, means more Star Finders, children's books, and trading cards in the hands of each and every Centre and ultimately more impact for our national IYA efforts.

In addition, the Society's Sustaining Membership program brought in a total of nearly $6,200, which was divided between the Society's general requirements and the Centre Projects Fund.

A complete summary and listing of all donor names and tributes is now available at the Society's Web site at `www.rasc.ca/society/donation.shtml`. Tax receipts for these donations were sent in early February to all donors on record.

A reminder to all members that 2008 is the first year where all Centres must issue their own receipts for charitable donations (if applicable). If you donated funds to your Centre, please contact your Centre Treasurer directly for the status of your donation and receipt.

On behalf of the Society, we express our heartfelt thanks to the many individuals who have "gone the extra AU" for the Society by contributing financially in 2008. It is not too late to contribute to our IYA efforts, and your donations for the IYA program will continue to expand and deepen our contributions to this year's unique celebration of astronomy.

| Fund or Appeal | Amount | Donations |
|---|---|---|
| International Year of Astronomy Appeal | $ 16,492.45 | 218 |
| General Donations to the Society | 5,906.39 | 155 |
| Peter Millman Endowment Fund | 307.00 | 9 |
| Ruth Northcott Education Fund | 448.40 | 12 |
| Sustaining Memberships | | 119 |
| - Society Portion | 3,850.75 | |
| - Centre Projects Fund | 2,887.00 | |
| **Total Donations Received** | **$29,891.99** | **513** |

*Summary of donations received for 2008*

# Great Images

A great image from the RASC *Observer's Calendar,* April 2009

**Illuminating Geology**
A mist-shrouded Moon highlights the rugged snow-capped beauty of the Canadian Rocky Mountains as it sinks into the western horizon along with Earth's shadow, just prior to sunrise. Among the major planets of our solar system, Earth is uniquely blessed with a single large Moon that lights our skies and informs human cultures around the globe.

Photo by Alan Dyer

# THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

## NATIONAL OFFICERS AND COUNCIL FOR 2009/CONSEIL ET ADMINISTRATEURS NATIONAUX

| | |
|---|---|
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| **Editor of *The Beginner's Observing Guide*** | Leo Enright, B.A., Kingston |
| **Editor of *Observer's Calendar*** | Dave Lane, Halifax |
| **Executive Secretary** | Jo Taylor, 203 - 4920 Dundas St W, Toronto ON M9A 1B7 Telephone: (416) 924-7973 |

## CENTRE ADDRESSES/ADRESSES DES CENTRES

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

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

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

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

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

**Halifax Centre**
PO Box 31011, Halifax NS B3K 5T9

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

**Kingston Centre**
PO Box 1793, Kingston ON K7L 5J6

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

**London Centre**
PO Box 842 Stn B, London ON N6A 4Z3

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

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

**Montréal Centre**
18455 Meloche St, Pierrefonds QC H9K 1N6

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

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

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

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

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

**Québec Centre**
2000 Boul Montmorency, Québec QC G1J 5E7

**Regina Centre**
PO Box 20014, Regina SK S4P 4J7

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

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

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

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

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

**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

# Great Images

Mike Wirths writes:

My Wife and I are setting up an astronomy B&B in the mountains of northern Baja, Mexico, which is where I took the image on 2008 October 18, 6:00-6:30 p.m. PDT.

I used an 18-inch Starmaster + 2.5 Tele Vue Barlow + Infinity 2-2 camera + R/IR True Tech filter. The image was processed in Registax 4 and PhotoShop Creative Suite (PS CS).